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Technical Note: Gatwick Northern Runway Project: Critical Review of Air Quality Assessment

Client: CAGNE

Reference: APS_ S1043A_A1-1 **Date Published:** 26 January 2024

Rev.	Date	Description	Prepared	Reviewed	Authorised
01	26/01/24	Issued	CH/KL	KL	CH

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1. Introduction

1.1. Air Pollution Services (APS), part of KALACO Group, has been commissioned by CAGNE to review the Air Quality chapter of the Environmental Statement (ES), and associated documents, accompanying the Development Consent Order (DCO) application for the Northern Runway Project (NRP) at Gatwick airport.

1.2. This note has been written by Dr Claire Holman and Kieran Laxen. Dr Holman has worked on air quality since being awarded her PhD for air pollution research in 1980. She has undertaken and reviewed numerous air quality assessments for many different types of development including airports. She has been closely involved in the development of guidance for the assessment of air quality produced by the Institute of Air Quality Management (IAQM) and has led several working groups that have produced guidance. She is currently the President of IAQM, the body that represents air quality professionals in the UK.

1.3. Kieran Laxen has over 15 years' experience of working on air quality, is a proficient and well respected air quality dispersion and meteorological modeller, having provided advice and support on modelling to government bodies. He has undertaken a large number of air quality assessments for a wide range of different types of developments including several airport projects. Kieran is currently a vice-Chair of IAQM and is leading an IAQM team producing best-practice dispersion modelling advice.

1.4. The following documents dated July 2023 (version 1) have been reviewed:

- 5.1 ES Chapter 13 Air Quality;
- 5.2 ES Air Quality Figures – Parts 1 to 5;
- 5.3 ES Appendices 13.2.1, 13.3.1, 13.3.2, 13.4.1, 13.6.1, 13.6.2, 13.8.1, 13.9.1 Parts 1 to 6, 13.9.2
- 5.1 ES Chapter 12 Traffic and Transport (Tracked) Version 2
- 5.1 ES Chapter 18 Health and Wellbeing
- 5.3 ES Appendix 18.8.1 Qualitative Health Assessment

1.5. The air quality assessment (AQA) consists of over 20 documents. Appendices 13.1.1, 13.5.1, 13.7.1 were not found on the National Planning Infrastructure document library for the NRP1, and are not listed as Appendixes in Chapter 13.

1.6. The Air Quality Chapter considers the impacts during construction and operation of NRP. This review focuses on the operational and the construction traffic and machinery impacts. This is because the construction dust impacts can be mitigated by using best-practice measures.

1.7. The ES Air Quality Chapter considers the impacts of the NRP on the concentrations of nitrogen dioxide (NO_2) and particulate matter both with an aerodynamic diameter of 10 microns (µm) or less (PM_{10}) and with an aerodynamic diameter of 10 microns (µm) or less ($PM_{2.5}$) in 2029, 2032 and

[1] https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/TR020005/documents

3038. It is comprehensive in that it considers a large geographical area and a very large number of individual receptors.

1.8. It considers the air quality impacts on both human health and ecological receptors and the effects on pollution levels. The effects on human health and ecology are considered in the Health and Wellbeing and Ecology and Nature Conservation chapters respectively, which rely, or should rely, on the information in the AQA. It is noted that the Air Quality chapter does not explicitly consider ultrafine particles (UFP) and therefore the Health and Wellbeing chapter does not rely on the Air Quality chapter in this respect.

1.9. The Air Quality chapter also presents an emission inventory for 2018 (base year), and 2029, 2032, 2038 and 2047 with and without NRP. The purpose of forecasting emissions for 2047, 29 years beyond the base year is unclear. The uncertainties for 2047 will be very large and engine emissions are expected to have declined significantly due to the transition to net zero.

1.10. These emission inventories do not take account of the reduction in emissions likely to occur as a result of measures to reduce greenhouse emissions such as the introduction of zero emission aircraft. They do take account of assumed improvements in vehicle technology and uptake of electric vehicles.

Main Issues

1.11. The AQA fails to adequately consider the impact of the NRP on ultrafine particles (UFP), simply considering that it is a component of $PM_{2.5}$. This simplistic approach is not appropriate as it fails to take account of the different properties of UPF.

1.12. It also fails to adequately take account of the uncertainties related to the estimate of emissions from the airport and dispersion modelling. For example, no comparison of the modelled and measured PM_{10} or $PM_{2.5}$ concentrations have been provided. It is therefore unclear how reliable the predicted data provided is.

1.13. We have concerns regarding the uncertainty in the emission inventories and the dispersion modelling, and whether the net effect of a number of expected conservative assumptions (note, there is not always evidence of why they are conservative) made at various stages of the assessment are sufficient to be confident that there will be no significant adverse impacts or an overall effect on air quality.

Health Effects and Standards

1.14. The focus of current national air quality policy is on $PM_{2.5}$, which reach deep into lungs. The 2021 Environmental Protection Act (HM Government, 2021) and associated Regulations (HM Government, 2023) have set long term targets for $PM_{2.5}$ but not for NO_2 or PM_{10}.

1.15. In 2006 the World Health Organization (World Health Organization , 2006) (WHO) published an annual mean guideline for the protection of human health for $PM_{2.5}$ of 10 $\mu g/m^3$ based on the available scientific and medical information at that time. In 2021 WHO published a new guideline for $PM_{2.5}$ of 5 $\mu g/m^3$ (World Health Organization, 2021), drawing on more recent evidence of the health impacts. Thus in a period of 15 years the annual mean WHO guideline for the project of human health has halved.

