Reading Friends of the Earth

WRITTEN REPRESENTATION

HIGHWAYS ENGLAND'S RESPONSE

ADDITIONAL COMMENTS FROM READING FRIENDS OF THE EARTH

1. OPEN FLOOR HEARING – 16TH NOVEMBER

Personal Observations:

Noise:

1.1 I live at RG6 5QH - one and a quarter km from M4. On some occasions traffic noise can be intense when I open the front door.

Highways England Comment

1.1.1 Highways England agrees that occasional and unusual atmospheric conditions can affect the propagation of noise which may lead to elevated noise levels at large distances from a motorway. However, a noise assessment cannot be based on complex and infrequent effects such as this.

1.1.2 A reasonable worst case approach has to be taken, which is provided in Design Manual for Roads and Bridges ("DMRB"). DMRB references the Calculation of Road Traffic Noise ("CRTN") as the method for the calculation of road traffic noise levels. It is recognised in DMRB that the calculation method becomes unreliable at distances greater than 600 metres from the motorway and for that reason, detailed calculations are limited to a 600 metre buffer around the Scheme.

1.1.3 Highways England considers that the approach adopted for the noise assessment for the M4 Junctions 3 to 12 Smart Motorway scheme (the "Scheme") as provided in DMRB, is robust and satisfactorily identifies the effects of the Scheme.

Safety:

1.2 I have been an owner-driver since 1972 but find busy 4-lane motorways scary – even when they have a hard shoulder.

Highways England Comment

1.2.1 Highways England notes the comment from Reading Friends of the Earth.

Option Selection:

1.3 Not clear what criteria were applied in Option Selection … Described in Chapter 3 of Environmental Statement … By September 2013 the Scheme was classified as a single option scheme … 'Smart Motorway' may not be best value for UK.

Highways England Comment

1.3.1 The Scheme options assessment concluded that the smart motorway solution proposed for the M4 is the most suitable option for this stretch of motorway and would provide greater benefits than other modal solutions and existing technology solutions. Further details on the Scheme options are detailed in Table 4 (reproduced below) and paragraph 5.1.11 of the EDR. These options were assessed in 2011, as part of Highways England's early scheme development work to identify the best option for the Scheme, with the conclusion that the current Scheme was the best option to take forward.

Table 4: Operational Scheme options

Option	Description
Option 1: Interim Advice Note 111/09 Managed Motorways implementation guidance - Hard shoulder running solution	Dynamic hard shoulder operating regime utilising the hard shoulder as a running lane during peak periods or for event management.
Option 2: Cantilever message signs Message Sign with bookend gantries	Dynamic hard shoulder operating regime with gantries at the start and end of the managed motorway section (bookend gantries). Inter-visibility, i.e. distances between gantries achieved through message signs at a nominal distance of 800m.
Option 3: All lane running	All lane running incorporating the controlled use of the hard shoulder as a permanent running lane. Gantry mounted overhead lane signals displaying warning and information provided at nominal 800m intervals along the main scheme section.
Option 4: Light message signs more widely spaced with no bookend gantries	Dynamic hard shoulder operating regime utilising absolute minimal infrastructure implemented in order to operate the dynamic hard shoulder, whilst meeting the overall objectives of the scheme, including highway safety. This option relies on the intuitive behaviour of the motorist, with message signs more widely spaced (at intervals of up to 3km).

1.3.2 The All Lane Running ("ALR") operating regime became Highways England Policy in 2012 when Interim Advice Note (IAN) 161/12 was introduced. Section 2.23 of the National Policy Statement for National Networks ("NN NPS") states that the Government's wider policy is to bring forward improvements and enhancements to the existing Strategic Road Network. Enhancements to the existing national road network will include implementing "smart motorways to increase capacity and improve performance". The NN NPS also acknowledges explicitly the implementation of ALR schemes in footnote 29, which notes that the hard shoulder is transformed into a permanent additional running lane.

1.4 Reading FoE position: 'Managed Motorway' improvements seem sensible but expect that all-lane-running will:

- *be less safe, and less resilient, than three lanes with a hard shoulder.*

Highways England Comment

1.4.1 Highways England explained at the Road Safety Issue Specific Hearing and in submissions at Deadline IV, that, as a congestion management scheme, the Scheme is required to maintain and not necessarily improve safety standards. This is consistent with Section 4.60 of the NN NPS, which states that some developments may have safety as a key objective, but even where safety is not the main driver of a development, the opportunity should be taken to improve safety, including introducing the most modern and effective safety measures where proportionate.

1.4.2 The requirement for smart motorways is to ensure that safety will be made 'no worse' than the baseline by the introduction of a scheme as referenced in the All Lane Running ("ALR") generic safety report, (Ref: 1039092-GSR-016, section 4.1.2 Road user safety objective). Despite the Scheme being aimed primarily at relieving congestion, rather than improving safety, there are predicted improvements in safety as a result of the Scheme.

1.4.3 Section 5.2.78 of the Planning Statement (Application Document Reference 7.1, APP-089) explains that the calculations from the hazard analysis work show that the total score given in relation to the period after construction of the Scheme represents a reduction of risk of approximately 18% in comparison to the safety baseline (the three lane motorway with no motorway incident detection and automatic signalling ("MIDAS") queue protection). Even when the additional safety benefit of 10% above the baseline with MIDAS is taken into account (as per the existing M4 three lane motorway), the Scheme would still expect to see a reduction in risk of approximately 8% and hence meet the required safety objective.

1.4.4 Highways England therefore considers that the Scheme will deliver the additional capacity required without compromising overall safety. The hazard assessment methodology used to assess the expected safety performance of the smart motorways concept uses evidence (i.e. monitoring data on performance) from the M42 Pilot and more recent operational smart motorway schemes, such as hard shoulder running ("HSR") schemes on the M6 around Birmingham. The monitoring of these schemes has demonstrated that the use of the hard shoulder as an additional lane does not compromise overall safety.

