Slough Additional Evidence

WRITTEN REPRESENTATION

HIGHWAYS ENGLAND'S RESPONSE

ADDITIONAL COMMENTS FROM SLOUGH ADDITIONAL EVIDENCE

1. INTRODUCTION

1.1 This note provides additional evidence to the issue specific hearing pertaining to the Application by Highways England for an Order Granting Development Consent for the M4 Junctions 3 to 12 Smart Motorway (Case ref. TR010019).

1.2 In the text that follows I will make specific reference to the questions that arose at the hearing so that the textual evidence I provide can be placed in context and to aid the Inspectorate in their deliberations. I will highlight the references to the appropriate questions as they appear in the "Issue Specific Hearing Agenda" e.g. Section C Air Quality, Question 1.

Personal details

1.3 My name is Dr Scott Hamilton (BSc, PhD, CSci. MIAQM, MIEnvSc). I am an environmental scientist specialising in air pollution modelling, with a particular emphasis on road traffic emissions and dispersion. I am the technical lead on urban air quality modelling at Ricardo Energy and Environment (formerly AEA Technology). I have over 15 years of experience in modelling and measuring air pollution from all types of sources and have worked in the UK, Europe and Asia applying my skills to large air quality issues arising from road traffic. I am fully conversant in all modelling methods used by the applicant having applied the same tools in many instances in my own work at home and abroad.

Commission by Slough Borough Council

1.4 I have been commissioned by Slough Borough Council to offer expert advice to them with specific regard to the M4 Smart Motorway project and how it might affect the air pollution climate at sensitive receptors during the operational phase of the scheme. I represented Slough Borough Council at the "issues specific hearing" on November 17th and offered specific concerns and recommendations to the Inspector with regard to the potential impacts of the scheme, how future air pollution levels have been calculated and what options exist for mitigation of impacts at key hotspots in Slough near the M4.

Highways England Comment

1.4.1 Responses to each of the topics raised in this representation are provided below.

Topics covered in this note

1.5 At the hearing we provided our thoughts on the questions as laid before us pertaining to air pollution effects of the scheme. Slough Borough Council is concerned not only about the effects of the scheme, but the effects of the M4 on air pollution in Slough now and in the future, with or without the scheme.

Highways England Comment

1.5.1 Responses to each of the topics raised in this representation are provided below.

1.6 *This note is not intended to replace the Local Impact Report already submitted and is mainly offered to provide additional evidence and discussion around key points that arose during the proceedings on the 17th of November. In addition I would like to take this opportunity to describe some additional concerns that I share with SBC with regard to the outcomes of the work undertaken for air quality given we have now had the opportunity to hear the methodology tested in the hearing.*

Highways England Comment

1.6.1 No response required.

1.7 *I will provide full references to all quantitative data sources and will provide the source documents as well in a separate file submission to the Council, who will then submit these to the Inspectorate on or before November 26th 2015.*

Highways England Comment

1.7.1 No response required.

2. CHARACTERISATION OF FUTURE NO2 CONCENTRATIONS IN SLOUGH

Uncertainties

2.1 *Relevant questions from the hearing: Traffic growth forecasts- Question 9, Question 10, Question 12*

2.2 *All air quality questions pertaining to modelling are relevant to the evidence in this section (including the question 29 on the HIA).*

2.3 *We heard during the hearing that what would appear to be quite significant levels of uncertainty exist in the air quality baseline assessment. There are a number of reasons for our concerns in this regard. Mainly these relate to uncertainties that compound as the modelling chain proceeds from traffic assessment, through emissions calculations, through dispersion modelling and finally future year forecasting.*

Highways England Comment

2.3.1 All assessments of air quality which consider the future situations will inherently include a measure of uncertainty. The air quality assessment for the M4 junctions 3 to 12 smart motorway scheme (the "Scheme") minimises this uncertainty by producing predictions for a realistic worst case scenario. This was achieved through the use of detailed traffic projections, detailed air quality modelling, model verification and long term trend predictions. The approach utilised was based on relevant best practice approaches as set out in Design Manual for Roads and Bridges ("DMRB"), associated Interim Advice Notes ("IANs"), and supplemented where relevant with Department for Environment, Food and Rural Affairs ("Defra") local air quality management guidance and tools.

2.3.2 The air quality assessment for the Scheme is also consistent with, or goes beyond, the requirements of the National Policy Statement for National Networks ("NN NPS"), and in particular paragraphs 5.7 to 5.9 inclusive.

2.3.3 Because a realistic worst case has been assessed, the likely outcome in practice can be expected to fall within the assessed scenario.

2.4 *The question of particular concern for Slough Borough Council is whether the future projections of compliance with air quality standards in Slough provided by Highways England are realistic and perhaps more importantly, conservative. In any modelling situation conservatism is used to effectively deal with uncertainty as we can never be absolutely sure of projections of air quality even into the quite near future. Our position is clear- when the future pollution climate along a road that is already causing air quality breaches is uncertain, mitigation should be explored.*

<u>Highways England Comment</u>

2.4.1 In relation to air quality standards (i.e. air quality objectives in the above context), the air quality assessment has identified that some locations along the Scheme route within Slough may already be above air quality objectives for annual average nitrogen dioxide.

2.4.2 The future projections for the Scheme are consistent with, or go beyond, the requirements of the NN NPS, and in particular paragraphs 5.7 to 5.9 inclusive, which refer to the use of Defra projections for future air quality within an Environmental Statement. This is because the air quality assessment for the Scheme was undertaken using the Highways England Long Term Trend ("LTT_{E6}") future projection curve, which is more conservative than Defra projections for future air quality. The use of more conservative future projections helps to address uncertainty in future air quality.

2.4.3 The need for air quality mitigation has been considered against the requirements of the NN NPS, and a need for mitigation has not been identified. This is because a compliance risk has not been identified for the Scheme, nor has a significant air quality effect been identified. This analysis is described in Chapter 6 of the Environmental Statement ("ES") (Application Document Reference 6-1, APP-146), and in particular in Section 6.18 *Summary*, paragraphs 6.18.3 to 6.18.8.

2.5 *The issue is further complicated by the fact that Slough's most exposed receptors are forecast in the ES) to experience levels of NO_2 very close to the annual mean UK air quality objective (and EU Limit Value which is numerically exactly the same being set at 40 micrograms per metre cubed as an annual mean). This means that even slight uncertainty in the projected levels in 2022 could cause exceedances of the standards where forecast levels are below the standard. If significant uncertainties exist in the work (say in the order of 10% of the standard being assessed- this equates to 4 μgm^3 of NO_2) then clearly the scheme will be operating in a quite different baseline air quality environment and should be viewed on that basis.*

Highways England Comment

2.5.1 As described above, Scheme air quality effects have been considered using an approach which is consistent with, and goes beyond the requirements of the NN NPS, through the use of LTT_{E6}, which is already a more conservative test compared to the Defra projections. Therefore, uncertainty has been factored into the assessment at a level consistent with, or beyond, that required by the NN NPS. The possibility that Slough receptors may be close to the annual mean UK air quality objective is reflected in the conservative approach and an additional measure of uncertainty need not apply since the DMRB approach accounts for this already. As is to be expected, the DMRB standard is not a minimum assessment standard, but rather comprises an approach designed to protect the environment without the addition of yet further sensitivity analysis.

2.5.2 In any event, if the air quality assessment for the Scheme had not already considered uncertainty in future air quality through the use of the LTT_{E6} approach, then a way of checking if the approach postulated by Mr Hamilton would add to the considerations already undertaken would have been to consider the potential for significant effects at sensitive locations at 36 $\mu g/m^3$ or above, i.e. a deviation of 10% against the air quality objective using Defra projections only. On the basis of this approach, there are predicted to be three small worsenings and two medium worsenings above 36 $\mu g/m^3$ across the air quality study area. Two of these small worsenings are predicted at receptors within Slough (A322 and A322_1), which have already been identified and hence taken into account in the assessment undertaken.

2.5.3 Therefore, Highways England considers that the use of either approach to consider the uncertainty in future air quality shows that there would not be a significant effect on air quality caused by the Scheme. As such, confidence may be placed in the approach to assessment that Highways England has adopted, which is consistent with its national and precedented standard.

