ENVIRONMENT AGENCY THAMES REGION RESPONSE TO THE DEPARTMENT FOR TRANSPORT'S CONSULTATION: ADDING CAPACITY AT HEATHROW, 22 NOVEMBER 2007

Please find below the EA Thames Region's response to the above consultation.

As the Government's principal environmental advisor we have a responsibility to comment on sustainability issues, on major environmental issues affecting public health and on the environmental impacts of proposed developments where they can potentially have a significant environmental effect, as in this instance, on air quality.

As you will be aware, the Environment Agency has concerns over the proposed expansion of UK airports, set out in the Air Transport White Paper 2003, because of its contribution to climate change and because of the potential for major environmental impacts.

The environmental conditions which must be met before a third runway at Heathrow could be built, or any significant increase in use of existing runways made, were set in The Air Transport White Paper 2003. We previously stated our concerns about the expansion of the airport and the air quality impacts in our submission to the Examination in Public of the further alterations to the London Plan, in July 2007, on the basis of the evidence then available.

This present consultation now attempts to present further work on meeting the environmental constraints with a third runway and increased runway use. Our specific concern in this context is the meeting of the relevant air quality standards.

We have presented this response in three sections:

A. A summary of our response and our conclusions as regards the validity and extent of the information presented.

B. Responses to those questions with overall specific relevance to air quality in the context of our conclusions concerning the consultation.

C. Detail in support of our conclusions. In 5 parts.

A. SUMMARY OF RESPONSE

The key question to be answered for purposes of protecting air-quality is:

Will improvements in road transport emissions create enough headroom to allow aviation activities to intensify without exceeding the EU Directive limit value for annual-average NO_2 ?

The consultation has developed an analysis that suggests that the improvements may be just enough to maintain compliance with the Directive. However, it is not clear how robust this suggestion is in the face of substantive uncertainties that do not appear to have been addressed in the documents including:

- growth of road traffic and its emissions
- effects of meteorological variability and climate change
- future atmospheric chemistry affecting NO_2.

What is being proposed at Heathrow is complex and far-reaching e.g. it includes changes in both the utilisation and number of runways, and extends to 2030. The technical material presented for consultation is rather difficult to follow, not just because of the complexity of the proposal, but also because it is in a series of reports from which information has to be pieced together.

After full consideration of the documents our conclusion is that overall, we do not think that the evidence presented is sufficiently robust to conclude that the proposed Heathrow development will not infringe the NO_2 Directive, bearing in mind the uncertainties that need to be addressed. This is because the assessment of air quality pays insufficient attention to these uncertainties and to the range of possible future scenarios for issues like road traffic, meteorological variability, climate change, background air quality and atmospheric chemistry.

We do not contend that the evidence does not exist to support the case for meeting the air quality requirements, but that, as presented in this consultation, the case is not made. When these uncertainties and scenarios have been considered in more depth it may be possible to conclude robustly that there will be no infringement, but this conclusion cannot yet be drawn from this consultation.

We have therefore tried to make some constructive suggestions about how the material might be made easier to follow, and how the uncertainties in assessing future air quality could be investigated and in some cases reduced. – see Section C.

We also question whether the economic analysis of options for Heathrow is robust. First we wonder to what extent the analysis has taken account of the other elements of the ATWP preferred strategy for South East airports (e.g. a new runway at Stansted), and to what extent these elements may lead to the displacement of any of the identified benefits of expanding Heathrow. Secondly, we are concerned that the greenhouse gas-related costs of all three options for Heathrow (all in the area of £5bn present value) represent a very large proportion of the identified Net Present Value of the options. Given that the greenhouse gas costs must be highly uncertain, it is notable and worrying that a doubling of these costs would more or less eliminate the stated net benefit of expanding Heathrow. Thirdly, we note that the impacts of worsening air quality (even within the identified limits) from expanding Heathrow are not yet monetised, and we urge DfT to complete this analysis as a priority since this may affect the overall economics of the options, given the potential for increased morbidity and mortality over a dense local population.

Section C of our response, Part IV (below) contains more detailed comments on the economic analysis.

B. RESPONSE TO RELEVANT QUESTIONS IN CHAPTER 4 OF THE MAIN DOCUMENT

Question 2

Do you agree or disagree with the Government's view on the continuing validity of the environmental conditions? What are your reasons? Are there any significant considerations you believe need to be taken into account? If so, what are they?