1.4.5 The Scheme is no less resilient than a motorway with 3 lanes plus a hard shoulder (A D3M). Annex E of the EDR, outlines the hazard analysis work undertaken and concludes that the Scheme's ALR design is likely to be no worse in terms of safety performance (than the baseline) due to a controlled environment being provided through a combination of regularly spaced [variable] mandatory speed signals, speed enforcement, and full CCTV coverage. When compared to an HSR scheme, as Highways England explained at the Road Safety Issue Specific Hearing, the permanent conversion of the hard shoulder maximises the use of the space available, removes the risks introduced by the part time use of the hard shoulder and reduces the amount of information the road user has to assimilate from the overhead signs and signals. As a result, the Scheme is no less resilient than a scheme operating with HSR. The level of potential technological failure on an HSR scheme results in a high maintenance burden, which itself results in Highways England's maintenance workforce being exposed to greater risk. The Scheme with an ALR operating regime reduces the risk of technology failure

(which itself would impact on the provision of additional capacity and have a subsequent impact on journey times) and risk to the Highways England's maintenance workforce.

- *encourage traffic volumes to grow causing worse noise and air quality, and more climate-changing emissions.*

Highways England Comment

1.4.6 The noise assessment for the Scheme is based on future traffic flows on the M4 and surrounding road network, both with and without the Scheme in operation. These traffic flows come from a complex traffic model and take into account changes in traffic flow over time and as a result of the operation of the Scheme. Thus, the noise assessment incorporates the effects of these traffic flow changes.

1.4.7 As reported in Chapter 12 of the ES (Application Document Reference 6-1, APP-152), the magnitude of impact for the Scheme on ambient noise is minor beneficial in the short term and negligible in the long term, with the vast majority of the Scheme corridor experiencing negligible or minor reductions in noise levels with the Scheme in operation. Thus, Highways England considers that Reading Friends of the Earth's expectations that noise levels will increase as a result of the Scheme are unfounded.

1.4.8 Whilst there will be a slight increase in air pollution as a result of the Scheme, the overall assessment of effects indicates that air quality effects of the Scheme are not significant. This is based on the evaluation of the Scheme undertaken following the methodology set out in Interim Advice Note 174/13 '*Updated advice for evaluating significant local air quality effects for users of DMRB Volume 11, Section 3, Part 1 'Air Quality'*.

1.4.9 Highways England has previously provided a written response setting out the consideration of the Scheme's carbon impact in terms of the national carbon plan. For any further details about the national carbon plan or the wider carbon policy, advice would need to be sought from DfT, which is the competent authority on this matter.

- *be significantly more expensive to implement than other options.*

Highways England Comment

1.4.10 Highways England disagrees that smart motorway improvements are significantly more expensive to implement than other options.

1.4.11 Highways England acknowledges that, in order to provide the additional capacity required for the M4, there would be a requirement to implement either a traditional widening scheme or a scheme to run traffic on the hard shoulder (i.e. a HSR or ALR scheme).

1.4.12 With regards to these options, it is generally acknowledged that smart motorway options are significantly cheaper to implement than traditional widening schemes, as confirmed in 2009, when DfT published "Britain's Transport Infrastructure Motorways and Major Trunk Roads" which stated in paragraph 20:

"For the sections where we had previously been considering motorway widening, we were able to compare this directly with HSR. This more detailed work suggests that in all cases where there was originally a proposed widening solution, HSR would provide a feasible alternative; and that on average it would save around 40% of capital costs, while for particular schemes savings could be almost 60%. HSR schemes provide the majority of benefits that widening would, generally at a lower cost to the environment. Combining this with the fact that capital costs are significantly lower means that the value for money of HSR is generally higher."

1.4.13 Furthermore, it has been noted ALR provides substantial cost savings, when compared to constructing and operating HSR, as it removes the need for heavily engineered designs to provide the complex and resource intensive operating systems to "open" and "close" the hard shoulder, and reduces the incumbent maintenance requirements.

1.5 So would like the Panel to separate the costs and benefits to make the case to delay or abandon all-lane running because we believe the Option Selection process did not evaluate the options in sufficient detail.

Highways England Comment

1.5.1 Highways England does not consider that it would be appropriate to assess the costs and benefits of ALR separately. Costs and benefits are based on the overall Scheme, and therefore individual elements cannot fairly be considered outside of the Scheme as whole.

1.5.2 Furthermore, in drawing on the experience gained from operating earlier generations of 'managed motorways', Highways England confirms that there has been extensive consideration of the alternatives to ALR as part of the development of the Scheme, as outlined in the response to paragraph 1.3 above. This consideration has confirmed that ALR provides best value for money.

1.6 Priority should be to reclaim the M4 from local traffic for long-distance travel - by demand management and modal shift – to maintain accessibility and improve local environment.

Highways England Comment

1.6.1 The priorities of the strategic road network are a matter of Government policy, and should not form part of the assessment of the Scheme. Nevertheless, Highways England agrees that the principal role for the M4 is as an important link in the strategic road network. However, in the absence of any additional regulation on motorway user, Highways England is unable to prevent the use of the M4 for local trips.

1.6.2 Highways England agrees that demand management can play a role in reducing local car trips. Demand management is a key part of the strategy recommended by the Thames Valley Multi-Modal Study ("TVMMS"). However, whilst demand management and modal shift are important components of transport policy, in themselves they do not remove the need for improvements to the strategic road network, which in the case of the M4, the Scheme will address.

1.6.3 Paragraph 3.1.11 of the Planning Statement (Application Document Reference 7-1, APP-089) states that *'consideration was given to a range of potential multi-modal interventions…to address the transport problems within the Thames Valley'*. Paragraph 3.1.13 also notes that the proposed *'strategy recognised that even with travel demand management and public transport enhancements in place, the overall magnitude of car-based demand would remain higher than now'* and that *'congestion will remain and, in specific areas, may intensify significantly, eroding some of the wider benefits delivered by a wider strategy'*. Consequently, even with better public transport links being provided or greater use of other modes, car-based demand on the M4 is such that improvements to the M4 to relieve congestion in the form of the Scheme are required.

