Luton Rising

Our airport.
Our community.
Our planet.

February 2023

London Luton Airport Expansion

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5.02 Appendix 13.4 Methodology for Health and Community Assessment

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The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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5.02 ENVIRONMENTAL STATEMENT APPENDIX 13.4 METHODOLOGY FOR HEALTH AND COMMUNITY ASSESSMENT

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Contents

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Insets

1   INTRODUCTION TO HEALTH AND COMMUNITY ASSESSMENT

1.1.1   The document is an appendix to the Environmental Statement (ES) submitted as part of Luton Rising's application for development consent to expand London Luton Airport (the airport) from the currently permitted capacity of 18 million passengers per annum (mppa) to 32 mppa (the Proposed Development, as described in **Chapter 4** of the ES **[TR020001/APP/5.01]**).

1.1.2   This appendix should be read in conjunction **Section 13.5** of **Chapter 13** Health and Community of this ES **[TR020001/APP/5.01]**.

1.1.3   The health and community assessment applied the established principles and methods of both Health Impact Assessment (HIA) and community assessment. These two assessments have been combined and presented as a joint topic within the ES as they share similar baseline information and are both concerned with assessing the effects on people living close to, or affected by, the Proposed Development.

1.1.4   This section outlines the methodology used for assessing the likely significant effects on health and community resulting from impacts arising from the construction and operation of the Proposed Development. It is structured as follows:

   a.   relationship of the assessment to other Environmental Impact Assessment (EIA) topics;

   b.   stages in the health and community assessment process;

   c.   baseline methodology for health and community assessment;

   d.   construction assessment methodology; and,

   e.   operation assessment methodology.

2 METHODOLOGY OVERVIEW

2.1.1 The health and community assessment identifies effects on the health of the population and on the lives of people within the local community, arising from direct and indirect impacts on community resources and the environmental, social and economic impacts of the Proposed Development. The health and community effects resulting from these impacts of the Proposed Development are defined as follows:

a. Health effects have been identified when an environmental, social, or economic factor that influences health and wellbeing (a 'health determinant') is impacted, and the number of people exposed to this change is considered sufficient to cause a change in health at population level (see **Inset 1** for an illustration of the health impact pathway and potential effects). The below health determinants have been considered within the assessment. Further information about the evidence base relating to health determinants is provided in **Appendix 13.5** Evidence Review for Health Assessment of the ES **[TR020001/APP/5.02]**.

   i. access to open space, recreation, and physical activity;
   ii. access to services;
   iii. employment and income;
   iv. housing;
   v. neighbourhood quality;
   vi. aircraft noise;
   vii. perception and uncertainty; and
   viii. social capital.

b. Impacts on community resources, and the resultant effects on the people ('receptors') using those resources, have been identified as community effects, including:

   i. residential properties;
   ii. schools;
   iii. community facilities;
   iv. open spaces and Public Rights of Way (PRoW); and
   v. leisure and recreation facilities.

Inset 1: The health impact pathway and potential effects.

2.1.2 **Inset 2** illustrates the relationship between, and the key components of, the health and community assessment.

Inset 2: The relationship between, and the key components of, the health and community assessment.
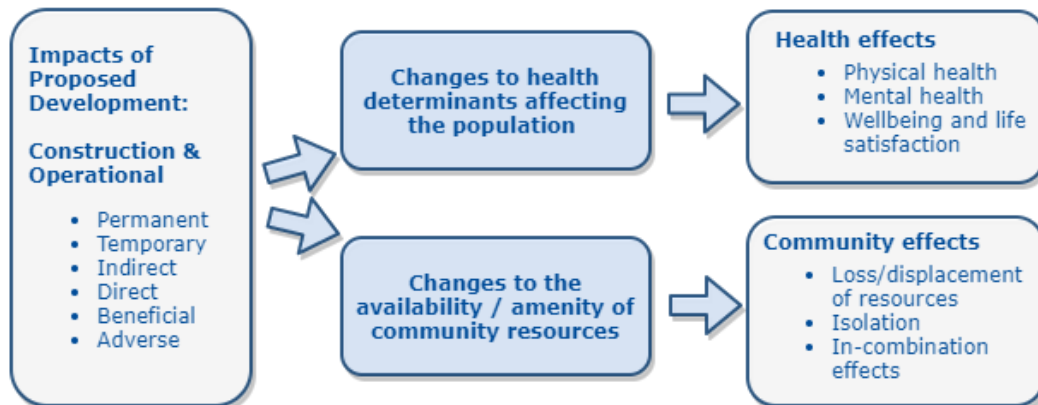
2.1.3   The assessment methodology for health and community effects is applicable to both the construction and operational phases of the Proposed Development.

2.2   Populations and individuals

2.2.1   The assessment of health effects is provided at a 'population', rather than an 'individual' level. The new Institute of Environmental Management and Assessment (IEMA) Guidance on 'Determining Significance for Human Health in Environmental Impact Assessment' (Ref. 1) states that 'EIA analysis at the level of individuals would likely mean that all determinants of health conclusions, positive or negative, would be significant on all projects because of the effects to some particularly sensitive individuals. This would be contrary to supporting decision-makers in identifying the material issues. Assessment of EIA significance at the level of individuals is not proportionate'.

2.2.2   An effect on population health may be defined as a change in the health outcomes, and the distribution of those outcomes, within a defined group of people at a defined geographical level. Further information on population health is available in the document 'A vision for population health: Towards a healthier future' (Ref. 2).