2.6 *Some receptors in Slough are forecast to breach (albeit slightly) the NO_2 standard in the modelling as it stands, and their exposure could be higher if the uncertainty has resulted in underestimates of traffic generation or resulting emissions.*

Highways England Comment

2.6.1 These comments are addressed in response to 2.5 above.

2.7 *Slough Borough Council were encouraged by the comments from HM Inspectorate of Planning in opening statements that the scheme should promote "enhancement" of the environment. If the air quality modelling is accepted as being uncertain, we would prefer mitigation were provided to achieve the stated aspirations of the Inspector by seeking to reduce existing exposure to exceedances of NO_2 standards, whilst also providing mitigation against the increases projected for the scheme in 2022.*

Highways England Comment

2.7.1 Highways England noted the Examining Authority's statement that Highways England should adopt environmental enhancements. Of course, the obligation in the NN NPS is to *consider* enhancements. Furthermore, such environmental enhancements need not necessarily include enhancement measures (this is in addition to mitigation) to reduce existing exposure to exceedances of NO_2 standards or providing mitigation for increases assessed as being not significant.

2.7.2 Additionally, the NN NPS Section 5 Generic Impacts – Air Quality does not include a requirement for air quality enhancement.

2.8 I would like to offer the following general comments about uncertainties I see in the "modelling chain" as outlined at the issues hearing.

1) *The traffic model outlined at the hearing is underpinned by national traffic forecasts which will themselves carry some uncertainty.*

<u>Highways England Comment</u>

2.8.1 National traffic forecasts are not directly used in the forecasts for the Scheme's traffic model. Local sub-sets of the national data, representing the various districts across the model area, are used, and as such are more relevant to the area of the Scheme. This reduces the level of uncertainty that would otherwise be associated with national average levels of growth. The 2009-based M4 model's ability to forecast was checked against observed data in 2013 and found to continue to meet the required level of validation.

2) *The forecasts are then used in the trip end model which I understand can also carry uncertainty due to the spatial allocation of trips potentially not fully representing the fine detail of local conditions.*

<u>Highways England Comment</u>

2.8.2 The trip end model represents the various factors underpinning growth at a local authority, district-wide level. It is for this reason that larger-scale development proposals (housing developments in excess of 50 units and commercial developments in excess of $1000m^2$) are modelled explicitly, both in geospatial and trip generation terms. This approach reduces the uncertainty and provides enhanced detail of local conditions for subsequent environmental assessment. In the case of Slough, based on details provided by the Slough Borough Council, a total of 40 individual developments across the Borough were included in the M4 smart motorway traffic model. It should be borne in mind that this approach is as set out at paragraph 7.3.5 onwards in the Department for Transport's Transport Analysis Guidance (TAG) Unit M4 – Forecasting and Uncertainty, which is considered acceptable by the Secretary of State.

3) *The road traffic model then provides speed and flows which can be passed to air and noise assessment methods. These are the two most fundamental variables in the emissions calculations (other than fleet mix and age) so any error in this step carries forward.*

<u>Highways England Comment</u>

2.8.3 Traffic flows (i.e. numbers of vehicles and split of vehicle types) and speeds are the key metrics output from the traffic model, which are then used to inform the environmental impact assessment.

2.8.4 The traffic flows used are the output of a variable demand traffic model, which has been through a process of model calibration and validation, defined within DMRB and Transport Analysis Guidance and verified by Highways England TAME Group Appraisal Certifying Officer. It is designed to provide outputs of a suitable quality for subsequent environmental assessment, which is why the standards contained in DMRB have been established. It should also be noted that flows are validated for the baseline year prior to forecasting future years to ensure that the model is accurate.

2.8.5 Therefore, confidence can be placed in the standard applied, the modelling approach used, the model outputs and the validated baseline. The use of consistent national standards materially reduces uncertainty and ensures the approach used for the Scheme is consistent with all other Highways England (and predecessor Highways Agency) projects. Indeed, DMRB is the standard and approach that Slough Borough Council would itself be required to use for its own road schemes.

4) *These flows and speed are then entered into emissions calculations, which even if the baseline traffic model was 100% certain, would add uncertainty by virtue of the emissions factors being average representations of vehicle emissions. The traffic model is not 100% certain.*

<u>Highways England Comment</u>

2.8.6 Highways England agrees that no forecasts are, by definition, 100% certain, and that traffic models are no exception. That said, the level of uncertainty is reduced as far as is practicable by the application of an industry standard approach in combination with professional experience to interpret the outputs appropriately. Furthermore, the range of possible outcomes is materially reduced by the adoption of a consistent national standard for assessment under DMRB.

2.8.7 Additionally, this uncertainty is dealt with through, in part, the verification process which effectively increases air quality dispersion model outputs as required to mirror baseline air quality monitoring. This approach is considered to represent a reasonable worst case approach.

5) *The emissions data is then passed to a dispersion model (in this case ADMS Roads). ADMS Roads1 is based on Gaussian dispersion algorithms that were empirically derived in the 1950s. These were primarily designed to describe plume dispersion from tall stacks, though parameterisations have since been developed to include line, area and volume sources. Traffic is treated as a series of line sources in the model. The mathematical treatment of the sources and how they affect very close receptors is still extremely basic (though this comment is not directed towards the applicant, ADMS Roads is the industry standard road traffic dispersion model in the UK). That said the use of flat topography in the model means that the model does not fully (or even attempt to) represent turbulent flow regimes that will exist around the motorway due to the interaction of winds and the surface topography. All told this means that the transport of the pollutants from the source to the receptors is quite uncertain though the use of model correction factors goes some way to deal with this empirically.*

Highways England Comment

2.8.8 Highways England agrees that ADMS-Roads is an industry standard dispersion model, but disagrees with the suggestion that no allowance has been made to represent turbulent flow regimes around the motorway – the tool was designed for modelling of road schemes. The flow regime was considered through surface roughness and model verification, whereby monitoring data from locations around the motorway (i.e. locations subject to the flow regimes around the motorway) were used to verify model outputs. The approach to model verification to address this interaction was also based on industry best practice.

6) *When concentrations have been calculated, Defra's NO_x to NO_2 model2 is used to convert annual average NO_x (from the model) to annual average NO_2 (for comparing with standards). Again this process is derived from an empirical model which uses quite broad assumptions with regard to available ozone to titrate NO_x to NO_2 and the reaction kinetics involved. This adds uncertainty in the ratio (or rate of formation) of NO_x from road traffic to the NO_2 that is experienced by the receptor.*

Highways England Comment

2.8.9 The uncertainty in the amount of NO_2 experienced at sensitive receptor locations due to rates of conversion of NO_x to NO_2 is one of the many variables that is corrected through the model verification process. In this process, baseline model predictions are adjusted using monitored concentrations of NO_2 in locations that are representative of sensitive receptor locations.

2.8.10 This approach is an industry standard approach which uses a Defra local air quality management tool and which is part of the suite of local air quality management tools (e.g. background maps) which have been used in the air quality assessment. There is no reason to suggest that this industry standard modelling tool is not suitable in this case.

7) *Also the tool relies on projections of the amount of "primary NO_2" that is released by the vehicles3- this is the proportion of NO_x emissions released as NO_2 at the exhaust and is an important factor in NO_2 concentrations at receptors (more primary NO_2 = more total NO_2 at receptors). Nitrogen oxides (NO_x) are emitted in the form of nitric oxide (NO) and nitrogen dioxide (NO_2). The fraction emitted directly as NO_2 (f-NO_2) is of particular interest for air quality modelling. Since NO_x is not a regulated pollutant but NO_2 is, any uncertainty in this calculation means that the final estimate of NO_2 is subject to some uncertainty all other things being equal. There is actually no way to know how reliable the future levels of ozone assumed in the model are given the regulatory response to ozone (both in the UK and Europe) is extremely complex and involves regulation of volatile organic compounds, NO_x and other precursor emissions.*

Highways England Comment

2.8.11 As described in response to 2.8(6) above, the relevant Defra local air quality management tool has been used in the assessment for the Scheme. In addition to correcting for variations in rates of NO_x to NO_2 conversion, the verification approach will also correct for emissions of direct NO_2 in the baseline situation.

2.8.12 Uncertainty in future rates of NO_x:NO_2 conversion and direct NO_2 emissions have been minimised through the use of the best available data including the use of Defra approved local air quality management tools and through the use of the Highways England LTT_{E6} which adds additional conservatism to the consideration of future air quality.

8) There is a fundamental difference between model evaluation, and assessing its power of prediction. In this instance my understanding is that the model has been evaluated - that is to say its performance is checked against local measurements and adjustments made to account for any biases (usually under-prediction). This is not the same as to assess the model's predictive power which is important when considering whether the model can represent 2022 with the accuracy implied by providing results to three significant figures in the Environmental Statement - this would typically be done by assigning a training set of measurements (say 50% of the available NO_2 measurements, and asking the model to predict values at a validation set of measurements, the other 50% of measurements not included in the training set). In practice this is not commonly done in air quality assessments (probably due to the usual lack of AQ measurements) which may go some way to explain why model predictions of future conditions can be inaccurate.

