**Centre for Environmental Policy**
**Faculty of Life Sciences**
**South Kensington Campus**
**Imperial College London**
London SW7 2AZ

To The Rt Hon Lilian Greenwood MP
Chair of the Transport Committee 3 February 2018

In answer to points raised in your letter of 22 January:-

The first point concerned the figure of 121,377 people being affected by higher NO2 concentrations for the Heathrow North-West runway scheme- a figure which I apologise for not remembering. The contribution of the airport emissions falls off strongly with distance, and is quickly dominated by the background from other sources. Hence a 2km wide belt surrounding the proposed scheme area was selected as the "Principal Study Area". Outside this any detectable impact of the airport would be close to roads from extra traffic associated with the airport. Hence outside this zone we also looked at roads where the traffic modelling suggested increases in traffic. The population of 121,377 people corresponds to the population within the Principal Study Area, and a detailed break-down of the extent to which they are affected is given in table 5.6 of the Airports Commission report of May 2015 " Local Assessment: Detailed Emissions Inventory and Dispersion Modelling". This was the table I remembered and referred to on 18th December, although I did not recall the figure for the total population. Table 5.7 gives estimated road-side concentrations outside this area with respect to any delay in compliance with limit values, where the Bath Road case is very dependent on the changes in the local road scheme round an extended airport.

Your second query concerned damage costs and monetisation of health impacts. This was a difficult topic for the Airports Commission study because of limitations in the official IGCB guidance at the time with respect to $NOx/NO_2$. Both small particles and NO2 are associated with health effects, and emissions of NOx contribute to both. This is because in addition to the very localised exposure to NO2, chemical reactions in the atmosphere convert the NOx to secondary nitrate particles as the air travels longer distances down-wind, which affect populations further away in the UK and other countries. These long-range effects of NOx are not very sensitive to the location or character of the emissions, and hence using a fixed damage cost per ton is excusable even though the resulting damage cost exceeds £50 million- the threshold above which more detailed assessment of dispersion and exposure are recommended in the full impact pathway approach. By contrast the exposure to NO2 is very dependent on the spatial pattern of emission and concentrations, and the density of the local population. Hence detailed modelling of concentrations and exposure reflecting the pattern of emissions is much more important.
The Defra damage cost per ton of £1037 of NOx only applied to the long range secondary particle part of this, and excluded the direct local NO2 effects- hence giving a small value for the damage costs of the NOx emissions compared with the primary particulate PM10 emissions. This is an underestimate, and was because at the time Defra had not determined

how to quantify the health risks of the local exposure to NO2, even if such exposure had been calculated. However recent studies by WHO (the HRAPIE and REVIHAAP studies) had reviewed the epidemiological evidence and this had been used in studies for the European Environment Agency and others to estimate health impacts from NO2 exposure. Evidence provided by Mike Holland, an environmental economist, suggested that these additional health impacts could be a substantial addition for NOx emissions despite large uncertainties- as reflected in table 5.8.

The new evidence from the WHO studies was considered by COMEAP (Committee on Medical Effects of Air Pollution) and on the basis of their interim advice on health risks, Defra published a report "Valuing impacts on air quality: updates in valuing changes in emissions of oxides of nitrogen (NOx) and concentrations of nitrogen dioxide (NO2)" in September 2015. Unfortunately there were erroneous assumptions in this report as well as uncertainties about distinguishing effects of NO2 itself when combined with other pollutants – so called "double counting". This is the report from which you have taken the value of £64,605 per tonne based on road transport in outer London (within a range £25,842 to £103,842 which does not reflect the full range of uncertainties). One additional factor to remember here is that a lot of the emissions from an airport are not as close to the public as roads, and aircraft once off the ground give much diluted concentrations at ground level. So it is important to distinguish airside emissions from traffic emissions associated with the airport. These are all reasons why using a value of £64,605 would be far too high.

More recent assessment by COMEAP, including the "double counting" aspects have resulted in revised advice to Defra, which has been used in their more recent report on the "UK plan for tackling road-side concentrations" in July 2017. Appendix A of the technical report on this work reproduces this advice, and is attached at the end of this note. It suggests that a considerably lower factor of .25 to .55 should be applied to adjust for double counting. This is what I am currently using in my own work for Defra in other contexts. Unfortunately it needs estimates of mapped concentrations and resulting exposure in order to apply it, and as you point out this was not included in the study for DfT ( but should be included in future assessment). I have no idea how DfT can have calculated their value- it seems quite wrong!

