AIR QUALITY EXPERT GROUP

Defra – AQEG engagement meeting on the $PM_{2.5}$ target setting process.

This short document provides some early feedback from the Air Quality Expert Group (AQEG) on the $PM_{2.5}$ target setting work plan, presented by Defra on 28th May 2020. It summarises some of the key elements captured during group discussions and the Menti on-line feedback sessions. The response is structured around the challenge questions (reproduced below) that were set by Defra during their presentation.

What are your thoughts on the work plan? Is there anything missing? Is it realistic? What are the key challenges?

Setting new targets for $PM_{2.5}$ is a substantial and complex task, and the Defra work plan as presented was considered to broadly encompass the major requirements. Several critical components of the work plan require inputs from air pollution $PM_{2.5}$ modelling, and this is an area where there is long-standing scientific and technical uncertainty. These include, but are not limited to, the representation of emissions (current and future), transboundary effects, the formation of secondary PM, both organic and inorganic, and the response of secondary PM to changes in emissions of precursors.

Defra is encouraged to consider a broad range of modelling approaches in its target setting work plan. This should include assessment of model performance and evaluation, or indeed modelling development if required, accepting that this would need to be balanced against the desire for a timely implementation of new targets in the Environment Bill.

The recent unanticipated changes to both concentrations and emissions of air pollutants during 2020, a consequence of COVID-19, will need to be properly accounted for in the work plan, and in subsequent modelling assessments. This event has created new challenges in establishing baseline cases against which future target feasibility or attainment progress is measured. This is an additional line of work for Defra that was not originally envisaged.

The work plan presents a national (England) approach to $PM_{2.5}$, but suitable emphasis and regard should be given to the applicability and deliverability of $PM_{2.5}$ targets at the Local Authority level, and the integration of targets into Local Air Quality Management. The work plan should ensure that it includes a suitable review of international $PM_{2.5}$ reduction approaches including for exposure reduction and the attainment of limit values.

It is essential that the scale and influence of transboundary effects, particularly from continental Europe, are properly quantified, and that UK target setting and assessment is expressed clearly in the context of those wider influences that may affect $PM_{2.5}$. The role and significance of international air pollution emission reduction obligations, such as the Gothenburg Protocol and Convention on Long-range Transport of Air Pollution, needs to be well-defined within the UK target setting framework, and the extent to which there are national dependencies on external actors made explicitly clear.

It was noted that international guidelines on $PM_{2.5}$ exposure from the World Health Organisation are currently under review and that the Defra work plan may need to retain sufficient flexibility to reflect on any change in international guidance and the possible impacts of this on target setting in the UK.

What role should AQEG play in target development? How can it contribute to the WPs? What is the best way to engage?

AQEG considers that it can play a role in providing expert scientific evidence and advice to Defra in support of the $PM_{2.5}$ target setting process, and to suggest priority areas for research in support of this process. This would be specifically in areas associated with i) the modelling, prediction and attribution of $PM_{2.5}$ (including estimation of relevant emissions), ii) the measurement and metrology of $PM_{2.5}$ (both past trends and future observations) and iii) the chemical sub-components of PM and relevant contributory precursors.

AQEG typically provides advice to Defra in one of two ways: the production of group reports summarising the state of the science associated with a particular broad aspect of air pollution or emissions, or, an expert evaluation of and/or challenge to specific scientific or technical evidence that is being considered by Defra, or that has been developed by them. In this particular case it appears most appropriate for AQEG to respond using the latter approach, for example providing scrutiny and advice on models or measurement evidence being used by Defra to inform the target setting process. Previous approaches have included AQEG responding in a Q&A format to specific technical questions posed by Defra, for example most recently on the modelling of future $PM_{2.5}$. This type of response would ideally be undertaken by the group as a whole, or by a subgroup if that was more appropriate based on the required level of work and expertise. The use of further *ad hoc* members to support this work could also be considered. It would not fall within the current AQEG Terms of Reference to complete work that independently advocated for a particular type of target setting framework, made independent recommendations on the exact nature of targets or their assessment, or gave explicit endorsement to Government proposals.

Given the national significance of the $PM_{2.5}$ targeting setting work, it was considered fully appropriate that this would form a standing item on the AQEG agenda for the next year, either for specific discussion in response to individual requests from Defra, or to receive updates from Defra on developments in the work plan more generally. Stand-alone AQEG meetings to support the Defra work plan could also be used if required, and may be a necessity should we continue to work with shorter video meetings for the remainder of 2020.

Due regard will need to be paid to managing potential conflicts of interests between AQEG members and their employers who may be externally contracted by Defra to undertake research or consultancy in support of the $PM_{2.5}$ target setting project, and any subsequent involvement with advice provided through AQEG.

What do you think of the two target approach? Will they work together coherently? Is the focus on long-term exposure sensible?