A recent review of modelling by Defra4 stated that

" the ability of an air quality model to reproduce measured concentrations from the past does not guarantee its adequacy for the future or for predicting the response to pollution control strategies. Agreement with observations is inherently partial. Models agree with some observations but not all. A model can certainly perform well against historic observations and the precision and accuracy of the fit can be quantified. The performance of models can be evaluated relative to past observations, relative to other models or against our own theoretical expectations, but the performance of a model, especially for future projections of concentrations, cannot be ascertained precisely. Nevertheless, the comparison of model predictions against past observations is a good first step in the evaluation of model performance".

Highways England Comment

2.8.13 The air quality model used for the Scheme has been evaluated through the use of model verification, which is industry best practice. This is a key step in the development of robust predictions of the future.

2.8.14 The presentation of air quality monitoring and modelling predictions to three significant figures is industry best practice and this number of decimal places is consistent with Interim Advice Note ("IAN") 174/13. This is also required to enable reporting of small changes in pollutant concentrations, with the lower criteria for a small change being more than 0.4 $\mu g/m^3$, which would not be possible if data were reported to two significant figures (the smallest reportable change would then be 1 $\mu g/m^3$).

2.8.15 The approach to the omission of data from the model verification process as described above is not a typical approach in infrastructure air quality assessments, nor any other air quality assessment that Highways England is aware of as part of the nationally significant infrastructure planning regime. Whilst data would have been available to undertake this approach, the risk of this is that variations in model performance in some areas (i.e. some zones identified) could be missed if the two halves of the dataset are used independently, or if the two datasets are used consecutively it simply adds an additional step to the verification process. This approach is also likely to draw criticism from other stakeholders, who may be reluctant for their data to be excluded and further problems would be caused by the fact that there are no industry guidelines on identifying which data would be excluded nor on the numbers of data points to be excluded.

9) *Model adjustment factors are calculated to account for some of the uncertainties, but these can only be considered reliable for the year of the measurements used to underpin the calculation. Projecting into the future assumes that the predictive power of the model is the same, which is difficult to ascertain.*

<u>Highways England Comment</u>

2.8.16 As stated in response to 2.8(8) above, this approach is consistent with industry best practice. A key factor that the verification process is correcting is the gap between the performance of vehicles within a laboratory environment, on which emission factors in air quality models are largely based, and the performance of vehicles in real world driving. With the announcement of the conformity test for diesel vehicles, Euro 6 will continue to have a mandatory laboratory level, but there will be an additional roadside test imposed once the vehicles are on the road to act as a backstop to make sure their performance is of an acceptable standard. This will minimise the differences between vehicle emission rates used in models and real world driving emissions. As this gap in emissions between laboratory and real world driving is a key factor in the verification process, it may be that in the future, smaller verification factors are required to correct air quality model performance, and as such the factors utilised for the future situations may be higher than necessary.

10) *The NO_2 modelling is then scaled forward to 2022 in tandem with the traffic models. Any time a model is projected forward uncertainty builds further. At the point of scheme opening in 2022, the modelling relies on several things being correct. These can be summarised thus:*

   a. *The traffic model must be accurate when there is actually no way to know if this will be true or not.*

   b. *Background concentrations of air pollution forecast by Defra5,6 and used in the modelling must be accurate when in actual fact these carry significant uncertainty (See point 11 below).*

   c. *Forecast emissions of NO_x (and primary NO_2) from road traffic must be accurate whereas this is known from recent experience to be open to question. This reference (open access) written by my colleague Dr David Carslaw demonstrates the lack of NO_x reduction from diesel vehicles in recent years in the UK7.*

   d. *The NO_x to NO_2 conversion calculation relies on values for ozone concentration and levels of primary NO_2 emissions that may not be accurate in 2022 so the calculated ratios of NO_x to NO_2 may be uncertain. This relates back to the item above pertaining to accuracy of future background forecasts.*

Highways England Comment

2.8.17 Whilst again the point about uncertainty and accuracy associated with traffic forecasts is acknowledged, the traffic model's forecasting ability was checked in 2013 and scaling forward to 2022 represents a fairly short-term horizon in forecasting terms.

2.8.18 All of these points concerning uncertainty in future air quality have been dealt with individually above, and the approaches used, which are industry best practice, have minimised uncertainty in future air quality.

2.8.19 The air quality assessment for the Scheme is also consistent with, or goes beyond, the requirements of the NN NPS, and in particular paragraphs 5.7 to 5.9 inclusive.

11) It is instructive to note the levels of uncertainty (also called "data quality") that are achieved in monitoring and modelling prescribed by the European Commission for assessing against the European Limit Values8. The below is a quote from their "Position Paper on Air Quality: Nitrogen Dioxide" as referenced in the footnotes of this document:

"The following data quality objectives that can be achieved through the implementation of this QA/QC programme are:

- *Continuous or semi-continuous measurements: 15% (individual measurements)*
- *Indicative measurements: 25% (individual measurements)*
- *Modelling 30 - 50% (may be different for daily, monthly or yearly averages)*
- *Objective estimation: 50 to 100%"*

Highways England Comment

2.8.20 The above percentages, associated with different monitoring values and modelling predictions, relate not only to potentially higher actual values of monitored values and modelling predictions, but conversely to lower values also. This is recognised in the air quality industry and where possible, these uncertainties are minimised through the use of industry best practice standards.

2.9 The NO_2 modelling can be viewed in the light of these for the following reasons:

- *The indicative measurements referenced above are usually taken using diffusion tubes, as has been done for the ES modelling - so these have up to 25% uncertainty even for current conditions*
- *The modelling done in the UK by Defra to provide the background maps used in the air quality models in the ES have the same data quality as the modelling standard above. This is because they are derived from the same model (usually referred to as the PCM model9) which is designed firstly to meet the data quality standards prescribed by the EC, and then secondly to provide the background maps. Therefore the background maps can be considered to carry error of a similar magnitude for any given 1km grid square in the UK, including Slough.*

Highways England Comment

2.9.1 Highways England confirms that the model verification, where diffusion tubes have been utilised, was subject to bias correction to relate measurements to continuous automatic monitoring methods to minimise uncertainty associated with this technique. This is consistent with industry best practice. Model verification using this technique has allowed for the incorporation of a large number of points in the verification process to avoid under-estimating pollutant concentrations within the air quality study area, which could otherwise be missed with a smaller number of sampling points.

2.9.2 The use of Defra mapping to develop total pollutant concentrations is industry best practice. Where possible, the Defra background mapping values have been cross-checked against monitoring data. It is noted that Ricardo AEA are not proposing an alternative approach to the consideration of background air quality.

2.10 Given these uncertainties it does not seem reasonable that Slough Borough Council should accept the implied accuracy of the air quality modelling assessment. Representing the modelled values to three significant figures implies a high level of precision and accuracy in the results, which we would argue cannot be guaranteed here.

Highways England Comment

2.10.1 As stated in response to paragraph 2.8(8) above, the presentation of air quality monitoring and modelling predictions to three significant figures is industry best practice and in accordance with IAN 174/13. These are the same standards that would be applicable to Slough Borough Council if it were to promote its own road schemes. This is also required to enable reporting of small changes in pollutant concentrations, with the lower criteria for a small change being more than 0.4 $\mu g/m^3$, which would not be possible if data were reported to two significant figures (the smallest reportable change would then be 1 $\mu g/m^3$).

2.10.2 All of these points concerning uncertainty in future air quality have been dealt with individually above. The approaches used, which are industry best practice, have minimised uncertainty in predicting future air quality.

2.10.3 It is also noted that Slough Borough Council itself routinely reports monitoring data to three significant figures, and that a number of significant figures are utilised in relation to modelling by Slough Borough Council, including source apportionment modelling which reported up to three significant figures. Additionally, Slough Borough Council has previously utilised detailed modelling with contour plots rather than specified receptor points as utilised in the air quality assessment for the Scheme. Highways England considers specified receptor points to be more accurate than contour plots due to the inherent estimation required for contour plots.

