Title: M4 J19-20 and M5 J15-17 Managed Motorway **IA No:** DfT00178 **Lead department or agency:** Highways Agency **Other departments or agencies:**	**Impact Assessment (IA)** **Date:** 25/09/2012 **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Secondary legislation **Contact for enquiries**: Paul Unwin, Highways Agency, paul.unwin@highways.gsi.gov.uk

Summary: Intervention and Options

RPC Opinion: RPC Opinion Status

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB on 2009 prices)	**In scope of One-In, One-Out?**	**Measure qualifies as**
£890.3m	£537.9m	-£22.6m	Yes	Zero Net Cost

What is the problem under consideration? Why is government intervention necessary?

The M4 between Junctions 19 and 20 and the M5 between Junctions 15 and 17 experience considerable congestion due to a high traffic volume. The congestion reduces the efficiency of movement of people and goods to the detriment of business productivity and the economic and social activities of individuals. If these problems are to be alleviated, then some form of intervention is required. The intervention needs to be undertaken by government since the motorways are owned, operated and maintained by government through the Highways Agency (HA) and Department for Transport (DfT). The intervention forms part of the DfT's programme of improvements to the trunk road network.

What are the policy objectives and the intended effects?

The objective is to reduce the cost of congestion to business and individuals and thereby encourage economic activity and improve social well-being. The intended effects are to reduce journey times and the variability in journey times caused by congestion. In particular, the intention is to reduce congestion on the motorway at all times of day, thereby reducing journey times and making them more predictable or reliable. A number of secondary social and environmental effects have been quantified and taken into consideration as part of the DfT appraisal process. These are described in the evidence base.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Option 1: The preferred intervention is a system called Managed Motorway (MM). MM involves allowing use of the hard shoulder as a running lane in congested conditions. The hard shoulder is opened when speeds reduce to approximately 60mph. At this point, a mandatory 60mph speed limit is imposed. This speed limit is subsequently reduced to 50 or 40mph if traffic levels continue to increase. A Variable Mandatory Speed Limit (VMSL) is therefore required as part of the Managed Motorway system. Secondary legislation is required in order to implement hard shoulder running (HSR) and VMSL.

There are no realistic alternatives to MM. The scheme section is largely dominated by the Almondsbury Interchange between the M4/M5 which includes numerous bridge structures required to separate the two motorways and connector roads. The cost of replacing these structures to widen the motorways would involve enormous expense and disruption to achieve similar benefits to MM.

Will the policy be reviewed? It will not be reviewed. **If applicable, set review date:** Month/Year

Does implementation go beyond minimum EU requirements?			N/A		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** Yes	**< 20** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** 0	**Non-traded:** 1.01	

I have read the Impact Assessment and I am satisfied that (a) it represents a fair and reasonable view of the expected costs, benefits and impact of the policy, and (b) that the benefits justify the costs.

Signed by the responsible Minister: Stephen Hammond Date: 25/09/2012

Summary: Analysis & Evidence

Policy Option 1

Description: M4 J19-20 and M5 J15-17 Managed Motorway

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2012	Time Period Years 60	Net Benefit (Present Value (PV)) (£m)		
			Low: n/a	**High:** n/a	**Best Estimate:** £890.3m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	n/a	2	n/a	**n/a**
High	n/a		n/a	**n/a**
Best Estimate	£115.3m		£3.7m	**£208.8m**

Description and scale of key monetised costs by 'main affected groups'

Breakdown of Best Estimate 'Total Cost' in 2011 market prices, discounted to 2012 Present Value Year
Govt. (Public Accounts): Installation, Enforcement, Operation, Maintenance and Renewal: £104.9m
Road Users (Economy):Reduction in Transport Economic Efficiency During Const.and Maint: £51.6m
Public (Environment): Increase in Greenhouse Gas Emissions: £52.3m

Other key non-monetised costs by 'main affected groups'

Public (Environment): Slight Adverse impact on Landscape and Townscape.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	n/a	2	n/a	**n/a**
High	n/a		n/a	**n/a**
Best Estimate	n/a		£43.3m	**£1,099.1m**

Description and scale of key monetised benefits by 'main affected groups'

Breakdown of Best Estimate "Total Benefit" in 2011 market prices, discounted to 2012 Present Value Year.
Road Users (Economy): Improvement in Transport Economic Efficiency: £826.4m
Road Users (Economy): Improvement in Journey Time Reliability: £186.2m
Road Users (Society): Reduction in Accidents: £56.0m
Govt (Public Accounts): Gain of Indirect Tax Revenue: £30.5m

Other key non-monetised benefits by 'main affected groups'

None

Key assumptions/sensitivities/risks — **Discount rate (%)** 3.5/3

The majority of the benefits are based upon the outputs of a traffic model: in particular, the differences between model outputs for the without and with scheme scenarios in the opening year and future years. The estimated benefits are therefore dependent upon the accuracy of the models and future traffic forecasts. To minimise the risk of error in this regard, the traffic models and forecasts have been prepared following DfT guidance. The traffic model meets DfT performance requirements.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			In scope of OIOO?	Measure qualifies as
Costs: £0m	**Benefits:** £22.6m	**Net:** -£22.6m	Yes	Zero net cost

Evidence Base

1. Problem under Consideration

The M4 motorway between Junctions 19 and 20 and the M5 motorway between Junctions 15 and 17 are located to the immediate north of Bristol and include the Almondsbury interchange between the two motorways at M4 J20 and M5 J15. The motorway interchange and the adjoining sections of the M4 and M5 suffer from substantial traffic congestion, especially during peak periods. Two-way daily traffic flows through the scheme average around 140,000 vehicles per day. This is over 50% higher than the Congestion Reference Flow (CRF) of 90,000 vehicles per day. The CRF represents the daily flow level at which a road is likely to be congested during peak hours.