1.16. Over the same time period the WHO annual mean guideline for NO_2 has reduced from 40 µg/m^3 to 10 µg/m^3 and for PM_{10} from 20 µg/m^3 to 10 µg/m^3.

1.17. It is good practice to take a precautionary approach when undertaking environmental assessments, particularly when forecasting impacts a long way in the future as is the case for the NRP (20 years from the base year to the 2038 forecast year). During that period air quality guidelines and standards are very likely to change. Air quality standards have, in general, progressively become more stringent as knowledge has increased over time. The size of the particles of interest has also declined from visible smoke to $PM_{2.5}$, now moving towards UFPs, which have a diameter of less than 0.1 µm.

1.18. The NRP ES uses the Environmental Protection UK (EPUK)/IAQM guidance for assessing the significance of the effect (EPUK/IAQM, 2017). This guidance uses a percentage change of the air quality assessment level (i.e. a standard) to assess the magnitude of the change. This approach has proved to be appropriate for development which takes a few years. For long term development projects this approach may be inadequate. It is not, however, possible to forecast how the standards may change in the future.

1.19. For $PM_{2.5}$ the Government has set a mandatory target to be achieved by 2040 (HM Government, 2023), two years beyond the latest air quality assessment year for NRP. We note that the Government's Chief Planner has provided a statement (Department for Levelling Up, Housing and Communities, 2023) stating that until further guidance is available on how to assess the $PM_{2.5}$ target local authorities should use existing guidance.

1.20. The NRP AQA uses the 2028 interim target. A more appropriate approach, given the need for caution given the uncertainties in forecasting future air quality, would be to assume a linear change (even given the limitations of such an approach) between 2028 and 2040. For example, the value for 2038 would be 10.3 µg/m3. This approach may make little difference to the outcome of the assessment but it would have given confidence that the assessment is precautionary.

1.21. The AQA acknowledges (paragraph 13.5.4) that 2038 is closer to 2040 than 2028 but states that due to the:

"challenges of modelling concentrations of $PM_{2.5}$ especially for a future date, the interim (2028) target is considered appropriate because of the conservative assumptions applied in the assessment."

1.22. We believe that given the acknowledged uncertainties in modelling the future $PM_{2.5}$ concentrations the 2040 target or a linear interpolation should have been used for modelling concentrations in 2029, 2032 and 2038. The more uncertainties in an assessment the more a precautionary approach is needed.

2. Air Quality Assessment Methodology

Airport Emissions

2.1. For road transport there are well established methodologies for estimating current and future emissions based on significant research into the emissions from different types of road vehicles undertaken over many decades. Much less is known, however, about the emissions from aircraft and the factors that influence them. No consideration has been given to the emissions of metals

from the brakes and tyres and therefore no assessment against the legislated targets has been undertaken.

2.2. For the NRP a new emission inventory was produced for the airport for nitrogen oxides (NOx)[2], NO_2, PM_{10} and $PM_{2.5}$. For road traffic ammonia (NH_3) emissions were also included.

2.3. The following emissions sources were included in the AQA

- aircraft main engines in the landing and take-off (LTO) cycle;
- aircraft auxiliary power units (APU);
- aircraft engine testing;
- ground support equipment (GSE);
- airport heating plant;
- fire training ground (FTG);
- road vehicles on the local and strategic highway network around the airport and at car parks; and
- CARE facility (the CARE combustion plant was later removed from the application).

2.4. The main source of airport emissions are the aircraft. The exhaust emissions are estimated from the fuel use (kg fuel per second) and an emission factor (kg pollutant per kg fuel). Combustion pollutants are not directly related to the fuel use, which is why road traffic NOx and PM emissions are not estimated based on fuel use in the UK. Aircraft emission information is available for four thrust settings. The annual emissions are obtained by summing the contributions from all engines and all operating modes for all air movements over a year, including the emissions during landing and take-off up to a height of 3,000 feet (approximately 914 m) above ground level.

Aircraft NOx emissions

2.5. The aircraft emission factors are based on certification data for new engines measured on a stationary engine in a test cell. There are no real-world emission factors for aircraft unlike for road vehicles. It was the measurement of real-world car emissions that identified the Dieselgate issue i.e. grossly higher emissions than anticipated, which was later found to be due to the emission control strategies adopted by different car manufacturers.

2.6. The certification data is then adjusted to take account of a number of factors that affect fuel use and the estimated emissions. Data to make these adjustments is often sparse and often available for only a small number of aircraft types.

2.7. There is other incomplete information e.g. how long the aircraft engines are lit during taxiing, the frequency of shutting down of one engine during taxiing, and the take-off thrust during the take-off roll.

2.8. Adjustments are also made for other factors that affect emissions such as atmospheric temperature and pressure.

[2] NOx is a mixture of nitric oxide (NO) and NO_2. The proportion of the NOx emission in the form of NO_2 was included in the inventory.

2.9. Whilst airport emission inventories are improving there remains considerable uncertainty. These uncertainties do not appear to have been adequately considered in the AQA. The ES Chapter states in several places that the aircraft emission assumptions are conservative with little evidence to support these claims. There is no discussion about the overall aircraft emission inventory uncertainties, and how this may impact on the robustness of the assessment.