2.11 However, Slough Borough Council and I agree that some pragmatism is required here. We agree that the modelling has been done largely following accepted guidance but we would like the applicant to accept that the modelling nevertheless carries potentially significant uncertainty (equal to at least 10% of the NO_2 standard, or 4 μgm^3 of NO_2 as an annual average) and explore mitigation options that are based on conservatism of future NO_2 concentrations. As a safety measure, perhaps mitigation should be targeted at locations in Slough where the projected NO_2 concentrations are 36 $\mu g/m^3$ (or higher) of NO_2 as an annual *average - this would offer some protection to human health at compromised areas, but still allow for progression of the scheme.*

Highways England Comment

2.11.1 Highways England agrees that pragmatism is required interpreting and applying any modelling work. Whilst the modelled results are reasonable there is still some element of residual uncertainty and this is due to inherent uncertainty in air quality monitoring, modelling and the traffic data used in the assessment. Such uncertainty is applicable to any model-based prediction and should not be used in the context of the Scheme to imply that it has a particular sensitivity to uncertainty. In fact, the way in which modelling has been undertaken is consistent with industry practice.

2.11.2 Nevertheless, the air quality assessment undertaken for this scheme is based on the most reasonable, robust and representative methodologies, taking advice from published guidance and applying the standards for modelling and assessment set out in DMRB. The results are verified against monitoring data and are used to inform a professional judgement.

2.11.3 Highways England does not consider that a lower threshold should be applied for the purpose of determining whether to apply mitigation measures of 36 µg/m3 should be utilised. This would be inconsistent with the standards that it applies under DMRB and which have been found to be acceptable by the Secretary of state.

2.11.4 It is to be noted that the above approach advocated by its own consultant is not used by Slough Borough Council in discharging its local air quality management duties where it has declared Air Quality Management Areas ("AQMAs"). There is also no evidence that any mitigation measures set out in Slough Borough Council's AQ action plan have been developed with a view to achieving NO_2 concentrations of 36µg/m³ or less. As such, there can be no justification for applying a materially more stringent threshold than the Borough Council applies to its own activities.

2.12 Perhaps mitigation should also provide for HM Inspectorate of Planning stated aims (at the hearing of November 17th) of environmental "enhancement" as well. This would represent a significant step towards Slough Borough Council achieving its aims of removing all exceedances of the annual mean NO_2 standards within the Borough and show Highways England's commitment to improving air quality.

Highways England Comment

2.12.1 The outcome of the air quality assessment demonstrates that the Scheme is not likely to have a significant air quality impact, nor is it likely to affect the UK's reported ability to comply with the air quality directive. Consequently, this would not trigger the need for additional mitigation.

2.12.2 However, Highways England has set out in its Delivery Plan and Strategic Business Plan a commitment to support improvements to the environment, including air quality, where it can.

2.12.3 Highways England is looking to achieve improved air quality across the Strategic Road Network, and is exploring options and opportunities to do this, and recognises the importance of other key partners e.g. local authorities in delivering any intervention. The M4 in common with other sections of the Strategic Road Network will be included in this work.

2.13 I now turn to providing additional documentary evidence which backs up my oral evidence from the hearing.

3. BARRIERS FOR AIR QUALITY MITIGATION

3.1 Relevant questions from the hearing Air Quality Mitigation measures- Questions 25, 26, 27, 28

3.2 I have already provided evidence to the Inspectorate on the potential impacts on air quality of roadside barriers - this was included in Appendix 1 of Slough Borough Council's Local Impacts Report10. It is our considered view that Slough Borough Council should, in light of the obvious uncertainties in future projected NO_2 concentrations in 2022, seek a thorough investigation by the applicant of barriers as a potential mitigation strategy at locations along the M4 where values of greater than 36 $\mu g/m^3$ of NO_2 as an annual average are predicted in the ES air quality modelling.

Highways England Comment

3.2.1 These comments are addressed in response to paragraph 2.11 above.

3.3 The Council cannot realistically be expected to impact on the emissions from the road traffic on the M4 as it has little or no control over this source - yet it must try under the LAQM legislation. This appears a quite futile exercise without the help of key partners like Highways England.

Highways England Comment

3.3.1 This representation confuses the position of the Scheme in the Examination process and wider consultation with Highways England and Government. The objectives of the Scheme are not related to road traffic emissions - this is a Scheme to improve capacity on the M4 between junctions 3 and 12.

3.3.2 As an organisation, Highways England takes its responsibilities to the wider community seriously and regularly engages with local authorities across England regarding LAQM duties.

3.4 The Council also cannot affect the location of receptors close to the road (and which are in effect brought closer by virtue of using the hard shoulder). It can however seek mitigation with regard to modification of the source/receptor pathway as a means to reduce exposure to air pollution. Again we would reiterate that we were grateful to hear that HM Inspectorate of Planning seek "enhancement" of existing conditions, and not merely mitigation of added pollution from the scheme.

Highways England Comment

3.4.1 As noted above, the outcome of the air quality assessment demonstrates that the Scheme is not likely to have a significant air quality impact, nor is it likely to affect the UK's reported ability to comply with the air quality directive. Consequently this would not trigger the need for additional mitigation.

3.4.2 However, as explained, Highways England has set out in its Delivery Plan and Strategic Business Plan a commitment to support improvements to the environment, including air quality, where it can.

3.4.3 Highways England is looking to achieve improved air quality across the Strategic Road Network, and is exploring options and opportunities to do this, and recognises the importance of other key partners e.g. local authorities in delivering any intervention. The M4 in common with other sections of the Strategic Road Network will be included in this work.

3.4.4 The 11 locations within Slough Borough Council that contribute to the overall evaluation of significance (i.e. predicted to experience a change of more than 0.4 $\mu g/m^3$ at concentrations above 40 $\mu g/m^3$ with the Scheme) are those with the highest predicted concentrations of NO_2 in Slough in 2022. Whilst these receptors are in close proximity to the M4, they are also adjacent to local A-Roads (the A355 or the A332). The A355 and A332 are managed by Slough Borough Council and as such, management options to improve air quality could be considered by Slough Borough Council.

3.4.5 Highways England notes that the A355 Tuns Lane/Farnham Road enhancements being carried out by Slough Borough Council, which is within the Tuns Lane AQMA, do not appear to have been subject to a detailed air quality assessment to identify opportunities to enhance air quality as part of the proposals. Highways England considers that it is disproportionate to request that it meets a standard that Slough Borough Council itself does not meet.

3.4.6 Additionally, the Scoping Report for the A355 Tuns Lane/Farnham Road enhancements identified the potential for adverse air quality impacts. This was because changes in traffic flows above DMRB criteria (> 1,000 AADT) were identified within the AQMA, and therefore a detailed air quality assessment was recommended. Roads identified to potentially experience an increase of more than 1,000 veh/day with the A355 enhancement proposals include the A4 Bath Road, M4 junction 6 roundabout and A355 Tuns Lane.

3.4.7 Furthermore, the A355 Tuns Lane and A4 Bath Road in this area are designated Compliance Links with regard to reporting of EU Limit Value compliance to the EC. In the anticipated opening year of the A355 enhancement scheme (2016), both of these roads are predicted to not be compliant with the EU Limit Value, and therefore there would be a compliance risk associated with the A355 enhancement scheme.

3.5 The potential scale of effectiveness of roadside barriers for mitigating high NO_2 concentrations in Slough's exposed receptors is still a somewhat open question, although a quite significant body of scientific evidence is emerging that barriers could be effective. During the hearing I committed to providing documentary evidence as to the potential effects of barriers. To assist HM Inspectorate of Planning in their deliberations I have provided *these papers as a separate submission, but I also paraphrase the conclusions of these papers in the bullet points below.*

3.6 *The papers provided (and paraphrased are as follows)*

- *1) "Dutch Air Quality Innovation Programme concluded" Rijkswaterstaat Center for Transport and Navigation (2010) : accessed via http://laqm.defra.gov.uk/documents/Dutch_Air_Quality_Innovation_Programme.pdf*

- *2) "Examples of air quality measures near roads within Europe, National measures of the international CEDR air quality group", P.B. van Breugel et al (2005) : accessed via https://www.hoevelakenbereikbaar.nl/www2/MilieuZaken/luchtkwaliteit/Examples-air-quality-measures-near-roads-in-europe-200507.pdf*

- *3) "Passive methods for improving air quality in the built environment: A review of porous and solid barriers", John Gallagher et al, Atmospheric Environment 120 (2015) 61-70 : accessed via http://www.sciencedirect.com/science/article/pii/S1352231015303204*

- *4) "Model evaluation of roadside barrier impact on near-road air pollution", Gayle S.W. Hagler, Atmospheric Environment 45 (2011) 2522- 2530 : accessed via http://www.sciencedirect.com/science/article/pii/S1352231011001646*

- *5) "Field investigation of roadside vegetative and structural barrier impact on near-road ultrafine particle concentrations under a variety of wind conditions", Gayle S.W. Hagler et al, Science of the Total Environment 419 (2012) 7–15: accessed via http://www.sciencedirect.com/science/article/pii/S0048969711014070*