2. Rationale for Intervention

The current congestion reduces the efficiency of movement of people and goods to the detriment of business productivity and the economic and social activities of individuals. If these problems are to be alleviated, then some form of intervention is required. The intervention needs to be undertaken by government since the motorway is owned, operated and maintained by the government through the Highways Agency (HA) and Department for Transport (DfT). The intervention forms part of the DfT's programme of major improvements to the trunk road network for the 2010-15 Spending Review period. The programme is delivered by the HA.

3. Policy Objective

The Department for Transport's Business Plan 2011-15 set out a vision for a transport system that is an engine for economic growth and one that is also greener and safer and improves quality of life in our communities. By improving the links that help to move goods and people around, the Department can help to build the balanced, dynamic and low-carbon economy that is essential for future prosperity.

The primary objective of the DfT's programme of trunk road improvements is to reduce the cost of congestion to business and individuals and thereby encourage economic activity and improve social well-being. The Department seeks to achieve this by reducing congestion through increasing network capacity and improving journey time reliability. On the M4 between Junctions 19 and 20 and the M5 between Junctions 15 and 17 in particular, the intention is to reduce congestion on the motorway, thereby reducing journey times and making them more predictable or reliable.

Although the objective for the scheme is to reduce congestion and improve reliability, there are a number of secondary social and environmental effects which have been quantified and taken into consideration as part of the DfT appraisal process. These are described in the following paragraphs.

4. Description of Options

4.1 Do Nothing Baseline i.e. Existing Situation

The Do-Nothing Baseline, or existing situation, is a dual three lane carriageway to motorway standard (D3M) with the MIDAS system (Motorway Incident Detection and Automatic Settings). MIDAS is a system comprising inductive loops buried in the carriageway surface which detect the presence of stationary or slow moving traffic. This information is transmitted to computers which will then provide written warnings and advisory speed limits upstream of the congestion event. The warnings and advisory speed limits are provided via variable message signs which are mounted on cantilevered mast arms above the carriageway. The purpose of the system is to minimise the risk of collisions between fast moving upstream traffic and the slow moving or stationary traffic detected by the loops.

4.2 Option 1 (Preferred): Managed Motorway

The preferred option is Managed Motorway (MM) which involves using motorway signals to allow the use of the hard shoulder as a traffic running lane during busy periods. MM includes a system known as Controlled Motorway, which in turn includes the existing MIDAS sub-system which will be retained.

The existing MIDAS system described above is the simplest application of motorway control technology. It is solely a safety feature designed to protect queues by providing a warning of their presence to upstream traffic. The next level of control is a system called Controlled Motorway (CM). This system includes MIDAS to protect against queues, but also uses Variable Mandatory Speed Limits (VMSL) to assist in preventing the development of queues. Controlled Motorway is sometimes implemented on existing carriageways as a stand-alone measure to improve journey time reliability. Alternatively, if the level of congestion is high enough to warrant it, CM can be introduced in conjunction with measures to increase the capacity of the carriageway. In the case of the M4/M5, traffic flow levels are such that there is substantial traffic congestion and an increase in traffic capacity is required.

The two alternative means of increasing traffic capacity are widening of the carriageway, or introduction of the next and highest level of motorway control technology known as the Managed Motorway (MM) system. Both alternatives include MIDAS and CM technology, the essential difference being that MM relies on temporary use of the hard shoulder rather than physical enlargement to provide additional traffic capacity at busy times.

The operation of the MIDAS component of MM is described above. Like MIDAS, the Controlled Motorway (CM) component uses the same carriageway loops to detect vehicles and also sets speed limits on variable message signs. The difference is that CM also sets speed limits at higher speeds when information on traffic density from the loops indicates that ‘bunching’ may be occurring. It does not therefore wait until a queue develops. Instead, CM sets variable mandatory speed limits of 60mph and 50mph to reduce bunching and thereby reduce the likelihood of a queue occurring. However, if traffic still becomes slow moving or stationary then, like MIDAS, it will set a 40mph limit. The only difference in these circumstances is that the 40mph limit is a mandatory limit rather than the advisory limit used by MIDAS.

In terms of the operational effects upon traffic flow, the CM system uses VMSL to slow down upstream traffic. This reduces the likelihood of it ‘catching up’ with a pocket of slower moving traffic and causing traffic density to reach a level at which flow breakdown occurs. Whilst the reduction in the speed limit increases journey times upstream of the high density region, these are cancelled out by journey time savings arising from a reduced incidence of flow breakdown and associated queuing. The net effect on average journey times is neutral but the range or variation in journey times is reduced, thereby improving reliability. This is measured in the assessment process by predicting changes in the standard deviation of journey times of trips using the Controlled Motorway as part of their route.

Managed Motorway (MM) takes CM a stage further by reducing congestion and journey times, as well as improving journey time reliability. In particular, opening the hard shoulder as a traffic running lane increases the available road space and thereby reduces the density of traffic (the number of vehicles per unit length of road). This reduced density allows traffic to travel at higher speeds whilst still maintaining a safe headway distance between themselves and the vehicle in front. The higher speeds mean reduced journey times and there is also an increase in the traffic carrying capacity of the road as a result of converting the hard shoulder to a traffic lane.

In order for MM to be successful, it is essential that the variable speed limits which form part of the system are complied with. This requires the speed limits to be mandatory. Secondary legislation is

required to allow mandatory variable speed limits to operate. Secondary legislation is also required for the introduction of hard shoulder running.