Aircraft PM Emissions

2.10. Operational PM emissions from the airport are assumed to come from the aircraft engines (exhaust), wear of the aircraft tyres and brakes and road traffic (exhaust and tyre and brake wear). The AQA does not take account of emissions due to the wear of the runway/roads or re-suspended dust. It also omits consideration of the metals emitted by from tyre wear.

2.11. The AQA acknowledges that there is '*major uncertainty*' in the PM emissions from aircraft engines (Appendix 13.4.1 paragraph 3.3.13). This is due to certification data being available only for newer engines. For older engines the PM emission were calculated from the smoke number (an indirect measure of PM emissions).

2.12. It is clear from the AQA (Appendix 13.4.1 section 3.6) that there is also little data on brake emissions of PM from aircraft, with data available for only three types of aircraft. It was assumed that all the eroded mass from the brakes is suspended in air as PM_{10} and that the mass varies with aircraft weight.

2.13. For tyre wear the estimate was based on data from BA from Heathrow airport. Details of this data are not provided and therefore it is unknown how many and what type of aircraft (or tyres) it is based on. It was assumed that the erosion of the tyres varies linearly with aircraft weight and that 10% of the eroded tyre mass is suspended as PM_{10}.

2.14. Assessment of the emissions from brakes and tyres during taxiing or take-off do not appear to have been included in the AQA, or at least the emission estimation methodology is not described. These are likely to be less than during landing but should also be accounted for.

2.15. The AQA states (Appendix 13.4.1 paragraph 3.6.7) that:

"It is recognised that there remain significant uncertainties in estimating PM_{10} emissions from brake and tyre wear, but these would only be reduced when more aircraft-specific data become available."

2.16. Paragraph 36.8 states:

"There are no specific data on the $PM_{2.5}$:PM_{10} mass ratio for aircraft brake and tyres, so equivalent data for road vehicles were used, adding to the uncertainty in the $PM_{2.5}$ estimates."

2.17. The assessment assumed that the $PM_{2.5}$:PM_{10} mass ratio for brake wear is 0.4 and for tyre wear is 0.7. The relevance of these figures for aircraft is unknown but given the different operational modes of aircraft and road transport (such as tyre temperature), it is likely to be significantly different.

2.18. It is unclear how the acknowledged uncertainty in the PM emissions and $PM_{2.5}$:PM_{10} mass emissions ratios for aircraft and the omission of other brake and tyre wear from aircraft taxing and taking off has been considered when assessing the results of the modelled data.

2.19. The assessment should not rely solely on modelled data but needs to consider the methodology and its uncertainties in the round when determining the magnitude of an air quality effect.

Dispersion Modelling

2.20. The dispersion model covers a very wide area: the 10 km by 11 km domain plus the affected road network. The topography and land use, which effect dispersion, varies over such a large area. The model used a single roughness length (0.2 m) and Monin-Obukhov length (20 m). The use of a single value is not appropriate for a large model domain incorporating a range of land uses. The same value was used for the meteorological site as in the modelled domain. Wind flows at Gatwick Airport (and other airports) are different to, for example, urban areas.

2.21. The presence of buildings affects the dispersion of emissions. It is well recognised that streets with buildings on one or both sides of the roads can be affected, and therefore it is good practice to include the effect of restricted dispersion (and recirculation within the street scape area) in the dispersion model. This has not been done. The ES Chapter recognises that the presences of vegetation can affect dispersion (see Table 3.2.2 in Appendix 13.1.6, rows M45, M91, M186, M203, M221 etc) but has failed to recognise the role of buildings and other barriers in affecting the dispersion of traffic emissions along the modelled streets. The omission of accounting for such situations is well recognised to lead to concentrations that are under-estimated, in some circumstances by a large amount.

Verification of Modelled NO_2 concentrations

2.22. Information is provided on the comparison of the modelled and measured NO_2 concentrations in Appendix 13.4.2. Paragraph 4.4.1 states:

"Model verification was used to compare modelled pollutant data with measured real-world concentrations to assess the performance of the model and determine adjustment factors where required in accordance with Defra guidance (Defra, 2022). The model verification results are detailed in ES Appendix 13.6.1: Air Quality Data and Model Verification (Doc Ref. 5.3)."

2.23. Paragraph 3.2.1 of Appendix 13.6.1 states that some locations are not suitable for model verification and that each site was investigated for its suitability for inclusion in the model verification. A number of monitoring sites were obstructed by vegetation and therefore concentrations would not be accurately represented in the model. It is unclear whether receptor locations obstructed by vegetation were included in the model and if so how accurate the predicted concentration would be. The street canyon model of the ADMS suite of models can be used to account for vegetation and other restrictions to the dispersion of emissions but does not appear to have been done.

2.24. The wider implications of this approach of excluding monitoring sites are not discussed, resulting in a likely underprediction of concentrations in the study area. In carrying out the assessment, the following should be considered:

- The measurements are real-world measurements and therefore a truer record of what is happening.
- Excluding monitoring from a model performance verification may be appropriate is certain circumstances, providing a review clearly sets out of the locations where the model is likely to be underpredicting the concentrations (potentially by a large margin) and this is accounted

for in the overall assessment. This would be anywhere which exhibits similar characteristics to the setting the monitoring which is excluded is located.