Traffic Modelling:

Traffic volumes:

1.7 Very hard to predict – many factors:

- *Marginal cost of travel is falling as fuel efficiency rises.*
- *Coming out of recession people take jobs wherever they can so drive further – but they and society would be better off if they did not travel so far.*
- *"Robots threaten 15m UK jobs" said Bank of England's chief economist last week.*
- *Economic projections are not reliable – for SE Plan in about 2005 Experian projected close to 3% p.a. economic growth (GVA) for the next 20 years.*
- *For SE Plan the 'Taking Stock' report said SE Region environmental footprint was 29 times its land area – so can growth be sustainable?*
- *Information technology has improved and working from home – at least part-time - has become much more popular.*
- *Government promises to get inward migration down from hundreds of thousands to tens of thousands per year.*

1.8 We think environmental and cost considerations should take precedence over 'predict and provide'.

Highways England Comment

1.8.1 Highways England does not promote schemes on the basis of 'predict and provide'. The objectives for the Scheme are set out in paragraph 1.2.9 of the ES (Application Document Reference 6-1, APP-141), the first of which is the objective to reduce congestion, smooth the flow of traffic to improve journey times and make journeys more reliable. The Scheme is intended to improve current and future congestion but in so doing, it is necessary to ensure the level of investment provides longer term net benefits across a wide range of economic, environmental and social impacts. It is, of course, recognised that not all impacts are beneficial and accordingly, Highways England seeks to strike the appropriate balance that meets the requirements of national policy guidance.

Effects of traffic volume on congestion and environment:

1.9 Also hard to predict:

- *Important that panel are aware that traffic volumes have very non-linear impacts on delays – when roads start to be overloaded delays can increase as the square or cube of traffic density until eventually flow breaks down at gridlock.*
- *For previous Examinations into 'Cross Town Route' and 'Wokingham District Plan' at our request consultants simulated scaling the Origin/Destination matrix … to look at sensitivity and see how close the roads are to gridlock*
- *Traffic on approaches to Reading has been said to increase by 4% - so may increase delays by 8% or 12% - what will this cost?*
- *Traffic on M4 when overloaded or lanes blocked may cause long delays, especially when there is no hard shoulder.*

Highways England Comment

1.9.1 Highways England agrees that once flow levels increase to the point where flow breakdown starts to occur, delays increase disproportionately. As stated above, a primary objective of the Scheme is to reduce congestion, smooth the flow of traffic to improve journey times and make journeys more reliable. The introduction of the traffic control technology associated with the Scheme will control speeds and reduce the incidence of flow breakdown. The benefits will extend to the local junctions and highway network as traffic will be able to better access the motorway with less queuing and delays.

1.9.2 The assertion that traffic on approaches to Reading has been said to increase by 4% is unsupported by any evidence, and it follows that the estimate of an increase in delays of "8% or 12%" is nothing more than a guess. Highways England considers that the traffic model is has presented is robust and has been tested.

Comments on Carbon Costs:

1.10 Figure for lifetime carbon emissions of scheme is 4 million tonnes of CO2 … how sensitive is this to assumptions about vehicle technologies and traffic volumes?

1.11 What is the economic cost of an additional 4 million tonnes of CO2?

- *Sweden taxes at $168 - about £100 - per tonne - already.*
- *Economist Nicholas Stern has written that by 2035 the price should be between $82 and $260 – a mean of about £112*
- *Committee on Climate Change came up with a potential range of £100-£300 per tonne of CO2 – mid-range £200 - in 2050.*
- *Airport Commission envisages future price of £330 per tonne by 2050.*

1.12 So 4 million tonnes would add around £400 million pounds to the cost of the project at £100 per tonne, and at £330 per tonne would add £1.3 billion.

Highways England Comment

1.12.1 The carbon costs associated with the 60 year appraisal period have been calculated in line with Web Based Transport Analysis Guidance ("WebTAG") available at the time of the assessment. This includes costs associated with carbon emissions which range between £64.22 per tonne of CO_2 in 2022 rising to £316.49 per tonne in 2081, with an average of £206.80 per tonne.

1.12.2 The range for the cost per tonne of carbon used in assessment is in keeping with the ranges reported elsewhere in Europe as described above.

2. ENVIRONMENTAL MATTERS – 17TH AND 18TH NOVEMBER:

(Numbered as in document 3512035)

Section B: Traffic Forecasting:

2.1 During Questions 17 to 23 (Realism and Uncertainty in Modelling, and Distributional Effects ….):

2.2 Mr. Whittle (for HE) used the word 'patchy' to describe the detail of modelling between 'screenlines', and there was discussion of three levels of modelling: strategic, local, and junction.

2.3 I commented that I was aware of 'Congested Assignment Models' to model junction delays and I could not see how higher-level models could be accurate in predicting flows or routes between 'screen lines' if they did not model junction delays with some accuracy.

2.4 Mr. Whittle also said that traffic on J11 would rise by 2% … which he seemed to imply was a small number … but J11 is already often congested, so (as in my comments to the Open Floor Hearing) a 2% increase in traffic could perhaps lead to 4% to 6% increase in delays.

Highways England Comment

2.4.1 The traffic model meets the required standards for validation set within DMRB and Transport Analysis Guidance ("TAG"). Model traffic volumes have been compared with observed values across 20 screenlines (lines bisecting roads across the model's study area). Total flows across these screenlines are within 3% of the observed total. The 20 screenlines comprise a total of 887 highway links. The validation requirement is that a minimum of 85% of the individual links on each screenline should achieve a set statistical 'goodness of fit' level. This requirement was exceeded at all screenlines. The model contains over 42,000 individual links and whilst it is not suggested that the model accurately replicates traffic flows on each and every one of these links, it has been validated to the required level for the assessment of the Scheme.

2.4.2 The SATURN modelling package used for the M4 smart motorway model contains many of the features of a congested assignment model (TAG Unit M3.1 Highway Assignment Modelling, paragraph 2.7.10 provides a useful summary). In particular, it has the ability to distinguish between the traffic that would like to get through the network but is restrained by a lack of capacity – the demand flow – and the flow that passes through the junction during the modelled time period – the actual flow. SATURN is also able to model 'blocking back' which replicates

queues associated with a junction blocking back to an upstream junction and incurring delays at that location. As such, Highways England considers that junction delays are modelled within the M4 smart motorway model to sufficient accuracy to properly assess the operation and impacts of the Scheme.

2.4.3 The assertion that traffic will increase by 2% and this will lead to a 4 - 6% increase in delays is groundless. No evidence to support this assertion has been presented, and there is no basis supplied as to how the asserted 2% increase in traffic would lead to an increase in delays.