It should be noted that the mandatory speed limit signs used as part of a controlled motorway are matrix signs which can display either 40, 50, 60 or the national speed limit sign. Being a mandatory sign, they are required to have a red outer ring in order to comply with the traffic signs regulations. They are also required to be displayed over each lane. Advisory signs used for MIDAS are also matrix signs, but do not have the red ring, nor is it a requirement to display them over every lane (though HA standards require this for carriageways of four or more lanes, making gantries a necessity).

Enforcement of VMSL is carried out using a combination of gantry-mounted speed enforcement cameras in conjunction with the Highways Agency Digital Enforcement Camera System (HADECS) to automatically monitor compliance and traditional enforcement by the Police. However, only a proportion of the gantries carry “live” enforcement cameras with the remainder having mock camera enclosures installed. These are known as Perceived Enforcement Gantries (PEGs).

4.3 Public Consultation

Following approval of the consultation stage IA, a formal consultation exercise was undertaken in respect of the preferred M4/M5 MM scheme. The consultation took place between 30 September 2011 and 23 December 2011 and involved sending the consultation document to 262 stakeholders including representative organisations of those affected and individual businesses. In addition, the consultation document was placed upon the Highways Agency’s web site. The consultation document included a copy of the consultation stage IA.

A total of four responses were received to the consultation. All responses were in favour of the scheme; however, one of these accepted the need for the scheme but raised a number of detailed environmental concerns, particularly with regard to Noise and visual intrusion.

The consultation responses received included a number of questions regarding the detailed operation, design and extent of the proposed MM scheme.

5. Details of Costs and Benefits for Option 1 (Preferred)

5.1 Do Nothing Baseline i.e. Existing Situation

The “Do-Nothing” represents the baseline against which the proposed managed motorway is assessed.

5.2 Option 1 (Preferred): Managed Motorway

The impacts of the Managed Motorway, including costs and monetised benefits, have been appraised using the Department for Transport’s (DfT) WebTAG (Web-based Transport Analysis Guidance) which is based upon HM Treasury Green Book principles. WebTAG identifies a wide range of possible impacts that transport schemes can have and prescribes detailed methodologies for quantifying these impacts and monetising them wherever possible. The range of impacts which must be considered come under the three main headings of Economy, Environment and Society which are then subdivided into sub-impacts such as journey times, reliability, noise, air quality, landscape, greenhouse gas emissions, accidents, etc. Scheme promoters are required to assess each of these impacts using the prescribed methodologies (links to the relevant sections of WebTAG are provided below) and to summarise the results of the analysis in an Appraisal Summary Table (AST). The AST forms a summary of the economic case for a scheme and is used by Highways Investment Board to inform all decisions relating to the selection of a preferred scheme option and the decision to ultimately invest in that option. The Managed Motorway scheme has been subject to these processes.

Because WebTAG relates to transport schemes generally, there is a second tier of more detailed appraisal guidance which relates specifically to trunk road schemes and which is contained within the DfT/HA’s Design Manual for Roads and Bridges (DMRB). In particular, Volumes 11 to 14 of the DMRB contain supplementary appraisal guidance on a number of issues including traffic model building, the assessment of accident impacts and environmental assessment.

The cornerstone of the appraisal process for road schemes is a traffic model. The model is a computer-based representation of the physical characteristics of the road network, the behaviour of different types of traffic using the network and the origins and destinations of that traffic. The model is built and calibrated to represent the road network (the “supply”) and the traffic “demand” upon it at the current time “the base year”. A set of independent traffic count and journey time data not used in the calibration process is then used to “validate” the base year predictions of the model.

Using the behavioural relationships between supply and demand contained within the model, it is possible to alter the network to represent a new road scheme, or change the traffic demand (to represent traffic growth), and identify how traffic flows and speeds change as a result. This provides the information necessary to identify changes in journey times, journey time reliability, vehicle operating costs, tax revenues and accidents across the network in any modelled future year. The information is also used to assess the environmental impact of a scheme in terms of greenhouse gas emissions, air quality and noise.

The assessment of the proposed scheme uses the Bristol Area Transportation Studies (G-BATS) multi-modal transport model which covers the local authority areas within Greater Bristol and sits within the Greater Bristol Modelling Framework. It contains a detailed spatial representation for the Greater Bristol area with a decreasing level of representation for the neighbouring authorities in the South West region and, in turn, the rest of the UK. The model has been developed and fully validated using a series of traffic surveys, journey time surveys, road side and household interview surveys and traffic counts in addition to existing data supplied by highway authorities.

There is some uncertainty in relation to forecasts of future traffic levels when modelling future years. These forecasts are made at a national level through the DfT’s National Transport Model and are based upon certain assumptions regarding household growth, income growth, changes in fuel price and how these affect the level of car ownership and usage. Changing these core assumptions can affect the level of future year benefits and it is a requirement of WebTAG that different scenarios of future traffic growth are modelled, in addition to the most likely or “Core Scenario”. These scenarios are termed the Highest and Lowest Benefits Scenarios and represent the highest and lowest levels of future traffic growth which might reasonably be expected to occur, though such outcomes are considered less likely than the Core Scenario. It is correct to infer from this that the greater the level of future traffic demand, the greater are the benefits of the proposed scheme (this applies to all road schemes). In addition, the future level of benefits is affected by future changes to the transport network or “supply”. In particular, future provision of roadspace elsewhere in the road network can affect the level of traffic demand on the scheme section

and thus the number of users who benefit from improved journey times. There is always some uncertainty regarding if and when transport improvements will occur, so the traffic model road networks for Highest and Lowest Benefits Scenarios are also different to those contained in the Core Scenario model. These scenarios therefore represent that combination of traffic demand and road supply which will produce the lowest and highest level of benefits that can reasonably be expected or, in other words, a full range of realistically possible outcomes.