2.25. Appendix 13.6.1 provides information on the model verification. The text states that the model performed well. The adjustment factors calculated are all under 2 which is considered good. This is likely to be the case because monitoring where the model performed poorly was excluded (see Paragraph 2.23 above). Review of the adjustment factors appears to be justification for the statement that the model performed well. There are, also, other parameters which also need to be considered. Considering the adjustment factor alone can give a false sense of certainty in the model results.

2.26. The correlation co-efficient is poor for the monitoring sites in London (0.5) and on Brighton Road (0.3). An ideal correlation is 1.0. The closer to zero the worst the correlation. For environmental parameters a correlation of 1 is not expected but 0.3 and 0.5 both show a poor correlation. This means there is a widespread in the data points, and that the model is not representing reality well.

2.27. The correlation co-efficient was negative for three of the zones (Crawley, Croydon Park Lane and Merstham). In lay terms this means that as the measured concentrations decrease the modelled concentration increase. This is obviously nonsensical, and its cause should have been investigated. It suggests poor performance of the model.

2.28. The root mean square error (RMSE) is also a measure of the spread of the data. For Brighton Road it was 6.1 µg/m^3, Croydon Park Lane 9.7 µg/m3 Storrington 6.2 µg/m^3, and between 5 µg/m^3 and 6 µg/m^3 at Hazelwick Roundabout (an air quality management area (AQMA)) (5.0 µg/m^3), M23 and M25 (5.0 µg/m^3), and London (5.7 µg/m^3).

2.29. In lay terms this means that the accuracy of the model, for example in the Croydon Park Lane zone is + 9.7 µg/m^3 (almost 25% of the objective). At best it is +2.9 µg/m^3 in the Cowfold zone. This is very important when comparing the model results with a fixed concentration (e.g. an air quality standard). It is also essential that any predicted concentrations from the model therefore accounts for this range of uncertainty.

Verification of the modelled PM_{10} and $PM_{2.5}$ concentrations.

2.30. No information is provided on the verification of the modelled PM_{10} or $PM_{2.5}$ concentrations and therefore there is no information on the accuracy of the model.

2.31. From our experience of a very large number of dispersion modelling studies, there can be large discrepancies between modelled and measured concentrations of PM and therefore a review of the performance of the model in relation to PM is essential for such a large scheme.

2.32. There is limited historic monitoring of PM_{10} in the area. For the base year of 2018 there are just three monitoring sites (CA2, LWG3 and RG1), all close to the airport. For $PM_{2.5}$ in 2018 there is data for just one monitoring site (LGW3).

2.33. Defra's technical guidance does not recommend using data from one site, even a high-quality continuous analyser, to verify a model but suggests it may be appropriate to apply the road-NOx adjustment to the modelled road-PM_{10} (and $PM_{2.5}$ [3]) (Defra, 2022). We do not believe that it is

[3] Defra's Technical Guidance for local air quality management (LAQM) does not consider $PM_{2.5}$ because it is outside the LAQM scope.

always appropriate to rely on the road-NOx adjustment where there is a mixture of different emission sources in the model (road traffic, aircraft etc) as in this model.

2.34. Although little PM monitoring data is available compared to that for NO_2, it would have been useful to provide confidence in the results by comparing the modelled and measured data for the airport emissions and/or using the NOx verification factor for road transport emissions.

2.35. The AQA claims that the PM assessment is conservative but without any model verification insufficient evidence is provided to support this claim and it is expected to be an inaccurate statement.

Relevance of an Annual Mean NO_2 concentration of 60 µg/m^3

2.36. Paragraph 13.5.33 of the Air Quality Chapter (5.3 Chapter 13 Air Quality) explains that it is unlikely that the hourly mean NO_2 standard will be exceeded if the annual mean NO_2 concentrations are less than 60 µg/m^3. This 'rule of thumb' is based on measurements at locations where road traffic is the dominant source of the NO_2. If the Applicants wish to use this 'rule of thumb' they should have undertaken an analysis of airport measurements to ensure that its use is applicable within and close to the airport where the emission sources are different.

Ultrafine Particles (UPF)

2.37. Several stakeholders queried if UFP[4] would be included in the AQA.

2.38. The Air Quality Chapter states (paragraph 13.2.5) that

"… $PM_{2.5}$ is considered to be a good indicator of general risk associated with exposure to fine and ultrafine particulate matter, and this has been quantitatively assessed in this ES, to allow an evaluation of effects and to respond to stakeholder queries."

2.39. This statement contradicts WHO (World Health Organization, 2021) which states:

"Generally, there is very little or no relationship between PNC[5] and mass concentration of larger particles ($PM_{2.5}$), and the existence and degree of relationship between PNC and traffic-emitted gaseous pollutants (carbon monoxide and NO_x) or black carbon varies, depending on location. Therefore, no other pollutant is a good proxy for UFP. However, quantitative knowledge of UFP is needed, since focusing only on $PM_{2.5}$ may result in overlooking the impact of UFP and there is no evidence that mitigating particle mass only (PM_{10}, $PM_{2.5}$), as the existing air quality measures do, will necessarily lead to a reduction in UFP".

2.40. Defra's Air Quality Expert Group (Air Quality Expert Group, 2018) states:

"The sources, behaviour and impacts of UFP in the atmosphere can differ from those of the substantially fewer, larger particles that dominate the currently regulated $PM_{2.5}$ and PM_{10} size fractions".

[4] UFP are particles with a diameter less than 0.1micron (µm).

[5] PNC = particle number concentration.