2.4.4 The modelling of junction 11 within the M4 smart motorway model simulates its complex layout and traffic control. In the Do-Minimum situation, without the Scheme, the model reflects the congested conditions that occur at the junction during peak periods. As confirmed at the Environment Issue Specific Hearing, a small increase in traffic flows at junction 11 is forecast as a result of the Scheme. However, the resulting delays predicted by the model are not significantly larger. It is to be noted that, as has also been discussed at the Environment Hearing, the Scheme is not forecast to induce additional traffic - the additional traffic flows using the M4 in the Do-Something situation arise from re-assignment from existing roads. The level of traffic forecast to use junction 11 (or any other route) with the Scheme takes account of existing congestion in selecting which roads to use. Where conditions are congested, traffic will in principle seek to use other, less congested routes, rather than queue.

Section D: Noise and Vibration, air quality and carbon:

2.5 Commenting on questions 6 to 10 on Noise levels … when HE had said there was a consensus around noise levels of 63dB (daytime) and 55 dB (night-time) being acceptable:

2.6 I referred to evidence given by Margaret Cocks at the Open Floor Hearing on 16th November who had advocated 40 dB as a safe level on health grounds. HE responded that this was an 'aspirational' target.

2.7 I commented that it would have been useful to ask Public Health England's views on this.

2.8 I said that speed reduction could reduce noise impacts, and would also improve air quality, safety, fuel use and carbon emissions. I note that this is discussed in http://www.racfoundation.org/assets/rac_foundation/content/downloadables/speed_limits-box_bayliss-aug2012.pdf (Sections 2.3 to 2.5)

2.9 Mr. Jones then commented that a 55 mph speed limit should be considered between J10 and J11.

Highways England Comment

2.9.1 Highways England did not say that there was a consensus around noise levels of 63 dB (daytime) and 55 dB (night-time) being acceptable. Highways England stated that these noise levels were employed in the noise assessment to define the Significant Observed Adverse Effect Level ("SOAEL") for daytime and night-time, and that there was wide consensus among consultants and local authorities in assigning these noise levels as the SOAEL values.

2.9.2 The 40 dB noise level referred to by Reading Friends of the Earth comes from the World Health Organisation ("WHO") Night Noise Guidelines for Europe (the "Guidelines"), where it is defined as the night-time Lowest Observed Adverse Effect Level ("LOAEL"). The Guidelines recognise that the achievement of this level is not currently feasible in many situations and an interim target level of 55 dB is proposed.

2.9.3 Identified areas along the Scheme corridor, with daytime and/or night-time noise levels equal to or above the SOAEL values, have been the driver for the enhanced noise mitigation study, which has been provided with the Deadline V submission.

2.9.4 With regard to the effects of a reduced speed limit, assuming traffic on the motorway is made up of 10% heavy goods vehicles, decreasing the speed from 70 mph to 55 mph would result in an approximate noise reduction of 1.8 dB, a minor reduction in the short term and a negligible reduction in the long term. The use of speed restrictions to reduce noise levels is not being considered by Highways England as a generality or in relation to the Scheme, because the implementation of the Scheme generally results in beneficial effects. The vast majority of the Scheme corridor experiencing negligible or minor reductions in noise levels with the Scheme in operation.

2.9.1 It is not necessarily the case that reduction in speed limits leads to improvements in air quality. Reducing speed limits during periods of the day on the motorway, could in some circumstances help to improve noise and air quality. This is as a result of reductions in flows along the motorway or more optimal driving conditions. The scheme will use speed control to manage the traffic flows as part of its operation. However, where a blanket speed control is applied there is potential for wider scale changes in traffic movements, as the motorway has a lower capacity, there are risks of increased levels of congestion, less journey time certainty and as a result has the potential to lead to traffic reassigning to alternative routes.

2.9.2 The Scheme is not predicted to result in a significant air quality effect nor affect the UK's reported ability to comply with the Air Quality Directive and therefore the use of speed restrictions are not required for air quality. Accordingly, the imposition of a speed restriction is not required.

2.9.3 As noted above, Highways England has previously provided a written response setting out the consideration of the Scheme's carbon impact in terms of the national carbon plan. For any further details about the national carbon plan or the wider carbon policy, advice would need to be sought from DfT, which is the competent authority on this matter.

2.9.4 With regard to the safety impact of a permanent speed reduction, the response in the hearing to the examiners' question number 3 explained the implications with regard to the introduction of a mandatory reduced speed limit (e.g. 50 or 60 mph) during off peak periods. The introduction of a non-safety related speed limit would have a negative implication in regard to driver frustration as a result of an increase in journey times, particularly during off peak periods. A significant disadvantage of reducing the speeds off peak is that journey times during the off peak would be significantly affected by a reduced speed limit and this would also have a negative impact on the business case for the Scheme.

2.9.5 Therefore, achieving a greater safety scheme benefit would require a high level of compliance during the off peak periods and therefore it is important that drivers do not become frustrated with driving at a reduced speed limit. A reduced speed limit during the off peak may have a significant impact on the level of frustration as drivers would experience higher journey times. This driver frustration may also have corollary effects on safety and compliance issues.

2.9.6 The safety benefit of introducing a reduced speed limit may result in a slightly greater reduction in risk, but this would depend on the effect on level of compliance achieved on the Scheme. Should non-compliance be an issue then it will impact on this Scheme and potentially across the network offsetting any potential reduction in risk.

2.9.7 It is noted that even without introducing a permanently reduced speed limit, the Scheme meets and betters its safety objective, namely that of making the safety of the M4 "no worse".

2.10 Section E: Visual Impact:

Question 6: Lighting.

2.11 Comments not made orally to hearing because it was agreed to take all inputs in writing to save time.

LEDs - Light Emitting Diodes:

2.12 Lighting design is a complex field – selecting the right light sources against safety, economy, climate change, and aesthetic criteria.

2.13 As well as brightness and directionality CCT - 'corrected color temperature' - is an issue. Colours range from 'Cool White' to Warm White. It is argued that 'Warm White' with CCT of 3000K or even 2700K has less impact on human health and on wildlife and is more aesthetically pleasing.

