Appendix A

TOPIC BASED SCHEMES ASSESSMENT: AoS FOR AIRPORTS NPS

A-4 NOISE

June 2018

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4 NOISE

4.1 INTRODUCTION

4.1.1 This topic-based assessment has been updated using the DfT's latest aviation demand forecasts for each airport expansion option, alongside up-to-date baseline data. Updates have been made to the local noise assessments, including predicted exposure of the population and noise sensitive buildings to noise and associated health and amenity effects. As described in section 4.7, the national noise and ground noise exposure assessments have not been updated; where these are reported below they are based on the data produced for the Airports Commission, as previously reported in the Appraisal of Sustainability. The ground noise assessment is based on the layout of the airport and the general expected operations within. The aviation demand forecasts are not an input to the modelling of ground noise and therefore the AC's modelling of ground noise is still reliable. Whilst the updated aviation demand forecasts will affect the national noise forecasts, the negative noise impacts due to airport expansion are focused largely on the expanded airport. Therefore to prevent unwarranted delays in this updated analysis, the DfT did not update the national noise assessment. The local noise assessments have also been updated to consider a lower bound daytime average exposure level of 54 dB; this is in line with recent research which is acknowledged under new UK airspace policy, as detailed further below.

4.1.2 This assessment considers each shortlisted airport expansion scheme under the Noise topic. These are London Heathrow Extended Northern Runway (LHR-ENR), London Heathrow Northwest Runway (LHR-NWR) and London Gatwick Second Runway (LGW-2R).

4.1.3 By law, before designating an Airports National Policy Statement (NPS) an Appraisal of Sustainability (AoS) must be carried out. This AoS is a strategic level assessment. It is based on the contents of the Airports NPS. The AoS considers alternatives to the Government's preferred scheme as set out in the Airports NPS, including the outline masterplans supplied to the Airports Commission (AC) for the three shortlisted schemes. This AoS considers the impacts of expansion without the benefits of the mitigation package put forward by scheme promoters, unless stated otherwise. The Government has outlined that it expects a significant mitigation package to be put in place by the promoter of its preferred scheme to ensure that wherever possible significant effects are avoided, reduced or offset.

4.1.4 Further project-level design will be required which will inform an environmental impact assessment (EIA) carried out by the promoter. This would involve an assessment that is likely to include effects identified in the AoS as well as more detailed mitigation developed as detailed design progresses. This will also be developed through consultation with both affected communities and other stakeholders.

4.1.5 This assessment builds on the sustainability assessment undertaken as part of the AC's Appraisal Framework1, but also responds to the AoS Appraisal Framework. The Framework addresses noise issues that have been identified through scoping (a review of plans, policies and programmes, and also the baseline conditions).

4.1.6 Each expansion scheme is considered against the AoS Appraisal Framework Objectives and Appraisal Questions. The Objective and Question which are addressed within this assessment are as follows:

[1] Airports Commission, 2014. *Appraisal Framework*. [online] Accessed 24/12/2015.

→ **AoS Objective 6:** To minimise and where possible reduce noise impacts on human receptors.

- **AoS Question 11:** Will it avoid, prevent or reduce the harmful effects due to exposure of people and sensitive buildings to noise?

4.2 POLICY AND LEGISLATION

4.2.1 The policy guidance framework considered relevant to this assessment is summarised below. Their context and applicability is explained as appropriate in the relevant sections of the assessment.

Aviation Policy Framework (APF)

4.2.2 The APF[2] sets out central Government policy on air transport, the role of the AC, and Government aims and objectives for a wide range of factors relevant to making plans and decisions on aviation provision, including the effects of noise. The aviation policy objectives are consistent with Government policy on noise.

Consultation Response on UK Airspace Policy

4.2.3 The Consultation Response on *UK Airspace Policy: A framework for balanced decisions on the design and use of airspace*[3] sets out the Government's policy framework for airspace decisions, including how noise should be assessed in these decisions. It includes updates to some areas of noise policy in the APF as well as confirming the establishment of a new Independent Commission on Civil Aviation Noise.

Noise Policy Statement for England (NPSE)

4.2.4 The NPSE[4] sets out central Government noise policy for England, and the guiding aims and principles to consider in the preparation of wider policies and planning.

National Planning Policy Framework 2012 (NPPF)

4.2.5 The NPPF[5] sets out central Government planning policies and guidance on policy application. Policies relevant to noise make reference to the NPSE.

Planning Practice Guidance (PPG)

4.2.6 The PPG[6] is an internet-based Government-produced resource, providing additional context and information for practitioners and policy makers in applying the NPPF.

Transport Analysis Guidance: WebTAG

4.2.7 The DfT WebTAG[7] resource provides guidance and tools to appraise the potential costs and benefits of transport proposals. TAG Unit A3[8] addresses environmental impacts, including noise, and outlines an approach to analysing the possible health and amenity effects associated with a

[2] Department for Transport, 2013. *Aviation Policy Framework.* [online] Accessed 21/12/2015.
[3] Department for Transport, 2017. *Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace.* [Published alongside this AoS]
[4] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England*. [online] Accessed 21/12/2015.
[5] Department for Communities and Local Government, 2012. *National Planning Policy Framework.* [online] Accessed 21/12/2015.
[6] Department for Communities and Local Government, 2014. *Planning Practice Guidance*. [online] Accessed 21/12/2015.
[7] Department for Transport, 2014. *Transport analysis guidance: WebTAG.* [online]. Accessed 04/07/2016.
[8] Department for Transport, 2015. *TAG Unit A3: Environmental Impact Appraisal*. [online] Accessed 03/05/2016.

transport option, based on World Health Organisation (WHO) guidance[9] and research reports from Department for Environment, Food and Rural Affairs (Defra)[10] and the Interdepartmental Group on Costs and Benefits (Noise) [IGCB(N)][11].

4.3 BACKGROUND TO THE ASSESSMENT

4.3.1 The assessment is based on the information contained within the following reports:

- Jacobs, 2014. *5. Noise: Baseline. Prepared for the Airports Commission*[12];
- Jacobs, 2014. *5. Noise: Local Assessment. Prepared for the Airports Commission*[13];
- Jacobs, 2014. *5. Noise: National Assessment. Prepared for the Airports Commission*[14];
- Jacobs, 2014. *5. Noise: Baseline and Local Assessment Methodology Addendum. Prepared for the Airports Commission*[15];
- Jacobs, 2014. *5. Noise: Figures. Prepared for the Airports Commission*[16];
- Jacobs, 2015. *5. Noise: Local Assessment Addendum. Prepared for the Airports Commission*[17];
- Civil Aviation Authority (CAA) Environmental Research Consultancy Department (ERCD), 2015. *Noise Modelling for the Airports Commission: Compendium of Results*[18]*;*
- Airports Commission, 2015. *Final Report*[19];
- Airports Commission, 2015. *Business case and sustainability assessment*[20];
- Airports Commission, 2015. *Compendium of Results* (Parts E-02 to E-20 and F-01 to F-02)[21]; and
- Clark,C, 2015. *Aircraft noise effects on health*[22].

4.3.2 Additionally, further assessment data has been provided by the CAA reflecting the updated demand forecasting.

4.3.3 It is not the purpose of this appraisal to repeat the detailed assessment conducted by the AC and reported in the documents listed in paragraph 4.3.1. Instead, the appraisal seeks to draw out the key strategic considerations relevant to noise within the context of the Appraisal Framework for this AoS.

4.3.4 Complementary work has been carried out for this AoS topic to augment the AC assessment information:

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[9] World Health Organisation, 2011. *Burden of disease from environmental noise*. [online]. Accessed 03/05/2016.
[10] Department for Environment, Food and Rural Affairs, 2014. *Environmental noise: valuing impacts on sleep disturbance, annoyance, hypertension, productivity and quiet.* [online]. Accessed 03/05/2016.
[11] Interdepartmental Group on Costs and Benefits (Noise). Noise and health – valuing the human health impacts of environmental noise exposure. [online]. Accessed 03/05/2016.
[12] Jacobs, 2014. *5. Noise: Baseline.* [online] Accessed 21/12/2015.
[13] Jacobs, 2014. *5. Noise: Local Assessment.* [online] Accessed 21/12/2015.
[14] Jacobs, 2014. *5. Noise: National Assessment.* [online] Accessed 21/12/2015.
[15] Jacobs, 2014. *5. Noise: Baseline and Local Assessment Methodology Addendum.* [online] Accessed 21/12/2015.
[16] Jacobs, 2014. *5. Noise: Figures.* [online] Accessed 21/12/2015.
[17] Jacobs, 2015. *5. Noise: Local Assessment Addendum.* [online] Accessed 21/12/2015.
[18] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results.* [online] Accessed 21/12/2015. NB: Unless otherwise stated, the assessment in this Appendix is based on the data as presented in this Compendium.
[19] Airports Commission, 2015. *Final Report*. [online] Accessed 21/12/2015.
[20] Airports Commission, 2015. *Business case and sustainability assessment.* [online] Accessed 21/12/2015.
[21] Airports Commission, 2015. *Compendium of Results, Parts E-02 to E-20 and F-01 to F-02)*. [online] Accessed 21/12/2015.
[22] Clark, C., 2015. *Aircraft noise effects on health.* [online] Accessed 21/12/2015.

- The significance criteria for the Noise topic assessment have been developed with reference to current national noise and aviation policies;
- The potential scale of health and amenity effects for each scheme have been compared against each 'do minimum'[23] case and across schemes;
- The cumulative effects of ground and airspace noise[24] are considered together alongside the discrete effects of each type of impact; and
- A sensitivity test is presented in Section 4.13, which examines a potential 'high demand' scenario for noise impacts; this test examines the change in impacts associated with a greater increase in future air traffic than assumed in the 'central scenario'.

4.4 INTERACTION WITH OTHER TOPICS

4.4.1 This assessment focusses on noise effects on human receptors, including (occupied) noise-sensitive buildings (NSBs)[25]. Noise can also have effects on historical sites, tranquillity, non-human biological organisms, and the wider quality of life for communities. These effects are considered in the AoS within the Historic Environment; Landscape; Biodiversity; Quality of Life and Community topics, respectively. In particular, the following interactions are noted within Table 4.1.

Table 4.1: Interactions with Other Topics

TOPIC	INTERACTION
Community	Noise can have indirect effects on communities, including affecting community and recreational facilities.
Quality of Life	Noise can impact upon annoyance and loss of sleep leading to effects on quality of life.
Biodiversity	Biodiversity can be affected by noise; disturbance of fauna can adversely affect breeding and foraging.
Historic environment	The setting of heritage assets and tranquillity can be affected by aviation and surface access noise.
Landscape	Landscapes and their tranquillity can be affected by noise.

4.5 ASSESSMENT CRITERIA

4.5.1 The general criteria used for assessing the significance of effects are set out in Section 3 of the AoS Report to which this appendix is attached.

4.5.2 The NPSE sets out three key aims[26]:

- Avoid significant adverse impacts on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life; and
- Where possible, contribute to the improvement of health and quality of life.

4.5.3 The NPSE states[27] that these aims are framed "within the context of Government policy on sustainable development".

[23] The 'do minimum' represents the conditions expected to exist if the scheme did not go ahead; this is also referred to as the 'future baseline'.
[24] Here, 'airspace' noise is meant as noise generated by aircraft in flight, takeoff, and landing; 'ground' noise is that generated by aircraft taxiing and ancillary operations (such as fuelling) around the runways.
[25] Schools, hospitals and religious places of worship are considered noise-sensitive buildings for the purposes of this appraisal. NB. Schools are assessed separately to other NSBs in Section 4.9.
[26] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England*, p. 4. [online] Accessed 21/12/2015.

4.5.4 The NPSE also establishes the concepts of Observed Effects Levels (OELs) within the field of environmental noise. These are outlined as:

- No Observed Effect Level (NOEL) – the level below which there are no detectable effects of noise on health and quality of life;
- Lowest Observed Adverse Effects Level (LOAEL) – the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effects Level (SOAEL) – the level above which significant adverse effects on health and quality of life are expected to occur.

4.5.5 In addition, the current PPG[28] on noise provides further relevant qualitative information, including a description of the adverse effects expected from noise impacts increased beyond the SOAE range:

- Unacceptable Adverse Effect (UAE) – Outcome: Extensive and regular changes in behaviour and / or an inability to mitigate effect of noise leading to psychological stress or physiological effects, eg regular sleep deprivation/ awakening; loss of appetite; significant, medically definable harm, e.g. auditory and non-auditory; Action: Prevent.

4.5.6 The APF sets out central Government policy with respect to air transport in the country. In this framework, some indicative threshold levels are provided, which designate degrees of action to be taken by airport operators. Some of the policy on noise in the APF has been supplemented by a more recent policy update set out in the Government Response to Consultation on *UK Airspace: A framework for balanced decisions on the design and use of airspace*[29].

Table 4.2: Aviation Policy Framework Threshold Noise Levels, as supplemented by policy set out in Government Response to Consultation on UK Airspace Policy: A Framework for Balanced Decisions on the Design and Use of Airspace

AVIATION POLICY FRAMEWORK THRESHOLD NOISE LEVELS, AS SUPPLEMENTED BY POLICY SET OUT IN GOVERNMENT RESPONSE TO CONSULTATION ON UK AIRSPACE POLICY: A FRAMEWORK FOR BALANCED DECISIONS ON THE DESIGN AND USE OF AIRSPACE	
NOISE LEVEL	POLICY DESCRIPTION
54 dB $L_{Aeq,0700\text{-}2300hrs}$[30]	Based on the results of the SoNA[31] study, a level of 54dB $L_{Aeq,0700\text{-}2300hrs}$ signifies a level at which significant community annoyance starts to occur.
63 dB $L_{Aeq,0700\text{-}2300hrs}$	The lowest level at which the Government expects airport operators to offer acoustic insulation to noise-sensitive buildings such as schools and hospitals. Where a residence experiences an increase in noise that leaves them exposed to levels above this threshold, the Government expects airport operators to offer financial assistance towards acoustic insulation.
69 dB $L_{Aeq,0700\text{-}2300hrs}$	The lowest level at which the Government expects airport operators to offer household assistance with the costs of moving or full insulation where home owners do not want to move.

4.5.7 A connection between the thresholds discussed in Table 4.2 and the first two aims of the NPSE together with the PPG advice may be drawn:

[27] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England.* p. 3, [online] Accessed 21/12/2015.
[28] Department for Communities and Local Government, 2014. *Planning Practice Guidance*. [online] Accessed 21/12/2015.
[29] Department for Transport, 2017. *Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace*.
[30] $L_{Aeq,T}$ is the A-weighted equivalent continuous sound pressure level, averaged over time period T.
[31] Civil Aviation Authority, 2017. CAP 1506 Survey of noise attitudes 2014: aircraft. [online] Accessed 13/09/2017.

- 54 dB $L_{Aeq,0700\text{-}2300hrs}$ is the level at which the recent UK SoNA research shows significant community annoyance starts to occur (9% respondents highly annoyed). This level can therefore be taken as within the Observed Adverse Effects (OAE) range;
- 63 dB $L_{Aeq,0700\text{-}2300hrs}$ is the lowest level at which the Government expects airport operators to provide assistance towards acoustic insulation and has been adopted as a SOAEL for the purposes of this assessment; and
- 69 dB $L_{Aeq,0700\text{-}2300hrs}$ has been adopted as the UAEL for the purposes of this assessment. This is the lowest level at which the Government expects airport operators to offer household assistance with the costs of moving (or full insulation where home owners do not want to move), and, in the absence of further guidance, this threshold is also appied to NSBs for the analysis in this AoS.

4.5.8 It is acknowledged that a range of views exist concerning the most appropriate threshold levels for the onset of effects due to daytime aviation noise[32,33]. It is important to realise that setting any noise threshold value involves simplification of the complexity of human responses to noise in real situations. Moreover, it is not necessarily possible (or desirable) to set a single value that is applied to all types of noise source, or noise impact assessment, and this position is reflected in national policy[34]. This interpretation does not represent an official or endorsed position on the approach to be taken in or adapted to any other assessments or appraisals, which should be considered separately to this AoS and within the set of contexts appropriate to the identified objectives.