- *6) "Sound wall barriers: Near roadway dispersion under neutrally stratified boundary layer", Sam Pournazeri et al, Transportation Research Part D 41 (2015) 386–400 : accessed via http://www.sciencedirect.com/science/article/pii/S1361920915001492*

3.7 *"Dutch Air Quality Innovation Programme concluded" Rijkswaterstaat Center for Transport and Navigation (2010)*

3.7.1 *"Noise barriers reduce concentrations of nitrogen oxides and airborne particulates along motorways. That is the conclusion drawn by (international) air quality experts based on the measurements obtained during two years of large-scale practical trials. The data were recorded at the Barrier Test Site, the experimental station set up by the Air Quality Innovation Programme, IPL, along the A28 at Putten.*

3.7.2 *From literature and wind tunnel studies it had already been concluded that noise barriers might make a significant contribution to improving air quality. In May 2007, IPL therefore organised a competition challenging companies to come up with innovative barrier designs having an additional impact on air quality compared with conventional barriers. This led to a large number of innovative noise barriers. Some of these were tested in a practical setting, others in the laboratory. Nowhere in the world had such large-scale practical trials previously been conducted in the context of air quality."*

3.7.3 *"At three distances behind the barriers the concentrations of nitrogen oxides and particulates were measured. At the locations behind the barriers this led to a reduction in levels of nitrogen dioxide, nitrogen oxides and particulates. The impact of noise barriers on air quality has thus been demonstrated."*

3.8 *"Examples of air quality measures near roads within Europe, National measures of the international CEDR air quality group", P.B. van Breugel et al (2005)*

3.8.1 *"The pollution is reduced by 20 to 10% depending on the distance from the barrier." (for upwind receptors and 45 degree winds in relation to the barrier)*

3.8.2 *"The pollution is reduced by 20 to 10% depending on the distance from the barrier, as shown by the following curves." (for upwind receptors and winds perpendicular to the barrier)*

90° Wind (perpendicular)

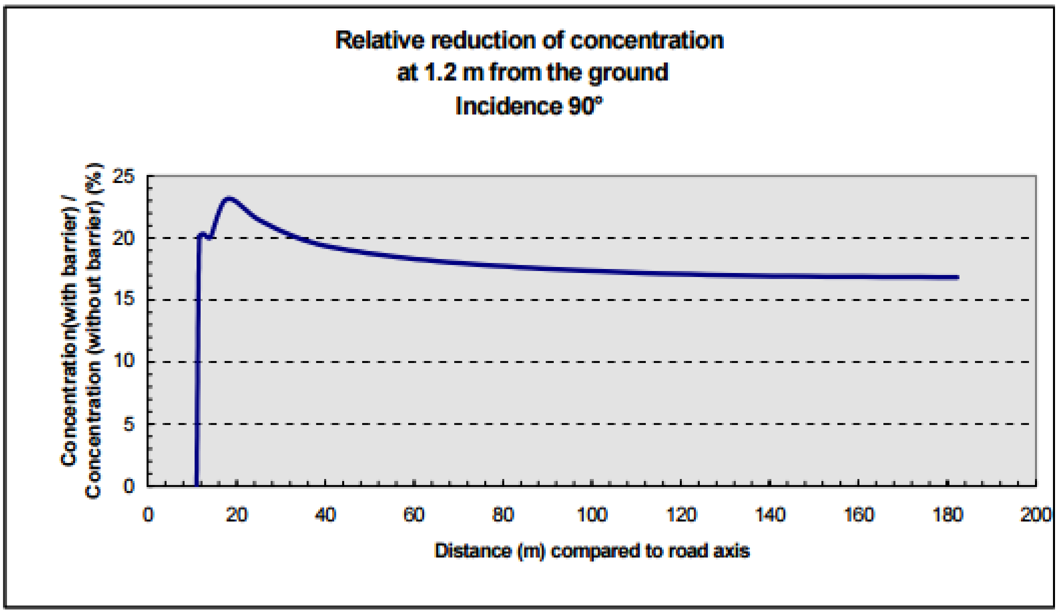


Figure 3 Relative reduction of concentration at 1.2 m from the ground.

3.8.3 *Source: Examples of air quality measures near roads within Europe, National measures of the international CEDR air quality group", P.B. van Breugel et al (2005)*

3.9 *"Passive methods for improving air quality in the built environment: A review of porous and solid barriers", John Gallagher et al, Atmospheric Environment 120 (2015) 61-70*

3.9.1 *"Noise barriers are commonly placed on major high-speed highways to reduce noise pollution for populated areas, but these barriers can also influence localised dispersion and have been shown to improve downwind air quality".*

3.9.2 *"The measurements reported by (Baldauf et al., 2008) for PM and CO demonstrated that the introduction of a noise barrier reduced pollutant concentrations behind the barrier by approximately 15% but at times reached 50%. With the inclusion of a barrier, the modelling results suggested that a* *reduction in pollutant concentrations would be achieved further downwind (Bowker et al., 2007)".*

3.9.3 *"The work by Ning et al. (2010) measured the size distribution of particulate concentrations and several other pollutants in two case studies of urban freeways. Very similar results were noted in this study for PM number concentrations, with reductions in the 45-50% range downwind of the barrier. Tracer pollutant investigations reported by Finn et al. (2010) demonstrated the potential for noise barriers to improve air quality by over 50% downwind of the barrier during certain meteorological conditions such as stable atmospheres.*

3.9.4 *The results of another tracer (C2H6) modelling investigation by Hagler et al. (2011) ranging from 15 to 61% and dependent on the height of the barrier (higher the barrier, the greater the downwind pollutant reduction)".*

3.9.5 *"The potential of noise barriers to affect pollutant transport and dispersion is influenced by the size and layout of the barrier, wind direction and turbulence conditions (Finn et al., 2010; Hagler et al., 2011; Jeong, 2014; Schulte et al., 2014; Steffens et al., 2014, 2013). As previously noted, results measured by Hagler et al. (2011) showed reductions in pollutant concentrations of up to 61%, with improved air quality conditions associated with an increase in the barrier height".*

3.9.6 *"The findings demonstrate that a reduction in pollutant concentrations occurs downwind of the barrier. In some cases, this downwind location may be a densely populated area, therefore implementing this type of barrier may help improve air quality conditions for urban inhabitants. Studies have also demonstrated the potential negative impact of increased concentrations of pollutant on the roadside of the barrier if vehicle turbulence does not increase mixing and dilution. Noise barriers can reduce downwind pollutant concentrations and further investigations can provide transferable results to ensure these solid barriers provide simultaneous air and noise quality benefits".*

3.9.7 *"Yet, it has to be recognised that their effectiveness is dependent on local geometrical and meteorological conditions, as this is what affects localised dispersion and turbulence in the built environment".*

3.10 *"Model evaluation of roadside barrier impact on near-road air pollution", Gayle S.W. Hagler, Atmospheric Environment 45 (2011) 2522- 2530*

3.10.1 *"Under winds perpendicular to the road, CFD model simulations show that roadside barriers reduce the concentration of an inert gaseous tracer (c), relative to a no-barrier situation, vertically up to approximately half the barrier height and at all horizontal distances from the road. At 20 m (3.3H, where H = 6 m) from the road, barriers of heights ranging from 0.5H to 3.0H reduce the maximum concentrations by 15-61% relative to a no-barrier case, with the location of the maximum shifted to occur near the top of the barrier".*

3.10.2 *"These results imply that roadside barriers may mitigate near-road air pollution, although local meteorology, the barrier structure, and the degree of lee-side emission sources are critical factors determining the outcome".*

3.10.3 *"If roadside structural and/or vegetative barriers are shown to improve air quality, the added air quality benefit may justify the addition of barriers to* *existing roadside developments or the preservation of existing roadside barriers".*

3.11 *"Field investigation of roadside vegetative and structural barrier impact on near-road ultrafine particle concentrations under a variety of wind conditions", Gayle S.W. Hagler et al, Science of the Total Environment 419 (2012)*

3.11.1 *"If roadside noise barriers or tree stands are found to consistently lower ground-level air pollution concentrations in the near-road environment, this may be a practical strategy for reducing exposures to air contaminants along populated traffic corridors. This study measured ultrafine particle (UFP) concentrations using an instrumented mobile measurement approach, collecting data on major roadways and in near-road locations for more than forty sampling sessions at three locations in central North Carolina, USA. Two of the sampling sites had relatively thin tree stands, one evergreen and one deciduous, along a portion of the roadway. The third sampling site had a brick noisewall along a portion of the road".*