2.41. The Applicant has made many assumptions throughout the AQA to enable the NOx and $PM_{2.5}$/PM_{10} mass emissions to be assessed but have not done this for UFP. All recent airport expansion applications including Stansted, Bristol, London City, and Gatwick have failed to address this issue, hiding behind a false premise, that $PM_{2.5}$ is a good surrogate for UFPs.

2.42. The importance of UFP emissions from aircraft is reflected in the establishment by the International Civil Aviation Organisation (ICAO) of a mandatory requirement for reporting non-volatile UFPs for new commercial aircraft.

2.43. There are both volatile and non-volatile UFP emissions from aircraft (and road transport). The volatile emissions are associated with the sulphur content of the fuel and are not easily quantified as they change as they are diluted with distance from the source. There is evidence that they decreased with the introduction of ultra-low sulphur automotive fuels. We recognise that any assessment is unlikely to include a quantitative element in relation to the volatile UFP. However, the UK Government is supportive of the use of sustainable aviation fuels (SAFs) in the transition to net zero emissions. The formation of volatile UFP is thought to be largely related to the sulphur content of the fuel; SAFs are sulphur free.

2.44. For non-volatile emissions the ICAO database contains the certified UFP emission for newer engines. These could be used to develop an emissions-based assessment of non-volatile UFPs.

2.45. A semi-quantitative assessment could be undertaken that combined:

- a simple review of the projected fuel use and the potential for uptake of SAFs to judge whether volatile UFP concentrations are likely to increase or decrease in the future with more and larger aircraft; and
- evaluation of the likely changes in non-volatile emissions based on the ICAO database and relevant literature with assumptions similar to those used in the production of the aircraft emissions inventory (i.e. there would be a similar level of uncertainty).

2.46. Whilst it is accepted that there is insufficient information to fully quantify the impact of aircraft on UFP (particularly volatile UFP) emissions an assessment of any type (qualitative or quantitative) in the Air Quality Chapter is missing and should have been provided to enable a conclusion to be drawn regarding the likely significant impact of the NRP.

National Emissions Ceiling (NEC)

2.47. The National Emissions Ceiling Regulations (NECR) (HM Government, 2018a) as amended (HM Government, 2020) sets out the nation's commitments to reduce emissions of NOx, $PM_{2.5}$ and other pollutants by 2030.

2.48. The NECR commitments have been made to reduce the long-range transport of air pollution, which has a deleterious effect on the environment many kilometres from the source. One historic example is the effect of emissions of sulphur dioxide from power stations in the UK causing acid rain in Sweden adversely affecting biodiversity in lakes and forests. These NECR targets are part of an international agreement to reduce emissions to protect human health and the environment by reducing acid and nitrogen deposition on important ecological sites and the formation of $PM_{2.5}$ and ozone in the atmosphere, both of which are harmful to human health.

2.49. There is no requirement for the airport to meet the NECR. However, it is important to understand the contribution of the airport to national emissions in the context of the need to reduce emissions. This should have been included in the assessment. It is noteworthy that the UK was not compliant with the $PM_{2.5}$ emission reduction target in 2021 (Defra, 2023).

2.50. In 2018 Gatwick Airport related NOx emissions represented 1.7% of the emissions ceiling. From 2018 to 2038 these emission will increase by 78%. Airport related $PM_{2.5}$ emissions are forecast to increase by 426% (from 35 to 184 t/yr). In itself 1.7% may not seem to be a large contribution but the combined emission from all UK airports will be a significant and growing contribution.

2.51. The ES Air Quality Chapter should discuss the implication of their increasing emissions for achieving the NECR which have been set for the protection of human health and the environment.

3. Health and Wellbeing

3.1. It is clear that the author of the Health and Wellbeing chapter is not familiar with air quality legislation. For example, the chapter mentions the Air Quality Standards Regulations 2010 (amended in 2016) but fails to mention the important 2020 amendment that reduced the limit value for PM_{10} from 25 µg/m^3 to 20 µg/m^3. It also states that the Office for Environmental Protection (OEP) sets targets when it is the Government which sets targets. The OEP's role is to protect and improve the environment by holding the Government and other public authorities to account. The 2040 $PM_{2.5}$ targets are set in secondary legislation (HM Government, 2023) under the 2021 Environment Act, with the 2028 interim target set out in the Environmental Improvement Plan (HM Government, 2023).

3.2. Para 18.8.4 of the chapter states that regard is given to various factors including:

"Statutory health protection standards for air quality set out by the Air Quality Standards Regulations 2010 (amended in 2016) (HM Government, 2016). Regard has also been had to the WHO 2021 advisory guidelines (WHO, 2021)."

3.3. However, there is no mention of the $PM_{2.5}$ targets, although it appears that the health assessment follows "the approach on $PM_{2.5}$ assessment set out in Chapter 13: Air Quality, i.e. using the 2028 interim target of 12 µg/m^3." (paragraph Para 18.8.3). As stated in the review of the Air Quality Chapter above, this is not considered to be the appropriate level for the assessment.

3.4. We also dispute the reliance on the quote from Defra's website (Paragraph 18.8.15) on the definition of a standard to justify that the statutory thresholds are the relevant levels to protect human health, which the Health and Wellbeing Chapter relies upon. The quote states that standards are "*concentrations recorded over a given time period, which are considered to be acceptable in terms of what is scientifically known about the effects of each pollutant on health and on the environment*". The website this was taken from (https://uk-air.defra.gov.uk/air-pollution/uk-limits) which also differentiates between the definition of standards, objectives and limit values. The Defra's website states "*two which feature within the UK's air quality strategy are standards and objectives*" while "*Air Quality Standards Regulations 2010 contain Limit Values*".