4.5.9 In particular, identifying a LOAEL for aviation noise is not straightforward, and this is an area of ongoing research and debate. For the purpose of this AoS, local population exposure to airspace noise has been assessed against a lower bound set at the >54 dB $L_{Aeq,16hr}$ contour. For practical reasons it becomes more difficult to estimate noise exposure accurately, and therefore population numbers affected, below this level. This is because it is difficult to measure aircraft noise levels at greater distances from airports where airport noise levels are closer to those of other noise sources. Since measurements are used to validate the model, the ability to validate the model reduces with increasing distance, leading to increased uncertainty in the position of the contour lines. Due to variability in aircraft position in the air at greater distances from the airport, the absolute noise levels (and thus also the position of the contour lines) also have a lower level of certainty. National population exposure to airspace noise, and local population exposure to ground noise have been assessed against a lower bound of >57 dB $L_{Aeq,16h}$, according to availability of modelling data. The assessment of impacts associated with noise-related health and amenity effects, as discussed further below, extends down to a threshold of 45 dB $L_{Aeq,16h}$ and 45 dB L_{night}[35]. The selected threshold levels are not defined here as aviation noise LOAELs, but are adequate to enable this strategic appraisal to be conducted. Following consultation on UK Airspace Policy, the Government has confirmed that it is adopting a daytime LOAEL of 51dB $L_{Aeq\ 16hr}$ for the purpose of assessing airspace changes, with impacts assessed using a risk-based approach above the LOAEL using WebTAG[36] rather than absolute numbers of people. This will allow options for airspace to be compared quantitatively in terms of noise performance and will allow health and amenity effects to be assessed as described below.

4.5.10 The assessment also includes consideration of possible health and amenity effects due to noise exposure from each scheme, following an approach set out in the DfT WebTAG cost-benefit analysis framework for environmental impacts. This assessment addresses annoyance and sleep disturbance (amenity effects), acute myocardial infarction (AMI: heart attack), hypertension-related stroke and hypertension-related dementia (health effects).

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[32] Airports Commission, 2015. *Consideration of Consultation Responses*, p. 52, paragraphs 2.7.19 – 2.7.22, [online] Accessed 04/07/2016.
[33] Airports Commission, 2014. *Appraisal Framework.* p. 55, paragraph 5.2, [online] Accessed 04/07/2016.
[34] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England*, p. 9, paragraph 2.22. [online] Accessed 21/12/2015.
[35] Lnight is the external night-time $L_{Aeq,2300\text{-}0700hrs}$ averaged over a year.
[36] Department for Transport, 2015. *TAG Unit A3 Environemental Impact Appraisal.* [online]. Accessed 04/07/2016.

4.5.11 The criteria adopted for assessing the scale of health and amenity effects have been formed by the exposure-response (or dose-effect) relationships identified by the WHO for annoyance[37], sleep disturbance[38], and AMI[39,40], and by the Health & Safety Laboratory for hypertension-related disorders[41] (commissioned by Defra). The output for this assessment of health and amenity effects is in terms of changes in the numbers of lost 'Disability-Adjusted Life Years' (DALYs; an estimate of the potential healthy life years lost due to premature morbidity or mortality); monetised values associated with these results are presented in the DfT's Updated Appraisal Report[42].

4.5.12 The potential health costs of noise on cognitive development in school-age children are not currently quantified in the WebTAG appraisal framework. An assessment of the potential aviation noise impacts of each scheme on children's cognitive development under the previous demand forecasts was conducted by Queen Mary University of London[43]. There were no specified 'significance' criteria applied, but the assessment examined numbers of schools exposed to daytime average noise contours down to 54 dB $L_{Aeq,16hr}$. This approach has also been adopted for this assessment, which examines noise exposure under the most recent demand forecasts.

4.5.13 The third aim of the NPSE (see paragraph 4.5.2) is intended to bring about improvements in health and quality of life by effective management and control of noise. Beneficial changes in these indicators could be expected to occur where the population exposed to levels exceeding 54 dB $L_{Aeq,16hr}$ and the other Adverse Effects Levels (AELs) discussed above is reduced.

4.5.14 On the basis of the framework discussed above, the criteria shown in Table 4.3 have been adopted for the Noise topic assessment. In developing the assessment criteria, a distinction has been made between i) people, ii) schools, and iii) other non-residential NSBs (in this context taken to comprise hospitals and religious places of worship). It is acknowledged that the criteria cannot and do not represent the full complexity of the potential effects of noise that could be experienced at an individual level. In particular, the assessment focuses on the 'L_{eq}' metric, which is an 'equivalent' sound level averaged over specified periods and as such does not directly represent the short-term levels of individual aircraft noise events that may be experienced subjectively. This is because this assessment approach has been developed with a view to providing a platform for a strategic appraisal of the most likely and significant effects associated with each expansion scheme, in view of current Government policy and established exposure-response research. A wider EIA would be required for any scheme taken forwards, including further consideration of potential environmental effects at a more detailed level.

[37] World Health Organisation, 2011. *Burden of disease from environmental noise*, p. 93. [online] Accessed 03/05/2016.
[38] World Health Organisation, 2011. *Burden of disease from environmental noise*, p. 59. [online] Accessed 03/05/2016.
[39] World Health Organisation, 2011. *Burden of disease from environmental noise,* p. 22. [online] Accessed 03/05/2016.
[40] Babisch,W, 2006. *Transportation noise and cardiovascular risk. Review and synthesis of epidemiological studies.* Dessau: Umweltbundesamt. [online] Accessed 03/05/2016.
[41] Harding, A-H., Frost, G., Mason, H., Tan, E., Tsuchiya, A. and Warren, N., 2011. *Quantifying the links between environmental noise related hypertension and health effects. Crown Copyright*. [online] Accessed 03/05/2016.
[42] Department for Transport, 2017. *Updated Appraisal Report.* [Published alongside this AoS]
[43] Clark,C, 2015. *Aircraft noise effects on health.* [online] Accessed 21/12/2015.

Table 4.3: Noise Topic AoS Assessment Criteria

CLASSIFICATION OF EFFECTS IN THE AOS		
CODE	CLASSIFICATION	DESCRIPTION
++	Significant positive effect	Reduction in population DALYs lost Reduction in schools exposed to SOAEL/UAEL
+	Positive effect	Reduced population/NSB exposure to the noise thresholds considered Reduction in schools exposed to daytime noise below SOAEL
-	Negative effect	Increase in numbers of schools/NSBs exposed to daytime noise below SOAEL
--	Significant negative effect	Increase in population DALYs lost Increase in population exposed to the noise thresholds considered Increase in numbers of schools/NSBs exposed to SOAEL/UAEL
+/-, ++/--,	Mixed positive and negative effects	Combinations of the above impacts where there is no dominating factor
?	Uncertain effect	Population exposure or effect uncertain
0	No relationship/neutral effect	No changes in population exposure to effects thresholds or DALYs

Notes to Table 4.3:

1. Throughout the assessment, the terms beneficial/positive and adverse/negative are used interchangeably in relation to effects, with the latter term in each case referring to the conclusions drawn from the assessment, in order to maintain compatibility with the wider AoS.

2. The assessment criteria have been developed to provide a platform for a strategic appraisal of the most likely and significant effects associated with each scheme, in view of current Government policy, which has been interpreted for the specific purposes of this assessment – this does not represent an official or endorsed position on the approach to be taken and criteria for use in any other assessments or appraisals.

4.5.15 It should be noted that schemes are assessed individually against the requirements of the Strategic Environmental Assessment (SEA) Regulations and presented together for comparison. This means that although the nature of effects can vary between schemes, the significance may be the same.

4.6 SUMMARY OF BASELINE AND FUTURE BASELINE

4.6.1 The baseline local airspace noise exposure figures reported below have been updated to more recent available data produced in 2015 (the ground noise baseline and national baseline are based on 2013 data as these assessments have not been updated, as noted).

4.6.2 The baseline noise assessment[44] for Gatwick and Heathrow describes how noise exposure is expected to change at the national and local levels in the absence of a scheme, and identifies the underlying reasons for these changes. Aviation noise associated with the 'do minimum' (future baseline) scenarios for the base year (2030), an intermediate year (2040), and end year (2050) were considered, in addition to the 'present-day' baseline noise situations at each airport (considered for 2015).

[44] Jacobs, 2014. *5. Noise: Baseline.* [online] Accessed 21/12/2015.

4.6.3 Numbers of people and non-residential NSBs exposed to the selected noise thresholds have been estimated from modelling described further in Sections 4.7 and 4.8. The study areas have been defined at the local level by consideration of the total areas covered by the modelled contours around each airport[45]. At the national level, the study area includes the modelled contour areas around each of 13 selected UK airports (see Paragraph 4.7.4 below), and considers the enclosed population exposures[46].

4.6.4 It is anticipated that there will be significant changes in the aircraft operated over the period, and by 2050, an increased percentage of the aircraft operating will be new or re-engined aircraft, which would be quieter than current aircraft[47]. It is expected that these developments would lead to smaller overall areas being subject to the current levels of noise in the future do minimum assessment years. Nationally, the improvements in aircraft technology could largely offset noise generated by additional Air Transport Movements (ATMs)[48]. As well as reducing noise at source, further noise benefits by 2050 would be expected from the increased use of quieter operating procedures such as steeper approaches, continuous climb and delayed deployment of landing gear. Improved navigational technology and airspace modernisation could also change how and where aircraft fly, providing increased potential to reduce the impact on communities.

4.6.5 The assessment of the potential aviation noise impacts generated by each scheme depends on the assumptions adopted in the prediction scenarios. There are two primary factors considered for the noise assessment at a local level:

i. Future aviation demand

ii. Flight path strategies

4.6.6 The DfT's demand forecasting considers two scenarios: a central scenario, and a high demand scenario. The central scenario is considered the best estimate to appraise the expected impacts of expansion. In this scenario, future demand is primarily determined by central projections published by sources such as the Office for Budget Responsibility, Organisation for Economic Coordination and Development (OECD) and International Monetary Fund (IMF) and assumes that there are no changes in airline business models. This is broadly consistent with the 'Assessment of Need' (AoN) scenario used in the AC's previous aviation forecasts (as discussed below).

4.6.7 The high demand forecasting produced by the DfT is expected to represent a high estimate of potential noise impacts; a sensitivity test has been conducted to examine the effect of this scenario on the assessment outcomes, and is included in Section 4.13.

4.6.8 The AC appraisal also considered a range of potential future demand scenarios. A detailed description of these scenarios was published in the AC's updated forecasts[49]. When considering future aviation demand, the AC adopted the AoN scenario as the starting point for its analysis of impacts, which forms the underpinning assumptions for the noise assessment at a national level.

4.6.9 The AC also considered two potential carbon policy futures: carbon traded and carbon capped – the carbon capped policy has been assumed for the national noise predictions according to the available data. The DfT's updated forecasts are not dependent on one single carbon scenario, and therefore future carbon policy is not a variable in the updated noise modelling scenarios. The carbon capped scenario was updated by employing technology from the updated 'Marginal Abatement Cost Curve' (MACC) study[50], which allows the carbon cap to be met even with the same number of ATMs forecast.

[45] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 10, 75-76 and 207-208. [online] Accessed 21/12/2015.
[46] Jacobs, 2014. *5. Noise: National Assessment*, p. 37, Appendix B. [online] Accessed 21/12/2015.
[47] Jacobs, 2014. *5. Noise: Baseline*, pp. ii-iv, Executive Summary. [online] Accessed 21/12/2015.
[48] Jacobs, 2014. *5. Noise: Baseline*, p. iv, Executive Summary. [online] Accessed 21/12/2015.
[49] Airports Commission, 2015. *Strategic fit: forecasts.* [online] Last accessed 29/07/2016.
[50] Holland, M et al, 2011. *DfT Aviation MACC study technical report: final v3: A marginal abatement cost curve model for the UK aviation sector*. DfT [online] Accessed 13/09/2017.

4.6.10 The relevant set of scenario assumptions adopted (aviation demand, and future carbon policy where applicable, i.e. to AC data) is designated for each noise consideration below. The adopted assessment scenarios are detailed further in Section 4.7.

4.6.11 The assumed flight path designs for LGW-2R[51], LHR-ENR[52], LHR-NWR[53] reflect those selected by the AC in its final assessment[54].

4.6.12 The baseline local population exposures to airspace noise (central scenario) are summarised in Table 4.4.

Table 4.4: Baseline Local Population Airspace Noise Exposure (Central)

Noise Contour ↓	Gatwick Population Noise Exposure				Heathrow Population Noise Exposure			
	Baseline 2015	Future baseline 2030	Future baseline 2040	Future baseline 2050	Baseline 2015	Future baseline 2030	Future baseline 2040	Future baseline 2050
>54 dB $L_{Aeq,16h}$	11,281	10,900	6,700	6,500	585,600	561,200	472,700	438,800
>63 dB $L_{Aeq,16h}$ (SOAEL)	572	600	400	400	45,900	38,500	28,900	29,200
>69 dB $L_{Aeq,16h}$ (UAEL)	132	200	<50	<50	3,100	2,500	1,500	2,000
>48 dB $L_{Aeq,2300-0700hrs}$ (night-time)	14,390	18,200	10,400	10,300	399,100	233,300	263,500	326,100

4.6.13 The baseline local schools and other NSB exposures to airspace noise (central scenario) are summarised in Table 4.5.

Table 4.5: Baseline Local Noise Sensitive Buildings Airspace Noise Exposure (Central)

Noise Contour ↓	Gatwick NSB Noise Exposure				Heathrow NSB Noise Exposure			
	Baseline 2015	Future baseline 2030	Future baseline 2040	Future baseline 2050	Baseline 2015	Future baseline 2030	Future baseline 2040	Future baseline 2050
Schools								
>54 dB $L_{Aeq,16h}$	14	14	8	8	397	372	285	261
>57 dB $L_{Aeq,16h}$	3	3	3	2	148	122	100	94
>60 dB $L_{Aeq,16h}$	2	2	2	2	59	49	32	33
>63 dB $L_{Aeq,16h}$ (SOAEL)	1	2	1	1	17	13	7	4
>66 dB $L_{Aeq,16h}$	1	0	0	0	6	2	1	1

[51] Jacobs, 2014. *5. Noise: Local Assessment*, p. 11, Figure 3.2. [online] Accessed 21/12/2015.
[52] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, p. 3, Figure 2.2. [online] Accessed 21/12/2015.
[53] Jacobs, 2014. *5. Noise: Local Assessment*, p. 78, Figure 4.2. [online] Accessed 21/12/2015.
[54] Airports Commission, 2015. *Final Report.* [online] Accessed 21/12/2015.

Noise Contour ↓	Gatwick NSB Noise Exposure				Heathrow NSB Noise Exposure			
	Baseline 2015	Future baseline 2030	Future baseline 2040	Future baseline 2050	Baseline 2015	Future baseline 2030	Future baseline 2040	Future baseline 2050
>69 dB $L_{Aeq,16h}$ (UAEL)	0	0	0	0	0	0	0	0
>72 dB $L_{Aeq,16h}$	0	0	0	0	0	0	0	0
Hospitals and places of worship								
>54 dB $L_{Aeq,16h}$	12	11	5	5	261	227	180	169
>63 dB $L_{Aeq,16h}$ (SOAEL)	2	2	2	2	17	10	8	7
>69 dB $L_{Aeq,16h}$ (UAEL)	0	0	0	0	1	0	0	0

4.6.14 The baseline local population exposures to ground noise are summarised in Table 4.6 (data is only available for ground noise levels of ≥57 dB $L_{Aeq,16h}$).

Table 4.6: Baseline Local Population Ground Noise Exposure[55]

Noise Area Threshold ↓	Gatwick Population Noise Exposure		Heathrow Population Noise Exposure	
	Baseline 2013	Future baseline 2030	Baseline 2013	Future baseline 2030
≥57 dB $L_{Aeq,16h}$	900	3,150	30,650	30,750

4.6.15 The baseline national population exposures to airspace noise are summarised in Table 4.7 (AoN carbon capped scenario; national exposure data is only available for noise levels of ≥57 dB $L_{Aeq,16h}$).

Table 4.7: Baseline National Population Airspace Noise Exposure (AoN Carbon Capped)[56]

Noise Contour ↓	Baseline 2013	Future baseline 2030	Future baseline 2040	Future baseline 2050
>57 dB $L_{Aeq,16h}$	363,450	340,750	346,400	357,050
>63 dB $L_{Aeq,16h}$ (SOAEL)	55,100	43,900	44,500	47,850
>69 dB $L_{Aeq,16h}$ (UAEL)	3,450	2,450	2,600	3,050
>48 dB $L_{Aeq,2300\text{-}0700hrs}$ (night-time)	578,950	449,100	533,650	594,500

[55] Jacobs, 2014. *5. Noise: Baseline,* pp. 29 and 67, Tables 3.6 and 4.6. [online] Accessed 21/12/2015
[56] Jacobs, 2014. *5. Noise: Baseline,* pp. 95, 96, 98 and 100, Tables 6.1, 6.2, 6.4 and 6.6. [online] Accessed 21/12/2015.