We support the Government's view that the environmental conditions, especially that on air quality, remain valid. The relevant EU air quality limit values, based on the protection of human health, for particulate matter and nitrogen dioxide will be in 2010, (or 2015 assuming a derogation is granted on the approval by the EU of a valid action plan), legal requirements in the UK and therefore must be met.

Possible future changes in atmospheric chemistry should be more comprehensively considered, especially their effects on NO_2 concentrations and the interaction with ozone and climate change effects. See Section C Part III paras 28&29. Consideration should also be given to how the airport is to contribute to the forthcoming requirement to reduce population exposure to fine particles.

Question 3

Do you agree or disagree with the Government's view on adding a third runway and being able to meet air quality limits without further measures? What are your reasons? Are there any significant considerations you believe need to be taken into account? If so, what are they?

We maintain that the case for being able to meet the air quality limits is not made in this consultation - see Section A above and Section C Part III below.

Question 7

Do you agree or disagree with the Government's view that full mixed mode operations could be introduced by 2015 and be compatible with compliance with the air quality limits in the vicinity of the airport? What are your reasons? Are there any significant considerations you believe need to be taken into account? If so, what are they?

We disagree with this, as, again, we contend that the case for this is not adequately made in this consultation – see Section A above. Additionally, para 3.120 of the main consultation document states that, during full mixed mode, there will still be residual areas of exceedence, which could be addressed by "potential alternative measures". Without firm plans and agreed measures we contend that the conclusion that the limit values can be met with full mixed mode cannot confidently be made.

C. DETAILED COMMENT ON PRESENTATION AND DETAIL OF THE CONSULTATION DOCUMENTS

(1) This section is divided into four parts:

PART I : considers the presentation and organisation of the evidence given on the air-quality implications of adding a third runway and changing modes of runway use.

PART II : considers the technical quality of the evidence on air-quality implications.

PART III: draws conclusions and suggests how the quality and scope of the air-quality impact evidence might be improved.

PART IV: presents some technical comments on the Cost Benefit Analysis presented in Annex B to the consultation, particularly the environmental impacts.

PART V: consists of technical annexes.

PART I. Presentation & Organisation of the Evidence

(2) The several technical reports issued in support of the consultation process provide a paper chase between documents. The information is rather scattered between the reports, so it is necessary to alternate between them in order to build up an understanding of the work. The reports are therefore not very user-friendly from an auditing point of view. For example, it would have been more helpful to the reader to have put the evidence on model validation in Demonstrating Confidence report (Atkins, 2007) in a single main air quality assessment report (CERC, 2007).

(3) A flow chart of the modelling strategy showing different components would avoid this. In addition a diagram showing how the various reports are related would help the reader. A timeline of the sequence of studies, their purpose, the sponsors and key reports with their authors would make the evidence clearer to the reader. The reader would then know where the evidence has come from over time.

Nested emission inventories
(4) The emission inventories used for the modelling (CERC, 2007) are very detailed: there is a detailed Heathrow inventory, local regional inventory, a 'Greater London plus' inventory, and the use of background measurements e.g. the Lullington Heath site on the south coast. The question arises as to how are emissions between the south coast and the edge of Greater London included? It would be helpful to have a map or diagram for each inventory date summarising the various nested inventory areas, and the source(s) of data for each area.

Climate change
(5) The area of uncertainty relating to climate factors leads to a Finding 16 (page 28 of Demonstrating Confidence report (Atkins, 2007)) which is an assertion, but has no link to evidence. Which particular evidence of the CERC (2007) report, which is not referenced, or the AQEG (2007) report is being referred to here?

Meteorological data
(6) On page 28 (Atkins, 2007) it says that it was necessary to adjust the 2002 data set because of various instrumental, siting and continuity problems, but this need for adjustment is not explained in the main air quality assessment report (CERC, 2007).

(7) The Demonstrating Confidence report (Atkins, 2007) has no conclusions. The report appears to be incomplete. The report ends with Chapter 4 on page 57. It does not state whether the modelling is adequate. It focuses on the airport signal and says little about the road transport effect, although this is the contribution which is predicted to change greatly by 2030 so that (according to the study) there is sufficient "headroom" available to allow airport/aviation growth without infringing the AQ directive limit.