The high-level approach that is being proposed by Defra uses a concentration limit value in combination with a population exposure metric, and target for its reduction, that would require wider continuous improvement in $PM_{2.5}$ air quality. This principle is broadly supported by scientific evidence. Reliance solely on limit values to deliver air quality improvements has been shown to lead to disproportionate emphasis being placed on improving air quality only in hotspots that exceed those limits and permit concentrations to increase in other areas. There is also a risk that deterioration of air quality is not seen as an issue of public health concern as long as it remains below the limit value. Retaining a limit value target would provide a common standard of air quality across the country as well as ensuring continuity with existing air quality standards and assessment approaches. Limit value approaches are

generally considered to be easily understandable by the general public. Extensive evidence, including international reviews, does not support the concept of a threshold concentration of $PM_{2.5}$ at which harm begins to occur, and this demands additional measures and targets beyond solely concentration limits.

Population exposure reduction targets are one mechanism to deliver wider air quality improvements, although they are more complex to define, and Defra should seek further input from COMEAP on this issue. Multiple variants of population exposure reduction using different metrics could be envisaged, however overall this approach is accepted as delivering broad population health benefits. It is considered essential that exposure reduction forms part of the Environment Bill target setting framework. The Defra work plan needs to take suitable advice on the linearity of exposure response, and the associated cost-benefit of exposure across the range of anticipated concentrations.

Using a two target approach would likely ensure that both local and more distant contributing sources of $PM_{2.5}$ were addressed. In practice, both targets are likely to require the reduction of emissions at a regional scale and internationally. The simplicity of the limit value should help motivate local action to reduce local emissions although quantifying the impact of such interventions may be complex since the local increment can be small relative to regional and transboundary PM contributions. Parallel population exposure reduction targets demand that suitable emphasis is also placed on the reduction of emissions at a regional scale and internationally. In each case, the delivery of these reductions is ultimately dependent on individual choices.Testing how these two measures have changed using recent $PM_{2.5}$ data on emissions and concentrations would be a valuable exercise. The exclusion of hotspot locations from comparison against a concentration limit may in principle be justifiable, but the criteria for such exclusions will need careful definition with decisions made being fully transparent.

Questions regarding the appropriateness of long-term $PM_{2.5}$ exposure as the central metric against which both limit concentrations and exposure reductions are measured are primarily for a COMEAP response. There are likely some technical advantages in focusing on long-term exposure, for example emissions may be more reliably predicted, or concentrations modelled, when compared with day to day variability.

A large body of evidence indicates that the greatest health burden arises from chronic exposure to $PM_{2.5}$, and with this in mind a primary focus on annual metrics seems appropriate. The additional value of a short-term limit value, for example a 24-hour average, should be put to COMEAP for comment. It should be recognised that managing/controlling short-term variability in concentrations is difficult, and sometimes impossible, due to meteorological factors or one-off pollution emission events. Daily Air Quality Indices (DAQI) are already used to inform the public about short-term health risks and there is some potential for overlapping or inconsistent metrics.

Are these the right metrics? Should more complex options be considered for the limit value? Is a regional population exposure target viable?

There is sometimes value in using more complex metrics in the context of attainment of short-term limits, and particularly so for air quality objectives that are measured against hourly, 8-hour or daily means. However for annual average metrics there is limited justification for using additional data qualifications, for example only data falling within a defined percentile of observations. It should be noted that in many locations $PM_{2.5}$

concentrations are already low, and the measurement uncertainty of the instruments used needs to be considered. The use of longer averaging in metrics, for example use of a 3-year rolling mean, would need further technical evaluation. Such an approach is needed if a metric is subject to large year-to-year meteorological variabilities, to the point where attainment of annual targets become unacceptably susceptible to natural factors, however it is not clear that this is the case for $PM_{2.5}$ in the UK. Setting targets around a trend, or rate of change, over several years is another possibility.

The assessment of population exposure reductions in $PM_{2.5}$ necessarily requires establishment of boundaries of populations and therefore will very likely provide information on progress at a regional level. A rationale for setting a requirement for differential rates of improvements in English regions would need further development, since the scientific case is not yet clear in this regard. The method of assessment used to quantify population exposure reduction would likely be a very important factor. If assessment is based solely on observations, then that may provide a degree of consistency between regions. If progress is assessed using information in part derived from models, then the quantification of change in exposure at a regional level would be significantly influenced by the quality of local emissions or activity data used in that assessment. The significant impact of inter-regional transport of secondary $PM_{2.5}$ and precursors, would also introduce technical challenges if developing exposure reduction targets for individual cities or regions. Such targets would need to be assessed for feasibility, fully accounting for the influences of upwind emitters. It is beyond the remit of AQEG as an advisory group, but the concept of regional targets for air quality could come into conflict with other issues of broader environmental justice and economic development.

The use of metrics that can be compared against measurements is widely considered as the fundamental foundation on which a robust framework of air quality assessment can be built. This is not at the exclusion of other possible methods of assessment, for example health impact assessment, or modelling studies, which can be very valuable complementary tools to support decision-making. The UK already has long experience of evaluating progress on $PM_{2.5}$ against limit values using observations.