3.11.2 *"At 10m from the road, UFPs measured using a mobile sampling platform were lower by approximately 50% behind the brick noise wall relative to a nearby location without a barrier for multiple meteorological conditions".*

3.12 *"Sound wall barriers: Near roadway dispersion under neutrally stratified boundary layer", Sam Pournazeri et al, Transportation Research Part D 41 (2015) 386–400*

3.12.1 *"In conclusion, results from this study show that roadside structure such as sound barriers, reduce both on-road as well as downwind ground level concentrations by enhancing the mixing of the pollutants and elevating the plume by a length scape proportional to the barrier heights.*

3.12.2 *"It is anticipated that diesel PM2.5 emissions will be reduced by 50% from anticipated levels between 2015 and 2023 as compared to a scenario without the rule in place. Although the implementation of this regulation can significantly reduce near-roadway exposure to diesel exhaust PM, more health protection strategies are required. This paper supports the deployment of sound walls as a strategy to reduce the exposures to emissions from cars; however, it does not provide any insight on impact of the roadside structures on emissions released at 3–4 m above the roadway".*

<u>Highways England Comment</u>

3.12.3 Highways England is aware of the published research in the Netherlands and America referred to above. Following a review of the evidence, Highways England has commissioned an air quality barrier trial alongside the M62 close to junction 18, which is currently underway. Highways England is measuring concentrations at 1.5m (ground floor) and 4.5m (1st floor) to assess any changes in concentrations.

3.12.4 Highways England is aware that there is some evidence from the studies in the Netherlands that there were some reductions at ground level identified by monitoring. However, no monitoring was undertaken at 1st floor and the published paper by Gayle Hagler indicates that there is potential for increase in pollution at 1st floor levels. It is also noted in the paper from John Gallagher that there is evidence that barriers can lead to an increase in pollution levels behind the barrier.

3.12.5 Highways England will need to conclude the air quality barrier trial before being able to consider whether air quality barriers can be an effective mitigation measure and it would not be appropriate to conclude that they have the potential to be effective in the context of the Scheme.

4. EVIDENCE ON POTENTIALLY FAILING EURO 6 STANDARDS FROM EUROPE

Reason for submission of this evidence

4.1 At the hearing I committed to providing some literature on the issue of Euro 6 standards potentially not providing anticipated benefits in NO_x emission reduction. This is summarised below and provided as a separate document submission. Relevant questions from the hearing Air Quality Assessment of effects Question 10, Question 11, and Question 15

4.2 "Real-world exhaust emissions from modern diesel cars, a meta-analysis of PEMS emissions data from EU (EURO 6) and US (Tier 2 Bin 5/ULEVII) diesel passenger cars", Vincente Franco et al, ICCT, 2014

4.2.1 In a significant research programme11 conducted by the International Council on Clean Transportation (ICCT) there is strong evidence to suggest existing Euro 6 diesel vehicles in Europe greatly exceed their NO_x emissions standards. Passages from the document are provided below.

4.2.2 "This study analyzed the on-road emissions performance of fifteen new diesel passenger cars, twelve certified to the Euro 6 standard and three to the US equivalent (Tier 2 Bin 5), using portable emissions measurement systems (PEMS), which provide a continuous stream of vehicle data signals including emission rates, velocity, acceleration, road gradient and exhaust temperature.

4.2.3 Emissions were measured over 97 trips, totalling more than 140 hours of operation and 6,400 kilometres driven. The high temporal and spatial resolution of PEMS datasets permitted the analysis to link elevated NO_x mass emission rates to the driving conditions that caused them.

4.2.4 This is the first systematic analysis of the real-world performance of modern diesel passenger cars, and the most comprehensive profile available of the on-road behaviour of the latest generation of diesel passenger cars".

4.2.5 On average, real-world NO_x emissions from the tested vehicles were about seven times higher than the limits set by the Euro 6 standard. If applied to the entire new vehicle fleet, this would correspond to an on-road level of about 560 mg/km of NO_x (compared to the regulatory limit under Euro 6 of 80 mg/km). This is compelling evidence of a real-world NO_x compliance issue for recent-technology diesel passenger cars, for both the EU and US test vehicles."

4.2.6 The figure below is taken from the ICCT report and shows graphically the scale of the NO_x over emissions from the Euro 6 diesel cars. Almost all of the vehicles exceeded the standard set for Euro 5 as well.

4.2.7 The acronyms in the diagram pertain to the NO_x abatement system employed which is supposed to reduce emissions in the diesel vehicles to Euro 6 levels - the *two main abatement systems employ Selective Catalytic Reduction (SCR) and Exhaust Gas Recirculation (EGR). There is actually no such thing as a "no-abatement required" Euro 6 engine, all require abatement as part of their design to attempt to achieve the standard.*

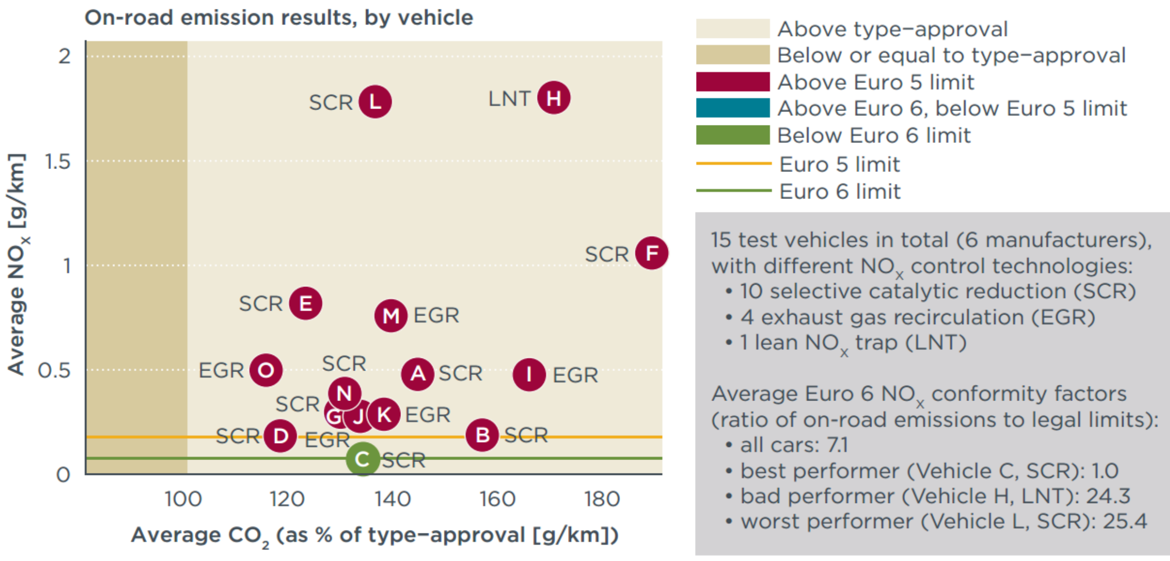
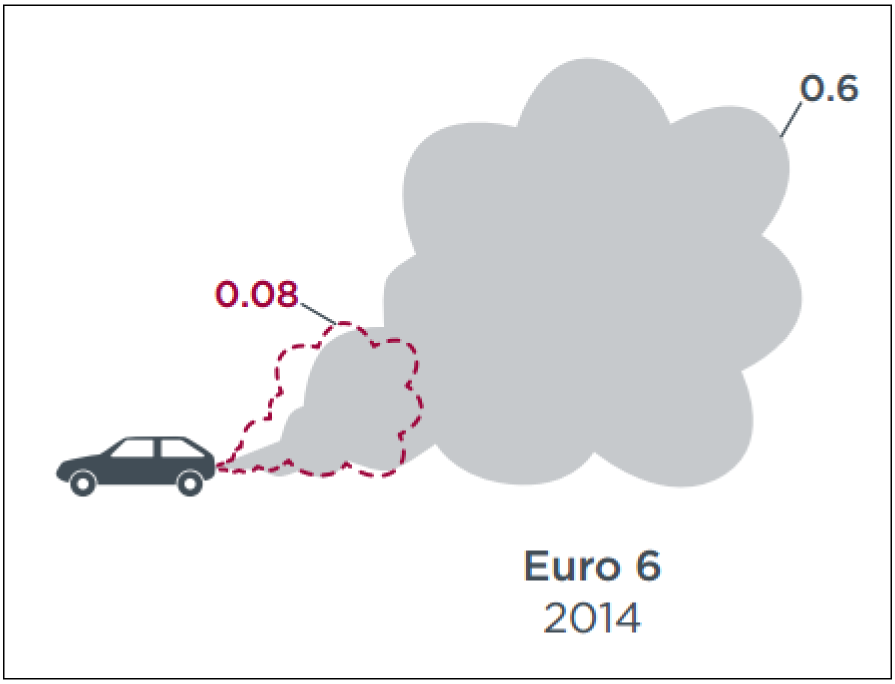