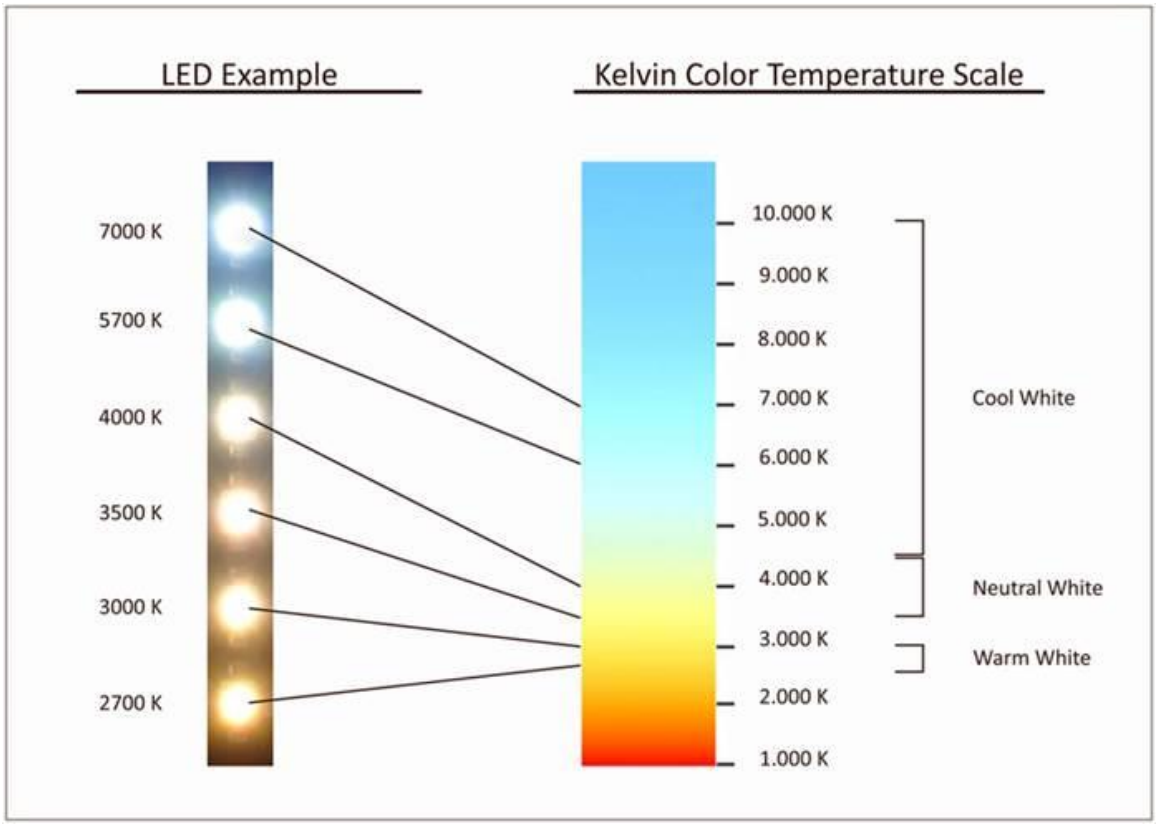
Highways England Comment

2.13.1 Paragraph 6.3.44 of the EDR (Application Document Reference 7-3, APP-096) states that where lighting is required, existing lighting would be removed and replaced with modern light emitting diode ("LED") lighting. The Outline Construction Environment Management Plan (Appendix 4.2A of the ES) (Application Document Reference 6-3, APP-293) states that lighting will be designed, positioned and directed so as not to intrude unnecessarily on adjacent buildings, ecological receptors, structures used by protected species and other land uses to prevent unnecessary disturbance, interference with local residents, railway operations, or passing motorists.

2.13.2 Highways England considers that the proposed LED lighting will have no adverse effect upon wildlife. The extent of light spill from the road to adjacent areas is a consideration for wildlife, but the Scheme's proposals will ensure less light spill, and therefore the Scheme is likely to result in a lower impact than the current lighting arrangements. Beyond light spill, it is also important that road lighting does not attract nocturnal species, such as night-flying invertebrates or, as a consequence, their predators such as bats, which may then be killed by collisions

with vehicles. LED lamps have been shown to have a lower insect attractiveness than, for example, low-pressure sodium lamps and thus are considered to be an appropriate lighting solution for the Scheme.

2.13.1 In additional, Highways England recognises that outdoors, the colour of the different types of LED light are easily distinguishable. The colour chart below gives an indication of the differences.



2.13.2 Highways England recognises that cool white is a more efficient light source than either neutral or warm white light, as it produces more light for the same amount of energy. However, all three types of white LED light provide effective light for road lighting. Warm white light, which is the less energy efficient, is suitable for town centres where there is greater pedestrian activity. For motorway lighting the preference is for a neutral white light, although at present there is no current Highways England guidance other than TD34/07 *'Design of Road Lighting for the Strategic Motorway and All Purpose Trunk Road Network'*, which states:

"3.2. Light sources shall have a colour rendering index (Ra) greater than or equal to 20 and shall be selected to minimise whole life cost and energy consumption".

2.13.3 Highways England considers that the aesthetic preferences expressed by Reading Friends of the Earth in terms of the type of white light are a matter of personal opinion, and that when selecting the type of light there are other more important matters to consider, such as energy consumption and impact on local ecology.

2.14 The Royal Commission on Environmental Pollution https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228832/978010

8508547.pdf.pdf reported on outdoor lighting in 2009 and warned of risks of stray light and replacing orange lighting with broad spectrum lighting.

Highways England Comment

2.14.1 There is now a general recognition that outdoor lighting should be designed not only to provide light where and when it is needed in an energy-efficient manner, but also to minimise or prevent the problems that can arise from stray light.

2.14.2 The use of modern LED luminaires, with very tight optical control, ensures that the light is only distributed onto the areas where it is needed. The Scheme's lighting proposal will ensure that the luminaires are installed horizontally and that there will be no upward light distribution.

2.14.3 The use of white light LEDs, as opposed to "orange" lighting significantly reduces the amount of light required to light the road and also uses significantly less energy.

2.15 In terms of LED technology applied to outdoor - and in particular to street lighting - there are the following problems:

1) blue-rich spectral content - and the resultant potential for disruption of circadian rhythms in the wider natural world, and also in humans

Highways England Comment

2.15.1 The proposed lighting on the M4 will control tightly the light distribution and ensure that there is minimal spill light outside the carriageway. On that basis, there should be minimal disruption to the circadian rhythms in the wider natural world, and also in humans.

2.15.2 Research shows that light exposure needs to be in excess of 30 lux continuously for an hour for any measurable shift to take place in melatonin, the hormone which governs our sleep patterns. Even then this shift is insufficient to disrupt sleep patterns. Typical street lighting levels are between 10 and 15 lux.