Traffic forecasts have previously been prepared which include both the highest and lowest levels of future traffic growth which can reasonably be expected to occur. An economic assessment based upon these forecasts indicated that, compared with the Core Scenario, the Benefit Cost Ratio (BCR) would decrease from 7.51 to 5.96 with low traffic growth and increase from 5.96 to 8.32 with high traffic growth. On this basis, it was concluded that the BCR is relatively insensitive to alternative levels of future traffic demand and that it was not necessary to repeat the analysis in subsequent appraisal work. As such, the analysis is now somewhat out of date and the results from it, in the form of Low and High estimates of the benefits, have not been included in the summary sheet for the proposed MM scheme (Option 1).

As regards the costs of implementing and operating the scheme, WebTAG does not require the production of highest and lowest cost scenarios as part of the economic assessment. A single "Best Estimate" is used which includes a risk allowance based upon a quantified risk assessment. The estimate and the risk assessment is refined as the scheme progresses towards implementation and design work allows more accurate quantification of the risks and costs. At the end of each scheme stage, the Net Present Value and Benefit Cost Ratio for the scheme are recalculated on the basis of the latest scheme costs before a decision is made by the Highways Investment Board to proceed to the next stage. High and Low estimates of the costs are also not therefore provided in the summary sheet for the proposed MM scheme (Option 1).

It should be noted at this stage that WebTAG only regards expenditure such as construction, maintenance and operating costs as "costs". Any adverse impacts of a scheme are instead considered as disbenefits and, where monetised, are dealt with on the benefits side of the equation for purposes of calculating the Benefit Cost Ratio metric used by the DfT. However, for purposes of the IA, disbenefits are treated as costs along with the scheme investment and running costs. The costs and benefits for the Core Scenario forecasts are defined on this basis in the following paragraphs and within the summary sheet for the proposed MM scheme (Option 1).

WebTAG and the DMRB require that the costs and benefits of transport projects are valued at 2002 prices and discounted to 2002. However, for the purpose of the impact assessment these have been converted to 2011 Market Prices using HM Treasury GDP deflator factors and discounted to a present value year of 2012.

The Treasury Green Book requires that the appraisal period over which the costs and benefits should be assessed should extend to the useful life of the assets. In the case of road schemes which create new roadspace, the life of the roadspace is indefinite and, in such cases, WebTAG specifies a maximum appraisal period of 60 years from the year of opening. This is therefore the standard appraisal period for conventional road schemes involving new and widened roads. MM schemes are not of course conventional road schemes and a large part of the expenditure relates to items which have a 15 year life such as variable message signs, CCTV, telecommunications systems and computer hardware and software. There is however also substantial expenditure on gantries (which have a 30 year life) and the provision of new roadspace in the form of emergency refuge areas constructed at regular intervals adjacent to the hard shoulder (which have an indefinite life). Since those items with a 15 or 30 year life can be renewed at 15 and 30 year intervals, the appraisal work is based upon the maximum 60 year period which is relevant to the emergency refuge areas. The costs of renewing those elements of the scheme with a shorter life than 60 years are of course included in the cost benefit analysis.

Monetised Costs (Core Scenario forecast – "Best Estimate")

All Managed Motorway schemes have the following types of financial costs. All costs are incurred by government.

- TRANSITION: Cost of Installation;
- RECURRING: Cost of Enforcement of VMSL;
- RECURRING: Cost of Maintenance and Operation;
- RECURRING: Cost of Renewing electronic equipment at 15 year intervals and gantries at 30 years .

In terms of non-financial costs, MM schemes are appraised against a range of potential impacts as set out in WebTAG. As mentioned above, the impacts which must be considered come under the three main headings of Economy, Environment and Society which are each then subdivided into a number of sub-impacts. A number of these sub-impacts can be monetised.

The proposed scheme has the following negative monetised impacts, or non-financial costs. These are described in the paragraphs below. All monetised values quoted relate to the Core Scenario forecast and are the Best Estimate:

- TRANSITION: Cost of disbenefits to Transport Economic Efficiency during Installation & Maintenance;
- RECURRING: Cost of increased Noise;
- RECURRING: Cost to Climate Change through an increase in greenhouse gas emissions.

Transition: Installation Costs

The current capital cost of installing the proposed MM scheme was derived through a standardised cost estimation process designed and undertaken by the HA. The designer supplies details of the scheme to the HA Commercial Team who apply standard rates and return the cost estimate to the designers. This estimation process is refined as the scheme preparation process proceeds and the final cost estimate is not available until the design is completed.

Table 1 provides a breakdown of the final scheme cost estimate. Preparation costs cover the balance of expenditure on the scheme design and preparation of tender documentation. Supervision costs cover the cost of the HA's design agent supervising the contract on behalf of the HA. Works expenditure is the cost of materials and labour for constructing the scheme. Lands expenditure includes an allowance for leasing land required during construction for the erection of gantries. An allowance of £12.2m for risk is included, based on the scheme's risk management plan. Historic or 'sunk' costs incurred to the end of 2011 are excluded.

Table 1: Installation Costs (2011 Constant Market Prices – Undiscounted – in £m)

Cost in 2011 market prices	2012	2013	Total
PREPARATION EXPENDITURE PROFILE	0.00	0.00	0.00
SUPERVISION EXPENDITURE PROFILE	1.35	0.70	2.05
WORKS EXPENDITURE PROFILE	40.23	9.12	49.35
LANDS EXPENDITURE OUTTURN	0.00	0.00	0.00
RISK	9.93	2.36	12.29
TOTAL EXPENDITURE FORECAST	51.51	12.18	63.69

Recurring: Enforcement Costs

The average annual enforcement cost of **£0.2m** over 60 years (2011 Constant Market Prices – Undiscounted), includes costs paid by the HA to cover the costs incurred by the Home Office in processing fixed penalty notices or prosecuting offenders.