(8) As an example of the incomplete nature of this report (Atkins, 2007) on page 29 a measure of the boundary layer stability H/L_{MO} is discussed without explaining what this is. This is makes the report difficult to understand.

PART II: Technical Comments

Validation

(9) The contribution from traffic is dominant at most of the monitoring sites. The assessment might have considered looking at periods in the diurnal and weekly cycle, such as Sunday mornings (see page 42 of air quality assessment report (CERC, 2007) for illustrations of the diurnal cycle), which would be more representative of future operations when the road transport contribution is much smaller. One could use these periods to test model predictions for future operations – including predictions of NO_2 chemistry.

(10) Though the performance of the model (CERC, 2007) is good compared with that generally expected in dispersion models this does not apply to all aspects when there is a high airport signal. If one is going to use plots to validate the aircraft signal, one should look particularly at the grounding of the aircraft plume. Monitoring shows a clear tail of direction from elevated plume knockdown during strong south-westerly winds at the site LHR2 in the polar plots on page 60 (CERC, 2007). However the modelling does not show the same strong effect. Measurements greater than modelling at high wind speeds are also shown in Fig. 9.4 on page 59 of the same report (CERC, 2007). There is a fall-off in model performance at high wind speeds. There appear to be points of similarity elsewhere on the plot, but these mainly arise from road transport sources in the rest of London to the E & NE.

(11) The overall statistics of the model performance is related to the behaviour of two categories of sources: airport related and road transport related. The model may perform better with one than another. The comparison of polar plots which is intended to distinguish these two contributions is not quantitative. The over-prediction at low speeds may be associated with the treatment of road transport sources. More could be done to increase confidence in the model.

Meteorological data

(12) There were site and instrument changes in 2002 as explained in the PDSH (2006) report Annex 3 page 266. This is not mentioned in the main air quality assessment report. The good agreement in 2002 may be fortuitous. Why not repeat the model validation for other years? There is measured data for other years. The question arises as to how representative is 2002? In fact 2003 gives worse air quality (see page 51 of PDSH report and pages 20-21 of Demonstrating Confidence report (Atkins, 2007)). Sensitivity analysis to investigate how inter-annual variability effects air quality is easy to perform and has been done in many other studies.

(13) Changes may occur in future in the surface roughness around Heathrow (as they have in the past) in both over time and in geographical area. Changes in the heat island effect from further urbanisation will affect atmospheric stability, further reducing the occurrence of night-time stable boundary layers. Changes in climate may affect the occurrence of higher wind speeds – which tend to increase the air-quality impacts of aviation by knocking thermally-buoyant aircraft plumes down towards ground level. The occurrence of photochemically elevated conditions may change. None of these possibilities are discussed in the modelling report (CERC, 2007). These changes are recognised in Section 4.2, on page 29 of Demonstrating Confidence report (Atkins, 2007) which acknowledges that changes may occur but the report goes on to contradict comments on page 28 of the same report which discounts climate variations. This also contradicts the AQEG (2007) recommendation. The issue is not investigated further. The model should have been re-run the model in other years with different meteorology. By 2050, it is thought that conditions similar to 2003 will be the norm. The assessment year 2030 is not too distant from 2050.

(14) There are two categories of sources: road transport and airport. The former is worse in light easterly winds; the latter is worse in strong westerly winds. Nowhere in the air quality assessment is this interplay investigated in the context of (a) inter-annual variability, or (b) climate change.

Emissions

(15) There is uncertainty in the performance of emission control technology for road vehicles in the future. One cannot be certain, for example, of the vehicle mix. However, the assessment reports place great emphasis on airport emissions with a very detailed treatment. In contrast, little information is provided on the emissions inventory for the road transport emissions outside the airport and how this may change in future. It is difficult to understand how the emission reductions by 2030 from road transport are derived. See paragraphs 31 to 33 of Annex 1 to these comments, which suggest that the emission reduction is larger that estimated in other studies. No detail is given. The treatment of the airport emissions is considered to be disproportionate. The uncertainty in the estimate of emissions should be discussed in more detail. We would expect there to be sensitivity analysis of alternative plausible road-traffic scenarios, in order to show how robust the conclusions for air quality are.