2) blue-rich spectral content - and the resultant increase in light pollution in the atmosphere through Rayleigh scattering

Highways England Comment

2.15.3 Light pollution, in the form of sky glow, refers to the glow effect that can be seen over populated areas. It is the combination of all light, which has reflected from what it has illuminated, escaping up into the sky and being scattered (redirected) by the atmosphere back toward the ground.

2.15.4 Rayleigh scattering and the eye's increased sensitivity to white or blue-rich light sources, when adapted to very low light levels of white or blue-rich light, contributes significantly more to sky-glow than an equal amount of yellow light.

2.15.5 As confirmed in the response to paragraph 2.15 1 above, in the proposed lighting for the Scheme there will be no directly distributed upward light, as flat glass

luminaires will be installed horizontally. The light will have a downward lighting distribution pattern with the only upward light being that which has reflected off the road surface.

2.15.6 The use of a neutral or warm white LED light source will reduce the blue-rich spectral content and thereby reduce light pollution. The details of the LED light source will be finalised during the detailed lighting design. This is secured under Requirement 19 of the draft DCO, which requires that a written lighting scheme must be submitted to and approved by the Secretary of State before any permanent lighting is installed.

3) blue-rich spectral content - and the resultant increase in the potential for photobiological damage

Highways England Comment

2.15.7 The photobiological effects of light are related to the spectrum and intensity of light, but are not specific to any type of light source. Particularly when night-time exposure is a concern, choosing lower corrected colour temperature ("CCT") sources will generally reduce the photobiological risk potential. This will be ensured for the Scheme by the use neutral or warm white LED light sources.

4) blue-rich spectral content - and the resultant increase in glare

Highways England Comment

2.15.8 The International Dark-Sky Association ("IDSA") recommends that, in order to reduce glare, LED lighting should emit no upward light. The horizontal installation of flat glass luminaires will ensure that no light will be emitted upwards.

2.15.9 The IDSA further recommends that warm white LEDs (CCT< 3,000k) are used to minimise blue-rich spectral emissions. However, these will not be used in the Scheme as they are not energy efficient and the use of intermediate colour temperature LEDs is required by TD34.

2.15.10 The lighting should only illuminate the areas where it is needed and variable lighting levels, as included in the preliminary design, should be used to ensure that the appropriate amount of light is used for the task. The above points will all be considered and finalised during the detailed lighting design, which is secured by Requirement 19 of the draft DCO.

5) LED 'flicker' - and the resultant potential to cause migraines and epileptic episodes

Highways England Comment

2.15.11 Modern high quality LEDs, such as those that are used in road lighting, do not flicker any more than the high intensity discharge lighting currently installed on the M4.

2.15.12 The lighting design will ensure very good overall and longitudinal uniformity. The sensation of flicker can cause visual discomfort to drivers and in some cases

can induce epileptic seizures. It is induced by periodic changes in luminance within the field of vision. Driving under incorrectly spaced luminaires within the tunnel or through an entrance zone with daylight louvres can give rise to this effect. The effect of flicker can be minimised by ensuring that:

i) flicker duration is no greater than 20 s; and/or

ii) unlit length between adjacent flashed areas in a luminaire row is less than the flashed length of a luminaire; and/or

iii) flicker frequency falls outside the band 2.5 Hz to 15 Hz.

2.15.13 The expected inter-column spacing in the region of 60m, as proposed by the preliminary lighting design, will ensure that the flicker effect between luminaries will fall outside the band of 2.5Hz to 15Hz. (At 70mph the flicker effect between luminaires will be approximately 0.5Hz.)

2.15.14 On this basis, Highways England considers that the potential for light flicker effects to impact on human health will be slightly reduced by the Scheme.

6) Glare - and the resultant potential to cause nuisance to residents and cause road safety issues

Highways England Comment

2.15.15 The glare from street lighting is not anticipated to cause road safety issues. The use of LED lighting, which is a form of white light and therefore simulates a daylight road environment, is likely to have a safety benefit for road users.

2.15.16 As noted above in the response to paragraph 2.15 4, tight optic control and the horizontal installation of the flat glass luminaires will minimise glare and so will not cause nuisance to residents or road safety issues.

7) Poor light uniformity - and the resultant potential to increase crime and road traffic accidents

Highways England Comment

2.15.17 Highways England does not agree that there will be poor light uniformity as a result of the Scheme. The overall and longitudinal uniformity levels obtained with LED road lighting designs generally exceed the minimum requirements of the design standards[1]. The lighting design will ensure that the required uniformity levels are achieved, and Highways England disagrees that this has any potential to increase crime or road traffic accidents. Highways England notes that no evidence to support this assertion has been offered by Reading Friends of the Earth.

[1] The design standards referred to include:

- BS 5489-1: 2013 – Code of Practice for the design of road lighting Part 1: Lighting of roads and public amenity areas
- BS EN 13201-2: 2003 – Road lighting Part 2: Performance requirements
- International Commission on Illumination CIE 115:2010 – Lighting of Roads for Motor and Pedestrian Traffic

2.16 I am told that at LuxLive http://luxlive.co.uk/ the recent lighting exhibition and conference the current LED installation on the M4 around J10 & J11 near Reading cropped up in conversation - with everyone present in the discussion agreeing that the LED lighting is very poor, and dangerously glary.

2.17 I would like HE to look closely at criticisms of this recent LED installation and learn from any mistakes made.

Highways England Comment

2.17.1 Highways England is not aware of any criticism of the LED installation on the M4 from any authoritative or expert study. A reported conversation should not form the basis for planning the lighting proposals for the Scheme.

2.17.2 However, Highways England notes that the majority of the recently installed LED lighting between J10 and J11 has been carried out as part of a luminaire replacement scheme by Highways England's maintenance contractor for Area 3. The luminaires are installed on the existing columns and brackets. The luminaires are at a 5 degree tilt above the horizontal which may result in some glare from the installation. This lighting will be removed as part of the Scheme.

2.17.3 The proposed lighting for the Scheme will use new columns located at optimal inter-column spacings. The proposed luminaires will also be installed horizontally, which will significantly reduce any potential glare and ensure the required uniformity levels.