I should add that Defra recently commissioned Ricardo to recalculate damage costs including those for NOx/NO2, and will be revising their guidance on this. I have seen draft figures, and suggest you contact Defra directly to obtain them, although they are based on the PCM model whose treatment of airport contributions is very crude. A proper assessment needs a specialised model like ADMS-Airports, which is the model we used for the Airports Commission work and which is currently being used by Heathrow.

I am sorry I cannot give a simpler answer!

Yours sincerely

Helen ApSimon (Professor of Air Pollution Studies)

From Defra Technical report on UK plans for tackling road-side concentrations.

# Annex A – Refined COMEAP recommendations letter

c/o COMEAP Secretariat
Air Quality and Public Health Group
Public Health England
Chilton
Didcot
Oxfordshire

Dr Thérèse Coffey MP
Parliamentary Under Secretary of State for the Environment and Rural Life Opportunities
Department for Environment, Food & Rural Affairs
Nobel House
17 Smith Square
London
SW1P 3JR

14 July 2017

Dear Dr Coffey

**Refined COMEAP recommendations for quantifying mortality effects on the basis of long-term average concentrations of nitrogen dioxide ($NO_2$)**

This letter summarises current thinking of the Committee on the Medical Effects of Air Pollutants (COMEAP) on the association between long-term average concentrations of nitrogen dioxide ($NO_2$) and mortality risk. We previously (July 2015) provided interim recommendations to assist Defra when developing plans to improve air quality. This letter presents updated recommendations that arose from discussion at the COMEAP meeting held on 24 February 2017.

**Summary**

1. Population-based studies following people's health over several years show statistical associations between higher long-term average concentrations of ambient $NO_2$ where people live and increased mortality risk. It is likely that some of this effect is due to $NO_2$ itself. However, as other co-emitted pollutants, e.g. from traffic, are also high in the same places, these could also be responsible to some extent. In our view, the available evidence and methods do not allow us to make a reliable assessment of the size of the effect which is attributable to $NO_2$ itself.

2. We therefore recommend two different approaches for assessing the mortality benefits of interventions intended to reduce $NO_x$ emissions from traffic: 80

- For interventions which reduce all traffic-related air pollutants, use the statistical association obtained from population studies. In this case, $NO_2$ is regarded as acting as a marker for the effects of the traffic pollutant mixture overall, including $NO_2$.
- For interventions which primarily target emissions of $NO_x$, use 25-55% of the statistical association obtained from population studies. This is, in our judgement, the likely extent to which this association represents effects causally related to $NO_2$. This is more uncertain than assessing traffic pollutants as a mixture.

**Background**

3. In our March 2015 *Statement on the evidence for the effects of nitrogen dioxide on health*[81] we noted the strengthening evidence linking $NO_2$ with health effects. We concluded that:

81 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/411756/COMEAP_The
_evidence_for_the_effects_of_nitrogen_dioxide.pdf

*i. Evidence of associations of ambient concentrations of $NO_2$ with a range of effects on health has strengthened in recent years. These associations have been shown to be robust to adjustment for other pollutants including some particle metrics.*

*ii. Although it is possible that, to some extent, $NO_2$ acts as a marker of the effects of other traffic-related pollutants, the epidemiological and mechanistic evidence now suggests that it would be sensible to regard $NO_2$ as causing some of the health impact found to be associated with it in epidemiological studies.*

4. At that stage, we did not draw conclusions on specific health outcomes nor look in detail at the methodological issues relevant to quantification of effects associated with ambient $NO_2$.

5. We were subsequently asked to propose approaches to quantifying mortality associated with long-term average concentrations of $NO_2$. This was primarily needed to provide Defra with a method for assessing the potential mortality benefits of measures to reduce $NO_2$ concentrations, to assist with the development of plans to improve air quality. In July 2015, a COMEAP working group provided interim recommendations to your predecessor as Parliamentary Under Secretary, Mr Rory Stewart. As well as recommending an interim recommendation for a coefficient, the letter explained that:

*"…there is uncertainty in the extent to which the association between long-term average concentrations of $NO_2$ and mortality is causal. It is likely that some of the effect is due to $NO_2$, but other co-emitted pollutants could also be responsible to some extent. Therefore, the uncertainty in applying a coefficient to assess the health benefit of measures to reducing $NO_2$ will depend on the extent to which the measure is specific to $NO_2$, or also reduces concentrations of other coemitted pollutants. There is likely to be more uncertainty when the measure is specific for a reduction in $NO_2$, compared to when an intervention aims to reduce the whole mixture of air pollutants."*