(16) The explanation of emission inventory boundaries is unclear. The inclusion of shipping in the inventory shows that it goes beyond 'Greater London plus', but there is no explanation of any treatment of the wider south-east. Fig. 4.12 and Fig. 4.13 of Demonstrating Confidence report (Atkins, 2007) discusses different ways of using the runways, reducing the tail in the probability distribution of exceedences, but the report ignores uncertainty in road traffic behaviour e.g. penetration of diesels, setbacks such as increases in primary NO_2 as a result of fitting particulate traps. The treatment of uncertainty in the published reports is considered to be partial and ignores major uncertainties.

(17) Background concentrations are treated using measurements chosen according to the direction recorded by the Heathrow wind vane. This may not be representative of the synoptic air movement. In addition there is a time lag while the air crosses from the background stations situated towards the rural/maritime edge of the SE Region (at Harwell, Wicken Fen, Rochester and Lullington Heath) to Heathrow. There is no consideration of uncertainties in the estimates of future background concentrations.

NOx chemistry

(18) There is insufficient explanation of the NO_2, NOx and ozone methodology. There is not enough description of the processes, assumptions and limitations which underlie the formulae used on page 9 of the main AQ assessment report (CERC, 2007) or of the three step rationale for background air. Are the factors from the LAQM tools appropriate for getting rural background concentrations? The NO_2:NOx relationship (step 2) in background air is taken to be fixed at 2002 levels although ozone is expected to increase by 3ppb according to Table 3.1 of the report on page 10. There is no explanation of the rationale for excluding 10% of the NOx from the oxidant or for assuming that this will stay the same in future. There must be some relationship between the NO_2, NOx and ozone; changing ozone will change NO_2 but this is not apparent from the formulae. The increase of 3ppb in background ozone leads potentially to an increase of 6µg/m^3 in the NO_2 concentration. The hemispheric ozone chemistry is running contrary to the benefits of local NOx emission abatement. There is no explanation of step 3 on page 9 of the report (CERC, 2007).

(19) AQEG (2004) has adopted an alternative approach to NOx and ozone. This can lead to significant differences and goes to emphasise that the atmospheric chemistry uncertainties need to be more clearly investigated. See paragraph 37 of Annex 2 to these comments which concludes that there may be much wider areas of exceedence of the NO_2 limit value in 2030 than suggested in the air quality assessment report (CERC, 2007).

(20) The Demonstrating Confidence report (Atkins, 2007) on page 28 recognises that changes in ozone can change the relationship, but the report does not comment. There is no discussion or comment on the chemistry scheme in ADMS, although the PDSH report states that uncertainty in model input parameters will become more uncertain. (See also page 28 of

the Demonstrating Confidence report (Atkins, 2007) which says increased summertime temperatures could lead to higher ozone but then makes no conclusion or further comment). Page 34 of the PDSH report specifically mentions that increasing primary NO_2 and background ozone could affect NO_2 concentrations. The former process (CERC, 2007) is described explicitly, but no mention is made of the latter. The lack of a detailed description of the chemistry scheme, and of its applicability to the Heathrow situation, contrasts with the detailed description of the aircraft modelling in the Appendix.

(21) The future of ozone could change predictions severely and invalidate the results for 2030. Without detailed justification and explanation of the methods one cannot have confidence in the predictions.

(22) The report could look at ozone chemistry on Sunday mornings. This time of week/day could be a useful surrogate for future chemical conditions in the atmosphere, because present road traffic emissions on Sunday mornings may approximate to future weekday emissions after the introduction of improved technologies. This would be a good way of validating the chemistry performance under future conditions.

PART III Conclusions & Suggested Improvements

Documentation
(23) This is fragmented and difficult to follow. Information on the same topic is distributed between several reports which rely on earlier studies without always explaining the earlier work. It is difficult to audit the conclusions and the thinking behind the methods used. The material would benefit from simple schematics to explain the sequence of and relationships between technical activities e.g. a nested map of emission domains, a timeline of studies and documentation including earlier work, a flow chart showing how model inputs were collated and scenarios developed.