3.5. The 2007 Air Quality Strategy is the basis for the current statutory standards. The 2007 Air Quality Strategy (which lead to the setting of the air quality objectives) stated that standards were defined from "*expert recommendations representing levels at which no significant health effects would be*

expected in the population as a whole" and goes on to state "*Standards, as the benchmarks for setting objectives, are set purely with regard to scientific and medical evidence on the effects of the particular pollutant on health, or, in the appropriate context, on the wider environment, as minimum or zero risk levels*."

3.6. The current standards were therefore set based on the evidence available around two decades ago. While there may be no appetite at a Government level to review the standards and objectives, there is no question that the current evidence shows there are health effects at significantly lower levels. This as reflected by the difference in the 2021 WHO guidelines and the current air quality standards/regulatory thresholds, for example:

- The NO_2 the annual mean objective/limit value is 40 µg/m^3 and the WHO guideline is 10 µg/m^3.
- The $PM_{2.5}$ annual mean the objective is currently 25 µg/m^3 and limit value is currently 20 µg/m^3. There is a 2040 target of 10 µg/m^{3}but the WHO guideline is 5 µg/m^3.

3.7. The standards are also set in relation to the risk to the general population, whereas a health impact assessment of a specific project or scheme should have consideration of the population which is likely to be impacted and specifically the more vulnerable and sensitive groups within that population.

3.8. Paragraph 18.8.14 states that *"…the assessment should give the public confidence in thresholds set by government for the purpose of health protection having taken into account other social economic and environmental considerations*"; and goes on to state (Paragraph 18.8.17) that "*the national statutory standards are the more relevant benchmark for informing an assessment of significance*" in relation to health effects.

3.9. We do not consider that the statutory standards provide any confidence to the public that they are protective of human health, in particular more vulnerable and sensitive groups and are thus not appropriate for a health impact assessment.

3.10. Furthermore, health impact assessments consider the multiple indicators of public health, for example socio-economic indicators, therefore the air quality indicator should only consider the health impacts of air quality and not be based on thresholds which "*account other social, economic and environmental considerations*" which is what the assessment suggests in Paragraph 18.8.14. This would be double counting the separate indicators and the air quality indicator would not be a true indicator of the effect on health due to air quality.

3.11. Paragraph 18.8.6 states: "*Section 18.2 and ES Appendix 18.2.1: Summary of Local Planning Policy – Health and Wellbeing (Doc Ref. 5.3) sets out the relevant policy context which includes the NPPF direction that planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants*."

3.12. While the statement is correct that planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants; that is addressed in the Air Quality Chapter which considers compliance with statutory standards. We believe the Health and Wellbeing chapter should consider the health impacts i.e. not consider compliance which is already covered in the Air Quality Chapter.

3.13. The Health and Wellbeing chapter also includes a quantitative approach to considering the health impact on the local population. As there are non-threshold effects of exposure to NO_2 and $PM_{2.5}$ the assessment has quantified the impacts using concentration response functions. This quantitative approach is a good and useful concept. However, Appendix 18.8.1 states:

*"This is a methodological verification exercise to confirm the findings through independent calculation. It also demonstrates in terms of proportionate EIA methods that a calculation using the total receptor number and the **average concentration** can be as robust in reaching an estimate to the population level health outcome as calculating the sum of multiple (in this case 177,962) individual receptor level health outcomes using individual receptor concentrations." [emphasis added].*

3.14. Based on this it is understood that an average concentration has been used, however, it is not clear how this average is calculated to account for locations of relevant exposure. For example if it is just an average of the receptor points which were modelled, then by including additional receptor along roads known to have minimal change in traffic, the average could be shewed down to a lower value. If only receptors of relevant exposure were included in the average it may be appropriate, however, account would also need to be taken to ensure there are enough receptors in the AQ modelling to represent exposure in each location (for example, if there are only a small number of receptors in a location with a high change but there a large number of residential properties, while in locations with spare exposure, there are large number of receptors to represent a risk of an impact but a low exposure. The unequal weighting of receptor points in the model would skew the results.

3.15. Paragraph 18.8.10 on population groups states: "*In addition to residents near the Airport, this assessment qualitatively takes into account passengers, visitors and workers at the Airport in terms of any effect of short-term exposure to air pollutants indoors or outdoors*." But does not state how this is done. In particular the air quality chapter does not provide any information on indoor air quality for the future passengers, therefore it is not clear how the health and well-being Chapter could account for this additional exposure.

Ultrafine Particles (UFP)

3.16. Paragraph 18.8.70 states that epidemiological studies indicate that exposure to ambient UFP in the air could pose a health risk and is therefore an important public health issue.

3.17. There is evidence of short- and long-term health effects of UFP including increased all-cause, cardiovascular, ischemic heart disease and pulmonary mortality (World Health Organization, 2021).

3.18. The air quality chapter did not undertake an assessment of the impacts on UFP levels neither emissions based, nor particle count or mass concentration based. It assumed that $PM_{2.5}$ is an adequate surrogate.