Recurring: Maintenance and Operating Costs

Maintenance and operating costs have been derived using the Highways Agency Managed Motorways Operational Cost Model spreadsheet.

The additional average annual maintenance cost is **£0.8m** over 60 years (2011 Constant Market Prices – Undiscounted). This includes the costs associated with the maintenance of gantries, signs, loops and cabinets, together with the additional costs associated with the use of the hard shoulder, including additional winter gritting, lighting, markings, loops and CCTV systems, plus specialist IT hardware and software. It also includes the cost of such items as additional control room staff and the power consumption of the various items of electronic equipment.

Recurring: Renewal Costs

The additional average annual renewal cost of **£0.6m** over 60 years (2011 Constant Market Prices – Undiscounted), is based on replacing all electrical equipment at expiry of a 15 year operational life. Gantries will require replacement after 30 years.

Transition: Transport Economic Efficiency Costs during Installation

The cost of disbenefits to transport economic efficiency during installation is **£51.6m** (2011 Constant Market Prices – Undiscounted). These costs are primarily the result of the traffic delays caused by the roadworks necessary to construct the scheme. In brief, WebTAG identifies a value of time for different types of vehicles and trip purposes and these values are multiplied by the number of additional hours of delay which are incurred during the roadworks (when a lower 50mph speed limit will be in operation).

WebTAG values of time and vehicle operating costs depend upon the vehicle type, trip purpose of the occupants, the number of occupants and the time of travel. The value of time also increases over time in line with GDP growth. The value of time for the average vehicle in 2011 at 2011 market prices is £15.14 per hour. Further details of the values and how they are calculated can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Recurring: Climate Change Costs

The average annual cost to climate change is **£2.1m** over 60 years (2011 Constant Market Prices – Undiscounted). The cost arises as a result of an increase in greenhouse gas (primarily CO_2) emissions from vehicle traffic within the road network. The increases are the result of additional traffic generated by the scheme (due to the reductions in congestion increasing traffic demand), as well as higher vehicle speeds.

The greenhouse gas emission impacts have been calculated using air quality models of the affected road network, which reflect forecasts of traffic composition, speeds and flows in the with and without scheme scenarios. These traffic datasets are taken from the traffic model in the form of link-based data. The output greenhouse gas emissions are then monetised using official values of non-traded carbon. WebTAG values of non-traded carbon for all future years and fuel types can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Non-Monetised Costs

There will be a slight adverse effect on the landscape arising from the construction works and built features. In particular, there will be a slight adverse impact to the views experienced by receptors arising primarily from the introduction of new structures, removal of existing structures and vegetation clearance for construction. Required levels of mitigation planting will be difficult to achieve due to the existing narrow verge and therefore it is likely that slight adverse effects will remain into the future. However, the adversely affected landscape is of low value comprising commonplace residential, commercial and retail developments.

Monetised Benefits (Core Scenario forecast – "Best Estimate")

MM schemes are appraised against a range of potential impacts as set out in WebTAG. As mentioned earlier, the impacts which must be considered come under the three main headings of Economy, Environment and Society which are each then divided into a number of sub-impacts. A number of these sub-impacts can be monetised.

The proposed scheme has the following positive monetised impacts, or benefits. With the exception of Indirect Tax Revenues, all of the monetised benefits are social rather than financial benefits.

- RECURRING: Benefits to Transport Economic Efficiency through a reduction in journey times, marginally offset by a slight increase in vehicle operating costs and a reduction in revenues received from road user charges and public transport fares (private sector providers);
- RECURRING: Benefits to Journey Time Reliability through a reduction in day to day journey time variability;
- RECURRING: Benefits to Road Safety through a reduction in accidents;
- RECURRING: Benefits from an increase in Indirect Tax Revenue.

Reducing accidents on the scheme section leads to the following additional benefits:

- RECURRING: A reduction in incident related journey time variability as a result of fewer accidents;
- RECURRING: A reduction in delay as a result of reducing the time spent queuing at an accident site.

The monetised benefits are described in detail within the paragraphs below. All monetised values quoted relate to the Core Scenario forecast and are the Best Estimate:

Recurring: Transport Economic Efficiency Benefit

The average annual transport economic efficiency benefit is **£32.6m** over 60 years (2011 Constant Market Prices – Undiscounted). This benefit comprises the following elements (negative values are disbenefits):

- Reduction in Journey Times: £32.89m
- Increase in Vehicle Operating Costs: -£0.01m
- Reduction in Operator Revenue -£0.31m

The reductions in journey time arise as a result of the additional traffic capacity provided by allowing use of the hard shoulder. In congested periods, the additional capacity reduces traffic density and increases speeds on the motorway. It also allows additional traffic to reassign to the motorway from other slower routes to reduce its journey time. This in turn reduces journey times on other routes in the network.

The change in vehicle operating costs is the sum of changes in both the fuel and non-fuel related costs of all vehicle trips in the network. These will increase if the scheme results in traffic reassigning to a longer (but quicker) route, or if vehicle speeds move in either direction away from the optimum speed for fuel efficiency for the type of vehicle concerned. The converse applies as well, so the overall change in vehicle operating costs is the sum of many increases and decreases over the area of the traffic model.

The change in operator revenue occurs from the combined impact of the diversion of some journeys from public transport to highways and the re-routeing of traffic away from routes which incur a bridge toll. These effects occur because of the reduced cost of road based travel via the scheme section.