4.7 APPROACH TO ASSESSMENT OF NOISE

4.7.1 As described above, the local airspace noise modelling results have been updated to reflect the latest demand forecasts. The national airspace and ground noise assessments presented are based on the AC's noise modelling, including the AoN carbon capped scenario (where relevant); it is acknowledged that a carbon capped scenario may produce lower estimates of noise impacts in some cases and use of each scenario has been highlighted in the relevant assessment sections. Operational assumptions underpinning the ground noise assessment are discussed further in Section 4.11.

4.7.2 Construction phase impacts have been assessed on a qualitative basis, considering the scale of the proposed schemes and the proximity to sensitive receptors. Detailed assessment of construction impacts and opportunities for mitigation would be required at the EIA stage for any scheme taken forward.

4.7.3 Impacts at the strategic level have been assessed for the operational phase of each scheme. During operation, potential impacts include airspace and ground noise, of which airspace noise is considered of greater importance due to its wide dispersion and the limitations of available mitigation.

4.7.4 While noise from surface access transportation has the potential to affect areas with changes in noise, any such effects would be localised and limited in spatial extent. It is acknowledged that aviation noise will be the predominant source of potentially significant impacts that entail strategic consideration, and no changes to the overall assessment outcomes are expected due to surface access noise. The potential for cumulative effects of surface access and aviation sources has been given outline consideration within the AoS, and the potential impacts of surface access noise and scope for mitigation should be assessed in further detail at the EIA stage.

4.7.5 The assessment of operational airspace noise impacts on local receptors is based on the results from the outputs of the CAA ERCD 'ANCON/ANCON2' models. The model predicts contours at specified level threshold intervals, overlaid on geo-referenced population data to produce estimations of population counts and numbers of NSBs exposed to each designated threshold.

4.7.6 The effects of airspace noise are considered at local and national levels separately. The 13 airports[57] included in the national assessment comprise those exceeding 50,000 annual ATMs, which represent the majority of UK air transport provision, as well as those within the London Terminal Manoeuvring Area (LTMA), which would be significantly affected by airport expansion.

4.7.7 The airspace noise assessment at the national level is based on modelling carried out using ANCON for Heathrow and Gatwick, and the Integrated Noise Model[58] (INM) for the other airports. Details of both models and the application to the national predictions are discussed in the AC's assessment report[59].

4.7.8 The ground noise impacts have been derived from a separate ground noise prediction model, which outputs an approximation of the total area exposed to a given threshold, centred on the airport[60]. This area has then been used to estimate population noise exposure. The potential cumulative effects of ground and airspace noise on local receptors have also been considered in the assessment below.

[57] Aberdeen, Birmingham, Bristol, East Midlands, Edinburgh, Glasgow, Manchester, London City, London Gatwick, London Heathrow, London Luton, London Southend and London Stansted.
[58] Federal Aviation Administration, 2015. *Integrated noise model (INM).* [online] Accessed 19/09/2017.
[59] Jacobs, 2014. *5. Noise: National Assessment.* [online] Accessed 21/12/2015.
[60] Jacobs, 2014. *5. Noise: Local Assessment,* Section A.1.5, Appendix A. [online] Accessed 21/12/2015.

4.7.9 The assessment of health and amenity effects is also based on data produced by the CAA, which adopts the WebTAG impact monetisation methodology detailed in WebTAG Unit A361. The monetised output quantities are produced in terms of the Net Present Values (NPVs) for each effect and in total, which have been assessed over a 60-year period. The NPVs are the sum totals of the Present Values (PVs) for each year in the assessment period, which are subject to standard HM Treasury discount rates.

4.7.10 The economic health and amenity valuations are presented in a separate economic cost-benefit analysis by the DfT62; for the purpose of this AoS, the monetised quantities have been converted to corresponding DALY values. To ensure that these estimates are not distorted by economic discount factors (which have no basis in the actual noise changes predicted, but relate to anticipated economic changes), this has been performed by dividing the pre-discounted annual cost values for each health outcome by the value of a DALY recommended by Defra63, ie £60,000 in 2014, adjusted to a 2010 value of £53,284 (since the WebTAG valuation tools use a base year of 2010). The output quantities are then stated in annual DALYs / assessment year (derived from pre-discount annual costs), or totals as DALYs over 60 years (derived by summing the annual values over the full period).

4.7.11 Effects on cognitive development in children (which, as discussed above, are not monetised in the current WebTAG method) have been assessed by separate consideration of schools to the other NSB types. To avoid double-counting of impacts, the assessments referring to 'NSBs' in Section 4.9 include data pertaining only to hospitals and religious places of worship.

4.8 MITIGATION INCLUDED IN ASSESSMENT

4.8.1 A range of mitigation measures have been proposed in relation to the schemes. The proposed mitigation measures that do not form part of this assessment are discussed in Section 4.10.

4.8.2 Flight path designs can provide mitigation for noise by minimising exposure, and are inherent in the modelling assumptions adopted in the assessment. The flight paths employed were developed specifically for the noise modelling and as such are indicative and not necessarily the actual routes that would be applied in practice. Precise flight paths can only be defined at a later stage after detailed airspace design work has taken place. This work will need to consider the various options available to ensure a safe and efficient airspace which also mitigates the level of noise disturbance. Once the design work has been completed, the proposal will be subject to extensive consultation as part of the separate airspace decision-making process established by the CAA. The flight path and operational scenarios relating to the schemes are set out in Table 4.8.

Table 4.8: Scheme Scenarios Assessed

SCHEMES ASSESSED			
Scheme	LGW-2R	LHR-ENR	LHR-NWR
Scenarios: application	**Central**: assessments of local population and NSB/schools noise exposure and noise-related health/amenity effects **AoN, carbon capped** (LGW-2R-X vs LGW-1R, in AC notation): available	**Central**: assessments of local population and NSB/schools noise exposure and noise-related health/amenity effects **Offset Arrivals**[64]**, AoN, carbon capped** (LHR-ENR-O vs LHR-2R, in AC notation): derived for	**Central**: assessments of local population and NSB/schools noise exposure and noise-related health/amenity effects **Minimise Total**[64]**, AoN, carbon capped** (LHR-NWR-T vs LHR-2R, in AC notation): available for assessment of national population

[61] Department for Transport, 2015. *TAG Unit A3 Environmental Impact Appraisal.* [online]. Accessed 04/07/2016.
[62] Department for Transport, 2017. *Updated Appraisal Report.* [Published alongside this AoS]
[63] Department for Environment, Food and Rural Affairs, 2014. *Environmental noise: valuing impacts on sleep disturbance, annoyance, hypertension, productivity and quiet.* [online] Accessed 03/05/2016.
[64] Refers to the indicative flight path design strategies adopted for the assessment presented in the AC Final Report.

	for assessment of national population exposure **High**: sensitivity test for local exposure and health/amenity effects	national population exposure **High**: sensitivity test for local exposure and health/amenity effects	exposure **High**: sensitivity test for local exposure and health/amenity effects

4.8.3 In all the assessment scenarios, it is assumed that noise will be mitigated to an extent by the future development of quieter aircraft technologies, and the gradual incorporation of newer aircraft into the fleet mixes. Details on the fleet mixes used in the assessment have been published[65,66].

4.8.4 The AC assessment of national effects for the LHR-ENR scheme did not include consideration of the Offset Arrivals flight paths noted in Table 4.8. Accordingly, for the AoS assessment at the national level, population exposure figures for the Offset Arrivals strategy have been calculated by comparing the available local assessment figures for the LHR-ENR-O[67] and LHR-ENR[68] scenarios. The differences obtained have then been applied to the national level figures for the LHR-ENR scenario[69] to form the national LHR-ENR-O assessment data. The adjustment calculation process is summarised in Table 4.9. This approach is based on the assumption that an offset arrivals strategy for the LHR-ENR scheme would not alter ATM assumptions for the other airports, when compared with the original ENR scenario modelled.

Table 4.9: Derivation of Adjustments for LHR-ENR National Assessment (AoN Carbon Capped)[70,71]

DO SOMETHING SCENARIO →	LHR-ENR			LHR-ENR-O		
	2030	2040	2050	2030	2040	2050
Local population >57 dB $L_{Aeq,16h}$	297,400	305,700	303,900	257,900	264,700	261,200
Difference in local populations [ENR-O minus ENR] (= adjustment to be applied to ENR national)	-39,500	-41,000	-42,700	-	-	-
National population >57 dB $L_{Aeq,16h}$	394,850	409,050	415,450	355,350 (calculated)	368,050 (calculated)	372,750 (calculated)
Local population >63 dB $L_{Aeq,16h}$ (SOAEL)	63,800	66,900	67,000	63,700	67,500	67,100
Difference in local populations [ENR-O minus ENR] (= adjustment to be applied to ENR national)	-100	600	100	-	-	-
National population >63 dB $L_{Aeq,16h}$ (SOAEL)	70,050	74,250	76,450	69,950 (calculated)	74,850 (calculated)	76,550 (calculated)
Local population >69 dB	3,900	4000	3,900	3,900	4000	3,900

[65] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, Appendix A.3. [online] Accessed 21/12/2015.
[66] Jacobs, 2014. *5. Noise: Baseline and Local Assessment Methodology Addendum.* [online] Accessed 21/12/2015.
[67] Jacobs, 2015. *5. Noise: Local Assessment Addendum,* pp. 8-9. [online] Accessed 21/12/2015
[68] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 212-213. [online] Accessed 21/12/2015.
[69] Jacobs, 2014. *5. Noise: National Assessment,* pp. 22-24. [online] Accessed 21/12/2015.
[70] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Tables A54-A56 and A64-A66 (local data). [online] Accessed 21/12/2015.
[71] Jacobs, 2014. *5. Noise: National Assessment,* Table A4, Appendix A (national data). [online] Accessed 21/12/2015.

$L_{Aeq,16h}$ (UAEL)						
Difference in local populations [ENR-O minus ENR] (= adjustment to be applied to ENR national)	0	0	0	-	-	-
National population >69 dB $L_{Aeq,16h}$ (UAEL)	4,200	4,200	4,400	4,200 (calculated)	4,200 (calculated)	4,400 (calculated)

4.9 ASSESSMENT OF SHORTLISTED SCHEMES

4.9.1 The assessment of the schemes in this section is based on the population and NSB exposure data presented in the succeeding tables, which detail all the source data references.

4.9.2 In this assessment, schools and other NSBs (ie hospitals and religious places of worship) are addressed separately.

4.9.3 It should be noted when viewing the assessment charts that axis scales vary in the graphical presentation in order to show clearly any predicted differences. Very small relative or zero values have been labelled where necessary to aid visibility. Positive chart values show disbenefits (increases in noise impacts), whereas negative values show benefits (reductions in noise impacts).

AoS Objective 6: To Minimise and Where Possible Reduce Noise Impacts on Human Receptors

LGW-2R

Construction Phase

4.9.4 During the construction phase, noise and vibration impacts could be generated by on-site vehicles, activities, plant and off-site traffic. In view of the proximity of existing residential areas, it is considered that construction noise and vibration impacts for LGW-2R would be likely to be negative, and potentially significant, depending on the nature and extent of the works and mitigation. The duration of the construction phase would be several years in length. For the purpose of this AoS, a worst case estimation is that the effects would be Significant Negative (--) for all schemes. Mitigation for construction impacts is discussed in Section 4.10. Assessment of construction mitigation would need to be considered in detail at the EIA stage, in order to minimise negative impacts, in particular to areas nearest to the new runway and along construction traffic routes.

Local Effects: Discrete

4.9.5 The local population exposures for the airspace AELs over the assessment periods for LGW-2R are compared with the do minimum in Figure 4.1, Figure 4.2 and Figure 4.3 (central scenario).

Figure 4.1: LGW-2R Local Airspace >54 dB Daytime Average Noise Population Exposure (Central)

Figure 4.2: LGW-2R Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposure (Central)

Figure 4.3: LGW-2R Local Airspace >69 dB Daytime Average Noise UAEL Population Exposure (Central)[72]

4.9.6 The local population assessment indicates that the LGW-2R scheme would result in increases in exposure to the >54 dB $L_{Aeq,16hr}$ contour and the >63 dB $L_{Aeq,16hr}$ SOAEL compared with the do minimum (Figure 4.1 and Figure 4.2). The population exposure to the >69 dB $L_{Aeq,16hr}$ UAEL is expected to be reduced compared with the do minimum in 2030 (Figure 4.3). This is partly because some properties would be within the expanded geographical boundary of the airport and therefore would no longer exist in the do something scenario.

[72] As shown in the corresponding assessment table, the population for the LGW-2R UAEL exposure is predicted as a range of possible values (<50); here, the worst-case values have been assumed.

4.9.7 In view of the criteria set out in Table 4.3, the effects of changes in airspace noise exposure on the local population for the LGW-2R scheme are considered to be predominantly Significant Negative.

4.9.8 The local NSB exposures (including hospitals and religious places of worship; schools are considered separately below) to the airspace AELs over the assessment periods for LGW-2R are compared with the do minimum in Figure 4.4 and Figure 4.5 (central scenario).

Figure 4.4: LGW-2R Local Airspace >54 dB Daytime Average Noise NSB Exposure (Central)

Figure 4.5: LGW-2R Local Airspace >63 dB Daytime Average Noise SOAEL NSB Exposure (Central)

4.9.9 The local NSB exposure to the >54 dB $L_{Aeq,16hr}$ contour for LGW-2R is expected to be increased across the assessment period. The numbers of NSBs exposed to the SOAEL are expected to be reduced over the assessment terms compared with the do minimum (Figure 4.5), while the number exposed to the UAEL is unchanged at zero (not shown).

4.9.10 In view of the criteria set out in Table 4.3, the local effects of changes in airspace noise exposure on NSBs for the LGW-2R scheme are considered to be mixed Positive/Negative.

4.9.11 The local population exposure to ground noise ≥57 dB $L_{Aeq,16hr}$ is compared with the do minimum in Figure 4.6.

Figure 4.6: LGW-2R Local Ground ≥57 dB Daytime Average Noise Population Exposure

4.9.12 The ground noise assessment for LGW-2R indicates that the total local population exposure to levels ≥57 dB $L_{Aeq,16hr}$ in 2030 is expected to remain very similar to the baseline current situation, and reduced compared with the do minimum in the 2030 assessment year. This is due to the relocation of some sources of ground noise, which would offset an increase in aircraft activity. In the do minimum case, exposure to ground noise is expected to rise due to increases in airport activity; in the do something case increases in activity are expected to be outweighed by reductions in taxiing, enabled by the new terminal and aprons between the runways[73].

4.9.13 In view of the criteria set out in Table 4.3, the effects of changes in ground noise exposure on the local population for the LGW-2R scheme are considered to be Positive, since a smaller population would be adversely affected compared with the do minimum.

4.9.14 The predicted scale of noise-related health and amenity effects, in terms of additional DALYs lost each year for LGW-2R (compared with the do minimum), is shown in Figure 4.7 (central scenario).

Figure 4.7: LGW-2R Estimated Changes in Annual DALYs Lost Compared with Do Minimum, by Health Effect (Central)

[73] Jacobs, 2014. *5. Noise: Local Assessment*, p. 69, paragraphs 1-2. [online] Accessed 21/12/2015.

4.9.15 The health and amenity effects assessment illustrated above indicates that:

- All assessed effects are expected to result in additional annual DALYs lost compared with the do minimum;
- Annoyance dominates the total estimated differences in DALYs lost; and
- DALYs lost due to annoyance are expected to increase over the assessment period.

4.9.16 Over a 60-year appraisal period, the estimations of total DALYs lost due to noise in the LGW-2R do something case (compared with the do minimum) are shown by effect in Figure 4.8 (central scenario).

Figure 4.8: LGW-2R Estimated Changes in DALYs Lost Over 60-year Period, Compared with Do Minimum (Central)

4.9.17 The effects of the LGW-2R scheme for the health and amenity outcomes assessed are considered to be Significant Negative, since it is expected that DALYs lost due to noise exposure would be increased by the do something compared with the do minimum.

4.9.18 The LGW-2R scheme is expected to result in increases in exposure of schools to the >54 dB $L_{Aeq,16hr}$ daytime average noise level contour (12 in 2030, 10 in 2040, 17 in 2050) and increases for exposure >57 dB $L_{Aeq,16hr}$ (4 in 2030, 1 in 2040, 6 in 2050). Reductions in exposure are, however, expected for exposure >60 dB $L_{Aeq,16hr}$ (1 in each assessment year) and >63 dB $L_{Aeq,16hr}$ (2 in 2030, 1 in 2040). These results can be interpreted as having mixed Significant Positive/Negative effects (++/-) for children's cognitive development.