6. In our *Interim statement on quantifying the association of long-term average concentrations of nitrogen dioxide and mortality* published in December 2015[82], we 81

82
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/485373/COMEAP_NO
2_Mortality_Interim_Statement.pdf

explained the additional work that we were undertaking to refine our recommendations. These included carrying out a systematic review and meta-analysis of epidemiological studies of long-term average concentrations of $NO_2$ and all-cause mortality. We noted that, in interpreting these, a number of scientific and methodological challenges needed to be considered, including the extent of independence of the associations of mortality with $NO_2$ and $PM_{2.5}$. We also noted the uncertainty in the extent to which the association between long-term average concentrations of $NO_2$ and mortality was causal.

**Recommendations arising from COMEAP meeting held on 24 February 2017**

7. We have discussed these complex scientific and statistical issues on several occasions since the publication of our interim statement. The Committee has not been able to come to a consensus view on how the epidemiological associations between $NO_2$ and mortality can be used to either predict the benefits of interventions to improve air quality or to estimate the current mortality burden imposed on the UK population by air pollution.

8. Some Members are doubtful that the evidence is sufficient to allow a robust recommendation for quantification to be made. This is particularly the case for effects likely to be caused by $NO_2$ itself. Others think it important to make an estimate of the possible mortality benefit from reducing $NO_2$ concentrations. They note that to recommend against undertaking quantification would have the same consequence, for policy development, as assuming that there would be no mortality benefit, which they do not consider to be likely.

9. We last discussed this issue as a Committee at a meeting held on 24 February 2017. We considered possible uses of the epidemiological associations (coefficients) between long-term average concentrations of $NO_2$ and mortality effects. For assessment of the benefits (impacts) of interventions to reduce emissions, we discussed the use of these coefficients to:

a. Predict the benefits of interventions which reduce all traffic-related air pollutants

b. Predict the benefits of interventions which primarily target emissions of nitrogen oxides ($NO_x$)

10. For both these types of intervention, we also discussed (c) assessing the benefits associated with reductions in secondary nitrate concentrations arising from reductions in $NO_x$ emissions.

11. We also discussed

d. Estimating the mortality burden attributable to current concentrations of air pollutants

***a. Predicting the benefits of interventions which reduce all traffic-related air pollutants***

12. We have derived a summary coefficient linking long-term average concentrations of $NO_2$ with all-cause mortality, by undertaking a meta-analysis of associations reported in cohort studies. We used associations from single-pollutant models (ie with no attempt to adjust for effects associated with correlated pollutants) in this analysis. This summary 82

coefficient reflects the effect of $NO_2$ and also, to some extent, other pollutants with which $NO_2$ is correlated. These include $PM_{2.5}$, other fractions of particulate matter (PM), and other components of the air pollution mixture. In particular, associations with $NO_2$ are likely to reflect the effects of the mixture of traffic-related pollutants.

13. Interventions that would reduce traffic movements, or remove traffic altogether, would reduce the whole mixture of traffic-related pollutants. Some other interventions, such as replacing Euro 3/III vehicles by Euro 6/VI, would also reduce emissions of a number of other potentially causal pollutants/metrics (eg volatile organic compounds, aldehydes, organic compounds bound to primary PM) as well as reducing $NO_x$ emissions.

14. We recommend that the summary unadjusted $NO_2$ coefficient of 1.023 (95% CI: 1.008, 1.037) per 10 $\mu g/m^3$ annual average $NO_2$ is used to estimate the effect on mortality of reductions in the whole pollution mixture.

15. Furthermore: as these measures will also reduce PM concentrations, an alternative calculation of benefits associated with this reduction, using an unadjusted $PM_{2.5}$ coefficient can also be undertaken. Discussion at the meeting held on 7 June 2017 confirmed that our recommendation is to use a coefficient of 1.06 (95%CI: 1.04 - 1.08) per 10$\mu g/m^3$ annual average $PM_{2.5}$ derived from a meta-analysis of single pollutant studies (Hoek et al, 2013)[83]. As either of these calculations is likely to underestimate the likely benefits of interventions, the higher of the two values calculated from these two approaches can be used as the most appropriate estimate of the predicted benefits.

83 Hoek, G., Krishnan, R. M., Beelen, R., Peters, A., Ostro, B., Brunekreef, B. & Kaufman, J. D. 2013.
Long-term air pollution exposure and cardio- respiratory mortality: a review. *Environ Health*, 12, 43.