Section G: Other Matters:

Question 5: mitigation of carbon impacts:

2.18 I asked whether embodied carbon in civil engineering works was included in the HE figure of 4 million tonnes of CO2 for lifetime emission. I pointed out that concrete and steel had high carbon footprints.

2.19 HE replied that they thought it was not included but would confirm this.

Highways England Comment

2.19.1 Highways England confirms that the figure of 4.18 million tonnes of CO_2 for the lifetime emissions of the Scheme does not include the embodied carbon in the civil engineering works. The lifetime emissions total, as provided in the Appraisal Summary Table (Appendix B to the Socio-Economic Report (Application Document Reference 7-2, APP-090)), comprises carbon emissions from vehicles over a 60 year appraisal period. This calculation is in line with WebTAG guidelines which do not include embodied carbon.

2.19.2 As shown in Table 11.10 of Chapter 11 of the ES (Application Document Reference 6-1, APP-151), which is reproduced below, it is estimated that the material resources for the Scheme will create 42,510 tonnes of embodied carbon.

Table 11.10 Embodied carbon content of material resources for the Scheme

Material Resource	Total estimated embodied carbon (tonnes of CO_2e)
Steel	15,831
Aluminium	851
Concrete	23,014
Inert fill materials	552
Inert Soils (Structural)	321
Inert Black	1,349
Plastic	255
Timber	337

2.19.3 The table shows that embodied carbon is equivalent to approximately 1% of the overall lifetime emissions for the Scheme. On that basis, Highways England considers that, proportionately, embodied carbon has minor impact on the carbon produced by the Scheme.

3. ROAD SAFETY – 18TH NOVEMBER:

(Numbered as in document 3511812)

Questions 1 to 5: Performance and Risk:

3.1 I asked HE to explain why risks differed between the three schemes discussed … MIDAS, Active Traffic Management, and All Lane Running.

Highways England Comment

3.1.1 As noted at the Issue Specific Hearings, the level of safety benefit varies between the different schemes and carriageway conditions. Figure 1 below shows that a generic ALR scheme is expected to provide a safety benefit of 18% when compared to a generic baseline (a dual three-lane motorway ("D3M") without MIDAS). It shows that the Scheme is expected to provide a similar safety benefit of 18% to that experienced by a generic ALR scheme compared to a generic baseline. It also shows that, as described in the response to paragraph 1.4 above, the Scheme is expected to provide an 8% reduction in risk when compared to the existing M4 motorway (D3M with MIDAS). The level of risk differs between schemes/carriageways as there are different levels of infrastructure and technology that are introduced in order to provide a controlled operating environment.

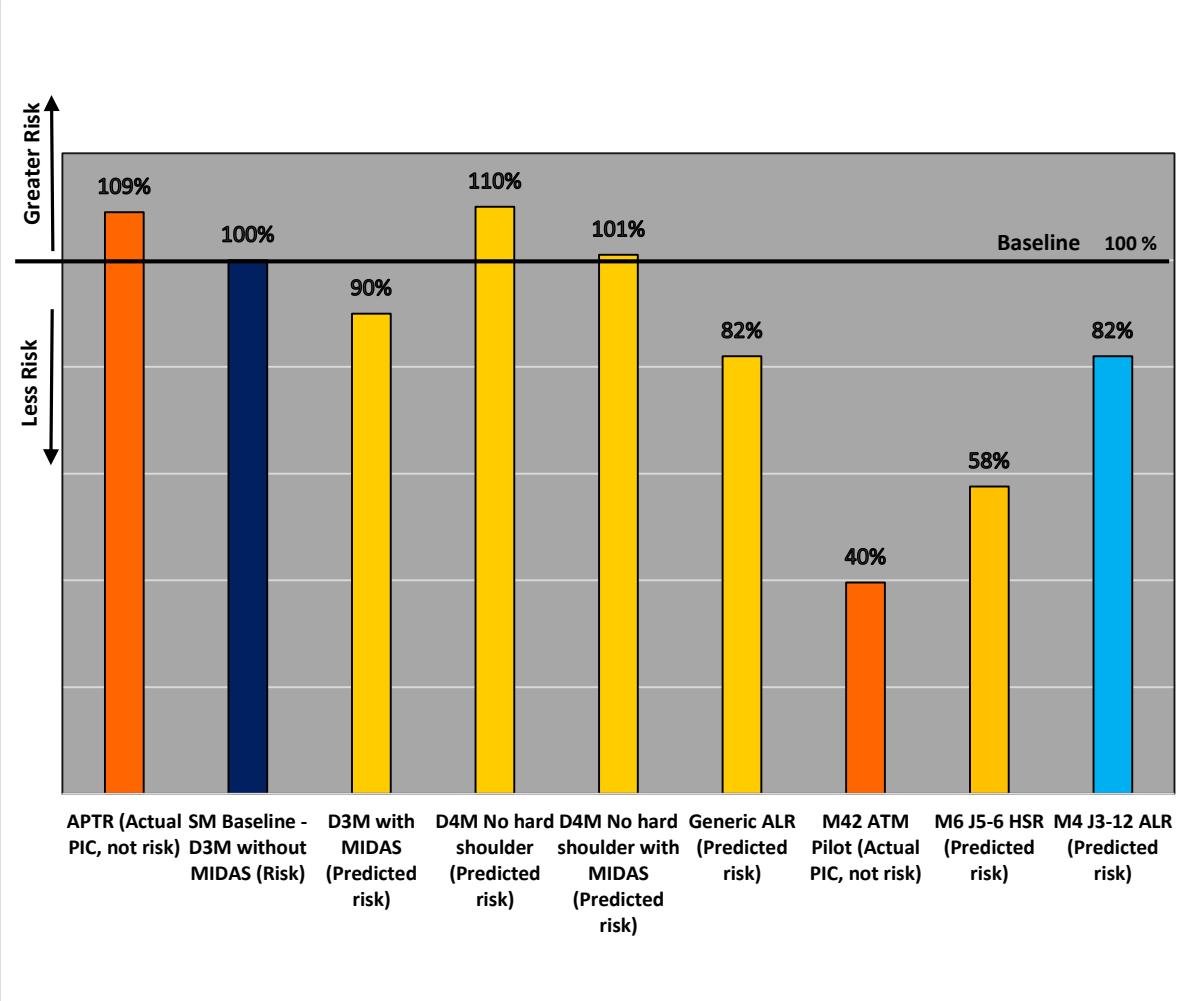


Figure 1: Updated comparison of risk for different carriageway conditions

3.1.2 The M42 Pilot introduced a new network operation concept, where the hard shoulder was opened to traffic as a running lane during peak periods for the first time. The priority for that scheme was to demonstrate to road users and broader stakeholders that the hard shoulder could be operated safely as a running lane in order to tackle congestion. Given the pilot nature of the scheme, a conservative approach was taken for the safety assessment and the design of the scheme to prove that the motorway could be operated at least as safely as a standard three lane motorway. This resulted in a high density of infrastructure such as overhead gantries with variable speed limit lane signals and a high frequency of emergency refuge areas (nominally at 500m spacing) for road users to use in the case of an emergency. The pilot scheme demonstrated that the hard shoulder can be operated safely as a traffic lane to manage congestion, whilst also delivering a significant overall safety improvement compared to the safety performance of a standard three lane motorway.