Local Effects: Cumulative

4.9.19 The combination of airspace and ground noise could lead to cumulative negative effects for some areas.

4.9.20 Based on the available information, it is estimated that there are areas that could be brought above the thresholds by the combination of ground and airspace noise.

4.9.21 For some areas, reductions in exposure to ground noise may to some extent be counteracted by increases in airspace noise; conversely some areas (particularly in close proximity to the north of the existing runway) may experience some reductions in both ground and airspace noise.

4.9.22 In view of the criteria set out in Table 4.3, the local cumulative effects of the LGW-2R scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).

National Effects

4.9.23 The national population exposures for the airspace thresholds over the assessment periods for LGW-2R are compared with the UK do minimum in Figure 4.9, Figure 4.10 and Figure 4.11 (AoN carbon capped scenario).

Figure 4.9: LGW-2R National Airspace >57 dB Daytime Average Noise Population Exposure (AoN Carbon Capped) [NB. Non-zero axis]

Figure 4.10: LGW-2R National Airspace Noise >63 dB Daytime Average Noise SOAEL Population Exposure (AoN Carbon Capped)

Figure 4.11: LGW-2R National Airspace Noise >69 dB Daytime Average Noise UAEL Population Exposure (AoN Carbon Capped)

4.9.24 The national assessment indicates that the LGW-2R scheme would result in reduced total population exposure to airspace noise above the thresholds over the full assessment period, compared with the do minimum. This is mainly due to a decrease in exposure at a number of other airports which more than offsets increases at Gatwick airport[74]. In consideration of the criteria set out in Table 4.3, the national effects of the LGW-2R scheme (under the AoN carbon capped scenario) are considered to be Positive.

LGW-2R Individual Assessment Outcome

4.9.25 In terms of local population noise exposure, and the potential for adverse health impacts affecting the local population, the LGW-2R scheme has the potential for Significant Negative effects. Both these elements have been assessed under the central scenario assumptions.

4.9.26 The assessment of the LGW-2R scheme has also identified the potential for some Positive and Significant Positive effects, with regards to noise exposure of local schools and other NSBs, and noise exposure of the population from a national perspective. However, the number of schools expected to have reduced exposure to noise is considerably smaller than the number likely to see increases in noise. The national exposure values have been assessed under the AoN carbon capped scenario assumptions, due to the unavailability of modelling data. It is possible that under a set of carbon trading assumptions, the results for this element would be less positive than has been assessed here, although it is acknowledged that an expected outcome cannot be directly extrapolated.

4.9.27 On the basis of the above considerations, the LGW-2R scheme is considered to have predominant Significant Negative (--) overall effects. This outcome is justified by emphasising the negative impacts on people in the local area in consideration of the AoS Noise topic Objective 'To minimise and where possible reduce noise impacts on human receptors'. However, it is acknowledged that the potential for some Positive effects from LGW-2R has also been identified, in particular due to a reduction in the exposure at a small number of schools (although larger numbers of schools could have increased exposure). This individual scheme assessment is summarised in the table at the end of Section 4.9. A comparative assessment of all the schemes is found in Section 4.12.

[74] Jacobs, 2014. *5. Noise: National Assessment*, pp. 12, 14. [online] Accessed 21/12/2015.

LHR-ENR

Construction Phase

4.9.28 During the construction phase, noise (and potentially, vibration) impacts could be generated by on-site vehicles, activities, plant and off-site traffic. In view of the proximity of existing residential areas, it is considered that construction noise and vibration impacts for LHR-ENR would be likely to be Significant Negative, depending on the nature and extent of the works and mitigation proposals. The duration of the construction phase would be several years in length. For the purpose of this AoS, a worst case estimation is that these effects would be Significant Negative. Mitigation for construction impacts is discussed in Section 4.10. Assessment of construction mitigation would need to be considered in detail at the EIA stage, in order to minimise negative impacts, in particular upon areas nearest to the extended northern runway and along construction traffic routes.

Local Effects: Discrete

4.9.29 The local population exposures for the airspace thresholds over the assessment periods for LHR-ENR are compared with the do minimum in Figure 4.12, Figure 4.13 and Figure 4.14 (central scenario).

Figure 4.12: LHR-ENR Local Airspace >54 dB Daytime Average Noise Population Exposure (Central)

Figure 4.13: LHR-ENR Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposure (Central)

Figure 4.14: LHR-ENR Local Airspace >69 dB Daytime Average Noise UAEL Population Exposure (Central)

4.9.30 The local population assessment indicates that the LHR-ENR scheme would result in increases in exposure to the SOAEL and UAEL thresholds over the full assessment period, compared with the do minimum.

4.9.31 The assessment also shows that, compared with the do minimum, the local population exposure to noise >54 dB $L_{Aeq,16h}$ is expected to increase in 2030, be almost equal (but higher) in 2040, and be reduced by 2050.

4.9.32 In view of the criteria set out in Table 4.3, the effects of changes in airspace noise exposure on the local population for the LHR-ENR scheme (under the AoN carbon traded scenario) are considered to be predominantly Significant Negative.

4.9.33 The local NSB exposures (comprising hospitals and religious places of worship; schools are addressed separately below) for the airspace thresholds over the assessment periods for LHR-ENR are compared with the do minimum in Figure 4.15, Figure 4.16 and Figure 4.17 (central scenario).

Figure 4.15: LHR-ENR Local Airspace >54 dB Daytime Average Noise NSB Exposure (Central)

Figure 4.16: LHR-ENR Local Airspace >63 dB Daytime Average Noise SOAEL NSB Exposure (Central)

Figure 4.17: LHR-ENR Local Airspace >69 dB Daytime Average Noise UAEL NSB Exposure (Central)

4.9.34 The local NSB assessment also indicates that the LHR-ENR scheme would result in increases in exposure to the SOAEL and UAEL thresholds over the full assessment period, compared with the do minimum.

4.9.35 For NSB exposure to the 54 dB $L_{Aeq,16h}$ contour, the assessment again indicates an increase in 2030, a smaller increase in 2040, and then drops to a slight reduction in 2050 compared with the do minimum.

4.9.36 In view of the criteria set out in Table 4.3, the effects of changes in airspace noise exposure on local NSBs for the LHR-ENR scheme are considered to be predominantly Significant Negative.

4.9.37 The local population exposure to ground noise ≥57 dB $L_{Aeq,16hr}$ is compared with the do minimum in Figure 4.18.

Figure 4.18: LHR-ENR Local Ground ≥57 dB Daytime Average Noise Population Exposure (NB. Non-zero axis)

4.9.38 The ground noise assessment for LHR-ENR indicates that the local population exposure to levels ≥57 dB $L_{Aeq,16hr}$ is expected to reduce compared with the do minimum in the 2030 assessment year. This is due to the relocation of some sources or receptors of ground noise in the assessment year[75]. In view of the criteria set out in Table 4.3, the effects of changes in ground noise exposure on the local population for the LHR-ENR scheme are considered to be Positive.

4.9.39 The predicted scale of noise-related health and amenity effects, in terms of changes in DALYs lost each year for LHR-ENR (compared with the do minimum), is shown in Figure 4.19 (central scenario).

Figure 4.19: LHR-ENR Estimated Changes in Annual DALYs Lost Compared with Do Minimum, by Health Effect (Central)

[75] Jacobs, 2014. *5. Noise: Local Assessment*, p. 271, paragraph 3. [online] Accessed 21/12/2015.

4.9.40 The health and amenity effects assessment illustrated above indicates:

- All effects are expected to result in initial increases in annual DALYs lost across the assessment period compared with the do minimum;
- The changes in annual DALYs lost due to annoyance and sleep disturbance are expected to reduce steadily over time;DALYs lost due to sleep disturbance are expected to be reduced compared with the do minimum beyond the 2042 assessment year; and
- The combined effects of annoyance and sleep disturbance dominate total additional DALYs lost, which accordingly get steadily smaller over time, resulting in a marginal reduction in total annual DALYs lost by 2050 compared with the do minimum.

4.9.41 60-year appraisal period estimations of total DALYs lost due to noise in the LHR-ENR do something case (compared with the do minimum) are shown by effect in Figure 4.20 (central scenario).

Figure 4.20: LHR-ENR Estimated Changes in DALYs Lost Over 60-year Period, Compared with Do Minimum (Central)

4.9.42 The effects of the LHR-ENR scheme for the health outcomes assessed under the central scenario are considered to be predominantly Significant Negative. It is recognised however that some positive effects may be expected due to potential future reductions in sleep disturbance, compared with the do minimum.

4.9.43 The LHR-ENR scheme is expected to result in increases in exposure of schools to noise (e.g. increases in exposure to the >63 dB $L_{Aeq,16hr}$ SOAEL are expected to be 20 in 2030, 13 in 2040 and 9 in 2050). A reduction in exposure to levels >54 dB $L_{Aeq,16hr}$ is also predicted for two assessment years (8 in 2040, 29 in 2050). These results can be interpreted as having predominantly Significant Negative effects for children's cognitive development.

Local Effects: Cumulative

4.9.44 Based on the available information, it is estimated that there are areas that could be brought above the thresholds by the combination of ground and airspace noise.

4.9.45 Although a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected, this potential benefit may be offset by increases in airspace noise for the affected populations in close proximity to the airport. For some areas, in particular towards the northwest of the northern runway, there is a risk that cumulative airspace and ground noise could be sufficient to bring populations above the thresholds considered.

4.9.46 In view of the criteria set out in Table 4.3, the local cumulative effects of the LHR-ENR scheme for the 2030 assessment year are considered to be Significant Negative.

National Effects

4.9.47 The national population exposures for the airspace AELs over the assessment periods for LHR-ENR are compared with the UK do minimum in Figure 4.21, Figure 4.22 and Figure 4.23 (AoN carbon capped scenario). As discussed in Section 4.8, the results of this assessment are derived from calculations using adjustments to the original ENR scenario and have not been modelled directly. This approach assumes that national flight movements at other airports would not be affected by an offset arrivals strategy at LHR-ENR.

Figure 4.21: LHR-ENR National Airspace >57 dB Daytime Average Noise Population Exposure (AoN, Carbon Capped) [NB. Non-zero axis]

Figure 4.22: LHR-ENR National Airspace Noise >63 dB Daytime Average Noise SOAEL Population Exposure (AoN, Carbon Capped)

Figure 4.23: LHR-ENR National Airspace Noise >69 dB Daytime Average Noise UAEL Population Exposure (AoN, Carbon Capped)

4.9.48 The national assessment indicates that the LHR-ENR scheme would result in increased population exposure to airspace noise above the thresholds over the full assessment period, compared with the do minimum.

4.9.49 In view of the criteria set out in Table 4.3, the national effects of the LHR-ENR scheme are considered to be Significant Negative.

LHR-ENR Individual Assessment Summary

4.9.50 Consideration of the various elements of the individual assessment indicates that the LHR-ENR scheme is principally expected to have predominant Significant Negative (--) overall effects, and this outcome is broadly consistent across the differing scenario assumptions. However it is acknowledged that there may be potential future reductions in noise-induced sleep disturbance, and some reductions in schools and other NSBs exposed to noise at the lower end of the range considered, both of which could have a Positive or Significant Positive effect for those benefitting. This individual scheme assessment is summarised in the table at the end of Section 4.9. A comparative assessment of all the schemes is found in Section 4.12.

LHR-NWR

Construction Phase

4.9.51 During the construction phase, noise (and potentially, vibration) impacts could be generated by on-site traffic, works, plant and off-site traffic. In view of the proximity of existing residential areas, it is considered that construction noise and vibration impacts for LHR-NWR would be likely to be Significant Negative, depending on the nature and extent of the works and mitigation proposals. The duration of the construction phase would be several years in length. For the purpose of this AoS, as a worst case estimate these effects are considered likely to be Significant Negative. Mitigation for construction impacts is discussed in Section 4.10. Assessment of construction mitigation would need to be considered in detail at the EIA stage, in order to minimise negative impacts, in particular to areas nearest to the new runway and along construction traffic routes.

Local Effects: Discrete

4.9.52 The local population exposures for the airspace thresholds over the assessment periods for LHR-NWR are compared with the do minimum in Figure 4.24, Figure 4.25 and Figure 4.26 (central scenario).

Figure 4.24: LHR-NWR Local Airspace >54 dB Daytime Average Noise Population Exposure (Central)

Figure 4.25: LHR-NWR Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposure (Central)

Figure 4.26: LHR-NWR Local Airspace >69 dB Daytime Average Noise UAEL Population Exposure (Central)

4.9.53 The local population assessment indicates that the LHR-NWR scheme would result in increases in population exposure to the 54 dB $L_{Aeq,16hr}$ and SOAEL thresholds over the full assessment period, compared with the do minimum. The scheme is also expected to result in reductions in the population exposed to the UAEL over the full assessment period. This is partly because some dwellings exposed in the do minimum scenario would be within the expanded boundary of LHR-NWR, and so no longer exist in the do something exposure[76].

4.9.54 In view of the criteria set out in Table 4.3, the effects of changes in airspace noise exposure on the local population for the LHR-NWR scheme (central scenario) are considered to be predominantly Significant Negative.

4.9.55 The local NSB exposures (comprising hospitals and religious places of worship; schools are addressed separately below) for the airspace thresholds over the assessment periods for LHR-NWR are compared with the do minimum in Figure 4.27, Figure 4.28 and Figure 4.29 (central scenario).

Figure 4.27: LHR-NWR Local Airspace >54 dB Daytime Average Noise NSB Exposure (Central)

Figure 4.28: LHR-NWR Local Airspace >63 dB Daytime Average Noise SOAEL NSB Exposure (Central)

[76] Jacobs, 2014. *5. Noise: Local Assessment*, p. 189, paragraph 2. [online] Accessed 21/12/2015.

Figure 4.29: LHR-NWR Local Airspace >69 dB Daytime Average Noise UAEL NSB Exposure (Central)

4.9.56 The local NSB assessment indicates that the LHR-NWR scheme would result in increases in NSB exposure to all thresholds over the full assessment period, compared with the do minimum.

4.9.57 In view of the criteria set out in Table 4.3, the effects of changes in airspace noise exposure on local NSBs for the LHR-NWR scheme are considered to be Significant Negative.

4.9.58 The local population exposure to the ground noise threshold is compared with the do minimum in Figure 4.30.

Figure 4.30: LHR-NWR Local Ground >57 dB Daytime Average Noise Population Exposure [NB. Non-zero axis]

4.9.59 The ground noise assessment for LHR-NWR indicates that the total local population exposure to levels ≥57 dB $L_{Aeq,16hr}$ is expected to reduce compared with the do minimum in the 2030 assessment year. This is due to relocation of some sources of ground noise away from more densely-populated areas[77]. In view of the criteria set out in Table 4.3, the local effects of ground noise for the LHR-NWR scheme are considered to be Positive.

4.9.60 The predicted scale of noise-related health and amenity effects, in terms of changes in DALYs lost each year for LHR-NWR (compared with the do minimum), is shown in Figure 4.31- (central scenario).

[77] Jacobs, 2014. *5. Noise: Local Assessment*, p. 197. [online] Accessed 21/12/2015.

Figure 4.31: LHR-NWR Estimated Changes in Annual DALYs Lost Compared with Do Minimum, by Health Effect (Central)

4.9.61 The health and amenity effects assessment illustrated above indicates:

- All effects are expected to result in initial increases in annual DALYs lost compared with the do minimum;
- For sleep disturbance, annual DALYs lost are expected to be greater in 2030, with the increases steadily reducing over time, with reductions in DALYs lost beyond 2042 (compared with the do minimum);
- Additional DALYs lost each year to annoyance also steadily reduce but more gradually beyond 2040 (than sleep disturbance); and
- Annoyance and sleep disturbance effects dominate total estimated differences in annual DALYs lost across the assessment period, which accordingly get steadily smaller over time, although total annual DALYs lost due to the LHR-NWR scheme remains higher by 2050 (compared with the do minimum).

4.9.62 60-year appraisal period estimations of total DALYs lost due to noise in the LHR-NWR do something case (compared with the do minimum) are shown by effect in Figure 4.32 (AoN carbon traded scenario).

Figure 4.32: LHR-NWR Estimated Changes in DALYs Lost Over 60-year Period, Compared with Do Minimum (Central)

4.9.63 The effects of the LHR-NWR scheme for the health and amenity outcomes assessed are considered to be predominantly Significant Negative, although it is recognised that some positive effects may also be expected, due to potential future reductions in sleep disturbance compared with the do minimum.