The information required to calculate the benefits is extracted from the traffic model in the form of matrices of trip numbers, travel times and distances between every origin and destination. Matrices are extracted for the 'with' and 'without' scheme scenarios and for different time periods, vehicle types and trip purposes in various future modelled years. The matrices are then fed into the DfT sponsored computer program called Transport User Benefit Appraisal (TUBA) which calculates the total journey times, vehicle operating costs, user charges, carbon emissions, fares and tax revenues in each year of the DfT 60 year appraisal period. All the components are monetised within TUBA and the 'with scheme' costs are subtracted from the 'without scheme' costs to determine the benefit or disbenefit.

WebTAG values of time and vehicle operating costs depend upon the vehicle type, trip purpose of the occupants, the number of occupants and the time of travel. The value of time also increases over time in line with GDP growth. The value of time for the average vehicle in 2011 at 2011 market prices is £15.14 per hour. Further details of the values and how they are calculated can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Recurring: Journey Time Reliability Benefit

The average annual journey time reliability benefit is **£7.3m** over 60 years (2011 Constant Market Prices – Undiscounted). This benefit comprises the following elements:

- Reduction in Journey Time Variability: £5.7m
- Reduction in Incident Related Delay: £1.6m

The reductions in journey time variability arise as a result of making journey times on the scheme section more uniform (day to day variability) and reducing accidents (incident related variability). In particular, congestion, flow breakdown and accidents generate significant variability in journey times which makes them less predictable or "reliable". The reductions in incident related delay arise from reducing the number of accidents on the scheme section.

The information required to calculate the benefits is extracted from the traffic model in the form of the numbers of trips per day using the scheme section, the length of these trips and which routes they use. The information is extracted for various future modelled years for both the 'with' and 'without scheme' scenarios. It is then entered into a DfT computer program called INcident Cost benefit Analysis (INCA) which calculates the change in standard deviation of the average journey time for each route at different

times of the day. The calculations are undertaken for both the 'with' and 'without scheme' scenarios and repeated for each year of the DfT 60 year appraisal period. A monetary valuation is attached to the changes in standard deviation which are then multiplied by the number of vehicles on each route. A reduction in standard deviation (or "variability) is a benefit and an increase is a disbenefit.

The WebTAG value for the standard deviation of journey time in minutes is equal to 80% of the WebTAG values of time. The value of time per vehicle depends upon vehicle type, trip purpose of the occupants, the number of occupants and the time of travel. The value of time also increases over time in line with GDP growth. The value of time for the average vehicle in 2011 at 2011 market prices is £15.14 per hour. More details can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

INCA is also used to calculate the reductions in incident related delay. INCA does this by using the traffic flow inputs and traffic capacity of the carriageways to calculate the total queuing delay generated by accidents in both the with and without scheme scenarios on the scheme section. The user supplies the 'with' and 'without scheme' accident rates. A reduction of 15% is used for Managed Motorway schemes as explained below in the section on road safety benefits.

Recurring: Road Safety Benefit

The average annual road safety benefit is **£2.2m** over 60 years (2011 Constant Market Prices – Undiscounted). The benefit arises as a result of a reduction in the accident rate (accidents per million vehicle-kilometres) on the scheme section following deployment of the Managed Motorway system. There are also accident reductions on other routes as a result of traffic reassigning from these routes to the motorway due to the increase in traffic capacity provided by opening of the hard shoulder i.e. the reduced journey times attract traffic to the motorway (accident rates for motorways are lower than other road types).

It is assumed that Managed Motorway schemes reduce the existing accident rate by 15%. This figure is recommended in the Interim Advice Note (IAN) "Appraisal of Technology Schemes", which is in turn based upon the before and after evaluation of the existing Controlled Motorway scheme between J15 to 16 of the M25. The reduction is believed to be the result of a number of factors (a) imposing mandatory rather than just advisory speed limits in the event of incidents and congestion (b) a requirement for drivers to stay in lane when the speed limits are in operation (c) the presence of speed enforcement cameras which discourages speeding even when reduced speed limits are not in operation.

In addition, there are anticipated to be further accident savings as a result of introducing the MIDAS system on parts of the scheme section as part of MM scheme. MIDAS has been extensively used across the motorway network and the warnings it provides of stationary traffic have proved to be effective in reducing accidents between queuing traffic and fast moving upstream traffic. Evaluation of many past schemes has shown that introducing the system results in an average 13% reduction in the accident rate. An additional reduction of 13% has therefore been applied to the existing accident rate when assessing the impact of the scheme on those sections of carriageway not currently benefiting from MIDAS (making a total reduction of 26%). This applies to the M5, but not the M4.

The accident impact was determined by calculating the number of accidents on the scheme sections in the with and without scheme scenarios in each year of the DfT's 60 year appraisal period. For the without scheme scenario, the accident numbers were based upon the existing accident rate per million vehicle kilometres calculated from past accident records and the volume of traffic flow recorded by automatic counters for the same time period. For the with scheme scenario, these accident rates were reduced by the percentages described above. Accident numbers in future years were calculated by applying forecast traffic traffic flows from the traffic model to the with and without scheme accident rates. The accident numbers were then multiplied by a monetary value per accident to get the total with and without scheme accident costs over the 60 year appraisal period. The difference gives the monetised accident benefit of the scheme.

WebTAG values of accidents vary by road and junction type and increase over time in line with forecast growth in GDP. However, the value of a motorway accident in 2011 with the average number and severity of casualties is £94,026 in 2011 market prices. More details of the values and how they are calculated can be found at Department for Transport - Transport Analysis Guidance - WebTAG - Documents - Guidance documents - expert

Recurring: Indirect Tax Revenue Benefit

The average annual increase in indirect tax revenue of **£1.2m** over 60 years (2010 Constant Market Prices – Undiscounted) arises as a result of changes in the volume, speed and distance travelled on the road network by vehicles. In particular, the scheme provides additional traffic capacity which results in traffic redistributing across the network to reduce its journey time. This can mean some traffic will travel a longer distance, or at a less fuel efficient speed. Also, the reduced journey times encourages additional traffic which consumes extra fuel. The tax revenues concerned are VAT and fuel duty.