3.1.3 It is acknowledged that the original smart motorway design (the M42 Pilot – an HSR scheme) provides a greater reduction in risk compared to predicted reduction for the M4 J3-12 Scheme.

3.1.4 The experience gained from the M42 Pilot led to the optimisation of the operation and design and meant that equipment and infrastructure could be located at greater spacing than the original design whilst still achieving an improvement in safety.

3.1.5 Optimising the smart motorways design, and subsequent operation, has enabled Highways England to establish a design which provides value for money, whilst maintaining safety above baseline levels. These efficiencies have made it possible to deliver a far greater number of smart motorway carriageway miles and deliver significant benefits faster than would have been possible by replicating the heavily engineered M42 Pilot scheme. Although there is an expected improvement in safety as a result of ALR, the safety objective for Highways England schemes (as set out in the ALR Generic Safety Report, Ref: 1039092-GSR-016 section 4.1.2 Road user safety objective) is to maintain and not necessarily improve safety standards.

3.2 I asked for cost of adding Active Traffic Management for three lanes without adding All Lane Running, and what the safety benefits of this would be. I was told that HE did not have this figure.

Highways England Comment

3.2.1 As noted previously, paragraph 2.23 of the NN NPS states that the Government's wider policy is to bring forward improvements and enhancements to the existing Strategic Road Network. The NN NPS acknowledges explicitly the implementation of ALR schemes in footnote 29, which notes that the hard shoulder is transformed into a permanent additional running lane.

3.2.2 The requirement for smart motorways, set out at section 4.1.2 of the ALR Generic Safety Report (Ref: 1039092-GSR-016), is to confirm that safety will be made 'no worse' than the baseline by the introduction of the Scheme as referenced in the ALR generic safety report, section 4.1.2 Road user safety objective. Despite the Scheme being aimed primarily at relieving congestion, rather than improving safety, there are predicted improvements in safety as a result of the Scheme.

3.2.3 Highways England acknowledges that the original smart motorway design (the M42 Pilot – an HSR scheme) provides a greater reduction in risk compared to predicted reduction in risk for the M4 J3-12 Scheme. A hazard assessment of the M4 operated under dynamic HSR operation has not been undertaken. The ALR operating regime became Highways England Policy in 2012 when Interim Advice Note (IAN) 161/12 was introduced. Therefore, although a number of operational regime options were originally considered, there was no requirement to fully assess the M4 with an HSR operating regime and provide a costed value for an HSR design.

3.2.4 As the policy is to implement ALR, it has not been established what the cost would be for an HSR scheme on M4 J3-12. The 'Action for Roads - Network for the 21st century' report (July 2013) provides the cost of implementing a smart motorway compared to traditional widening. It says: *'Because of the way managed motorways work, they have many advantages over conventional widening. They can be introduced without the need to take large amounts of land.*

They have a significant impact on journey reliability and fewer environmental impacts. They can also be delivered at up to 40% less cost with improved safety'.

3.2.5 If HSR had been proposed for the Scheme there would have been a significantly greater level of technology and infrastructure along with higher operational and maintenance requirements compared to the proposed smart motorways design. This would have resulted in significantly greater costs. For example, in terms of infrastructure costs, an IAN 111/09 hard shoulder running design has more closely spaced gantries and more closely spaced ERAs compared to the IAN 161/13 ALR design.

3.3 I asked if general speed reduction would have useful benefits in improved safety.

Highways England Comment

3.3.1 As explained at the Road Safety Issue Specific Hearing and the submission for Deadline IV, there has been no assessment undertaken using a reduced speed limit, and so it would not be possible to advise on the level of safety benefit that could be achieved. However, if the national speed limit was not in force during off peak times, it is possible that a slightly greater safety benefit may be achieved. Achievement of a slightly greater safety benefit is on the basis that a reduced mandatory speed limit would result in slower moving traffic and therefore the severity and likelihood of any incidents that occur would be expected to reduce (should all drivers comply with speed limits). It is noted that the risks associated with, for example, pedestrians in running lanes would not be expected to reduce as a vehicle hitting a pedestrian at 60mph likely to be the same as at 70mph.

3.3.2 As described above in the response to paragraph 2.9, imposition of a non-safety related off peak speed limit would have a negative implication in regard to driver frustration as a result of an increase in journey times. A significant dis-benefit of reducing the speeds off peak is that journey times during the off peak would be significantly affected by a reduced speed limit and this would have a negative impact on the business case for the Scheme.

3.3.3 Achieving a greater safety benefit would require a high level of compliance during the off peak periods and therefore it is important that drivers do not become frustrated with driving at a reduced speed limit. A reduced speed limit during the off peak may have a significant impact on the level of frustration as drivers would experience higher journey times. Drivers are unlikely to understand why their speed is being restricted as there would be no apparent traffic condition related need for the speed restriction and therefore the risk of drivers not complying with the speed limit is likely to increase. The issue of non-compliance if there is no clear need for the speed limit would not only have an impact on the scheme itself but would also increase the risk of non-compliance across the road network. The credibility of the signs and signals across the network set by Highways England could be significantly affected. A comprehensive driver education campaign would be required in order to encourage drivers to comply.

3.3.4 Therefore, introducing a reduced speed limit potentially may affect the viability of the Scheme. Whilst lowering speed limits may potentially result in the safety benefit of a slightly greater reduction in risk, if the Scheme cannot be shown to be viable, it may not be constructed - which would maintain safety at the baseline level.