4.9.64 The LHR-NWR scheme is expected to generally result in increases in exposure of schools to the metrics assessed (e.g. increases in exposure to the >63 dB $L_{Aeq,16h}$ SOAEL are 10 in 2030, 4 in 2040 and 3 in 2050), with the exception of a reduction of 6 in schools exposed to noise >54 dB $L_{Aeq,16hr}$ in the 2050 year. These results can be interpreted as having predominantly Significant Negative effects for children's cognitive development.

Local Effects: Cumulative

4.9.65 Based on the available information, it is estimated that there are areas that could be brought above the thresholds by the combination of ground and airspace noise.

4.9.66 Some areas could experience increases in both ground and airspace noise, particularly towards the northwest around the new runway. The combined noise may in some cases be sufficient to push areas above the thresholds.

4.9.67 Whilst a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected in 2030, this potential benefit may be somewhat counteracted by increases in airspace noise for areas in close proximity to the airport. However, there are also some areas that (in the 2030 assessment year) may experience a reduction in both ground and airspace noise (averaged over the daytime period), such as the area to the southwest of the southernmost runway.

4.9.68 The local cumulative effects of the LHR-NWR scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).

National Effects

4.9.69 The national population exposures for the airspace thresholds over the assessment periods for LHR-NWR are compared with the UK do minimum in Figure 4.33, Figure 4.34 and Figure 4.35 (AoN carbon capped scenario).

Figure 4.33: LHR-NWR National Airspace >57 dB Daytime Average Noise Population Exposure (AoN, Carbon Capped) [NB. Non-zero axis]

Figure 4.34: LHR-NWR National Airspace Noise >63 dB Daytime Average Noise SOAEL Population Exposure (AoN, Carbon Capped)

Figure 4.35: LHR-NWR National Airspace Noise >69 dB Daytime Average Noise UAEL Population Exposure (AoN, Carbon Capped)

4.9.70 The national assessment indicates that compared with the do minimum, the LHR-NWR scheme is expected to result in reduced population exposure to airspace noise above the 57 dB $L_{Aeq,16hr}$ threshold in the 2030 assessment year, which would be a positive effect. In the longer term however, the population exposed to noise >57 dB $L_{Aeq,16hr}$ is expected to be slightly higher (but similar to) the do minimum. Population exposure to the SOAEL is expected to be slightly increased in the 2030 assessment year, and increased further in the longer terms, ie Significant Negative effects. On the other hand, the population exposure to the UAEL would be expected to be reduced over the full assessment period, compared with the do minimum. In consideration of the criteria set out in Table 4.3, the national effects of the LHR-NWR scheme are considered to be mixed Positive/Significant Negative (+/--).

LHR-NWR Individual Assessment Summary

4.9.71 It is considered from the various elements of the individual assessment that the LHR-NWR scheme is expected to have predominant Significant Negative (--) overall effects, and this outcome is broadly consistent across the differing scenario assumptions. However it is recognised that there may be potential future reductions in noise-induced sleep disturbance, and some possible reductions in schools exposed to noise at the lower end of the range considered, both of which could have a Positive or Significant Positive effect for those benefitting. This individual scheme assessment is summarised in the table at the end of Section 4.9. A comparative assessment of all the schemes is found in Section 4.12.

All Schemes

4.9.72 For all three schemes, local and national cumulative noise effects may arise from airport expansion in combination with other major infrastructure development. This may include: transport infrastructure which is associated directly with airports expansion, or delivered in support of the National Networks National Policy Statement[78]; construction noise from other infrastructure such as HS2 or Crossrail; nearby residential, commercial or infrastructure development that is planned by local authorities as part of their plans for growth, as set out in individual local development plan documents. Given the range of possibilities and uncertainty in such developments, it is impractical to assess these potential effects, which are therefore classified as Uncertain.

4.9.73 Performance comparisons between the different schemes are discussed in Section 4.12. The tables below detail the data used in the assessment figures above, along with the relevant source references.

[78] Department for Transport, 2014. *National Policy Statement for National Networks.* [online] Accessed 17/03/2016.

Objective 6: To minimise and where possible reduce noise impacts on human receptors.

Question 11: Will it Avoid, Prevent or Reduce the Harmful Effects Due to Exposure of People and Sensitive Buildings to Noise?

SEA TOPIC	LGW-2R	LHR-ENR	LHR-NWR
Description of Impact (including receptor)	**CONSTRUCTION**		
Construction noise and vibration	Construction phase impacts are likely to be negative, with potential for significance at sensitive receptors near to the new runway or along construction routes. The effects cannot yet be assessed in detail but as a worst case estimate can be considered as potentially Significant Negative.	Construction phase impacts are likely to be negative, with potential for significance at sensitive receptors near to the runway extension or along construction routes. The effects cannot yet be assessed in detail but as a worst case estimate can be considered as potentially Significant Negative.	Construction phase impacts are likely to be negative, with potential for significance at sensitive receptors near to the new runway or along construction routes. The effects cannot yet be assessed in detail but as a worst case estimate can be considered as potentially Significant Negative.
	LOCAL EFFECTS: DISCRETE		

Airspace noise: daytime (central)

Airspace noise – total exposures in do something[79]						
	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>54 dB $L_{Aeq,16hr}$	27100	16	21400	11	27800	17
SOAEL	1000	0	600	0	800	0
UAEL	<50	0	<50	0	<50	0

Airspace noise – total exposures in do something[80]						
	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>54 dB $L_{Aeq,16hr}$	558400	246	474000	188	420600	165
SOAEL	80100	21	57200	14	51600	12
UAEL	4900	1	3700	1	3400	1

Airspace noise – total exposures in do something[80]						
	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>54 dB $L_{Aeq,16hr}$	653900	263	525600	199	475600	173
SOAEL	60200	19	35600	10	31800	8
UAEL	2000	4	800	2	300	1

[79] CAA ERCD, 2017. *20170904 Gatwick Central and High Results*. Data provided for updated DfT analysis.
[80] CAA ERCD, 2017. *20170904 Heathrow HH and 3R Central and High Results*. Data provided for updated DfT analysis.

Airspace noise – changes in exposure relative to Do minimum[79]

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>54 dB $L_{Aeq,16hr}$	16200	5	14700	6	21300	12
Effect	--	-	--	-	--	-
SOAEL	400	(2)	200	(2)	400	(2)
Effect	--	+	--	+	--	+
UAEL	(151 to 200)	0	0 to 49	0	0 to 49	0
Effect	+	00	?	00	?	00

NOTE: Decreases indicated by values in parentheses

The effects of changes in airspace noise exposure on the local population from the LGW-2R scheme are considered to be predominantly Significant Negative.

The effects of changes in airspace noise exposure on local NSBs from the LGW-2R scheme are considered to be mixed Positive/Negative.

Airspace noise – changes in exposure relative to Do minimum[80]

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>54 dB $L_{Aeq,16hr}$	27200	19	1300	8	(18200)	(4)
Effect	--	-	--	-	+	+
SOAEL	41600	11	28300	6	22400	5
Effect	--	--	--	--	--	--
UAEL	2400	1	2200	1	1400	1
Effect	--	--	--	--	--	--

NOTE: Decreases indicated by values in parentheses

The effects of changes in airspace noise exposure on the local population from the LHR-ENR scheme are considered to be Significant Negative.

The effects of changes in airspace noise exposure on local NSBs from the LHR-ENR scheme are considered to be Significant Negative.

Airspace noise – changes in exposure relative to Do minimum[80]

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>54 dB $L_{Aeq,16hr}$	92700	36	52900	19	36800	4
Effect	--	-	--	-	--	-
SOAEL	21700	9	6700	2	2600	1
Effect	--	--	--	--	--	--
UAEL	(500)	4	(700)	2	(1,700)	1
Effect	+	--	+	--	+	--

NOTE: Decreases indicated by values in parentheses

The effects of changes in airspace noise exposure on the local population from the LHR-NWR scheme are considered to be predominantly Significant Negative.

The effects of changes in airspace noise exposure on local NSBs from the LHR-NWR scheme are considered to be Significant Negative.

Ground noise

Ground noise – population exposure and changes, Do minimum vs do something[81]		
	2030	
	Population (DS)	Population change (DS vs DM)
>57 dB $L_{Aeq,16hr}$	1,000	(2150)
Effect	N/A	+
NOTE: Decreases indicated by values in parentheses		

The local effects of ground noise from the LGW-2R scheme are considered to be Positive.

Ground noise – population exposure and changes, Do minimum vs do something[82]		
	2030	
	Population (DS)	Population change (DS vs DM)
>57 dB $L_{Aeq,16hr}$	29300	(1450)
Effect	N/A	+
NOTE: Decreases indicated by values in parentheses		

The local effects of ground noise from the LHR-ENR scheme are considered to be Positive.

Ground noise – population exposure and changes, Do minimum vs do something[83]		
	2030	
	Population (DS)	Population change (DS vs DM)
>57 dB $L_{Aeq,16hr}$	27000	(3750)
Effect	N/A	+
NOTE: Decreases indicated by values in parentheses		

The local effects of ground noise from the LHR-NWR scheme are considered to be Positive.

Airspace noise: health/amenity effects (central)

A) Annoyance

B) Sleep disturbance

C) AMI

D) HT Strokes

E) HT Dementia

*Total DALYs are summed from unrounded values

Airspace noise – health/amenity effects, do minimum vs do something, changes in annual DALYs lost/assessment year[84]			
	2030	2040	2050
A	63	68	106
B	32	18	24
C	0	0	1
D	5	5	7
E	8	7	10
Total*	108	99	148
NOTE: Decreases indicated by values in parentheses.			

Airspace noise – health/amenity effects, do minimum vs do something, changes in annual DALYs lost/assessment year[86]			
	2030	2040	2050
A	525	256	136
B	213	42	(160)
C	16	12	10
D	24	8	(2)
E	36	12	(3)
Total*	814	331	(19)
NOTE: Decreases indicated by values in parentheses.			

Airspace noise – health/amenity effects, do minimum vs do something, changes in annual DALYs lost/assessment year[88]			
	2030	2040	2050
A	652	399	351
B	315	90	(230)
C	9	4	2
D	29	15	10
E	43	22	15
Total*	1,047	529	148
NOTE: Decreases indicated by values in parentheses.			

[81] Jacobs, 2014. *5. Noise: Local Assessment*, p. 68, calculated from data in Table 3.47 [online] Accessed 21/12/2015.
[82] Jacobs, 2014. *5. Noise: Local Assessment,* p. 270, calculated from data in Table 5.50. [online] Accessed 21/12/2015.
[83] Jacobs, 2014. *5. Noise: Local Assessment,* p. 196, calculated from data in Table 4.99. [online] Accessed 21/12/2015.
[84] CAA ERCD, 2017. *LGW-2R_Central_Monetisation_Noise_Workbook_updatedOBRforecasts*. Data provided for updated DfT analysis.
[86] CAA ERCD, 2017. *LHR-HH_Central_Monetisation_Noise_Workbook_updatedOBRforecasts*. Data provided for updated DfT analysis.
[88] CAA ERCD, 2017. *LHR-3R_Central_Monetisation_Noise_Workbook_updatedOBRforecasts*. Data provided for updated DfT analysis.

	Airspace noise – health effects, do minimum vs do something, changes in total DALYs lost over 60 years[85] **A** 5307 **B** 1387 **C** 27 **D** 349 **E** 526 **Total*** 7595 **NOTE: Decreases indicated by values in parentheses.** ***Total DALYs are summed from unrounded values**	**Airspace noise – health effects, do minimum vs do something, changes in total DALYs lost over 60 years[87]** **A** 12671 **B** (3964) **C** 658 **D** 217 **E** 320 **Total*** 9901 **NOTE: Decreases indicated by values in parentheses.** ***Total DALYs are summed from unrounded values**	**Airspace noise – health effects, do minimum vs do something, changes in total DALYs lost over 60 years[89]** **A** 23661 **B** (5397) **C** 205 **D** 786 **E** 1,183 **Total*** 20,439 **NOTE: Decreases indicated by values in parentheses.** ***Total DALYs are summed from unrounded values**
	The overall effects of the LGW-2R scheme on the health and amenity outcomes assessed are considered to be Significant Negative, since it would result in increases in DALYs lost compared with the Do minimum.	The overall effects of the LHR-ENR scheme on the health and amenity outcomes assessed are considered to be predominantly Significant Negative, since it would result in increases in DALYs lost compared with the Do minimum.	The overall effects of the LHR-NWR scheme on the health and amenity outcomes assessed are considered to be predominantly Significant Negative, since it would result in increases in DALYs lost compared with the Do minimum.

Airspace noise : effects on children's cognitive development (central)

Airspace noise – school exposures in do something[85]

Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	26	18	25
>57 dB	7	4	8
>60 dB	1	1	1
SOAEL	0	0	1
>66 dB	0	0	0
UAEL	0	0	0
>72 dB	0	0	0

Airspace noise – school exposures in do something[80]

Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	376	277	232
>57 dB	160	127	122
>60 dB	86	70	62
SOAEL	33	20	13
>66 dB	7	4	2
UAEL	2	2	1
>72 dB	0	0	0

Airspace noise – school exposures in do something[80]

Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	416	312	255
>57 dB	156	117	106
>60 dB	75	53	48
SOAEL	23	11	7
>66 dB	6	2	1
UAEL	1	1	0
>72 dB	0	0	0

[85] CAA ERCD, 2017. *LGW-2R_Central_Monetisation_Noise_Workbook_updatedOBRforecasts*. Data provided for updated DfT analysis.
[87] CAA ERCD, 2017. *LHR-HH_Central_Monetisation_Noise_Workbook_updatedOBRforecasts*. Data provided for updated DfT analysis.
[89] CAA ERCD, 2017. *LHR-3R_Central_Monetisation_Noise_Workbook_updatedOBRforecasts*. Data provided for updated DfT analysis.

Airspace noise – changes in school exposures relative to do minimum[90]			
Daytime $L_{Aeq,16hr}$	**2030**	**2040**	**2050**
>54 dB	12	10	17
Effect	-	-	-
>57 dB	4	1	6
Effect	-	-	-
>60 dB	(1)	(1)	(1)
Effect	+	+	+
SOAEL	(2)	(1)	0
Effect	++	++	00
>66 dB	0	0	0
Effect	00	00	00
UAEL	0	0	0
Effect	00	00	00
>72 dB	0	0	0
Effect	00	00	00
NOTE: Decreases indicated by values in parentheses			

The local effects of airspace noise from the LGW-2R scheme on children's cognitive development are considered to be mixed Significant Positive/Negative (++/-).

Airspace noise – changes in school exposures relative to do minimum[91]			
Daytime $L_{Aeq,16hr}$	**2030**	**2040**	**2050**
>54 dB	4	(8)	(29)
Effect	+	+	+
>57 dB	38	27	28
Effect	-	-	-
>60 dB	37	38	29
Effect	-	-	-
SOAEL	20	13	9
Effect	--	--	--
>66 dB	5	3	1
Effect	--	--	--
UAEL	2	2	1
Effect	--	--	--
>72 dB	0	0	0
Effect	00	00	00
NOTE: Decreases indicated by values in parentheses			

The local effects of airspace noise from the LHR-ENR scheme on children's cognitive development are considered to be predominantly Significant Negative.

Airspace noise – changes in school exposures relative to do minimum[91]			
Daytime $L_{Aeq,16hr}$	**2030**	**2040**	**2050**
>54 dB	44	27	(6)
Effect	-	-	+
>57 dB	34	17	12
Effect	-	-	-
>60 dB	26	21	15
Effect	-	-	-
SOAEL	10	4	3
Effect	--	--	--
>66 dB	4	1	0
Effect	--	--	--
UAEL	1	1	0
Effect	--	--	--
>72 dB	0	0	0
Effect	00	00	00
NOTE: Decreases indicated by values in parentheses			

The local effects of airspace noise from the LHR-NWR scheme on children's cognitive development are considered to be predominantly Significant Negative.

[90] CAA ERCD, 2017. *20170904 Gatwick Central and High Results*. Data provided for updated DfT analysis.
[91] CAA ERCD, 2017. *20170904 Heathrow HH and 3R Central and High Results*. Data provided for updated DfT analysis.