Emissions fields
(24)It is not readily apparent how the various inventories are composed, nested, and then related to background influx estimates (background concentrations). The inventories appear to extend only as far as the 'Greater London plus' area so that emissions in the rest of the south-east of England are not explicitly modelled or are perhaps incorporated in background values. However the background values are at outlying sites e.g. Lullington Heath near the south coast, so there may an annulus of home county emissions which are not treated explicitly? A map of nested emission domains would clarify this.

Meteorology
(25)There does not appear to be a clear rationale for the choice of 2002 meteorology. There were changes to the instrumentation, height, and siting of the Heathrow meteorological station during 2002 which compromise the homogeneity of the record. The issue of meteorological variability from year to year does not seem to be addressed.

Air pollution: base case year and background monitoring
(26) There is no rationale for the choice of 2002 as a representative year for air quality. In fact air pollution levels were higher in 2003 which it could be argued is the hotter, more photochemically active year which may become more common in the period under discussion, 2030 and beyond. The use of outlying monitoring stations introduces potential errors including the time lag between the measurement and the arrival of that air mass in the Heathrow area.

Road traffic emission projections
(27) The key finding of the study is that future road traffic growth will be offset by technological improvement so that NOx contributions from this sector decline markedly allowing headroom for Heathrow development. It is therefore very important that the basis of the road traffic emission projections is fully explained. There is extensive explanation of the airport emissions, but this is not matched by similar explanation of the road traffic emissions. These explanations need to be presented in a convenient format and should cover the assumptions and uncertainties including diesel penetration of the fleet and primary NO_2

emissions. In view of the importance and uncertainty of road traffic emissions it is surprising that there is not a spread of future scenarios covering different plausible projections of road transport emissions, with which to test the robustness of the conclusions.

Atmospheric chemistry
(28) The conversion of NO to NO_2 is a key consideration for EU Directive compliance. Although equations are given there is not enough explanation of the processes, assumptions and limitations covered by these formulae. It is not clear how future background ozone changes are treated though these are clearly important. This is another important aspect of air quality that could affect compliance, and where there are substantive uncertainties that are best treated using a range of scenarios.

Climate change
(29) The reports have an equivocal outlook on climate change. On the one hand they acknowledge that this can affect the meteorology and the atmospheric chemistry, including such processes as the high-windspeed knockdown of aviation plumes and secondary NO_2 formation. On the other, they conclude from the AQEG report (2007) that there is no need to consider such climate change effects. This is a surprising interpretation as others have concluded from the AQEG report that climate changes should be considered in air quality assessments of major long-term infrastructure proposals [e.g. Air Quality Management, Issue 136, May 2007]. Moreover, climate change can affect the relative contributions of aviation and road transport because higher (lower) wind speeds can increase (decrease) the impacts of emissions from aviation (road traffic); however, this redistributive effect of climate change is not examined.

Model evaluation
(30) The reports may have overlooked some specific opportunities to test model performance in future pollution climate situations. The relationship between aircraft and road impacts in the future, 2020-2030, is broadly comparable to the prevailing relationship at certain times of day each week. Specifically the emission ratios on Sunday mornings, now, are comparable to those that will occur during most working hours in 2020-2030. The models should be explicitly validated for these comparable conditions and, in particular, the chemistry should be tested. The bi-variate plots of wind speed, direction and concentration suggest that that the model does not well reproduce monitored high speed knockdown of aviation plumes. Again the model should be explicitly validated for those situations with a high aviation signal.

Uncertainty
(31) There needs to be a clearer and more explicit treatment of key uncertainties. Specifically one would expect the sensitivity of results against different choices of meteorology, road emissions and atmospheric chemistry schemes to have been investigated. The case that Heathrow development will not infringe the NO_2 Directive is not established given the uncertainties which need to be addressed.

PART IV: Technical comments on the Cost Benefit Analysis of Capacity Expansion: Environmental Impacts

(32) Three expansion options are considered.

(33) Options 1 and 2 lead to climate change impacts of £4.8bn over the 70 year appraisal period and to noise impacts of £0.3bn. Option 3 leads to climate change impacts of £5.0bn over the 70 year appraisal period and noise impacts of £0.3bn.

(34) Note that these impacts do not include noise and GHG emissions generated by additional surface transport.

Climate change impacts
(35) Any of the three options for the airport will result in increased carbon emissions. It is unclear how the GHG emissions have been valued or indeed how they ought to be valued.