The increase in tax revenues reflects the fact that the scheme results in an overall increase in the cost of operating vehicles. This is taken account of as a cost to road users and reduces the transport economic efficiency benefit (see above). Although a cost to road users, the additional revenue is a benefit to wider society since it can be used by government to the benefit of society.

Changes in tax revenues are an output of the TUBA program which is described above under the Transport Economic Efficiency benefit. In particular, TUBA calculates the total volume of fuel (petrol and diesel) used by business and non-business users in the road network in the with and without scheme scenarios for each year of the 60 year appraisal period (using information from the traffic model on trip numbers, travel times and distances). The difference in the volume of fuel used then allows the difference in fuel duty and VAT between the with and without scheme scenarios to be calculated.

Non-Monetised Benefits

The proposed scheme has no non-monetised benefits.

6. Rationale and Evidence for Proportional Approach

The proposed scheme is at the Final stage and a Level 5 Analysis has therefore been undertaken. A Level 5 Analysis is the most detailed level of analysis identified in the IA Toolkit document and involves quantifying and, where possible, monetising the costs and benefits of the proposal. In the case of the proposed MM scheme, the analysis has been undertaken in accordance with the full requirements of WebTAG. In particular, all the potential impacts identified in WebTAG have been quantified and all of these have been assessed using the methodologies prescribed therein.

7. Risks and Assumptions

A Quantified Risk Assessment has been undertaken in relation to risks affecting the costs of construction and a Risk Allowance of £12.2m in 2011 market prices is included in the scheme estimate.

The magnitude of the benefits is primarily dependent upon the accuracy of the traffic model and the future year forecasts of traffic demand. The primary issue with the modelling is that commercially available models are designed to deal with links which have static rather than dynamic traffic capacities i.e. capacities which change in response to traffic demand through opening of the hard shoulder. It has been necessary therefore to represent the operation of the managed motorway in a simplified and somewhat idealised manner. In order to ensure that the managed motorway operates as closely as possible to the way in which it has been modelled, the HA is developing a Managed Motorway Performance Reporting Tool. This is software which will collect and analyse traffic control centre data on how managed motorway has been operating. It will then identify changes that can be implemented to ensure that the system is being operated in an efficient manner, as per the modelling assumptions.

An implicit assumption is that road based travel will continue to have the same level of importance for the full 60 years of the appraisal period. Whilst this seems likely, there is much less certainty as to whether Managed Motorway will continue in its present form for this length of time. However, since it is likely that any changes will be the result of innovation from experience or developments in technology, these can be expected to reduce the operating/maintenance costs and/or increase the benefits.

8. Direct Costs and Benefits to Business (One-In, One-Out Approach)

The One-in, One-out (OIOO) rule means that no new primary or secondary UK legislation that imposes costs on business can be brought "In" without the identification of existing regulations with an equivalent value that can be removed, or taken "Out". The deployment of VMSL requires secondary legislation, as does the introduction of hard shoulder running. The proposals are therefore in scope for the OIOO rule.

The benefits of the proposed scheme to business will manifest themselves in terms of improvements in productivity. Although the WebTAG appraisal process does not measure business productivity as such, it does measure the impact on transport economic efficiency (journey times) and journey time reliability. Reductions in journey times and improvements in reliability for business users, as predicted for the proposed scheme, will both lead to increased business productivity.

The transport economic efficiency and reliability impacts for business users have been considered in net terms since there will be some users who benefit and some who disbenefit. For example, business users of the proposed scheme will suffer journey time disbenefits during installation because of the effect of the roadworks. However, these disbenefits will be outweighed by journey time benefits for business users after the scheme has opened.

The transport economic efficiency and reliability impacts of the scheme on business users are therefore benefits to business in net terms. They are also considered to be direct benefits to business unlike certain other benefits. For instance, businesses can also expect to benefit from the reduction in accidents associated with the scheme. These however are considered to be indirect benefits and are not therefore relevant to this assessment.

In terms of direct costs to business, the appraisal has not identified any such costs. The net cost to business is therefore equal to zero direct costs minus the direct benefits to transport economic efficiency and reliability, giving a negative value. As such, the proposed scheme can be regarded as an "In" regulation with "Zero net cost" to business.

As described in Section 5, the computer program TUBA is used to calculate the monetised transport economic efficiency benefits of the proposed scheme. TUBA also calculates the benefits by different trip purposes: business users, commuting users and other users. These detailed TUBA results reveal that the proportion of the transport economic efficiency benefits received by business users is 60%.

The computer programs INCA and COBA are used to calculate the monetised journey time reliability and accident benefits respectively. Unfortunately, INCA and COBA do not disaggregate the journey time reliability and accident benefits between business and non-business users. However, a reasonably reliable estimate of the proportion of the benefits received by business users can be calculated by assuming a national average mix of vehicle types and trip purposes. It is estimated on this basis that 45% of the reliability and accident benefits will accrue to business users.

The total Core Scenario forecast (Best Estimate) benefits to business users over 60 years are as follows (in 2009 market prices, discounted to 2010 at 3.5% for years 0-30 and 3% thereafter). It should be noted that only the transport economic efficiency and journey time reliability benefits are considered to be direct benefits to business. As stated above, the accident impacts are considered to be indirect (second round) costs and are not included in either the Business NPV on Page 1 of the IA, or as benefits within the Business Assessment on Page 2.