	LOCAL EFFECTS: CUMULATIVE		
Airspace noise and ground noise	The combination of airspace and ground noise could lead to cumulative negative or mixed effects for some areas.Aviation noise (ie both ground and airspace-generated) could also lead to cumulative effects when considered in combination with the potential impacts from surface access transportation. This could include both that associated with infrastructure changes required to facilitate airport expansion, and with other local and national developments (such as the implementation of the National Networks National Policy Statement[92], or from nearby development planned by local authorities as part of their plans for growth); these potential effects are uncertain.		
	→ It is estimated based on the available information[93] that there are some areas that could be brought above the AEL thresholds by the combination of ground and airspace noise. → For some areas, reductions in exposure to ground noise may to some extent be counteracted by increases in airspace noise; conversely some areas (particularly in close proximity to the north of the existing runway) may experience some reductions in both ground and airspace noise. The local cumulative effects of the LGW-2R scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).	→ It is estimated based on the available information[94] that there are some areas that could be brought above the AEL thresholds by the combination of ground and airspace noise. → Although a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected, this potential benefit may be offset by increases in airspace noise for the affected populations in close proximity to the airport. For some areas, in particular towards the northwest of the northern runway, there is a risk that cumulative airspace and ground noise could be sufficient to bring populations above the relevant AEL thresholds. The local cumulative effects of the LHR-ENR scheme for the 2030 assessment year are considered to be Significant Negative.	→ It is estimated based on the available information[95] that there are some areas that could be brought above the AEL thresholds by the combination of ground and airspace noise. → Some areas would experience increases in both ground and airspace noise, particularly towards the northwest around the new runway. The combined noise may in some cases be sufficient to push areas above the AEL thresholds. → Whilst a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected, this potential benefit may be somewhat counteracted by increases in airspace noise for areas in close proximity to the airport. However, there are also some areas that (in the 2030 medium term) may experience a reduction in both ground and airspace noise (averaged over the daytime period), such as the area around the southwest of the southernmost runway. The local cumulative effects of the LHR-NWR scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).

[92] Department for Transport, 2014. *National Policy Statement for National Networks*. [online] Accessed 17/03/2016
[93] Jacobs, 2014. *5. Noise: Local Assessment. Prepared for the Airports Commission*, p. 68, Figure 3.68 [online] Accessed 21/12/2015
[94] Jacobs, 2014. *5. Noise: Local Assessment. Prepared for the Airports Commission*. p. 271, Figure 5.76 [online] Accessed 21/12/2015
[95] Jacobs, 2014. *5. Noise: Local Assessment. Prepared for the Airports Commission*, p. 197, Figure 4.137 [online] Accessed 21/12/2015

NATIONAL EFFECTS: DISCRETE

Airspace noise
(AoN carbon capped)

Airspace noise – changes in national exposure relative to do minimum[96]

	2030	2040	2050
	Population	**Population**	**Population**
>57 dB $L_{Aeq,16hr}$	(3200)	(4600)	(1950)
Effect	+	+	+
SOAEL	(750)	(1750)	(900)
Effect	+	+	+
UAEL	(150)	(150)	(400)
Effect	+	+	+
NOTE: Decreases indicated by values in parentheses			

The national effects of the LGW-2R scheme are considered to be Positive (+).

Airspace noise – changes in national exposure relative to do minimum[97]

	2030	2040	2050
	Population	**Population**	**Population**
>57 dB $L_{Aeq,16hr}$	14600	21650	15700
Effect	--	--	--
SOAEL	26050	30350	28700
Effect	--	--	--
UAEL	1750	1600	1350
Effect	--	--	--
NOTE: Decreases indicated by values in parentheses			

The national effects of the LHR-ENR scheme are considered to be Significant Negative.

The results presented above are calculations using adjustments derived from the original ENR scenario (ie not including an offset arrivals strategy), and assume that ATMs at other airports would not be affected by an offset arrivals strategy at LHR-ENR.

Airspace noise – changes in national exposure relative to do minimum[98]

	2030	2040	2050
	Population	**Population**	**Population**
>57 dB $L_{Aeq,16hr}$	(7700)	1000	500
Effect	+	--	--
SOAEL	750	3300	3950
Effect	--	--	--
UAEL	(1250)	(1500)	(1900)
Effect	+	+	+
NOTE: Decreases indicated by values in parentheses			

The national effects of the LHR-NWR scheme are considered to be mixed Positive/Significant Negative (+/--).

[96] Jacobs, 2014. *5. Noise: National Assessment*, calculated from data in Tables A1-A2, A13-A14, A17-A18, Appendix A. [online] Accessed 21/12/2015.
[97] Jacobs, 2014. *5. Noise: National Assessment*, calculated from national data in Tables A1, A4, A13, A16, A17 and A20, Appendix A. [online] Accessed 21/12/2015 and local data in tables A54-A56 and A64-A66, CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*. [online] Accessed 21/12/2015.
[98] Jacobs, 2014. *5. Noise: National Assessment*, calculated from data in Tables A1, A3, A13, A15, A17 and A19, Appendix A. [online] Accessed 21/12/2015.

	NATIONAL EFFECTS: CUMULATIVE		
	Aviation noise could result in cumulative effects when considered nationally in combination with the potential impacts from surface access transportation. This could include both that associated with infrastructure changes required to facilitate airport expansion, and with other major national projects; these potential effects are uncertain.		
Direct/ Indirect/ Cumulative	**Direct and cumulative** People and sensitive buildings could experience direct and cumulative effects during the construction and operational phases.	**Direct and cumulative** People and sensitive buildings could experience direct and cumulative effects during the construction and operational phases.	**Direct and cumulative** People and sensitive buildings could experience direct and cumulative effects during the construction and operational phases.
Probability (High, Medium, Low, Very Low)	**High** There is a High probability of the identified effects occurring.	**High** There is a High probability of the identified effects occurring.	**High** There is a High probability of the identified effects occurring.
Phase, Duration (Long-term, Medium-term, Short-term), Frequency	**Construction** Short term (0-5 years) **Operation** Long-term The identified effects could occur throughout the 60-year design life.	**Construction** Short-term (0-5 years) **Operation** Long-term The identified effects could occur throughout the 60-year design life.	**Construction** Short-term (0-5 years) **Operation** Long-term The identified effects could occur throughout the 60-year design life.
Permanent/ Temporary **Irreversible/ Reversible**	**Construction** Temporary, Reversible: The effects would occur during the construction phase. **Operation** Permanent: The effects would arise from fundamental infrastructure. Irreversible: The effects would arise from changes in infrastructure and, although operations could be altered via management, the scheme would require significant intervention to return to baseline conditions.	**Construction** Temporary, Reversible: The effects would occur during the construction phase. **Operation** Permanent: The effects would arise from fundamental infrastructure. Irreversible: The effects would arise from changes in infrastructure and, although operations could be altered via management, the scheme would require significant intervention to return to baseline conditions.	**Construction** Temporary, Reversible: The effects would occur during the construction phase. **Operation** Permanent: The effects would arise from fundamental infrastructure. Irreversible: The effects would arise from changes in infrastructure and, although operations could be altered via management, the scheme would require significant intervention to return to baseline conditions.
Magnitude and Spatial Extent, incl. Transboundary	**Construction** Unknown, but likely to be low magnitude as impacts will only affect those in close proximity to construction activities (ie local extent). **Operation** High magnitude given numbers of population exposed. National extent:	**Construction** Unknown, but likely to be low magnitude as impacts will only affect those in close proximity to construction activities (ie local extent). **Operation** High magnitude given numbers of population exposed. National extent:	**Construction** Unknown, but likely to be low magnitude as impacts will only affect those in close proximity to construction activities (ie local extent). **Operation** High magnitude given numbers of population exposed. National extent:

	Primary effects will be local but wider national effects will also occur due to changes in ATMs at other UK airports.	Primary effects will be local but wider national effects will also occur due to changes in ATMs at other UK airports.	Primary effects will be local but wider national effects will also occur due to changes in ATMs at other UK airports.
Assumptions and Limitation	The most significant assumptions apply to all the schemes, and include: → Indicative flight path designs used for the modelling; → Future mixes of different fleet aircraft types; → Future operational procedures; and → Future changes in population densities. All of these assumptions will have significant influence on the predictions of noise exposure. Limitations are discussed in Section 4.11 below.		
Significance:	Predominant **Significant Negative** effects **(--)**	Predominant **Significant Negative** effects **(--)**	Predominant **Significant Negative** effects **(--)**
Explanatory:	This outcome is justified by emphasising the negative impacts on people in the local area in consideration of the AoS Noise topic Objective. However, it is acknowledged that the potential for some Positive and Significant Positive effects from LGW-2R has also been identified, in particular due to a reduction in the exposure at a small number of schools (although larger numbers of schools could have increased exposure).	This outcome is broadly consistent across the differing scenario assumptions. However, it is acknowledged that the potential for some Positive and Significant Positive effects from LHR-ENR have also been identified, due to anticipated future reductions in noise-induced sleep disturbance, and schools and other NSBs exposed to noise at the lower end of the range considered.	This outcome is broadly consistent across the differing scenario assumptions. However, it is acknowledged that the potential for some Significant Positive effects from LHR-NWR have also been identified, due to anticipated future reductions in noise-induced sleep disturbance, and schools exposed to noise at the lower end of the range considered.
	Construction: People and sensitive buildings could experience direct and cumulative effects due to noise and vibration impacts. High probability of short-term effects occurring during construction, which are temporary and reversible. Low magnitude and local extent. **Operation**: People and sensitive buildings could experience direct and cumulative effects due to airspace and ground noise impacts. High probability of long-term effects occurring during operation, which are permanent and irreversible. High magnitude and potential national extent.	**Construction**: People and sensitive buildings could experience direct and cumulative effects due to noise and vibration impacts. High probability of short-term effects occurring during construction, which are temporary and reversible. Low magnitude and local extent. **Operation**: People and sensitive buildings could experience direct and cumulative effects due to airspace and ground noise impacts. High probability of long-term effects occurring during operation, which are permanent and irreversible. High magnitude and potential national extent.	**Construction**: People and sensitive buildings could experience direct and cumulative effects due to noise and vibration impacts. High probability of short-term effects occurring during construction, which are temporary and reversible. Low magnitude and local extent. **Operation**: People and sensitive buildings could experience direct and cumulative effects due to airspace and ground noise impacts. High probability of long-term effects occurring during operation, which are permanent and irreversible. High magnitude and potential national extent.
Note:	**This assessment table presents the identified effects for each scheme individually and not comparatively. A comparative assessment is presented in Section 4.12.**		

4.10 MITIGATION

Construction Phase

4.10.1 Mitigation for construction noise and vibration will need to be assessed in detail at the EIA stage for any scheme taken forward. The design of mitigation should draw on best practice guidance and ensure that relevant regulations are met. Noise impacts from construction works are regulated under section 60 of the Control of Pollution Act 1974[99]. A code of practice for assessing and mitigating construction noise and vibration impacts is contained in BS 5228:2009[100]. Standard forms of mitigation include (but are not limited to):

- Utilisation of low-noise equipment and acoustic attenuation (control at source);
- Planned layout of construction sites to maximise distances between noisy equipment and sensitive receptors, and screening by solid structures such as buildings, barriers etc. (control on transmission path);
- Operational controls (hours, activities, working practices etc, detailed in an environmental management plan); and
- In some cases, further mitigation for unavoidable and significant impacts could also be considered, such as temporary rehousing or offers of noise insulation (control at receptor).

Operational Phase

4.10.2 Suggestions made by the AC in its Final Report for ways in which airports can reduce noise at source include[101]:

- Preferential routing over areas with lower population densities (discussed further below);
- Steeper descent angles (discussed further below);
- Displaced runway landing thresholds (discussed further below);
- Limiting sharp turns;
- Keeping landing gear up as long as possible;
- New aircraft technology (discussed further below);
- Incentives for airlines to optimise noise performance (eg fines); and
- Air traffic movement limits.

[99] Control of Pollution Act 1974. Crown Copyright [online]. Accessed 06/01/2017.
[100] BSI, 2014. *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*. London: British Standards Institution.
[101] Airports Commission, 2015. *Final Report*, p. 277, paragraph 14.12. [online] Accessed 21/12/2015.

4.10.3 Noise-preferential routing, steeper descent angles and displaced landing thresholds have been investigated as part of the AC assessment work[102,103,104,105]. Preferential flight path routing has been incorporated into the assessment scenarios considered in this AoS, as discussed in Section 4.8. Developing aircraft technologies and future fleet mixes form a key part of the assumptions underpinning the AC noise modelling work[106], and are also adopted in this assessment.

4.10.4 Assumptions regarding the adoption of newer, quieter aircraft technology formed an inherent component of the modelling of both the do minimum and do something, including the results from which the AoS has drawn its conclusions.

4.10.5 The AC's assessment report also included consideration of specific mitigation proposals offered by the scheme promoters for each scheme. Relevant measures are summarised below.

4.10.6 The mitigation measures proposed by the promoter for the LGW-2R scheme include[107]:

- Continuation of the Continuous Descent Approach and Aeronautical Information Publication joining height limits, with the runway and airspace designed to facilitate these measures;
- Compensation and noise insulation schemes for dwellings and a commitment to provide annual compensation for households inside the 57 dB $L_{Aeq,16hr}$ contour; and
- Development of new noise preferential routes (taking advantage of P-RNAV), including increased stakeholder engagement on the design of preferential routes.

4.10.7 The mitigation measures proposed by the promoter for the LHR-ENR scheme (subject to agreement from the airport operator) include:

- No night-time operations within a 6½-hour 'core' night period 2330-0600hrs[108];
- Noise preferential routes using curved and angled approaches[109];
- Displacement of runway landing thresholds (ie deeper landings)[110]; and
- Provision of a scheduled runway alternation scheme to enable predictable respite (NB. as discussed below, the AC considered the scope for runway alternation respite under the LHR-ENR scheme more limited than available under the LHR-NWR scheme)[111].

4.10.8 The mitigation measures proposed by the scheme promoter for the LHR-NWR scheme include[112]:

- Incentives to promote incorporation of quieter aircraft in fleet mixes;
- Designing airport infrastructure to be as quiet as possible through positioning of a third runway;

[102] Multiple references, Jacobs, 2014. *5. Noise: Local Assessment.* [online] Accessed 21/12/2015.
[103] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, pp. 1-35. [online] Accessed 21/12/2015.
[104] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 187-196. [online] Accessed 21/12/2015.
[105] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, pp. 36-40. [online] Accessed 21/12/2015.
[106] Jacobs, 2014. *5. Noise: Local Assessment*, Appendix A.1-A.3. [online] Accessed 21/12/2015.
[107] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 73-74. [online] Accessed 21/12/2015.
[108] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 275-276, paragraphs 5.17-5.18 [online] Accessed 21/12/2015.
[109] The effect of offset arrival approaches for LHR-ENR is assessed within Jacobs, 2015. *5. Noise: Local Assessment Addendum.* [online] Accessed 21/12/2015 and has been included in the assessment detailed herein.
[110] Jacobs, 2015. *5. Noise: Local Assessment Addendum*. [online] Accessed 21/12/2015.
[111] Airports Commission, 2015. *Final Report*, p. 181, Paragraphs 9.31-9.32. [online] Accessed 21/12/2015.
[112] Jacobs, 2014. *5. Noise: Local Assessment,* p. 205. [online] Accessed 21/12/2015.

- Compensation and noise insulation schemes for dwellings and community buildings;
- Displacement of runway landing thresholds;
- Development of quieter operating procedures, including steeper approach slopes (discussed further below), and night fleet management;
- Provision of pre-conditioned air (PCA) and fixed electrical group power (FEGP) or ground power units (GPUs) for all aircraft stands to reduce use of auxiliary power units (APUs);
- Reduced taxi and holding times; and
- Use of modern airside equipment such as electric vehicles and clatter-resistant baggage trolleys, maintained using enhanced procedures to avoid excessive noise.

4.10.9 In its Final Report, the AC made a number of recommendations on mitigation measures for the LHR-NWR scheme (which they assessed as offering the strongest solution to the UK's aviation capacity and connectivity needs[113]), including[114]:

- Clear and legally-binding noise performance targets, in the form of a 'noise envelope';
- Periods of predictable respite to be more reliably maintained (discussed further below). The airport operator to work with local communities to determine how respite would best be provided;
- A ban on all scheduled flights during the 6½-hour 'core' night period 2330-0600hrs (discussed further below);
- Holding the promoter for LHR-NWR to its public commitment to deliver a compensation package for noise insulation, and significant investment in noise insulation and other support for schools;
- Introduction of a noise levy at major UK airports; and
- Creation of an Independent Aviation Noise Authority and Community Engagement Board under an independent Chair.