Since GHGs are a stock pollutant the social cost of carbon rises through time as concentrations rise. It is therefore inappropriate simply to take the current social cost of carbon and discount it for future emissions, if this is indeed what has happened. It may anyway be inappropriate to value emissions using the social cost of carbon if the UK adopts a voluntary emissions target. In this case the appropriate value for emissions would be the marginal cost of meeting that self-imposed constraint. There is enormous uncertainty regarding the social costs of carbon which does not seem to be reflected in the range of figures presented in the consultation document. Doubling the estimates for the social costs of carbon would make the net present value of the three schemes essentially zero.

(36) There are arguments for postponing irreversible investment decisions in the face of uncertainty.

Noise nuisance

(37) Under the three options considered some individuals will experience reduced noise nuisance but more will experience increased noise nuisance.

(38) The marginal willingness to pay for the avoidance of noise increases nonlinearly. The calculations however appear to assume that the willingness to pay for a unit increase in noise levels is independent of the current level of noise experienced by the household which may have the effect of depressing the overall estimate of noise nuisance. There is no good evidence to show how individuals' assessments of noise nuisance might increase over time although this is critical to determining the present value.

(39) Noise nuisance should be evaluated by primary research looking at the relationship between house prices and noise levels around Heathrow.

Air quality

(40) The effect of these schemes on local air quality has not yet been fully examined and hence not included in the cost benefit analysis.

(41) It is likely that worsened air quality (relative to base) will result in increased morbidity and mortality impacts as well as a range of other impacts. These air quality impacts will be present irrespective of whether air quality remains within EU guidelines and are likely to be especially important given the very high population density of the SE region.

(42) This is likely to be a very significant omission and quantitatively of far greater importance than noise nuisance.

Other impacts

(43) Impacts arising from the loss of heritage sites and visual intrusion have not been valued.

(44) Impacts arising from the loss of biodiversity have not been valued.

(45) Impacts arising from the possible contamination of surface water and groundwater have not been valued.

(46) Impacts from additional surface transport have not been included.

PART V: Annexes

Annex 1 Reduction in emissions 2015-2030

(47) The report demonstrates clear reductions in NO_2 concentrations from road transport sources in the Heathrow area by 2030. This is already seen in the results of the National Strategy (2007, Volume 2 page 54) showing changes in London using the same ADMS model as this report and differences between 2001 and 2020. The AQEG report (2004) on NO_2 illustrates the projected reductions in NOx from urban road transport, on page 74. The AQEG report, page 323, gives specific numbers on urban road transport, which is seen to reduce

from 233kt in 2002 (Strategy Volume 2 page 120) to 113kt in 2025 reflecting little change from 2015 and no assumptions beyond Euro 4. This is a reduction of 50%.

(48) The National Air Quality Strategy (page 172) suggests that Euro 6 and VI would reduce emissions by 100kt from the baseline. Assuming that road transport contributes 700kt in 2002 and 322kt in 2025 (AQEG, 2004 page 323) and the introduction of Euro 6 and VI would reduce emissions by a further 100kt, the road transport reduction ratio is about one third [(322-100)/700 = 32%].

(49) These reductions to 50% and 32% should be compared with the reductions quoted in the report:
(a) between 2002 and 2030 the reduction of emissions from Heathrow roads is to 19% [665 t/y/3571 t/y].
(b) between 2002 and 2030 the reduction of emissions from Greater London roads is to 18% [9728 t/y/55072 t/y].
These reductions are the main factor driving the conclusions from the report and they require further justification. The report should also explore the effect on air quality of assuming alternative (lesser) reductions, such as those cited above.

Annex 2 NO_2 to NOx relationship

(50) AQEG (2004 page 159) recommend the following relationship to calculate nitrogen dioxide concentrations from the modelled oxides of nitrogen concentrations:

$$[NO_2] = f\{NO_x\}$$

where $f\{NO_x\}$ the AQEG relationship is derived from:

$$[NO_2]/[Ox] = (1.015 \times 10^{-1}) + (1.367 \times 10^{-2}\ [NO_x]) - (6.127 \times 10^{-5}\ [NO_x]^2) - (4.464 \times 10^{-8}\ [NO_x]^3)$$

over the applicable range, 19 to172 µg m^{-3} NO_x as NO_2 (10 to 90 ppb), where inclusion of a specified applicable range avoids problem of the curve turning negative, and where [Ox] is the total oxidant concentration given by

$$[Ox] = A[NO_x] + B$$

where B represents the regional Ox concentration, B = 35.7 ppb, and A=0.09 is the proportion of NO_x emitted from the source as nitrogen dioxide.