- Transport Economic Efficiency £463.6m
- Journey Time Reliability £74.3m
- *Accidents* *£22.3m*

The equivalent annual values are as follows:

- Transport Economic Efficiency £19.5m
- Journey Time Reliability £3.1m
- *Accidents* *£0.9m*

9. Wider Impacts

Consideration has been given to the list of potential impacts set out on Pages 16-18 of the IA Toolkit. A number of these are relevant to transport schemes and are recognised as potential impacts of transport schemes in WebTAG. This includes the economic impact on consumers and businesses, safety, crime, greenhouse gases, air quality, landscape, water environment and noise. Where these impacts are non-neutral, they are discussed in Section 5 above.

The potential impact of the proposed scheme upon equalities issues is described below. The remaining potential impacts identified in the IA Toolkit are not relevant to the proposed scheme and can be considered as neutral. This includes health, education, waste management and human rights.

9.1 Equalities

The proposed scheme would not introduce any additional regulatory restrictions on the use of the motorway over and above those pertaining to the existing use. As such there are no specific impacts in terms of the public sector duties towards disability, gender (including gender identity), race, pregnancy and maternity, religion or belief, age, sexual orientation and discrimination in relation to marriage and civil partnership. Furthermore, whilst the use of motorways is restricted to certain categories of driver, based on tested ability to operate a vehicle, there is no additional or lesser restriction for the use of a managed motorway and, as such, the effect in terms of furthering equality aims has been assessed as neutral.

10. Recommendation, Implementation and Review

10.1 Proposed Solution

The proposed scheme involves the implementation of Managed Motorway between Junctions 19-20 of the M4 and Junctions 15-17 of the M5.

The Managed Motorway system is essentially the Controlled Motorway (CM) system with a facility to provide additional traffic capacity by opening the hard shoulder to motorway traffic at busy times i.e. Hard Shoulder Running (HSR). The purpose of the CM element of MM is to reduce the incidence of flow breakdown by using Variable Mandatory Speed Limits (VMSL) of 60, 50 and 40 mph to reduce the likelihood of faster moving upstream traffic ‘catching up’ with a pocket of slower moving traffic and causing traffic density in this region to reach a level where flow breakdown occurs. By reducing the incidence of flow breakdown, there is less variation in journey times and journey times become more predictable or ‘reliable’.

The HSR element of MM reduces average journey times as well as improving journey time reliability. This is achieved because the hard shoulder temporarily acts as a running lane, thereby reducing traffic density and increasing traffic speeds above what they would otherwise be. The aim is to open the hard shoulder when traffic volume on the three normal lanes reduces average speeds to around 60mph and to then close it again (and remove the 60mph limit) when the volume has reduced to the extent that speeds on the normal three lanes would be in excess of 60.

In order for MM to be successful, it is essential that the variable speed limits which form part of the system are complied with. This requires the speed limits to be mandatory. Secondary legislation is required to allow mandatory variable speed limits to operate. Secondary legislation is also required for the introduction of hard shoulder running.

Enforcement of the VMSL is planned to be carried out using a combination of gantry-mounted speed enforcement cameras and traditional enforcement by the Police. The Highways Agency Digital Enforcement Camera System (HADECS), which has been installed on the adjacent sections of Managed Motorway, will be used to automatically monitor compliance with the VMSL in operation on the scheme.

A summary of the costs and Core Scenario benefits (“Best Estimate” benefits) of the proposed scheme is provided in Table 2 below. The costs and benefits cover the standard DfT 60 year appraisal period from 2013. In accordance with the Treasury Green Book, the discount rate is 3.5% per year for 30 years from the present year and 3% per year thereafter.

Table 2 – Summary of 60 year Costs and Benefits (2011 Market Prices, Discounted to 2012)

Type of Cost (A)	Cost (£m)	Type of Benefit (B)	Benefit (£m)
Installation	63.3	Journey Times (TEE)	834.5
Enforcement	4.4	Vehicle Operating Costs (TEE)	-0.3
Operation	6.9	Operator Revenue (TEE)	-7.8
Maintenance	14.4	Journey Time Reliability	145.4
Renewal	15.9	Incident Related Delay	40.8
Journey Times and Vehicle Operating Costs during Installation (TEE)	51.6	Accidents	56.0
Greenhouse Gases (CO_2)	52.3	Increase in Tax Revenue	30.5
ALL (TOTAL A)	**208.8**	**ALL (TOTAL B)**	**1,099.1**

Net Present Value (B-A)	**890.3**
Benefit Cost Ratio (B/A)	**5.3**

10.2 Implementation Plan

The scheme is due for completion in 2013.

10.3 Post Implementation Review (Evaluation)

The Post Implementation Review Plan is attached as Annex 1.

Annex 1: Post implementation review (PIR) plan

Basis of the review: A review of the project performance will be undertaken in accordance with the Highways Agency's Interim Advice Note 39/01: Post Opening Project Evaluation (POPE) process. This involves a formal evaluation of the project one year and five years after opening. More information on POPE can be found on the HA web site at: Highways Agency - Post Opening Project Evaluation (POPE)
Review objective: The objectives of the POPE review are to evaluate whether the predicted outcomes were realised and to identify any lessons learned as part of a continual improvement process.
Review approach and rationale: The approach to the review is as prescribed in the Highways Agency's POPE Methodology Handbook. It comprises: • Before and after comparison of traffic flows, journey times and accidents • Assessment against scheme objectives; • Comparison of predicted costs and benefits vs outturn costs and benefits; • Evaluation of the NATA objectives, as detailed in the AST, using POPE+ toolkit.
Baseline: Existing situation without scheme.
Success criteria: Outturn costs and benefits to be consistent with predicted costs and benefits.
Monitoring information arrangements: As prescribed in the Highways Agency's POPE Methodology Handbook. Existing arrangements for the collection of data relating to traffic flows, speeds and accidents will enable the systematic collection of monitoring information.
Reasons for not planning a review: Not Applicable.