4.10.10 The AC compared the scope for provision of predictable respite under runway alternation schemes for each Heathrow scheme. It was stated that:[115]

"*Neither Heathrow option would be able to deliver the same level of respite as is currently provided, which sees communities around the airport generally benefiting from respite for half of the operating day. The Northwest Runway scheme would reduce this to a third, but would maintain the ability to offer respite throughout the operating day. The Extended Northern Runway scheme would reduce this further, as runway alternation would only be possible outside peak hours. In both cases however, new navigational technologies would enable this to be supplemented with more effective respite through flightpath design. Although not quantifiable at this stage, there is also potential for the respite provided by runway alternation to be more predictable than today as resilience is enhanced through the provision of new capacity. This is true for both* [Heathrow] *schemes, but the effects are likely to be greatest under the Northwest Runway proposal.*"

[113] Airports Commission, 2015. *Final Report*, p. 274, paragraph 13.96. [online] Accessed 21/12/2015.
[114] Airports Commission, 2015. *Final Report*, chapter 14, pp. 275-310. [online] Accessed 21/12/2015.
[115] Airports Commission, 2015. *Final Report*, p. 183, paragraphs 9.34-9.35. [online] Accessed 21/12/2015.

4.10.11 It has also been stated[116] that runway alternation for LGW-2R would not be feasible if the runways were operated in mixed-mode, as proposed by the scheme promoter. However, respite could be enabled by varying flightpaths[117]. The AC analysed the feasibility of a runway segregation respite scheme for LGW-2R, concluding that this could provide respite from noise, at the cost of substantially-reduced capacity[118].

4.10.12 The CAA ERCD analysis of a core night-flight ban indicates such a measure would offer potential reductions in the cost of health impacts due to sleep disturbance for all schemes[119] (which represent corresponding reductions in the estimations of DALYs lost in each assessment year). However, the AC considered a night-flight ban to be a credible measure in the immediate term only at an expanded Heathrow[120].

4.11 ASSUMPTIONS AND LIMITATIONS

4.11.1 The assessment is based on the outputs of the CAA ERCD ANCON modelling. The modelling is very sensitive to its inputs including[121]:

- Assumed ATMs and fleet mixes;
- Flight paths, approach angles, landing thresholds, take-off power and climb rates;
- ATM distribution to flightpaths and runways;
- The assumed noise characteristics of future aircraft types;
- Assumed operational modal splits; and
- The data used to calculate populations and buildings within exposure contours (incorporating future population growth assumptions).

4.11.2 It should be noted that the flight paths used in the modelling are indicative, and would not necessarily be the same as implemented in practice[122]. A degree of uncertainty in flight path centrelines is however inherent in the modelling, which incorporates dispersion factors considered to be representative for each scheme[123]. The routes used are considered compatible with anticipated future airspace and navigational technology[124].

4.11.3 The differing scenario assumptions underpinning the assessments at local and national levels imply a degree of uncertainty. Noise impacts could be increased further by adoption of 'high demand' aviation forecasts, and a sensitivity test considering the effects of this can be found in Section 4.13; the analysis indicates that the assessment outcomes would be broadly the same as for the main case considered, in terms of both individual (Section 4.9) and comparative (Section 4.12) assessment outcomes. However, whereas assumption of a higher demand scenario tends to slightly increase the predicted noise impacts for LGW-2R, the reverse is broadly observed for LHR-ENR and LHR-NWR; reasons for this outcome are discussed in Section 4.13, however the overall assessment conclusions remain unaltered..

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116 Airports Commission, 2015. *Final Report*, p. 178, paragraph 9.27, [online] Accessed 21/12/2015.
117 Airports Commission, 2015. *Final Report*, p. 178, footnote 64, [online] Accessed 21/12/2015.
118 Airports Commission, 2015. *Consideration of Consultation Responses*, p. 53, paragraph 2.7.26. [online] Accessed 04/07/2016.
119 CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Table D18. [online] Accessed 21/12/2015.
120 Airports Commission, 2015. *Final Report*, p. 185, paragraph 9.45, [online] Accessed 21/12/2015.
121 Jacobs, 2014. *5. Noise: Local Assessment*, section A.1.2, Appendix A. [online] Accessed 21/12/2015.
122 Airports Commission, 2015. *Final Report*, p. 171, paragraph 9.13, [online] Accessed 21/12/2015.
123 Jacobs, 2014. *5. Noise: Local Assessment*, section A.3, Appendix A, p. 12, paragraph 3.27. [online] Accessed 21/12/2015.
124 Jacobs, 2014. *5. Noise: Local Assessment*, section A.3, Appendix A, p. 12, paragraph 3.28. [online] Accessed 21/12/2015.

4.11.4 The lower threshold used in assessing population and NSB noise exposure has been selected with reference to the updated evidence acknowledged in the Government Response to Consultation on *UK Airspace: A framework for balanced decisions on the design and use of airspace*[125] at 54 dB $L_{Aeq,16h}$. While it has been recognised that there may be some effects at lower exposure levels, 54 dB $L_{Aeq,16h}$ has been suggested in the SoNA study as broadly equivalent in terms of expected subjective response to that previously thought to correspond to exposure at 57 dB $L_{Aeq,16h}$.

4.11.5 The assessment data show only estimations of the numbers of receptors (people or NSBs) exposed to lower threshold noise levels (eg >54 dB $L_{Aeq,16hr}$). A limitation of this approach is that it is not possible to assess changes in noise level exposure that may be experienced by each receptor over time[126]. For example, a receptor exposed to 54 dB in 2013, and then 60 dB by 2030, would experience a 6 dB increase within the 17 year interval. Changes in noise exposure over time could have greater tangible meaning for the experiences of individuals and communities.

4.11.6 Similarly, no distinction has been made between those already exposed to a given level of noise, and those that may be 'newly-exposed' as a result of each scheme. This approach is deemed suitable for a strategic-level appraisal, and reflects current Government policy to limit and where possible reduce the number of significantly affected people[127], but it would also be appropriate at a later stage (such as EIA) to expand the approach to include consideration of the predicted impacts from changes in noise for communities and areas. Over time, subjective responses to significant step-changes in aviation noise (such as increases in annoyance reactions due to being exposed to higher noise levels from the introduction of a new or extended runway) may in some cases reduce[128]. However at the current state of knowledge it is unclear whether any 'change effect' in relation to aviation noise can be considered broadly equivalent to those corresponding to noise exposure from other forms of transport[129,130], since it has been observed that responses to aviation noise exposure differ (eg to those relating to road noise)[131,132].

4.11.7 There is no definitive agreement on assessment methodology for airport ground noise[133]. The assessment of ground noise impacts has been based on an approximation of the total geographical area exposed to noise exceeding 57 dB $L_{Aeq,16hr}$ in the 2030 assessment year. The limitations of the model preclude consideration of the screening that could be expected from buildings and structures at ground level, and the effects in longer term assessment years. Furthermore, the assumptions of aviation demand and future carbon policy underpinning the ground noise calculations have not been stipulated, and lower emphasis has therefore been placed on these results compared with the airspace noise modelling.

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[125] Department for Transport, 2017. *Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace*.
[126] Jacobs, 2014. *5. Noise: Local Assessment*, p 10, final paragraph. [online] Accessed 21/12/2015.
[127] Department for Transport, 2013. *Aviation Policy Framework*, p. 11, paragraph 17, [online] Accessed 21/12/2015.
[128] Gemeinnützige Umwelthaus GmbH. NORAH Study Results: Noise-related annoyance and quality of life over time. [online]. Accessed 27/07/2016.
[129] Brown, A. L. *et al*., 2009. Response to a change in transport noise exposure: a review of evidence of a change effect. *Journal of the Acoustical Society of America*. 125, 5, 3018-3029.
[130] Highways Agency, 2011. *Design manual for roads and bridges,* Volume 11 Section 3 - Environmental assessment techniques Part 7. HD 213/11 – Revision 1: Noise and Vibration, Paragraph A6.16, Annex 6. [online]. Accessed 01/03/2016.
[131] Babisch, W. et al, 2009. Annoyance due to aircraft noise has increased over the years–results of the HYENA study. *Environment International,* 35, 1169-1176.
[132] Janssen, S.A. et al, 2011. Trends in aircraft noise annoyance: the role of study and sample characteristics. *Journal of the Acoustical Society of America*. 129,4, 1953-1962.
[133] Jacobs, 2014. *5. Noise: Local Assessment*, Section A.1.5, Appendix A. [online] Accessed 21/12/2015.

4.11.8 The relevant Defra guidance on valuation of health and amenity effects highlights the uncertainties involved in the form of the Disability Weightings (DWs) that can be applied to such calculations[134]. It has also been shown in research carried out to support the AC assessment that the lower threshold used to estimate health effects of noise exposure has a significant influence on the results[135]. The current WebTAG method that has been followed in this assessment uses the mid-point DWs for the valuations that have been used to derive DALY estimations, and thresholds recommended by the WHO. This is a rapidly-developing area of understanding; estimations of health and amenity effects must be interpreted with some caution, and should be considered alongside the direct estimations of noise exposures.

4.11.9 Changes to surface transportation access for all schemes would be expected to generate noise and vibration that could result in cumulative effects with aviation noise. These have not been assessed at the current stage, as there is uncertainty surrounding possible routes and modal options that could be taken forward and modelling has not been undertaken for surface transport. This is because the dominant source of noise is from aviation. However it would be necessary to consider surface transport effects as part of an EIA for any scheme taken forwards when more information is available about the proposed surface transport package.

4.11.10 Similarly, the impacts of construction noise and vibration could adversely affect receptors in the vicinity of the works, including any changes to surface access infrastructure necessary to accommodate passenger transport. This would need to be addressed in detail in an EIA.

4.11.11 Finally, it should be recognised that human receptors (both individuals and communities) can react to environmental noise in different ways, and that the outcome of effects often depends greatly on local conditions, attitudes and expectations. Standardising these complex responses involves inevitable simplification, but provides a means to directly compare expected effects from the strategic perspective required for the AoS.

4.12 CONCLUSIONS

4.12.1 Objective 6: "To Minimise and Where Possible Reduce Noise Impacts on Human Receptors

INDIVIDUAL ASSESSMENT SUMMARY

4.12.2 The LGW-2R scheme has the potential for predominant Significant Negative effects (--). However, it is acknowledged that the potential for some Positive and Significant Positive effects has also been identified. Key considerations in reaching this outcome are:

- → local population exposure to noise levels >54 dB $L_{Aeq,0700\text{-}2300hrs}$ and the SOAEL[136] would be expected to be increased compared with the do minimum situation, while exposure to the UAEL[137] may be expected to be slightly reduced compared with the do minimum situation, although the small numbers involved make this uncertain (central scenario);
- → local NSBs[138] exposure to the SOAEL would be expected to be reduced compared with the do minimum situation (central scenario);

[134] Department for Environment, Food and Rural Affairs, 2014. *Environmental noise: valuing impacts on sleep disturbance, annoyance, hypertension, productivity and quiet.* [online]. Accessed 03/05/2016.
[135] Rhodes, D. P., Weston, E. and Jones, K., 2013. *ERCD Report 1209. Proposed methodology for estimating the cost of sleep disturbance from aircraft noise*, p. 6, paragraph 2.5, [online] Accessed 11/08/2015.
[136] Significant Observed Adverse Effects Level, identified as 63 dB $L_{Aeq,0700\text{-}2300hrs}$ for the purpose of this assessment.
[137] Unacceptable Adverse Effects Level, identified as 69 dB $L_{Aeq,0700\text{-}2300hrs}$ for the purpose of this assessment.
[138] Noise Sensitive Buildings (excluding schools), ie hospitals and religious places of worship.

- annual and total DALYs[139] lost to adverse health and amenity effects are expected to be increased compared with the do minimum (central scenario);
- Effects on cognitive development of children are expected to be mixed (++/-) due to some increases and reductions in schools noise exposure (central scenario);
- National population exposure to noise levels >57 dB $L_{Aeq,16hr}$, as well as the SOAEL and UAEL would be expected to be reduced compared with a do minimum situation (AoN carbon capped scenario); and
- The overall outcome (--) is justified by emphasising the central scenario negative impacts on people in the local area in consideration of the AoS Noise topic Objective 'To minimise and where possible reduce noise impacts on human receptors'.

4.12.3 The LHR-ENR scheme has been assessed as showing predominant Significant Negative effects (--) on the Noise topic objective. However, it is acknowledged that the potential for some Positive and Significant Positive effects has also been identified. Key considerations in reaching this outcome are:

- Local population exposure to noise levels >54 dB $L_{Aeq,16hr}$ is expected to increase for 2030 and 2040, but be reduced in 2050, while exposure to the SOAEL and UAEL would be expected to be increased over the assessment period compared with a do minimum situation (central scenario);
- Local NSBs exposure to noise levels >54 dB $L_{Aeq,16hr}$ is also expected to increase in 2030 and 2040, but be reduced by 2050; exposure to the SOAEL and UAEL is expected to be increased over the assessment period compared with a do minimum situation (central scenario);
- Annual DALYs lost to adverse health and amenity effects are expected to be increased by 2030 and through 2040, but with gradual reductions in sleep disturbance beyond 2040 up to 2050. Total DALYs lost over 60 years to adverse health effects would be expected to be increased compared with the do minimum, although reductions in total DALYs lost solely due to sleep disturbance have also been identified (central scenario);
- Effects on cognitive development of children are expected to be Significant Negative due to general increases in schools exposed to daytime noise, although some reductions in exposure to the lowest levels of noise (>54 dB $L_{Aeq,16h}$) are also expected in 2040 and 2050 (central scenario);
- National population exposure to noise levels >57 dB $L_{Aeq,16hr}$, the SOAEL and UAEL would be expected to increase compared with a do minimum situation (AoN carbon capped scenario); and
- The outcome (--) is justified by emphasising the overall negative effects expected for the local population.

4.12.4 The LHR-NWR scheme has been assessed as showing the potential for predominant Significant Negative effects (--). However, it is acknowledged that the potential for some Positive and Significant Positive effects has also been identified. Key considerations in reaching this outcome are:

- Local population exposure to noise levels >54 dB $L_{Aeq,16hr}$, as well as the SOAEL would be expected to be increased compared with a do minimum situation (central scenario);
- Local population exposure to the UAEL would be expected to be reduced compared with a do minimum situation (central scenario);

[139] Disability-adjusted life years.

- Local NSB exposure to noise levels >54 dB $L_{Aeq,16hr}$, as well as the SOAEL and UAEL would be expected to be increased compared with a do minimum situation (AoN carbon capped scenario);
- Annual DALYs lost to adverse health and amenity effects are expected to be increased by 2030 and through 2040, but with gradual reductions in sleep disturbance beyond 2040 up to 2050. Total DALYs lost over 60 years to adverse health effects would be expected to be increased compared with the do minimum, although reductions in total DALYs lost solely due to sleep disturbance have also been identified (central scenario);
- Effects on cognitive development of children are expected to be Significant Negative due to broad increases in schools exposed to daytime noise, although some reductions in exposure to the lowest levels of noise (>54 dB $L_{Aeq,16h}$) are also expected by 2050 (central scenario);
- National population exposure to noise levels >57 dB $L_{Aeq,16hr}$ (2040 and 2050 assessment years), and the SOAEL (all assessment years) would be expected to be increased compared with a do minimum situation (AoN carbon capped scenario);
- National population exposure to the UAEL would be expected to be reduced compared with a do minimum situation (AoN carbon capped scenario); and
- The outcome (--) is justified by emphasising the overall negative effects expected for the local population.

COMPARATIVE ASSESSMENT SUMMARY

4.12.5 A comparative assessment drawing on the same data presented in Section 4.9 is shown below. Figure 4.36, Figure 4.37 and Figure 4.38 show the total local population exposures to airspace noise expected as a result of each scheme (central scenario).

Figure 4.36: Comparison of LGW-2R, LHR-ENR and LHR-NWR Local Airspace >54 dB $L_{Aeq,16hr}$ Daytime Average Noise Population Exposures (Central)

Figure 4.37: Comparison of LGW-2R, LHR-ENR and LHR-NWR Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposures (Central)

Figure 4.38: Comparison of LGW-2R, LHR-ENR and LHR-NWR Local Airspace >69 dB Daytime Average Noise UAEL Population Exposures (Central)[140]

4.12.6 The exposure assessment illustrated above indicates that:

- The local population exposed to noise >54 dB $L_{Aeq,16hr}$ the 63 dB SOAEL and the 69 dB UAEL near to LGW-2R is expected to be a fraction of those exposed near to LHR-ENR or LHR-NWR; and
- Compared with LHR-ENR, the LHR-NWR scheme is expected to result in a smaller proportion of the local population exposed to the 63 dB SOAEL and 69 dB UAEL, but a larger number exposed to levels >54 dB $L_{Aeq,16h}$ over the full assessment period. In other words, total exposure of people to lower levels of noise is expected to be greater for LHR-NWR than LHR-ENR, but exposure to higher levels of noise is expected to be greater for LHR-ENR than LHR-NWR.