3 RELATIONSHIP OF ASSESSMENT TO OTHER EIA TOPICS

3.1.1 The health and community assessment has on drawn information from other topic assessments in order to identify impacts on health determinants and community resources, including:

   a. Air quality (**Chapter 7** of the ES **[TR020001/APP/5.01]**);

   b. Economics and employment (**Chapter 11** of the ES **[TR020001/APP/5.01]**);

   c. the **Equality Impact Assessment** (**EqIA**) submitted as part of the application for development consent **[TR020001/APP/7.11]**;

   d. Landscape and Visual (**Chapter 14** of the ES **[TR020001/APP/5.01]**);

   e. Light Obtrusion Assessment (**Appendix 5.2** of the ES **[TR020001/APP/5.02]**);

   f. Noise and vibration (**Chapter 16** of the ES **[TR020001/APP/5.01]**); and,

   g. Traffic and transportation (**Chapter 18** of the ES **[TR020001/APP/5.01]**).

3.1.2 The health and community assessment has been largely based on the significant and residual effects identified by the topics listed above. Residual effects are effects which remain after mitigation measures have been taken into account e.g. acoustic screening, landscape planting.

3.1.3 The **EqIA [TR020001/APP/7.11]** is a standalone document which shares a baseline with the health and community assessment, and cross-references are provided where appropriate. The Light Obtrusion Assessment has been included as **Appendix 5.2** of the ES **[TR020001/APP/5.02])** in response to scoping opinion comments.

3.1.4 The health assessment considered impacts of the Proposed Development on the health determinant of 'neighbourhood quality', which is determined by the character and attractiveness of the public realm within a neighbourhood. An impact on this health determinant has been identified where there are two or more significant impacts on the physical environment, i.e. noise, air quality, landscape, visual, light and traffic and transport impacts. When these environmental factors are altered, people's level of satisfaction with their neighbourhood and living environment may change, which in turn may affect their wellbeing.

3.1.5 The community assessment contained an assessment of in-combination effects. The assessment of in-combination effects on community receptors drew from the findings of other assessment topics, taking into account professional judgement about the sensitivity of the individual receptor to the predicted effect. An in-combination community effect occurs where two or more residual significant effects from air quality, noise and vibration, traffic, and transport, or visual or light effects occur on specific community receptors, as presented in **Inset 3**.

Inset 3: In-combination effects for community assessment.
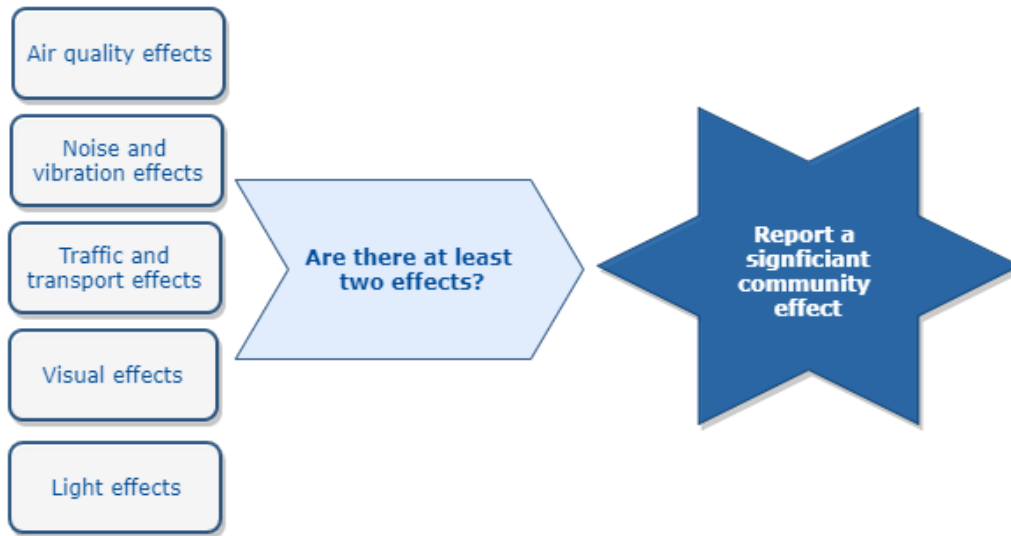
4 STAGES IN THE HEALTH AND COMMUNITY ASSESSMENT

4.1.1 The health and community assessment has been completed in the following stages:

a. **Population profile:** The demographic, social and health characteristics of the population has been described using publicly available data. This provided an overview of the population's resilience to health effects, and the prevalence and distribution of vulnerable sub-groups. The term 'vulnerable groups' refers to groups of individuals who are made vulnerable by the situations and environments they are exposed to (as opposed to any inherent weakness or lack of capacity). This includes groups of people who may be more likely to be exposed to a change in a health determinant, or to experience health effects as a result of exposure (see **Appendix 13.5** of the ES **[TR020001/APP/5.02]** for further information about vulnerable groups).

b. **Community baseline:** A description of the existing community resources in the Study Area has been provided. This includes residential properties, schools, community centres, parks and open spaces and leisure facilities.

c. **Surveys:** Additional baseline information has been gathered through surveys of open spaces, recreational spaces, and routes, to inform the community impact assessment. This includes quality surveys, user counts and questionnaires (see **Appendix 13.2** and **Appendix 13.3** of the ES **[TR020001/APP/5.02]**).

d. **Health evidence base:** A review of publicly available scientific literature describing how environmental, social, and economic factors influence health and wellbeing. The literature review uses credible, up to date sources, focusing on secondary evidence such as Government literature reviews (see **Appendix 13.5** of the ES **[TR020001/APP/5.02]**).

e. **Assessment of effects**: An assessment of the likely significant health and community effects, using qualitative and quantitative techniques.

f. **Mitigation**: A description of measures to be incorporated to reduce the adverse and/or enhance the beneficial effects of the Proposed Development on population health and community receptors.

g. **Residual effects:** An assessment of the likely residual effects of the Proposed Development after health and community mitigation measures are implemented.