3.19. The Health and Wellbeing chapter undertook a qualitative assessment of the health effects due to UFPs generated by the NRP but without any assessment of the UFP impact.

3.20. The Health and Wellbeing chapter acknowledges that UFP are a public health issue (paragraph 18.6.68), and that UFP is elevated in and around airports. It references the WHO guidelines (World Health Organization, 2021) and reviews some of the literature published since the WHO review. It acknowledges that there is a lack of full scientific certainty and concludes that the available

epidemiological evidence suggests a relatedly small effect size. It is unclear what is meant by a 'small effect size'. It is smaller than the $PM_{2.5}$ health risk; smaller than the NO_2 health risk? If so, is the health risk an order of magnitude smaller?

3.21. It is also unclear how, in the absence of an assessment of the NRP impact on concentrations, a conclusion on the health effect could be made.

3.22. Neither the Air Quality Chapter nor the Health and Wellbeing chapter mention the measurements made in the local community around Gatwick Airport from June 2018 to September 2019. Reigate and Banstead Council provided information to the Gatwick Airport Consultative Committee (GATCOM) in June 2020 and July 2022 on this monitoring programme. These measurements suggest that the mean number of particles at the RG1 Monitoring site in Horley Green Estate are twice those at a background site in London, and the particles are typically smaller. The particle number concentrations at RG1 on average are slightly lower than those measured at the very busy Marylebone Road in London, although it is worth noting that the Marylebone Road site is only 1.5 m from the road edge compared to 350 m at RG1 or 610 m from the airport itself. A number of residential premises in the Horley Gardens Estate are also far closer to the airport than the RG1 site and so are likely to see higher exposures than recorded at RG1. The typical number concentrations is twice as high when the wind blows from the airport than during other wind directions.

3.23. Although the 2021 WHO air quality guidelines (World Health Organization, 2021) did not give guidelines values for UFP they did distinguish between low and high particle number concentrations to guide decisions on the priorities for UFP emission control. High concentrations are when there are more than 10,000 particles/cm^3 averaged over 24-hours or more than 20,000 particles/cm^3 averaged over one hour. Low concentrations are less than 1,000 particles/cm^3 averaged over 24 hours. Applying these values to the measured data shows that there are high number of UFPs for more than a third of the time (with respect to the 24-hour value). More than 50 percent of the days there was at least one hour when the UFP concentration was above the WHO high level. There were zero days with WHO low concentrations.

3.24. We agree that there the lack of standard methods used for UFP in air quality and epidemiological studies that makes it difficult to compare the data from different studies and there are relatively few long-term epidemiological studies. However it is clear that there are elevated concentrations around the airport (Air Quality Expert Group, 2018) and increasing airport activity is likely to increase emissions in residential areas close to the airport. This change should be considered in the AQA.

4. Significance of Effects

Air Quality

4.1. The air quality impact of NRP at all human receptors in all future 'with NRP' scenarios (including the construction scenarios) are predicted to be not significant.

4.2. For the ecological receptors the screening criteria were widely exceeded. However, this does not mean that there will be a significant adverse effect. Where the impact screening criteria are exceeded an ecologist is required to investigate whether there will be a significant effect or not (IAQM, 2020). This is outside the expertise of APS.

4.3. Airport-related emissions of NO_2, PM_{10} and $PM_{2.5}$ are predicted to increase significantly with the NRP (see paragraph 2.50), but emissions have not been explicitly assessed in the Air Quality Chapter. As noted paragraphs 2.47 to 2.51 , they should be assessed with respect to the targets in the NECR.

4.4. There were no exceedances of the NO_2 or PM_{10} objectives or limit values predicted in any assessment year. The government's 2028 interim target for $PM_{2.5}$ was predicted to be exceeded in 2029, 2032, and 2038 with and without the NRP. As no information is provided regarding the robustness of the $PM_{2.5}$ airport emissions estimates and $PM_{2.5}$ dispersion model there must be low confidence that there is no significant impact with respect to $PM_{2.5}$.

4.5. In 2029 a slight beneficial impact was predicted at Gatwick Ambulance Station (H_113). This is due to a decrease in NOx emissions from the airport. According to the ES these include shorter taxiing times, moving some aircraft departures to the northern runway, different fleet mix and transition to electrification. There are predicted to be negligible impacts elsewhere.

4.6. In 2032 there were predicted to be two slight adverse impacts at M23 Airport Way EHO_75 and Gatwick Ambulance Station (H_113) and negligible impacts elsewhere.

4.7. In 2038 there were also predicted to be two slight adverse impacts at M23 Airport Way (EHO_75) and Mertsham Road (R-302) and negligible impacts elsewhere.

4.8. It should be noted that moderate and slight adverse impacts were predicted in the 2024 and 2029 construction scenarios in Sutton and Croydon, and one slight impact in the 2029 operation scenario. These were considered not to be significant by the Applicant as the project is considered unlikely to change traffic significantly in Sutton and Croydon. The traffic was predicted to increase in these areas due to "*noise*" in the traffic model (see Annex E of ES Chapter 12: Traffic and Transport). As the changes are not representative of changes due to NRP, the Applicant did not consider the impact to be significant. Although the potential for 'noise' in the traffic model leading to underestimates elsewhere in the modelling domain was not consider or addressed.

4.9. As negligible and slight impacts are considered, in general, to be not significant, the overall conclusion is that the impacts on human receptors is not significant. This is a valid conclusion based on the tables of predicted concentrations. However, in coming to a judgement on significance other considerations need to be considered including the influence and validity of the assumptions adopted and the uncertainty of the results.