4.12.7 A comparison of estimated differences in annual and overall 60-year DALYs lost due to the key health/amenity effects (annoyance and sleep disturbance) assessed for each scheme is set out in Figure 4.39 and Figure 4.40 (central scenario, NB. axis scales vary).

[140] The populations for the LGW(-1R) and LGW-2R UAEL exposures are given as a range of possible values (<50); in the figure, the worst-case values of 0 and 49 (respectively) have been assumed..

Figure 4.39: Estimated Changes in DALYs Lost Due to Annoyance Compared with Do Minimum (Central)

Figure 4.40: Estimated Changes in DALYs Lost Due to Sleep Disturbance Compared with Do Minimum (Central)

4.12.8 The assessment illustrated above indicates:

- With respect to annoyance, LGW-2R is predicted to result in the smallest increases in lost DALYs compared with the do minimum, but with a gradually increasing trend. Both Heathrow schemes on the other hand show larger increases but with gradually reducing trends, and overall LHR-NWR shows the largest total increases out of the three schemes; and
- With respect to sleep disturbance, both Heathrow schemes show initial increases in 2030 but with steadily reducing trends that result in relatively large reductions in the estimations of lost DALYs for assessment years beyond 2040 (compared with the do minimum). LGW-2R shows smaller initial increases, but with gradually increasing trend, which results in overall increases in lost DALYs, which contrasts with overall reductions for the Heathrow schemes (it is important to reiterate that these values represent *changes compared with the do minimum*, and not total health benefits or disbenefits associated

with operations at each airport; as shown in Table 4.4, a beneficial change in sleep disturbance compared with the do minimum for Heathrow is based on a much larger total population exposure to night noise than for Gatwick). LHR-NWR is predicted to result in the greatest total beneficial changes in sleep disturbance compared with the do minimum over a 60-year period.

4.12.9 The estimated differences in DALYs lost compared with the do minimum as a total for all health and amenity effects assessed (excepting children's cognitive development, discussed below) are shown for each scheme in Figure 4.41 (central scenario).

Figure 4.41: Estimated Changes in Total DALYs Lost Due to All Assessed Health and Amenity Effects Compared with Do Minimum (Central)

4.12.10 The assessment illustrated above indicates that:

- → LGW-2R is predicted to result in the smallest initial annual increases in adverse health and amenity effects, with a gradually increasing trend, whereas both Heathrow schemes show larger initial increases with steadily reducing trends, such that by 2050 the changes in annual DALYs lost for LHR-ENR become reductions, and increases for LHR-NWR are equivalent to LGW-2R; and
- → Over a 60-year period, LGW-2R is predicted to result in the smallest total increases in adverse health effects of nearly 7,600 DALYs. LHR-ENR shows increases of around 9,900 DALYs; the impact of both schemes is less than 10,000 additional DALYs lost. LHR-NWR is expected to result in the largest total increases in adverse health effects over 60 years, of slightly more than 20,000, i.e. roughly double those of LHR-ENR. This is primarily due to the larger initial increase and slower reductions in annoyance over time for LHR-NWR compared with LHR-ENR.

4.12.11 With respect to cognitive development of children, the assessment in Section 4.9 indicates that LGW-2R performs most strongly as it is expected to result in some reductions as well as increases in noise exposure of schools. Both LHR schemes perform very similarly, and show predominant Significant Negative Effects, with possible slight Positive effects at the lower end of the noise exposure range.

4.12.12 Figure 4.42, Figure 4.43 and Figure 4.44 show the total national population exposures to airspace noise expected as a result of each scheme (AoN carbon capped scenario).

Figure 4.42: Comparison of LGW-2R, LHR-ENR and LHR-NWR National Airspace >57 dB Daytime Average Noise Population Exposures (AoN, Carbon Capped) [NB. Non-zero axis]

Figure 4.43: Comparison of LGW-2R, LHR-ENR and LHR-NWR National Airspace >63 dB Daytime Average Noise SOAEL Population Exposures (AoN, Carbon Capped)

Figure 4.44: Comparison of LGW-2R, LHR-ENR and LHR-NWR National Airspace >69 dB Daytime Average Noise UAEL Population Exposures (AoN Carbon Capped)

4.12.13 The assessments illustrated above show that:

- → National population exposure to the identified noise AELs and thresholds is expected to be highest for the LHR-ENR scheme over the full assessment period;
- → National population exposures to noise >57 dB $L_{Aeq,16hr}$, and the >63 dB $L_{Aeq,16hr}$ SOAEL for the LGW-2R and LHR-NWR schemes are comparable over the full assessment period; and
- → National population exposure to the >69 dB $L_{Aeq,16hr}$ UAEL is expected to be lowest for the LHR-NWR scheme.

4.12.14 In conclusion, the LGW-2R presents the scheme with the least negative effects in relation to the Noise topic objective, and may offer some positive effects. The total exposure increases and the total negative impact on health and amenity are expected to be considerably smaller for LGW-2R, relative to that of either LHR-ENR or LHR-NWR.

4.12.15 Of the two Heathrow schemes, the LHR-NWR scheme is expected to offer reduced local and national exposure to the higher noise levels compared with the LHR-ENR scheme, but increased local exposure to the lower bound noise contour >54 dB $L_{Aeq,16h}$.

4.12.16 It is recognised that both LHR schemes are expected to offer reductions in sleep disturbance compared with the do minimum, but this is not expected to occur until after 2040. Overall, LHR-ENR performs better than LHR-NWR for both the key amenity effects in the long term (annoyance and sleep disturbance).

4.12.17 In this analysis it is important to re-emphasise that the estimations are of *changes* in health effects *relative to the respective do minimum*, and do not represent the *total* health and amenity effects that might be associated with the operations of individual airports. Due to the much lower total population exposures, the overall impact of aviation noise on human health and amenity associated with Gatwick is expected to be lower than at Heathrow, with or without expansion.

4.12.18 The AC assessment also concluded that the LGW-2R scheme performed most strongly[141] with regards to the sustainability objective for noise outlined in its Appraisal Framework[142]. This was primarily due to the relative differences in the sizes of local populations adversely affected by noise; population noise exposure around LGW-2R[143] was predicted to be around 40 times smaller than for either of the Heathrow expansion schemes LHR-ENR and LHR-NWR[144].

4.13 ANNEX: SENSITIVITY ANALYSIS – HIGH DEMAND NOISE IMPACTS

4.13.1 This section analyses a key sensitivity factor that may affect the noise assessment: a 'high demand' case in terms of ATMs, which is considered by the DfT to represent a worst-case scenario for noise emissions from each airport.

[141] Airports Commission, 2015. *Final Report*, p. 186, paragraph 9.49. [online] Accessed 21/12/2015.
[142] Airports Commission, 2014. *Appraisal Framework*. p. 55, Chapter 5. Noise. [online] Accessed 21/12/2015.
[143] *assessment of need, low cost is king, global growth, global fragmentation* and r*elative decline of Europe*; see: Airports Commission, 2015. *Final Report*, p. 172, paragraph 9.19. [online] Accessed 21/12/2015.
[144] Predicted population exposure to 57 dB $L_{Aeq,16h}$ contour in 2040, from data in CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results,* Tables A21, A49, and A68. [online] Accessed 21/12/2015.

SCENARIO USED

4.13.2 Under the high demand scenario, the population exposed to noise increases compared to the central scenario. This is largely a result of changes to fleet mix and traffic on flight paths as well as a change in air traffic movements. GDP is higher and operating costs are lower than in the central scenario for all world regions resulting in higher passenger demand growth rates. It is important to note that high demand forecasts increase ATMs in *both* the do minimum and do something cases; this means that noise effects due to each scheme (compared with the do minimum) could be greater or smaller under the high demand scenario.

ASSESSMENT

LGW-2R

4.13.3 Figures 4-45, 4-46 and 4-47 show the predicted *changes* in local population noise exposures for the LGW-2R scheme relative to the respective do minimum cases, under both the high demand scenario and the central scenario.

Figure 4.45: High Demand Noise Impact Sensitivity Test – Changes in LGW-2R Local Airspace >54 dB Daytime Average Noise Population Exposure

Figure 4.46: High Demand Noise Impact Sensitivity Test – Changes in LGW-2R Local Airspace >63 dB SOAEL Daytime Average Noise Population Exposure

Figure 4.47: High Demand Noise Impact Sensitivity Test – Changes in LGW-2R Local Airspace >69 dB UAEL Daytime Average Noise Population Exposure

4.13.4 The data shown above indicates that with one exception there are either increases or no change in exposure impacts expected under the high demand scenario compared with the central scenario, and the differences observed are largest in 2040. In the case of the >69 dB UAEL, the change in 2040 is sufficient to turn a disbenefit in the central scenario (increase in exposure) into a benefit in the high demand scenario (reduction in exposure), relative to the respective do minimum cases. Nonetheless, the effect on the exposure assessment for LGW-2R is negligible.

4.13.5 Figure 4.48 and Figure 4.49 below show the estimations of changes in annual and total DALYs lost compared with the do minimum for the high demand LGW-2R scenario alongside the central scenario (NB. for clarity, only the key effects are shown).

Figure 4.48: High Demand Noise Impact Sensitivity Test – LGW-2R Estimated Changes in Annual DALYs Lost for Key Effects

Figure 4.49: High Demand Noise Impact Sensitivity Test – LGW-2R Estimated Changes in DALYs Lost over 60 Years for Key Effects

4.13.6 The assessment above indicates that under the high demand scenario, estimated adverse health and amenity effects for LGW-2R are slightly increased, with greatest change (compared with the central scenario) in 2040.

4.13.7 Overall, the assessment outcome for LGW-2R is not substantially affected by the assumption of high demand forecasts.

LHR-ENR

4.13.8 Figures 4-50, Figure 4.51 and Figure 4.52 show the predicted changes in local population noise exposures for the LHR-ENR scheme relative to the respective do minimum cases, under both the high demand scenario and the central scenario.

Figure 4.50: High Demand Noise Impact Sensitivity Test – Changes in LHR-ENR Local Airspace >54 dB Daytime Average Noise Population Exposure

Figure 4.51: High Demand Noise Impact Sensitivity Test – Changes in LHR-ENR Local Airspace >63 dB SOAEL Daytime Average Noise Population Exposure

Figure 4.52: High Demand Noise Impact Sensitivity Test – Changes in LHR-ENR Local Airspace >69 dB UAEL Daytime Average Noise Population Exposure

4.13.9 The assessment above indicates that the high demand scenario generally slightly reduces the disbenefits of the LHR-ENR scheme, which is due to the increases in exposure under the do something case being somewhat smaller than the increases under the do minimum case. For predicted exposure to levels >54 dB $L_{Aeq,16h}$ in 2040, this change is sufficient to turn a disbenefit in the central scenario (increase in exposure) into a benefit in the high demand scenario (reduction in exposure), relative to the respective do minimum cases.

4.13.10 Figure 4.53 and Figure 4.54 below show the estimations of changes in annual and total DALYs lost to annoyance and sleep disturbance compared with the do minimum for the high demand LHR-ENR scenario, alongside the central scenario.

Figure 4.53: High Demand Noise Impact Sensitivity Test – LHR-ENR Estimated Changes in Annual DALYs Lost for Key Effects

Figure 4.54: High Demand Noise Impact Sensitivity Test – LHR-ENR Estimated Changes in DALYs Lost over 60 Years for Key Effects

4.13.11 The estimated adverse health impacts of noise for the LHR-ENR high demand scenario are also marginally reduced compared with the central scenario, which reflects the results for exposure.

4.13.12 Overall, the assessment outcome for LHR-ENR is not substantially affected by the assumption of high demand forecasts.

LHR-NWR

4.13.13 Figure 4.55, Figure 4.56 and Figure 4.57 show the predicted changes in local population noise exposures for the LHR-NWR scheme relative to the respective do minimum cases, under both the high demand scenario and the central scenario.

Figure 4.55: High Demand Noise Impact Sensitivity Test – Changes in LHR-NWR Local Airspace >54 dB Daytime Average Noise Population Exposure

Figure 4.56: High Demand Noise Impact Sensitivity Test – Changes in LHR-NWR Local Airspace >63 dB SOAEL Daytime Average Noise Population Exposure

Figure 4.57: High Demand Noise Impact Sensitivity Test – Changes in LHR-NWR Local Airspace >69 dB UAEL Daytime Average Noise Population Exposure

4.13.14 The assessment above indicates that the high demand scenario also generally slightly reduces the disbenefits of the LHR-NWR scheme, again due to the do minimum exposure tending to increase more than the do something under the high demand scenario (compared with the central scenario).

4.13.15 Figure 4.58 and Figure 4.59 below show the estimations of changes in annual and total DALYs lost to annoyance and sleep disturbance compared with the do minimum for the high demand LHR-NWR scenario, alongside the central scenario.

Figure 4.58: High Demand Noise Impact Sensitivity Test – LHR-NWR Estimated Changes in Annual DALYs Lost for Key Effects

Figure 4.59: High Demand Noise Impact Sensitivity Test – LHR-NWR Estimated Changes in DALYs Lost over 60 Years for Key Effects

4.13.16 Similarly to LHR-ENR, the estimated adverse health impacts of noise for the LHR-NWR scheme are marginally reduced in the high demand scenario compared with the central scenario when considered relative to the do minimum case; this is due to the increase in the do minimum impacts in the high demand case.

4.13.17 Overall, the assessment outcome for LHR-NWR is not substantially affected by the assumption of high demand forecasts.

COMPARATIVE ASSESSMENT

4.13.18 It can be seen by comparing the exposure charts above that, although the adoption of the high demand scenario tends to increase the impacts associated with LGW-2R, the size of adverse changes in exposure remains considerably smaller than for either LHR-ENR or LHR-NWR. This is especially true in terms of the upper range exposure levels of >63 dB (SOAEL) and >69 dB (UAEL).

4.13.19 It can also be seen by comparing Figure 4.49, Figure 4.54 and Figure 4.59 that adoption of the high demand scenario has the effect of increasing key adverse health and amenity effects for LGW-2R, which by contrast are reduced for both Heathrow schemes – this finding is reflected in the exposure data.

4.13.20 Figure 4.60 below shows a comparison of the changes in total DALYs lost over 60 years in the high demand and central scenarios for each scheme option, including all health and amenity effects assessed.

Figure 4.60: High Demand Noise Impact Sensitivity Test –Estimated Changes in DALYs Lost over 60 Years for All Effects Across Each Scheme Option

4.13.21 Figure 4.60 indicates that in the high demand scenario, the total health impact for noise-related effects associated with LHR-ENR becomes comparable with that for LGW-2R, and in fact very marginally smaller (8,084 compared with 8,101) – this is primarily due to beneficial reductions in DALYs lost to annoyance and sleep disturbance for LHR-ENR, which by contrast are increased for LGW-2R. LHR-NWR remains the least favourable scheme in terms of adverse effects on health and amenity. Again, it is important to reiterate that the health and amenity effects represent *changes* compared with the do minimum, and do not represent the total health impacts associated with each airport.

4.13.22 It is notable that the sensitivity test indicates an increase in the beneficial reductions in sleep disturbance expected for both LHR-ENR and LHR-NWR under the high demand case. This slightly counterintuitive result is explained by the larger increases in the do minimum LHR case for the high demand scenario. It can be inferred that, since in the do minimum case, daytime capacity cannot increase due to current constraint, more ATMs must be fitted into night-time shoulder hours to meet the high demand, resulting in higher night-time average exposure to

aircraft noise. On the other hand, both Heathrow expansion options should enable more flexibility with regards to distribution of the higher demand throughout the day, leading to reductions in night noise relative to a constrained (do minimum) Heathrow airport.

SENSITIVITY ANALYSIS CONCLUSION

4.13.23 The sensitivity analysis indicates that the high demand scenario tends to increase noise exposure and adverse effects for LGW-2R, but broadly reduces adverse effects for both LHR-ENR and LHR-NWR. It is important to realise that the impacts are assessed relative to the do minimum case, which is also affected by higher demand. In the case of Heathrow airport, the high demand scenario results in larger increases in exposure in the do minimum case than in the do something, relative to the central scenario.

4.13.24 Overall, the LGW-2R scheme remains more favourable in the high demand scenario, since, while the total health and amenity impact (in terms of changes in DALYs) becomes virtually equal to LHR-ENR, the increases in noise exposure are smaller. LHR-ENR remains more favourable than LHR-NWR, although increases in exposure to the higher levels of noise are greater under LHR-ENR than LHR-NWR. Beneficial reductions in sleep disturbance and adverse increases in annoyance remain greater for LHR-NWR compared with LHR-ENR.