4.1.2 Engagement with key health and community stakeholders has been ongoing throughout the health and community assessment process (see **Section 13.4** of **Chapter 13** Health and Community of the ES **[TR020001/APP/5.01]**).

5 BASELINE METHODOLOGY FOR HEALTH AND COMMUNITY ASSESSMENT

5.1 Health baseline

5.1.1 The health assessment considers the effects on the population within the study area arising from impacts of the Proposed Development on relevant health determinants. In order to understand the current demographic, social and health characteristics of the population, baseline data for the health assessment was obtained from the following principal sources:

a. 2011 Census and 2021 Census (Ref. 3) where available;

b. The English Index of Multiple Deprivation 2019 (Ref.4);

c. Office for National Statistics;

d. Office for Health Improvement & Disparities, Local Authority Health Profiles (Ref. 5);

e. Mental Health and Wellbeing Joint Strategic Needs Assessments (Ref. 6); and

f. Information from consultation with technical and community stakeholders.

5.1.2 The health baseline for the local neighbourhood and wider study area has been based on the same indicators where possible. However, in some instances data for indicators at the two spatial scales was not available so different indicators have been used. For local neighbourhood baseline conditions, mental health data at ward level was not available; however, corresponding National Health Service (NHS) Clinical Commissioning Group (CCG) data has been used to provide an overview of mental health baseline within the local neighbourhood area.

5.2 Community baseline

5.2.1 The community baseline identified community resources within the study area. Only those community resources considered to be potentially affected by the Proposed Development have been reported within the community assessment. To understand the community resources and the receptors (people) that use them, baseline data for the community assessment has been identified using the following principal sources:

a. OS Address Base Data which contains information about the type of property to which the address relates to (e.g. dwelling, school, place of worship etc.);

b. search engine mapping features;

c. information from local strategies and policies;

d. information from consultation with community stakeholders and relevant feedback received from public consultation on the Proposed Development.

5.2.2   The community assessment has considered effects arising from impacts on the following community resources and the receptors (people) that use them:

     a. residential properties;

     b. schools;

     c. community centres;

     d. open spaces and PRoW; and

     e. leisure and recreation facilities.

5.2.3   A series of surveys of open spaces and recreational routes have been undertaken to verify the baseline of community resources, and to ascertain quality and usage. These were undertaken throughout 2019 (from April to November) prior to any changes in usage resulting from the Covid-19 lockdowns. Results of the open space surveys have been used to determine significance and in particular receptor sensitivity by providing further details on use of the space. Further details of the methodology for undertaking open space surveys and the results can be found in **Appendices 13.1 and 13.2** of this **ES [TR020001/APP/5.02].**

5.3   Future baseline

5.3.1   Over the timescale of the Proposed Development's delivery, the profile of the affected communities is likely to change, influenced by wider economic and health policy, and demographic trends. The approach to defining future baseline is described in **Section 5.4** of **Chapter 5** Approach to the Assessment of the ES **[TR020001/APP/5.01]**. The future baseline considered for health and community is described in **Section 13.7** of **Chapter 13** of the ES **[TR020001/APP/5.01]**.

5.3.2   Data on future population trends has been obtained from the following sources:

     a. Eddie Holmes, LBC, 2002 (Ref. 7).

     b. Office for Health Improvement and Disparities, 2018 (Ref. 8).

     c. Office for Health Improvement and Disparities, 2018 (Ref. 9).

     d. Office for Health Improvement and Disparities, 2018 (Ref. 10).

6 CONSTRUCTION ASSESSMENT METHODOLOGY

6.1 General approach for assessing significance of effects

6.1.1 The health and community assessment is largely qualitative in nature. However, for health effects arising from operational noise and air quality, the effects have been quantified. See the Operation Assessment Methodology (**Section 7)** for information on quantitative assessment of noise and air quality related health effects.

6.1.2 The assessment determined the significance of health and community effects in line with the requirements of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations). This is a judgement-based exercise to identify those effects that are considered likely to be significant and therefore assessed and reported in an Environmental Statement (ES) and considered in the overall evaluation of the Proposed Development by decision makers.

6.1.3 The approach for defining significance has considered:

    a. the magnitude of the impact on a health determinant and/or community resource; and

    b. the sensitivity of the population or receptors who will experience the impact.

6.2 Magnitude of impact

6.2.1 The magnitude of an impact on a health determinant and/or community resource has been assessed on a scale of high, medium, low, and very low. **Table 6.1** below provides guidance on the criteria used to determine the magnitude of impact. This guidance has been applied using professional judgement.

Table 6.1: Guidelines for the assessment of magnitude of health and community impacts.

Magnitude	Guidelines for magnitude of impact on health determinants	Guidelines for magnitude of impact on community resources
High	A large change to a health determinant and/or outcome, with two or more of the following characteristics: a. assessed as 'major' by relevant environmental topics (where applicable*); b. likely to be perceived by the population as a substantial change;	An impact that has the potential to result in loss or be substantially disruptive (positively or negatively) to the way in which a resource or receptor is currently used. Usually has a long term or permanent impact on the baseline conditions (judgements on timescales are dependent on nature of impact).

