ADMS-ROADS VALIDATION AND ITS APPLICATION FOR TRAFFIC MANAGEMENT SCHEMES

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This paper presents a study carried out in the South West of England using ADMS-Roads. The town is located either side of a river in an area of complex topography. The landscape has the effect of causing steep road gradients in the northern half of the town of up to 8%. Additionally, the town has several narrow streets with tall buildings on either side. This produces a street canyon effect that can result in a re-circulation of air within the street during unfavorable metrological conditions. Dispersion of pollutants from the street is greatly reduced during these periods and may be very small resulting in a build-up of pollutant concentrations to several times those usually expected for a particular volume of traffic.

Using ADMS-Roads which was validated against local measurements, the work aims to address the issues associated with the gradients and the canyon effects along the affected streets. Published factors for altering emissions due to additional or decreased load on the engine as vehicles pass up or down hill have been used (Hassel and Weber, 1997). This work has indicated that locations within the town will exceed the annual mean objective for Nitrogen Dioxide under the UK Air Quality Strategy. Consequently, this assessment considers various traffic management schemes to improve local air quality.

INTRODUCTION

As a preliminary to this study an air quality assessment of the town in SW England has been carried out for current and future pollutant concentrations without traffic management measures. Estimations of road traffic emissions were modified for steep gradients using factors of Hassell and Weber (1977). These have a significant impact on NO_x emissions. The air quality model ADMS-Roads was validated against the measurements at a number of residential properties and the forecasts were adjusted appropriately. The assessment indicated that the government/UK targets for air quality are forecasted to be exceeded very locally at four residential properties on a particular road 'Street B' in 2010.

Following a review of options it was recommended that a demand/traffic management strategy be progressed, in combination with "soft" measures and enhancements to the environment, the principal being to reduce car traffic to meet the air quality standards at Street B by 2010. Further to public consultations on these recommendations and in response to comments from the public, a number of key issues were reconsidered: the traffic forecasts, the implications of the vehicle mix, and in particular, the model validation and "do nothing" scenario. As a result of these reviews, it was confirmed that the forecasts predict the conditions which will pertain on Street B in 2010 to sufficient accuracy.

It was agreed that the solution for the air quality exceedences in Street B should be tailored around the scale and scope of the problem, ie local measure were most appropriate for managing a very local exceedence of the NO_2 standard. Various options were discussed in detail and it was agreed that a Single Lane Shuttle Working Scheme for Street B be tested as an option to reduce the air quality impact. This would move vehicles further away from the affected properties, thereby reducing pollutant concentrations at the property facades.

The following sections describe an air quality assessment of the Proposed Single Lane Shuttle Working Scheme for Street B.

PROPOSED SINGLE LANE SHUTTLE WORKING SCHEME

To assess air quality impact, a cross section of the single lane shuttle working arrangement needs be determined and this was undertaken by examining the published design standards, though there is little guidance available appropriate to the specific arrangement required. In the UK the most relevant references are those by TRL (1994) as follows:

- DMRB TD22/06 gives design standards for single lane roads, but this is in relation to slip/link roads associated with grade-separated junctions. The minimum width stated is 5.3 m including a 1.6 m wide hard strip.
- DMRB TD42/95 gives widths for single lanes with space to pass a stationary vehicle, but these relate to bends rather than straight sections. The width for a 100 m radius is 6.3 m. It is recommended that this additional width only needs be provided on a single lane section greater than 50 m long. For radius greater than 100 m reference is made to TD9 but this doesn't cover single lane roads.
- DMRB TD42/95 gives widths for single track through lanes at ghost island junctions – 3.0 m minimum, 3.65 m maximum, exclusive of hard strips. Hard strips are normally 1 m wide. At a single lane dualling junctions, the through lane should be 4.0 m wide, exclusive of hard strips. This will allow the passing of a stationary vehicle.

There is no general guidance on designing roads in an urban environment to reduce the environmental impact.

A full topographic survey of Street B has not been carried out and all dimensions have been based on supplied Ordnance Survey data. This has been updated by visual observations. Figure 1 shows a plan of the road layout.

The existing width on Street B varies between 6 m and 6.5 m, with the footway adjacent to the relevant properties varying between 1 and 1.5 metres wide. There is just a kerb and a retaining wall on the opposite side of the road.