4.10. Table 7.1 of ES Appendix 13.4.1: Air Quality Assessment Methodology provides information on the assumptions and limitations. It is, however, not clear how these have feed into the judgement of significant. The assumption seems to be that because the background concentrations have been assumed to be at the 2030 level that the assessment is conservative. Road traffic exhaust emissions have decreased significantly over the last decade but from 2030 to 2038 the reduction is likely to be much smaller. It would be useful to see evidence of how they may change. Is this assumption really so very conservative that it outweighs all the uncertainty in aircraft emissions and the uncertainty in the traffic model such as the 'noise'? Furthermore, given the lack of PM performance evaluation and the high variability and potentially poor performance in relation to NOx/NO_2, how much can the values predicted be relied upon?

Odour

4.11. During the operational period aircraft emissions would be the key sources of odour. The water treatment plant for the de-icing run-off is not considered to be a source of odour. The CARE facility, if best practice methods are used to contain and reduce odour emissions, is considered unlikely to give rise to a slight adverse effects at community areas around the airport and it understood to be removed from the application.

4.12. A qualitative odour assessment using the IAQM methodology (IAQM, 2018) was undertaken. It concluded that Horley Gardens Estate may experience occasional, short-term odour under specific weather conditions as a result of the increase in airport activity. The number of odour complaints is considered likely to remain at a limited level due to the low frequency of the wind blowing towards this residential area.

4.13. The odour effect was considered to be not significant.

Health and Wellbeing

4.14. The effects on public health of the NRP is considered in the Health and Welling chapter of the ES (chapter 18). This chapter draws on the information presented in the air quality chapter (chapter 13), as well as the non-threshold effects of exposure to NO_2, PM_{10} and $PM_{2.5}$ and the 2021 WHO air quality guidelines.

4.15. It provides both quantitative and qualitative assessments of the public health effect of the NRP (Appendix 18.8.1) and concludes that the health effect of NRP would be a minor adverse effect. The public health effect considers the effect on the local population not on individuals and therefore there may remain a risk of significant adverse effects on individuals even if a population-based effect is not significant.

4.16. Paragraph 18.8.46 states that:

"The minor adverse (rather than negligible) score represents a conservative assessment finding given scientific uncertainty (and emerging evidence) about non-threshold health effects of NO_2, and $PM_{2.5}$. The score takes into account WHO advisory guidelines, the updated $PM_{2.5}$ standards and also reflects that air pollution is a specific local public health priority. The level of change in the health baseline due to the Project is likely to be very limited, with at most a marginal effect on the delivery of health policy and inequalities. This is a public health acknowledgement of the very small incremental contribution to air pollution that the Project would make, but also recognition that at the Project level this should not be considered a significant effect on population health or health inequalities."

4.17. This judgement of a 'very small incremental contribution to air pollution' is based on the level relative to the air quality regulatory/statutory thresholds, which we believe to not be the appropriate assessment thresholds for health effects on a local population which includes vulnerable and sensitive groups. If a more stringent assessment threshold had been used (e.g. the 2040 $PM_{2.5}$ target) then the magnitude of this change may have been greater which may have had an implication on the significance of effect.

4.18. The Health and Wellbeing Chapter concludes that the significance of any UFP effect for population health would be "up to minor adverse (not significant). The minor adverse rather than negligible

score is a conservative assessment based on the scientific uncertainty and precautionary approach." Insufficient evidence has been provided in the ES to justify this conclusion, particularly the 'precautionary approach'.

4.19. This conclusions on the health effects of the NRP due to air pollution is consistent with the results presented in the Air Quality Chapter (Chapter 13) but will also be subject to the same uncertainty in the emission and dispersion modelling which, if accounted for, may alter the conclusion of the health effects.

5. Conclusion

5.1. This note has identified that there are considerable uncertainties in the emission estimates and the dispersion modelling for all pollutants, but particularly $PM_{2.5}$. As a consequence, there is little confidence in the baseline modelling.

5.2. Uncertainties increase the further into the future the emissions and air quality are predicted, with one scenario looking at emissions 29 years after the base year. These uncertainties do not appear to have been adequately considered when reaching the conclusions of the AQA. This is justified by the use of "*conservative assumptions*" but this is not backed up by evidence that the assumptions are conservative, nor how conservative they are.

5.3. No assessment of the increased emissions due to NRP in the context of the NECR has been provided.

5.4. In the Air Quality Chapter $PM_{2.5}$ is incorrectly assumed to be a good surrogate for UFP when the World Health Organization and other authoritative sources clearly state that $PM_{2.5}$ is not a good proxy for UFPs.

5.5. The Health and Wellbeing chapter has concluded that the UPF effect will not be significant, yet there is no assessment of the impact.

6. Glossary

APS	Air Pollution Services
EPUK	Environmental Protection UK
f-NO_2	Fraction of nitrogen dioxide
GATCOM	Gatwick Airport Consultative Committee
IAQM	Institute of Air Quality Management
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter
$PM_{2.5}$	Small airborne particles, more specifically particulate matter less than 2.5 micrometres in aerodynamic diameter

UFP	Ultra fine particles i.e. particles with an aerodynamic diameter less than 0.1 µm
µg/m³	Micrograms per cubic metre

7. References

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