Magnitude	Guidelines for magnitude of impact on health determinants	Guidelines for magnitude of impact on community resources
	c. has the potential to affect the occurrence of acute or chronic mental or physical illness; d. change occurs over a wide geographical area and/or affects a large number of people (e.g. over 500) (judgements on exposure are dependent on nature of impact); e. long term duration or permanent (not reversible) (judgements on timescales are dependent on nature of impact).	
Medium	A change to a health determinant and/or outcome, with two or more of the following characteristics: a. assessed as 'moderate' by relevant environmental topics (where applicable*); b. likely to be perceived by the population as a noticeable change; c. has the potential to improve / reduce mental wellbeing or quality of life, or exacerbate / alleviate symptoms of existing illness; d. change occurs over a relatively localised area and/or affects a moderate-large number of people (e.g. 100-500); e. Medium to long-term duration or unlikely to be reversible.	An impact that has the potential to be considerably disruptive (positively or negatively) to the way in which a resource or receptor is currently used. Usually has a medium to long term impact on the baseline conditions, but likely to be reversible.
Low	A modest change to a health determinant and/or outcome, with two or more of the following characteristics: a. assessed as 'minor' by relevant environmental topics (where applicable*); b. likely to be perceived by the population as a modest change; c. has the potential to lower or raise wellbeing in terms of levels of	An impact that has the potential to noticeably change (positively or negatively) the way in which a resource or receptor is currently used, but the overall purpose of the resource is unchanged. Usually has a short to medium term impact on the baseline conditions, but likely to be reversible.

Magnitude	Guidelines for magnitude of impact on health determinants	Guidelines for magnitude of impact on community resources
	comfort and contentment or give rise to a low level of change in physical or mental health outcomes; d. change occurs over a small area and/or affects a small number of people (e.g. fewer than 100); e. short to medium term duration, or likely to be reversible.	
Very Low	A minor change to a health determinant and/or outcome, with two or more of the following characteristics: a. likely to be perceived as a small change by some members of the population; b. occurs over a localised area; c. has the potential to lower or raise wellbeing in terms of levels of comfort and contentment; d. affects a small number of individuals. e. short-term in duration or completely reversible.	Anticipated to make little or no difference or no discernible change to the way a receptor can use a resource. An impact that is very short term in nature and completely reversible.

6.3 Sensitivity of receptors

6.3.1 For the health assessment, sensitivity is defined by the vulnerability of the population to potential health and wellbeing impacts. This takes into account demographic, health and social factors as described in the baseline.

6.3.2 For the community assessment, sensitivity of receptors (people using community resources) has been determined by the extent to which the individuals have the capacity to experience the effect without a substantial loss or gain. Factors considered when assessing receptor sensitivity will include personal circumstances and ability to access alternatives.

6.3.3 **Table 6.2** sets out guidelines for defining the sensitivity of the population and receptors.

Table 6.2: Guidelines for the assessment of sensitivity.

Sensitivity	Guidelines on sensitivity of population (for health assessment	Guidelines on sensitivity of receptors (for community assessment)
High	Affected population includes a higher than national average proportion of groups who are more likely to experience health effects as a result of the impact in question by virtue of their socio-demographic or health status.	Receptors who are at risk and have little or no resilience to the impact either through personal circumstance or an inability to access alternatives or no alternative resources provided locally.
Medium	Affected population includes an average or close to average proportion of groups who are more likely to experience health effects as a result of the impact in question by virtue of their socio-demographic or health status.	Receptors who have limited resilience to the impact either through personal circumstance or a restricted ability to access alternatives or a shortage of alternative resources provided locally.
Low	Affected population includes a below average proportion of vulnerable or disadvantaged groups who are more likely to experience health effects as a result of the impact in question by virtue of their socio-demographic or health status.	Receptors who have average resilience or some slight restrictions on resilience to the impact either through personal circumstance or a slightly restricted ability to access alternatives.
Very Low	Not applicable (no population is considered more likely to experience health effects as a result of the impact in question by virtue of their socio-demographic or health status).	Receptors that generally have adequate capacity to experience impacts without incurring a significant effect. Many comparable and accessible alternative options exist within the relevant catchment area

6.4　Significant effects

6.4.1　The matrix used for the assessment of the significance of effects for the health and community assessment is provided in **Table 6.3**.

Table 6.3: Health and community effects matrix.

Magnitude of impact	Guidelines on sensitivity of receptors			
	High	**Medium**	**Low**	**Very low**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	Negligible
Very Low	Minor	Minor	Negligible	Negligible

6.4.2 The matrix is a tool to assist with judgement and that there are no clear cut-off points between categories. The point at which an impact changes category is a professional judgement and is supported by evidence and justification. As a general rule, major and moderate effects are considered to be significant, whilst minor and negligible effects are considered to be not significant.

6.4.3 Professional judgement has been applied in the application of the above significance criteria to draw reasoned conclusions on probable health outcomes. For example, another EIA topic's assessment of significance may not be directly relevant to the health assessment; a 'major' effect identified by a topic for an individual receptor would not constitute a major change to a health determinant at population level if related to an individual receptor. Likewise, the timescale or extent of exposure that would constitute a high, medium or low magnitude impact may vary depending on the nature of the health determinant.

6.4.4 Professional judgements of significance have taken account of scientific evidence linking changes in health determinants with health outcomes, as described in **Appendix 13.5** of the ES **[TR020001/APP/5.02]** to determine the likelihood of an effect on population health. Judgements also take into account the likely importance, desirability or acceptability of the effect and extent to which health inequalities may be increased or reduced.

7 OPERATION ASSESSMENT METHODOLOGY

7.1 General approach for assessing significance of effects

7.1.1 The assessment methodology for health and community effects described in the Construction Assessment Methodology **(Section 6)** above is applicable to both the construction and operational phases of the Proposed Development. The assessment is largely qualitative in nature, but health effects arising from operational air emissions and operational aircraft noise have been quantified in the ES, as described below.