Figure 1. On-road emissions of nitrogen oxides (NO_x) from 15 Euro 6-equivalent diesel passenger cars, as measured by portable emissions measurement systems (PEMS)

4.2.8 *Source: http://www.theicct.org/sites/default/files/ICCT_PEMS-study_diesel-cars_2014_factsheet_EN.pdf*

4.2.9 *This diagram shows the difference between the anticipated Euro 6 emission levels, and the average measured value during the ICCT study.*



4.2.10 Source: http://www.theicct.org/sites/default/files/ICCT_PEMS-study_diesel-cars_2014_factsheet_EN.pdf

4.2.11 This evidence would suggest that a cautious approach is warranted when trying to estimate future NO_x emissions from diesel vehicles, which are forecast to make up over half of the fleet in the UK at the time of the scheme opening. In fact for motorways the expected split between petrol and diesel in the road fleet in 2022 is 33% and 67% respectively12. This makes issues with Euro 6 performance in future years particularly pressing when attempting to characterise future NO_2 concentrations in Slough near the M4.

Highways England Comment

4.2.11.1 Highways England notes that the ICCT PEMS study concerns diesel cars only and the results reinforce the likely benefits of the forthcoming conformity tests for vehicles as a backstop to manage real world driving performance. It should also be noted that whilst some evidence (such as the ICCT study) suggests a gap between laboratory and real world driving performance, other studies for petrol vehicles show they are delivering lower levels of NO_x and similarly, heavy duty vehicles are also delivering significant reductions in NO_x emissions from Euro 5 (for example, the '*In-service emissions performance of Euro 6/VI vehicles. A summary of testing using London drive cycles'*, published by Transport for London in 2015).

4.2.11.2 It is agreed that there is uncertainty in future rates of improvement, and this is why Highways England has undertaken an air quality assessment for the Scheme using the long term trend profile ("LTT_{E6}") to account for uncertainty. The approach is sufficiently conservative that the gap between real world and laboratory driving is accounted for.

5. RESULTS BASED ON APPLICATION OF PREVIOUS LONG TERM TRENDS (LTT) METHODOLOGY

5.1 Relevant questions from the hearing Air Quality Question 9, Question 11, Question 15

5.2 My calculations using the previous LTT method suggest much higher concentrations for 2022 in Slough for the base case. The calculations below are based on scaling the values reported in the ES but using the methodology outlined in the "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 (HA207/07)". I understand this document is already included in evidence to the Inspectorate.

5.3 To show the effect of the rescaling according to this methodology I have used receptors in Slough presented in "Results for All Receptors, Appendix 6.6, Page 14" of the ES. The results of the new analysis add about 11 $\mu g/m^3$ of NO_2 as an annual average to the 2022 results with some receptors seeing concentrations well above 50 $\mu g/m^3$. I argued at the hearing that Highways England should be seeking to mitigate existing high concentrations along the M4 *regardless of the scheme progression and should not rely on engine standards delivering the required reductions in NO_2 concentrations.*

5.4 *If the concentrations in the order of 50 μg/m³ are indeed realised in 2022, but say where mitigation has been ruled out by the Inspectorate during these proceedings, Slough Borough Council will seek assurances from Highways England that mitigation will be installed post-scheme as their evidence base will have been proven to be too optimistic about future NO_2 concentrations falling with time. Otherwise Slough Borough Council will be in a position of taking on a regulatory burden of trying to reduce emissions on a road they have no control over, but were assured that would not cause future exceedances of the NO_2 standard during these proceedings.*

Highways England Comment

5.4.1 Highways England confirms that the calculations presented in the ES use the current LTT_{E6} spreadsheet. It appears that the calculations undertaken by Dr Hamilton represent the previous LTT curve that was in use before updates to the method were made to incorporate information on Euro 6 technology.

5.4.2 As stated in paragraph 4.2.11.1 above, Highways England is not relying on the full rates of improvements in vehicle technology, as the air quality assessment is based on the LTT_{E6} approach rather than the full rates of improvement projected by Defra.

5.4.3 As stated earlier Highways England engages with a local authorities regarding their LAQM duties which happens out with consideration of any decision made at planning inquiry which is based on the most reasonable, reliable and robust information currently available at that time.

5.5 *A useful comparison could be made with regulation of industrial pollution - if an operator of an industrial process proposed levels of any air pollutant that turned out through the passage of time to be false and limits were exceeded, they would be mandated to mitigate those effects (through process engineering) by environmental regulators. NO_2 from an industrial source is no different to NO_2 from a road source and receptors will see the same effects, so I would argue that similar guarantees are appropriate to a scheme of this nature.*

Highways England Comment

5.5.1 Highways England agrees that health effects associated with NO_2 are unlikely to differ between NO_2 associated with industrial or road sources. However, unlike an industrial process, the sources of pollution and the level of abatement for road sources are not within the control of Highways England or a local authority such as Slough Borough Council. Therefore, Highways England does not consider that controls on managing industrial sources and road sources represent a suitable comparison. Were that to be the case, the implications would have equal force for Slough Borough Council, which is also responsible for roads in AQMAs.

5.6 *The table in the Appendices provides the results of the rescaled receptors in Slough.*

Highways England Comment

5.6.1 Highways England notes the results provided in Appendix 1.

6. BARRIER LOCATIONS

6.1 Relevant questions from the hearing Air Quality Mitigation measures- Questions 25, 26, 27, 28

6.2 Slough Borough Council will seek mitigation wherever the projected concentrations of NO_2 exceed 36 µg/m^3 as an annual average. We expect that the applicant will conduct their own analysis and advise Slough Borough Council as to the locations and necessary barrier heights and designs. Slough Borough Council do not have the resources to make these detailed technical investigations.

Highways England Comment

6.2.1 Highways England does not agree that a lower threshold for mitigation measures of 36 µg/m^3 should be imposed, and notes that such a threshold is not in keeping with Slough Borough Council's approach to air quality management.

6.2.2 Highways England will need to conclude the air quality barrier trial prior to making any decisions on the use of barriers as air quality mitigation generally. It would not be appropriate to suppose that an untried method be deployed in the context of the Scheme

7. CONTINUOUS MONITORING LOCATION

7.1 Relevant questions from the hearing: Air quality Question 30

7.2 Slough Borough Council would like an automatic monitoring station for both NO_x/NO_2 and $PM_{10/2.5}$. This should be placed near our station at Chalvey but at a distance from the road more representative of the worst case receptor concentrations. Slough Borough Council will offer advice on siting of the monitoring station when the applicant accepts the request to install one.

Highways England Comment

7.2.1 Highways England does not consider that additional air quality modelling is required based on the Scheme air quality effects. Highways England is currently reviewing this request to support Slough Borough Council, but notes that the request does not relate to the Scheme.

7.2.2 Highways England has developed a National Air Quality Monitoring Strategy and in the future is rolling out a National Air Quality Monitoring Network ("NAQMN"). It is expected that the M4 will be included in that monitoring network. Highways England will engaged with local authorities in relation to any monitoring installed as part of the NAQMN in this area

8. SBC CONCERNS OVER IMPACTS ON THEIR AQMAS

8.1 Relevant questions from the hearing: Air quality Question 3, Question 4, Question 5, Question 16

*8.2 **Specific to Q3** there has been no attempt to characterise the effects of the scheme on Slough Borough Council's existing AQMAs. This should be rectified by additional modelling by the applicant which Slough Borough Council will be happy to support with air quality monitoring* *data where available. If the Inspectorate accepts the need for the applicant to undertake this additional modelling Slough Borough Council will fully engage with the methodological discussions that would have to take place. We would advise that Slough Borough Council seek a conservative assessment given their Low Emission Strategy is currently being prepared and the scheme could negate some of that effort (which is supported by Defra funding and policy) - any negative air quality impact on their AQMAs would contradict the stated aims of the Low Emission Strategy which could call its potential effectiveness into doubt.*

8.3 ***Specific to Q4**, Slough Borough Council have no evidence before them to comment on this hence the recommendation under Question 3.*

8.4 ***Specific to Q5** Slough Borough Council recommend that their AQMAs are modelled by the applicant in order to better understand the effect on their AQMAs. This requires an obvious expansion in study area.*

<u>Highways England Comment</u>

8.4.1 In summary, in relation to the above questions, Highways England does not propose further air quality modelling in these AQMAs, as these areas do not trigger the criteria set out in paragraph 3.12 of the DMRB v11, S3,P1 (HA207/07).