Following a review of the above relevant design guidance, the recommended design comprises:

- the property facade
- a 1.5 m footway
- a hatched area with variable width between 1.5 m and 2.5 m wide
- a 3.5 m running lane
- a 0.5 m rubbing strip
- a retaining wall

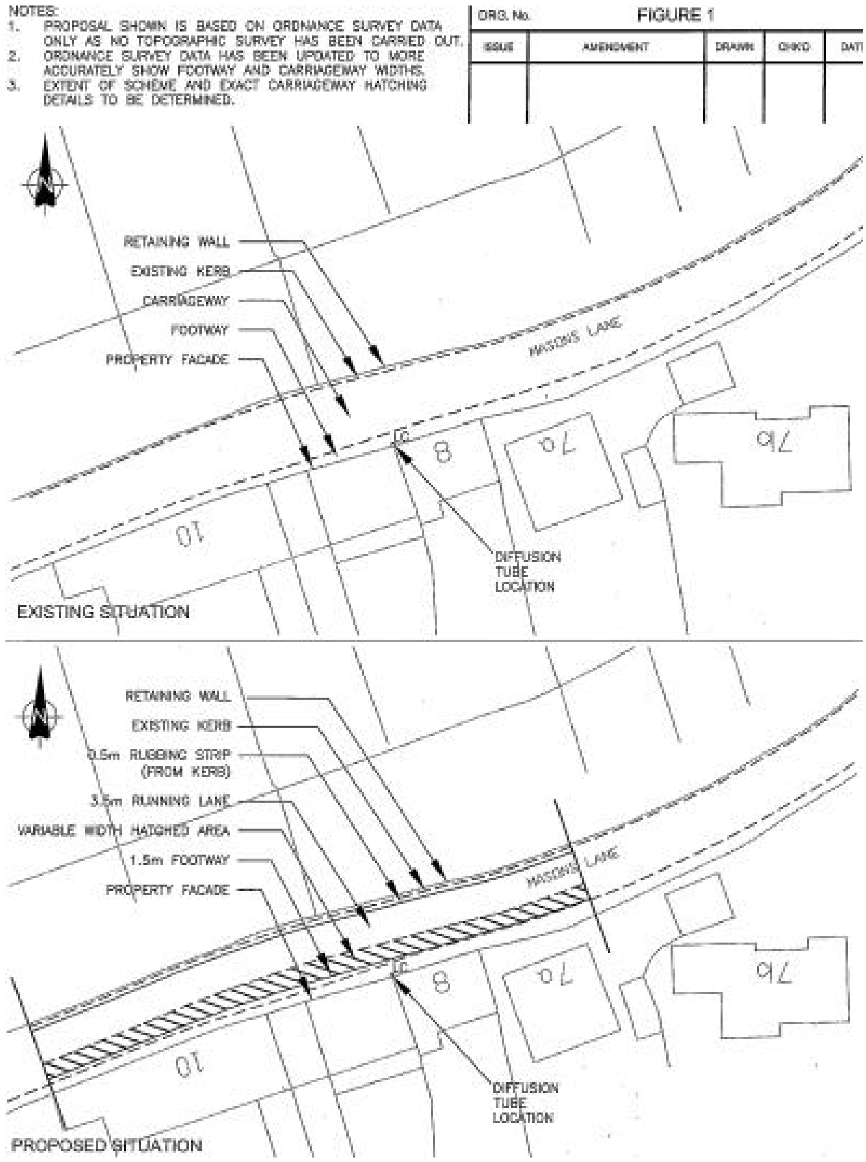

Fig. 1; Plan of current and planned road layout. This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office ã Crown copyright.

The plan shows existing and proposed carriageway layouts immediately in front of the Street B properties, which also shows the location of the existing diffusion tubes.

The proposed layout gives an overall minimum carriageway width of approximately 5 m (including the hatched area), which should be sufficient to allow a vehicle to pass a stationary vehicle, and still leave a reasonable width footway and a margin next to the retaining wall. This places the road centreline a minimum of 4.75 m from the house facade, 0.75 m further away than at present. This could be increased to 5 m if the rubbing strip was omitted and the running carriageway was increased to 4 m. It is not recommended to have a 3.5 m running lane adjacent to the stone wall although this would be greater than the existing situation.