7.2 Health assessment: quantitative assessment of noise related effects

7.2.1 It is possible to quantify the effects on health resulting from long term exposure of a population to aircraft noise, using established exposure-response relationships for specific health outcomes, published by DEFRA (the Department for the Environment, Food, and Rural Affairs) on behalf of the Interdepartmental Group on Costs and Benefits (Noise Subject Group) (IGCB(N)) in 2010 (Ref. 11) and 2014 (Ref. 12). These relationships cover the effects of aircraft noise on acute myocardial infarction (AMI) (heart attacks), amenity (annoyance), hypertension (stroke, dementia) and self-reported sleep disturbance. This assessment considers the health effects but does not consider the monetary evaluation as a full WebTAG appraisal is not required.

7.2.2 The Defra report presents recommended methods to assess the impacts of noise on health to support project appraisal. This includes guidance on how to both quantify the expected number of people affected and then value this impact in terms of either Disability-Adjusted Life Years (DALYs)[1] or Quality Adjusted Life Years (QALYs)[2]. These recommended methods have informed the assessment of health effects associated with air noise from the Proposed Development. The steps applied in the assessment are set out in the following paragraphs.

Population exposed

7.2.3 Noise contour outputs have been used to define the geographical scope of population affected by air noise levels in excess of 45 dB$L_{Aeq,16h}$ [3] and 45 dB$L_{Aeq,8h}$ for the following scenarios:

    a. 2019 Actual;

    b. Assessment Phase 1, 2027, without development (Do Minimum (DM));

    c. Assessment Phase 1, 2027, with development (Do Something (DS));

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[1] DALYs indicate the estimated number of healthy life years lost in a population from premature mortality or morbidity, i.e. the health burden. For the Proposed Development, this is calculated using the central disability weighting values from WHO and 2.3 people per residential dwelling.

[2] Quality Adjusted Life Year (QALY) is a measure of disease burden that takes account of the impact on quality of life.

[3] This level is taken from 'Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet' (Ref. 8) and is below the daytime LOAEL of 51 dB $L_{Aeq,16hr}$ set in aviation noise policy.

    d. Assessment Phase 2a, 2039, without development (DM);

    e. Assessment Phase 2a, 2039, with development (DS);

    f. Assessment Phase 2b, 2043, without development (DM); and

    g. Assessment Phase 2b, 2043, with development (DS).

7.2.4   Ordnance Survey (OS) AddressBase Plus data (Ref.22) was used to assist in the identification of residential property locations and numbers in each of these scenarios.

7.2.5   For the derivation of stroke and dementia impacts, the number of properties predicted to experience a change in air noise in each of the bands within the DfT TAG Appraisal 'Noise Workbook – Aviation' has been derived for each of the following scenarios:

    a. Assessment Phase 1, 2027, with and without the Proposed Development;

    b. Assessment Phase 2a, 2039, with and without the Proposed Development; and

    c. Assessment Phase 2b, 2043, with and without the Proposed Development.

Exposure-response relationships

Annoyance

7.2.6   The following relationship, as described in the DEFRA 2014 report (Ref. 12), has been used to estimate the percentage of people said to be Highly Annoyed (%HA) by air noise in each of the scenarios presented in **Paragraph 7.2.3**. This exposure-response relationship is a function of noise exposure indicated by L_{den}, where L_{den} is the equivalent continuous noise levels for a 24-hour period[4].

$$\%HA = -9.199*10^{-5} *(L_{den}-42)^3 +3.932*10^{-2} *(L_{den}-42)^2 +0.2939*(L_{den}-42)$$

7.2.7   A correction factor of + 2 dB (Ref. 13) has been applied to the L_{Aeq} air noise values in deriving %HA in each noise contour band.

7.2.8   When applying this exposure-response relationship to the effect levels defined in **Table 16.13** in **Section 5** of **Chapter 16** of the ES **[TR020001/APP/5.01]**, the %HA in the population due to air noise are as follows:

    a. LOAEL of 51dB(A) $L_{eq,16h}$ = 7.9%HA

    b. SOAEL of 63dB(A) $L_{eq,16h}$ = 26.4%HA

    c. UAEL of 69dB(A) $L_{eq,16h}$ = 39.5%HA

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[4] The day-evening-night level, L_{den} is a logarithmic composite of a L_{day} (0700-1900), $L_{evening}$ (1900-2300), and L_{night} (2300-0700) levels but with 5 dB(A) added to the $L_{evening}$ value and 10 dB(A) added to the L_{night} value to account for increased residential population exposure during those periods.

Self-reported sleep disturbance

7.2.9   The following WHO (2011) relationship, as described in the Defra 2014 report (Ref. 12), has been used to estimate the percentage of people said to be Highly Sleep Disturbed (%HSD) by air noise in each of the scenarios presented in **Paragraph 7.2.3** This exposure-response relationship is a function of noise exposure indicated by L_{night}, where L_{night} is the equivalent continuous noise levels for the 8-hour period 2300- 0700:

$$\%HSD = 18.147 - 0.956 L_{night} + 0.01482 (L_{night})^2$$

7.2.10 When applying this exposure-response relationship to the effect levels defined in **Table 16.13** in **Section 5** of **Chapter 16** of the ES **[TR020001/APP/5.01]**, the %HSD in the population due to air noise are as follows:

   a. LOAEL of 45dB(A) $L_{eq,8h}$ = 5.1%HSD

   b. SOAEL of 55dB(A) $L_{eq,8h}$ = 10.4%HSD

   c. UAEL of 63dB(A) $L_{eq,8h}$ = 16.7%HSD

Acute Myocardial Infarction (AMI)