***b. Predicting the benefits of interventions which primarily target emissions of $NO_x$***

16. Some interventions are primarily targeted at reducing $NO_x$ emissions, and would have little impact on emissions of other traffic-related pollutants. Using the unadjusted coefficient to predict the mortality benefits of these interventions would produce an over-estimate.

17. We have discussed whether it would be possible to use epidemiological associations for $NO_2$ reported from two-pollutant models (with PM) to refine the summary coefficient. These coefficients would be adjusted, as far as possible, for effects associated with PM, especially $PM_{2.5}$. In our view, the available evidence and methods do not provide a satisfactory basis on which to reliably propose an adjusted coefficient. It should be noted that even a coefficient adjusted for effects more closely associated with $PM_{2.5}$ concentrations than with $NO_2$ would not reliably reflect the size of the causal effect of $NO_2$ itself: the adjusted coefficient would also reflect effects of other pollutants which are more closely spatially correlated with $NO_2$ than with $PM_{2.5}$, such as ultrafine particles, primary combustion particles, volatile organic compounds etc.

18. The majority of Members therefore considered it preferable to use expert judgement to make a recommendation as to how the benefits of interventions that primarily target $NO_x$ could be estimated. We considered it likely that the effect of $NO_2$, itself, on mortality was likely to be in the range of 25 – 55 % (mid-point of range 40%) of the unadjusted coefficient of 1.023 (95% CI: 1.008, 1.037) per 10$\mu g/m^3$ annual average $NO_2$, and recommend that this be used in assessments of interventions that primarily target $NO_x$ 83

emissions. This is equivalent to reducing the unadjusted coefficient by 20% (an approximate adjustment for effects associated with $PM_{2.5}$ concentrations, based on two-pollutant models) and applying expert judgement, inferred from other types of evidence, suggesting that 30-70% of this adjusted coefficient may be caused by $NO_2$ itself, rather than other correlated (e.g. co-emitted) pollutants.

***c. Assessment of effects associated with secondary nitrate***

19. For both types of intervention, we consider it appropriate to, additionally, assess mortality benefits associated with reductions in secondary nitrate concentrations arising from the reductions in $NO_x$ emissions. Because secondary nitrate concentrations occur some distance from the source of NOx emissions, effects associated with them would not be represented by the $NO_2$ coefficient.

20. We recommend using the unadjusted coefficient 1.06 (95%CI: 1.04 - 1.08) per 10μg/$m^3$ annual average $PM_{2.5}$.

***d. Estimating the mortality burden attributable to current concentrations of air pollutants***

21. We do not think it appropriate to try to estimate the mortality burden attributable to current concentrations of $NO_2$ alone. In numerical terms, the same coefficient could be applied to impact or burden calculations. However, several Members felt that there were differences in terms of how the results are used. Burden estimates may include estimation of effects at low concentrations (typically, impact estimates do not) where there is a lack of certainty whether $NO_2$ increases mortality and/or over the shape of the concentration-response relationship. Impact calculations typically involve comparisons across policies. The uncertainties may not affect the relative comparisons whereas burden has a more absolute status. Burden calculations may be publicised in the media without the associated uncertainties. Finally, the main interest is in the overall burden associated with air pollution as a whole, as a general impetus for action, rather than the effects of particular pollutants.

22. Some Members do not think it appropriate to try to calculate an overall burden of the mortality associated with the air pollution mixture. Others are of the view that an attempt can be made based on associations with $NO_2$ and $PM_{2.5}$, and using information from two-pollutant models. This could be presented as a range of central estimates, but methods to represent the full statistical uncertainty are unlikely to be available.

***Provision of these recommendations to Defra***

23. Summaries of these draft recommendations were provided to Defra officials following the COMEAP meeting held on 24 February 2017. It was noted that they were subject to confirmation by the Committee, and that a number of caveats would need to be borne in mind when any calculations were undertaken.

**Next steps**

24. These recommendations remain draft until they are formally signed off by Members during finalisation of our report. We are currently working to develop a version of the report which will present the recommendations agreed by the majority of Members. It will also reflect the full range of contrasting views held across the Committee. 

We hope these draft recommendations are useful for your revised cost-benefit analyses of measures to reduce $NO_2$ concentrations.

Yours sincerely

Professor Frank Kelly, COMEAP Chair Professor Roy Harrison, COMEAP $NO_2$ Working Group Chair

Dr Heather Walton, COMEAP's subgroup on Quantification of Air Pollution Risks Chair

CC: Mr Jesse Norman MP, Parliamentary Under Secretary of State for Roads, Local Transport and Devolution