In terms of the length over which this narrowed carriageway is provided, it is suggested that the upper of the two box junctions be included. This would also include the C junction. It could extend to the private access part way up Street B. Another way would be to keep this section as short as possible and manage the uphill traffic so that it receives priority to avoid queuing and any problems within the town centre. Subject to a satisfactory outcome from the air quality assessment, a detailed traffic analysis of capacity, storage, queuing and potential diversion will be the subject of a second stage of scheme assessment.

AIR QUALITY ASSESSMENT FOR PROPOSES SCHEME

The most effective way of reducing concentrations of NO_2 in a straightforward manner is to reduce emissions of NOx by reducing traffic flows. However, traffic flows in Street B are predicted to grow by 9.5% between 2005 and 2010. The other possibility is to move the road within the canyon to increase the distance between the centreline of the carriageway and the property façades. However this option cannot be tested in a straightforward manner with the ADMS-Roads model because the model assumes that the road width is the same as that of the canyon.

In ADMS-Roads the canyon contribution to the concentration comprises two parts: (i) a direct contribution in which the pollutant has travelled directly from the emitter to the receptor and (ii) an indirect contribution in which the pollutant is moving in the recirculating flow in the canyon. The latter depends little on where the source is in the canyon but the former does. However it can be approximately determined how the former direct contribution to NO_X varies with distance from the road by modelling the road source without a canyon using actual road widths and distances form the road to the receptor . It is this procedure that is followed in this case, that is the total concentration is determined as the sum of the direct road contribution without the canyon and the canyon recirculating component.

In street B a receptor was placed where a diffusion tube monitoring nitrogen dioxide had previously been located and which had measured exceedences of the NO_2 annual mean standard. Pollutant concentrations at the Street B receptor were remodelled in accordance with the scheme layout described in Section 2 as part of the changes to Street B. For the 2010 case, this receptor is located 0.75 m further away from the proposed centre line of the road or 4.75m away from the centre line of the road..

Predicted NO_2 concentrations at the Street B receptor for 2005 (base year) and 2010 with and without the canyon are shown in Tables 1 and 2, respectively.

In 2010 the case, which estimated the canyon effect at the Street B receptor using the standard canyon model, the predicted NO_2 concentration remains higher than the UK AQS of 40 $\mu g\ m^{-3}$ in 2010. However as illustrated in Table 2, the reduction in concentration is 4.17 μgm^{-3} in 2010 if the distance from centre line of the road is increased by 0.75 metres. Taking this reduction into account, as the worst-case, the predicted concentration at Street B in 2010 is 39.97 μgm^{-3}. This level satisfies the AQS requirement of 40.0 μgm^{-3}.

Table 1. Predicted NO_2 concentrations for 2005 - Street B Receptor (mgm^{-3}).

Case	Receptor name	NO_2
A	Street B existing layout including standard canyon model	51.94
B	Street B existing layout excluding canyon model	28.30
C	Street B proposed layout excluding canyon model	23.71
D	Reduction due to change in carriageway cross section (B–C)	4.59
E	Street B proposed layout including improved estimates of canyon effect (A–D)	47.35

Table 2 Predicted NO2 concentrations for 2010 - Street B Receptor (mgm^{-3}).

Case	Receptor name	NO_2
A	Street B existing layout including standard canyon model	44.14
B	Street B existing layout excluding canyon model	23.88
C	Street B proposed layout excluding canyon model	19.71
D	Reduction due to change in carriageway cross section (B–C)	4.17
E	Street B proposed layout including improved estimates of canyon effect (A–D)	39.97

CONCLUSIONS AND RECOMMENDATIONS

An air quality assessment has been undertaken using ADMS-Roads for the proposed Single Lane Shuttle Working Scheme for Street B in order to provide a robust justification to develop and implement a demand management scheme to avoid the predicted exceedances of air quality objectives on Street B.

The assessment indicated that the proposed scheme would reduce air pollution and the UK AQS would be met by 2010. It is recommended that the minimum distance between the property façade and centre of the road be increased to 4.75 m for the proposed scheme, compared with 4m at present. This is equivalent to "moving the traffic away from the property". In view of these findings, the assessment proceeded to the second stage, namely the traffic signal capacity assessment of the option.

The paper illustrates how predicted exceedences of an air quality standard can lead to significant air quality management studies even when exceedences are limited to a very small area.

Note: The true locations are not shown in this paper for the purpose of client confidentiality as the scheme is currently under consideration.

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