7.2.11 The impacts relating to AMI as a result of air noise changes due to the Proposed Development have been informed from the methodology set out in the 2010 IGCB(N) report 'Noise and Health - Valuing the Human Health Impacts of Environmental Noise Exposure' (Ref. 11). This report recommended AMI to be applied into the procedure for the monetary valuation of environmental noise, using the following exposure-response function derived from research undertaken by Babisch (2006) (Ref. 14):

Odds ratio: $1.629657 - 0.000613 \times L_{day}^2 + 7.356734623455 \times 10^{(-6)} \times L_{day}^3$

7.2.12 This odds ratio describes the relative risk associated with incidence of AMI associated with noise above a baseline of 55 L_{day}. This odds ratio been used to derive the additional incidences of AMI due to air noise, using average prevailing probability of AMI based on 2006 London data as stated in the 2010 IGCB(N) report (Ref. 11) of 0.084034%, the latter which is incorporated into the current DfT TAG Appraisal Noise Workbook – Aviation (Ref. 15).

7.2.13 In accordance with the methodology proposed in the 2010 IGCB(N) report (Ref. 11), L_{day} has been assumed to be equivalent to $L_{Aeq,16h}$ and therefore no correction factor has been applied to the $L_{Aeq,16h}$ values in deriving relative risk of AMI at individual air noise levels.

7.2.14 When applying this exposure-response relationship to the effect levels defined in **Table 16.13** in **Section 5** of **Chapter 16** of the ES **[TR020001/APP/5.01]**, the increase in risk of AMI due to air noise is as follows:

   a. LOAEL of 51dB(A) $L_{eq,16h}$ - this is below the level at which the risk of AMI associated with air noise increases

   b. SOAEL of 63dB(A) $L_{eq,16h}$ - increase in risk of AMI is 3.62%

c.   UAEL of 69dB(A) $L_{eq,16h}$ - increase in risk of AMI is 12.8%

Hypertension – Stroke and Dementia

7.2.15   The impacts relating to hypertension as a result of air noise changes due to the Proposed Development are described by a change in loss of QALYs associated with on Stroke and Dementia, in accordance with the methodology set out in DEFRA 2014 (Ref. 12) which has been incorporated into the current DfT TAG Appraisal Noise Workbook – Aviation (Ref. 15)

7.2.16   This methodology applies a two-stage approach by firstly quantifying the link between noise exposure and hypertension and then the link between hypertension and the probability of dementia and strokes. These steps are summarised below.

7.2.17   The first stage of the methodology requires the number of cases of hypertension associated with air noise to be estimated using an odds ratio of 1.13 for each 10 dB increase in $L_{den,}$ in accordance with the Defra 2014 (Ref. 12) guidance.

7.2.18   The second stage of the methodology then values the expected incidents of hypertension by quantifying the consequential changes in incidents of both dementia and strokes. The report 'Quantifying the links between environmental noise related hypertension and health effects' (Ref 16) provides further detail into the studies underpinning the evidence base adopted in the DfT TAG methodology to quantify these changes. As a result of this two-stage approach, it is not possible to quantify the LOAELs, SOAELs and UAELs in the same way as annoyance, self-reported sleep disturbance and AMI described above.

Additional awakenings

7.2.19   An assessment on the likely impact on sleep disturbance, through calculation of additional awakenings, has also been undertaken and has been informed by the findings of the systematic review by Basner and McGuire (Ref. 17) on sleep disturbance undertaken for the WHO 2018 ENG. Further details of the methodology applied are set out in **Appendix 16.1** of the ES **[TR020001/APP/5.02].**

Quantification of Impacts

7.2.20   Using the exposure response relationships described in **Paragraphs 7.2.5 to 7.2.14**, the number of DALYs associated with AMI, self-reported sleep disturbance and annoyance outcomes have been calculated for each scenario set out in **Paragraph 7.2.3** using the following equation:

DALY = Years of life lost (YLL) + Years lived with Disability (YLD), where

YLL = number of deaths associated with health outcome x years of life lost due to health outcome, and

YLD = number of cases of health outcome x disability weight associated with health outcome x average duration of disability in years

7.2.21   As stated in DEFRA 2014 (Ref. 12), noise induced sleep disturbance nor annoyance results in premature death and therefore YLL for each of these health outcomes is zero. However, for AMI, this is not the case and therefore the YLL has been calculated assuming the average duration of years of life lost to be 10.8 years and the % of cases leading to death as 72%, in accordance with the methodology set out in IGCB(N) 2010 (Ref. 11).

7.2.22   For the derivation of YLD, the following disability weights (DW) have been applied in the derivation of the DALYs for the individual health outcomes, all of which are in accordance with those applied in Defra 2014 guidance (Ref. 12) (annoyance and self-reported sleep disturbance) and IGCB (N) 2010 report (Ref. 11) (AMI):

    a. Annoyance: 0.02

    b. Self-reported sleep disturbance: 0.07

    c. AMI: 0.405

7.2.23   Additionally for AMI, the average duration of disability in years has been assumed to be 10.8 years and the % of cases leading to disability has been assumed as 28%, in accordance with the methodology set out in IGCB(N) 2010 (Ref. 11).

7.2.24   The changes in DALYs relating to changes in annoyance, self-reported sleep disturbance and AMI as a result of the Proposed Development in the individual assessment years (2027, 2039 and 2042) has been derived to identify the likely impact of the Proposed Development.

7.2.25   For stroke and dementia, the change in loss of QALYs (Quality Adjusted Life Years) in the individual assessment years (2027, 2039 and 2042) has been derived directly from calculations undertaken using TAG Appraisal Noise Workbook – Aviation (Ref.15), which have been adapted to remove the effect of valuation and discounting.