8.5 ***Specific to question 16 -** Slough Borough Council are concerned that the location of a construction phase depot in the Brands Hill AQMA will compromise their efforts in their Low Emission Strategy and would suggest it is re-sited to an area where air quality is less of a sensitivity. Slough Borough Council prefer the screening criteria for additional traffic set out in the EPUK/IAQM guidance in any event.*

<u>Highways England Comment</u>

8.5.1 Preliminary estimates of the construction traffic presented in the Engineering and Design Report (Application Document Reference 7-3, APP-096) indicate that on average it is expected that there will be an additional 150 heavy goods vehicles ("HGVs") on the local highway network daily, across the length of the Scheme route and between any construction compounds used. Therefore, it is unlikely that a detailed air quality assessment will be required for Construction Compound 9, as this traffic will be spread across the Scheme route and compounds – the individual compound will receive a fraction of this traffic.

8.5.2 However, if following the completion of any further compound construction traffic flow assessments, higher numbers of HGVs are anticipated (more than 200 HGVs per day as defined in DMRB Air Quality guidance), then an air quality assessment will be undertaken for Construction Compound 9 to determine the impact on local receptors and to determine whether any further mitigation measures will be required.

8.5.3 Highways England follows the published Government advice set out in DMRB and associated Interim Advice Note and does not use the Institute of Air Quality Management ("IAQM") / Environmental Protection UK ("EPUK") '*Land-Use Planning & Development Control: Planning For Air Quality'* guidance to inform its judgment on the outcome of the Scheme impacts. That Highways England's approach is appropriate is expressly recognised in the IAQM guidance because following advice is provided in paragraph 6.3 of the IAQM document:

"6.3 As set out in the introduction in Chapter 1 , this guidance document is not intended to replace guidance that exists for certain types of development, notably:

- *industrial developments that require a Permit;*
- *highways schemes promoted by Highways England;"*

8.5.4 The Outline Construction Environmental Management Plan has been updated and submitted at Deadline V.

9. FEEDBACK ON HEALTH IMPACT ASSESSMENT

9.1 Relevant questions from the hearing Air Quality Question 29

9.2 I have no feedback to provide on the HIA as I did not review the document during my deliberations on behalf of Slough Borough Council. That said, my discussions around uncertainty has raised several sources of potential error in the future NO_2 projections. Any error in these NO_2 concentrations will have carried forward into the HIA.

Highways England Comment

9.2.1 It is acknowledged that the findings of the Health Impact Assessment ("HIA") (REP3-012) are inextricably linked to those of the relevant sections of the ES, for example Chapter 6 Air Quality (Application Document Reference 6-1, APP-146). Should there be changes to the air quality assessment undertaken to date (for example if supplementary traffic modelling is required, or the vehicle emissions assumptions are reviewed), the HIA will be reviewed.

9.2.2 The current situation, however, is that the air quality assessment, as set out in Chapter 6 of the ES, concludes that a minor negative air quality impact is anticipated during the operational phase of the Scheme and that accordingly, no mitigation is required.

10. OTHER MATTERS

10.1 Typical barrier designs

10.1.1 Relevant questions from the hearing Air Quality Mitigation measures- Questions 25, 26, 27, 28

10.1.2 To assist the Inspectorate in their deliberations I have sourced some typical designs for roadside barriers that are of the height that the scientific evidence suggests could reduce off road concentrations of air pollution. These are provided below.

Highways England Comment

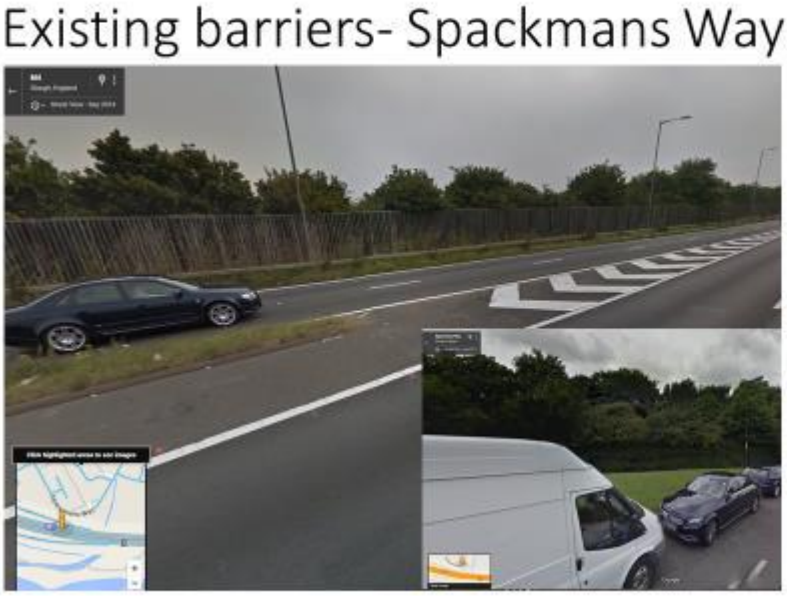
10.1.2.1 The above barrier designs are noted. The potential benefits and dis-benefits of such barriers have been discussed in paragraphs 3.6.1 to 3.6.6 above.

10.2 Image showing Spackman's Way existing barriers and view from the street to M4 Relevant questions from the hearing Air quality Question 27

10.2.1 The purpose of this image is to show the existing roadside barriers at the Spackmans Way site in Slough. In addition I have provided a view looking back to the motorway from the street - this is shown in the inset of the image below. There are quite significant obstacles between the street and the view to the motorway which would potentially offset some of the visual impacts of roadside barriers (at least from the street).

Highways England Comment

10.2.1.1 Highways England acknowledges receipt of the images. Although Dr Hamilton makes a valid point regarding the presence of existing vegetation, it should be noted that Highways England needs to consider any existing vegetation to be retained, vegetation to be removed and vegetation to be replaced as part of the Scheme when assessing the visual impacts associated with the provision of additional/replacement barriers.



APPENDIX 1 – Results of application of the previous LTT projection method on NO_2 concentrations in 2022

Environmental Statement version

Receptor ID	Drawing	x	y	2013 Base NO2 (ugm3)	Projected 2022 Base NO2 (ugm3)	2022- Do Min NO2 (ugm3)	2022- Do Som NO2 (ugm3)	LTT 2022 Do-Min NO2 (ugm3)	LTT 2022 Do-Som NO2 (ugm3)
A247	6.11c	496222	179222	51.6	32.2	33.5	34.5	39.4	40.7
A248	6.11c	496225	179218	51.5	32.2	33.4	34.5	39.3	40.6
A249	6.11c	496229	179209	51.6	32.3	33.5	34.6	39.4	40.8
A250	6.11c	496231	179205	51.9	32.4	33.7	34.8	39.6	41
A251	6.11c	496234	179201	52.2	32.6	33.9	35.1	39.9	41.2
A252	6.11c	496236	179196	52.6	32.9	34.1	35.3	40.2	41.6
A253	6.11c	496238	179192	53.1	33.2	34.4	35.6	40.6	42
A254	6.11c	496227	179213	51.5	32.2	33.4	34.5	39.3	40.6

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New analysis using Previous LTT method

Receptor ID	Drawing	x	y	2013 Base NO2 (ugm3)	Projected 2022 Base NO2 (ugm3)	2022- Do Min NO2 (ugm3)	2022- Do Som NO2 (ugm3)	Ratio A (=2013 base/ 2022 base)	Ratio B (=2022 factor/ 2013 factor)	Gap Factor	LTT 202 Do-Mi NO2 (ugm3)
A247	6.11c	496222	179222	51.6	32.2	33.5	34.5	0.62	0.94	1.50	50.3
A248	6.11c	496225	179218	51.5	32.2	33.4	34.5	0.63	0.94	1.50	50.0
A249	6.11c	496229	179209	51.6	32.3	33.5	34.6	0.63	0.94	1.50	50.1
A250	6.11c	496231	179205	51.9	32.4	33.7	34.8	0.62	0.94	1.50	50.6
A251	6.11c	496234	179201	52.2	32.6	33.9	35.1	0.62	0.94	1.50	50.9
A252	6.11c	496236	179196	52.6	32.9	34.1	35.3	0.63	0.94	1.50	51.1
A253	6.11c	496238	179192	53.1	33.2	34.4	35.6	0.63	0.94	1.50	51.5
A254	6.11c	496227	179213	51.5	32.2	33.4	34.5	0.63	0.94	1.50	50.0