Setting new targets for population exposure reduction will be particularly challenging because of the recent perturbations to air quality and related emissions due to COVID-19 and the unpredictability of the pandemic recovery. Irrespective of the technical approach used to evaluate population exposure reduction, decisions will need to be made around the base case year(s) against which progress is measured. 2020 is already now established to be a highly abnormal year, and this may also apply to 2021 as well. Use of a historic base case is possible in principle, but presents obvious challenges if an enhanced monitoring network is used to assess compliance.

What are your views on using monitoring for assessing compliance? What changes need to be made? Should there be a separate roadside target?

There is no perfect independent method to determine whether air quality limits or exposure reduction targets have been met. Measurements are vital however since they provide a definitive measure of concentrations and are traceable to known physical quantities and have well-defined uncertainties. Measurements typically have broad public acceptance, and are rarely subject to legal challenge in an air quality context. The key limitation is of course that measurements only occur at a very limited number of points in space, and indeed there is no such thing even as a perfect measurement location.

Models aim to estimate concentrations at all points in space and time using a range of input data, but they are limited to the quality of the representation of the underlying processes and the input data and are eventually limited by spatial resolution. In the specific case of $PM_{2.5}$, the substantial and longstanding challenges of estimating concentrations using atmospheric models is a key factor that differentiates how this pollutant might be addressed compared to approaches used for NO_2. There is currently rather poor agreement between different research models that aim simulate $PM_{2.5}$, or when they are externally compared to observations. Compliance or otherwise with legal targets could become a function of the model chosen (or indeed model software version), so it is difficult therefore to envisage this forming part of a formal compliance assessment or indeed a legal measure of exposure. The owner of a model used for such a purpose would arguably be in a position of regulatory capture.

There is however an enduring and critical role for modelling in support of assessments of where monitoring can best be conducted, how concentrations have changed in unmonitored locations, and exposure across the population more broadly. There is likely to be a need for modelling to provide periodic health impact assessments in support of regulation, conducted as complementary to annual compliance monitoring. Models remain of course the only tool available to assess how concentrations of $PM_{2.5}$ may change in the future in response to changes in emissions.

The limitations of compliance assessment based solely on monitoring are however well known. High quality monitors are costly to maintain and no matter how many sites are instrumented, it is inevitable that the vast majority of the population will still live in locations where air quality is not directly measured. This creates the long-standing requirement for monitoring to be made representative of regions and the population as whole. This is not however a new challenge in air quality. Since $PM_{2.5}$ is a relatively long-lived pollutant its geographic distribution differs from pollutants such as NO_2. A consequence is that the observational infrastructure and locations of monitors is likely to be different to NO_2, with greater emphasis placed on quantifying urban background and rural concentrations, using measurements located such that they provide a reasonable (if inevitably imperfect) surrogate for population exposure.

This document is not the place to go in to details of exactly how monitors should be sited, where or how measurements should be used to inform models. AQEG would however be open to review future proposals for monitoring approaches as they are developed by Defra. Further feedback can be provided once details have been developed on the role of roadside or hotspot monitoring and how this information will fit within the assessment and compliance framework.

Whilst measurements of $PM_{2.5}$ should form the key data source against which compliance and attainment of standards can be measured, it is important to recognise the critical role that is played by ancillary measurements (including PM precursors such as ammonia, NOx and VOCs) that allow $PM_{2.5}$ data to be fully interpreted. $PM_{2.5}$ is a somewhat blunt measure of particulate pollution and it is only when it is interpreted alongside information on chemical composition or size distributions that insight is gained observationally into the contributing sources.

How should the reporting regions be defined? How should population be included? How should spatial and temporal differences be account for?

Natural and transboundary effects impact on $PM_{2.5}$ in different ways in different regions of the UK. These regional influences include a multitude of factors dependent on time of year, meteorology and historical sources of industry and pollution. It is tempting to try to correct for such regional influences to create a 'level playing field' when comparing data or trends between locations or different periods of time. For example, should aerosols where there is a contribution from 'natural' processes and over which the UK may have limited controls (e.g. sea salt, biogenic secondary organic aerosol BSOA, wildfires), be deducted from either targets or observations before compliance is assessed? Should specific one-off or abnormal events be excluded from calculations, such as bonfire night, moorland fires or industrial accidents? The number of possible local, regional or national exclusions or corrections that could be conceived of is very large, and in application always imperfect. Whilst this type of approach can have considerable value in scientific studies, shedding light on processes and controlling factors, it is likely inappropriate if applied in a regulatory context. Additionally, it is important to consider that the epidemiological and other studies that are used to set health guidelines or standards will not have included these types of adjustment. The use of all $PM_{2.5}$ data collected, then evaluated on an annual average basis, is likely to provide some significant buffer against short-term influences.

The geographic definitions of regions is to a degree arbitrary, but should sensibly follow boundaries that are meaningful for air quality management. The metrics chosen and the areas of assessment need to be consistent with the wider UK air quality management framework. The distribution of monitoring should in a broad sense be population weighted in these regions, although many variants could be conceived of and more detailed proposals from Defra should be subject to review.

Submitted by: Prof. Alastair Lewis, on behalf of the members of the Defra Air Quality Expert Group,

17th June 2020