Sensitivity test

7.2.26   The assessment has been supplemented by a sensitivity test, as agreed with Office for Health Improvement and Disparities (OHID), formerly Public Health England (PHE), specifically on the likely impacts of the project on annoyance and self-reported sleep disturbance using the following exposure-response relationships presented in the 2018 WHO Environmental Noise Guidelines (ENG) (Ref. 18):

    a. Annoyance

$$\%HA = -50.9693 + 1.0168 \times L_{den} + 0.0072 \times L_{den}^2$$

    b. Self-reported sleep disturbance

$$\%HSD = 16.79 - 0.9293 \times L_{night} + 0.0198 \times L_{night}^2$$

7.2.27   For annoyance, the WHO 2018 Exposure Response Function (ERF) results in a steeper relationship between increasing air noise level and %HA compared to that applied in the DEFRA 2014 guidance (Ref. 12), with a similar pattern observed in the WHO 2018 ERF for %HSD. As a consequence, the application of these ERFs is likely to result in an increase in DALYs for an individual noise exposure level when compared to the DEFRA 2014 (Ref. 12) ERFs.

7.2.28   The systematic reviews which were used to derive the WHO 2018 ERFs (Basner and McGuire (2018) (Ref. 17) and Guski et al (2017) (Ref. 19) provide discussion on the potential reasons for these observed differences.

Assessment of significance

7.2.29   An assessment of significance has been made using the methodology outlined in **Section 6** of this appendix; using the outcomes of the quantitative assessment to inform the magnitude of impact.

7.3   Health assessment: quantitative assessment of air quality related effects

7.3.1   Evidence shows associations between exposure to air pollutants and adverse health outcomes, most notably premature mortality and hospital admissions linked to long-term exposure to PM_{10}, $PM_{2.5}$ and NO_2. DEFRA guidance (Ref. 20) provides exposure-response coefficients that can be applied to calculate changes in health outcomes at population level. These exposure-response coefficients have been used to calculate changes in health outcomes across the study population resulting from increased exposure to air pollutants.

7.3.2   The study area for the assessment of changes in air pollutant concentrations for NOx, PM_{10} and $PM_{2.5}$ resulting from traffic-related, on-airport and aircraft emissions has been defined in accordance with IAQM/EPUK guidance (Ref. 21), detailed in **Chapter 7** of the ES **[TR020001/APP/5.01]**. The assessment considers the following scenarios:

   a.   Assessment Phase 1, 2027, with and without the Proposed Development (including construction traffic);

   b.   Assessment Phase 2a, 2039, with and without the Proposed Development (including construction traffic); and

   c.   Assessment Phase 2b, 2043, with and without the Proposed Development (including construction traffic).

7.3.3   Air quality dispersion modelling (the methodology for which is detailed in **Chapter 7** of the ES **[TR020001/APP/5.01]** and **Appendix 7.1** of the ES **[TR020001/APP/5.02]**) has been carried out to determine the change in air pollutant concentrations for NO_2, PM_{10} and $PM_{2.5}$ resulting from traffic-related, on-airport and aircraft emissions at all human receptor locations in the study area.

7.3.4   Ordnance Survey (OS) AddressBase Plus data (Ref. 22) was used to assist in the identification of residential property locations in the study area. Concentrations have been modelled at these property locations for the

assessment years, 2027 (assessment Phase 1), 2039 (assessment Phase 2a) and 2043 (assessment Phase 2b).

7.3.5   Modelled concentrations at each property location have been multiplied by the average population at each residential property to derive population-weighted concentrations for the DS and DM scenarios. The results of these multiplications have been summed over all locations and divided by the total population to give the total population-weighted average concentrations (PWAC) for DS scenario and DM scenario, and hence the change resulting from the Proposed Development. The average population at each residential property was calculated using a combination of AddressBase Plus data (providing the property counts within an area) and Office of National Statistics data (providing the total population within an area).

7.3.6   The following health outcomes have been assessed:

   a. mortality attributable to air pollution[5];

   b. respiratory hospital admissions attributable to PM_{10} [6]; and

   c. cardiovascular hospital admissions attributable to PM_{10}.

7.3.7   Mortality calculations have been carried out for NO_2 and $PM_{2.5}$. The Committee on the Medical Effects of Air Pollutants (COMEAP) advice states that the size of the overlap between results derived from associations with NO_2 and $PM_{2.5}$ is likely to be substantial and therefore the results of single-pollutant estimates should not be added together, as doing so would lead to over-estimation of the effects. Instead, the higher of the two estimates can be used.

7.3.8   Baseline data on these health outcomes is presented in **Table 7.4**below. This has been obtained for the study population from OHID's Fingertips Public Health Data (Ref. 23), and includes data from the following datasets:

   a. Public Health Outcomes framework; and

   b. Inhale – Interactive Health Atlas of Lung Conditions in England.

7.3.9   The data was obtained by District or Unitary Authority (UA), for April 2021.

Table 7.4: Health baseline data

District or UA	Count	Rate per 100,000 population		
Luton				
Annual all-cause mortality rate per hundred thousand people (1 year range) (2020)	631	435.7		
Fraction of mortality attributable to particulate air pollution (2021)	6.20%			

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[5] Mortality rates for NO_2 and $PM_{2.5}$ have been calculated and the higher change is presented, since the results are not additive.

[6] Note that outcomes attributable to PM_{10} include $PM_{2.5}$ as a subset.