(51) Various polynomials showing the dependence of NO_2 on NO_x are shown in Fig. 1 below. These demonstrate that considerable uncertainty is associated with this aspect of the calculation.

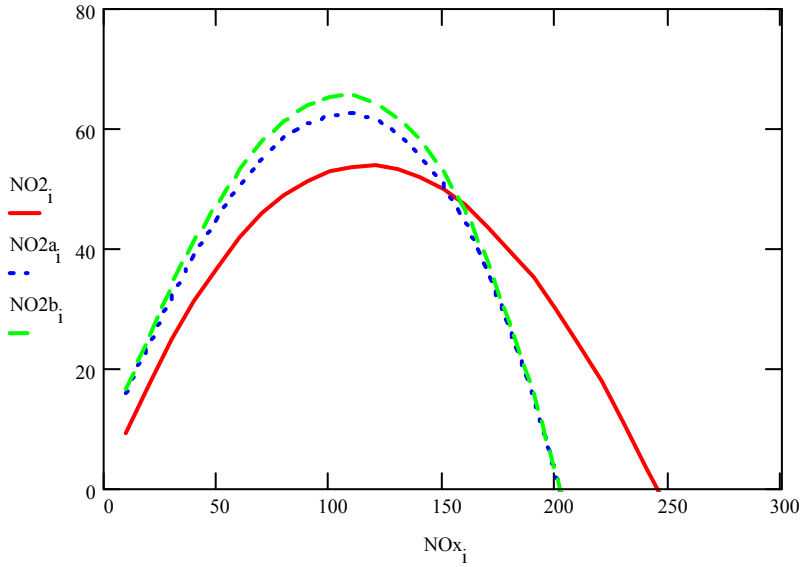

Figure 1 Polynomial used in the main air quality assessment report (red line, CERC 2007) compared with the AQEG (2004) polynomial (blue line) and the AQEG polynomial assuming a 2ppb increase in background ozone (green line)

(52) One sees that for sufficiently large NOx the NO_2 concentrations turn negative. This suggests that the relationship quoted in the air quality assessment report (CERC, 2007) applies to long-term average concentrations (which are lower) rather than to hourly concentrations as stated in the report. This raises a possibility that there may be some inconsistency between the relationship (long-term average) and the time base required for hourly pollutant estimates.

(53) One can consider the relationship between NO_2 and NOx in Fig.1 in more detail.

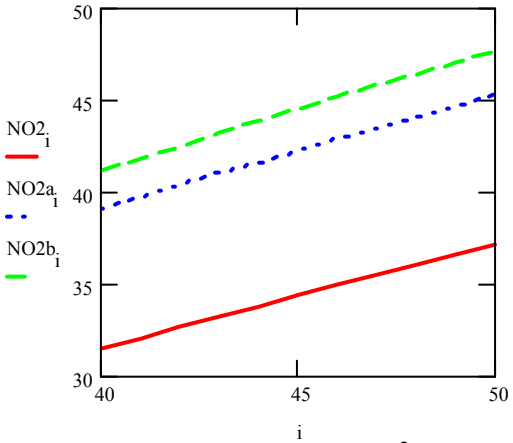

Fig. 2 Relationship between NO_2 and NOx near the 40 µg/m^3 limit value for the polynomial used in the air quality assessment report (red line, CERC 2007), the AQEG (2004) polynomial (blue line) and the AQEG polynomial assuming a 2ppb increase in background ozone

Around year 2030 the map of predicted NO_2 concentration shows a considerable area subject to a concentration of 35 µg/m^3 or more, corresponding to about 46 µg/m^3 NOx. Fig. 2 show the relationship between NO_2 and NOx in this region of concentration for the three polynomials plotted in Fig. 1. The difference between the AQEG and modified AQEG polynomial are sufficient to bring concentrations above the 40 µg/m^3 limit value, suggesting that concentrations over a much larger area than that shown in the plotted maps for 2030 (CERC, 2007), exceed the limit value.

References

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