District or UA	Count	Rate per 100,000 population
Central Bedfordshire		
Annual all-cause mortality rate per hundred thousand people (1 year range) (2020)	789	303.6
Fraction of mortality attributable to particulate air pollution (2021)	5.70%	
Dacorum		
Annual all-cause mortality rate per hundred thousand people (1 year range) (2020)	411	309
Fraction of mortality attributable to particulate air pollution (2021)	5.70%	
North Hertfordshire		
Annual all-cause mortality rate per hundred thousand people (1 year range) (2020)	293	246.9
Fraction of mortality attributable to particulate air pollution (2021)	5.70%	
St Albans		
Annual all-cause mortality rate per hundred thousand people (1 year range) (2020)	341	278.4
Fraction of mortality attributable to particulate air pollution (2021)	5.70%	
NHS Bedfordshire, Luton and Milton Keynes CCG		
Emergency hospital admissions for respiratory disease per hundred thousand people (2021)	7120	743
Emergency hospital admissions for cardiovascular conditions per hundred thousand people (2021)	3165	381.7
Herts Valleys CCG		
Emergency hospital admissions for respiratory disease per hundred thousand people (2021)	3415	554
Emergency hospital admissions for cardiovascular conditions per hundred thousand people (2021)	1385	252.5
Buckinghamshire		
Emergency hospital admissions for respiratory disease per hundred thousand people (2021)	3510	610
Emergency hospital admissions for cardiovascular conditions per hundred thousand people (2021)	1595	289.6

7.3.10   The exposure-response coefficients are expressed as the Relative Risk per 10 µg/m^3 increase in concentration of the pollutant (RR10) and are:

     a. 1.06 for $PM_{2.5}$ attributable mortality;

     b. 1.023 for NO_2 attributable mortality; and

     c. 1.008 for PM_{10} attributable respiratory and cardiovascular hospital admissions.

7.3.11   Guidance from Public Health England (Ref. 24) provides a methodology to determine the proportion of local deaths attributable to long term exposure to a pollutant (the 'attributable fraction'). The steps followed are described below:

     a. RR10 has been scaled to a Relative Risk for the population-weighted average concentration for the exposed population. The Relative Risk (RRc) for the population weighted concentration (c) has been derived as follows:

        i.   RRc = RR10(C/10)
        ii.   The Attributable Fraction (AF) of the health outcome has been derived from the Relative Risk as follows:
        iii.   AF = (RRc – 1)/RRc
        iv.   The Attributable Fraction has then been applied to the base data to calculate the change in health outcome attributable to the Proposed Development.

Assessment of significance

7.3.12   An assessment of significance has been made using the methodology outlined in **Section 6** of this appendix; using the outcomes of the quantitative assessment to inform the magnitude of impact.

GLOSSARY AND ABBREVIATIONS

Term	Definition
AF	Attributable Fraction
AMI	Acute Myocardial Infarction
CCG	Clinical Commissioning Group
COMEAP	Committee on the Medical Effects of Air Pollutants
DALYs	Disability Adjusted Life Years A DALY is a quantitative measure used to express the burden of disease on a population. A DALY is a sum of the potential years of life lost due to premature death and the equivalent years of 'healthy' life lost from being in a state of poor health or disability. The latter is calculated using a 'disability weight' associated with a particular health state such that a value of zero represents full health, and a value of one represents states equivalent to death
Lday	Noise indicator for annoyance during the day
Lden	The day–evening–night noise level
dB(A) Leq	Equivalent Continuous [Noise] Level.
DEFRA	Department for Environment, Food and Rural Affairs
Dft	Department for Transport
DM	Do Minimum
DS	Do Something
DW	Disability Weights
EIA	Environmental Impact Assessment
EqIA	Equality Impact Assessment
ERF	Exposure Response Function
ES	Environmental Statement
HA	Highly annoyed
Health Determinants	The economic and social conditions that influence individual and group differences in health status.
HIA	Health Impact Assessment
HSD	Highly Sleep Disturbed
IGCB(N)	Interdepartmental Group on Costs and Benefits (Noise Subject Group)
NO_2	Nitrogen Dioxide
OHID	Office for Health Improvement and Disparities (Formerly Pubilc Health England (PHE))
OS	Ordnance Survey
PEIR	Preliminary Environmental Information Report

Term	Definition
PM$_{10}$ and PM$_{2.5}$	Particulate Matter where particles are less than 10 micrometres in diameter (PM10) and less than 2.5 micrometres (PM2.5)
PRoW	Public right of way
PWAC	population-weighted average concentrations
RR	Relative Risk
QALY	Quality Adjusted Life Years A QALY is a measure of the value of health outcomes on a population. However, instead of using disability weights, QALYs use a quality-of-life weight associated to a particular health state such that a value of one represents full health, and a value of zero represents states equivalent to death. The amount of time spent in the particular health state is then multiplied by the quality-of-life weight.
TAG	Transport Analysis Guidance
UA	Unitary Authority - The unitary authorities of England are those local authorities which are responsible for the provision of all local government services within a district. They are constituted under the Local Government Act 1992, which amended the Local Government Act 1972 to allow the existence of counties that do not have multiple districts.
Vulnerable groups	Individuals who are made vulnerable by the situations and environments they are exposed to (as opposed to any inherent weakness or lack of capacity). This includes groups of people who may be more likely to be exposed to a change in a health determinant, or to experience health effects as a result of exposure.
WebTAG	Web-based Transport Analysis Guidance
YLD	Years lived with disability
YLL	Years of life lost

REFERENCES

Ref.1 Institute of Environmental Management and Assessment (IEMA) (2022) Determining Significance for Human Health in Environmental Impact Assessment

Ref.2 The Kings Fund. (2018) A vision for population health: Towards a healthier future.

Ref.3 Office for National Statistics 2011 and 2022 (Online).

Ref.4 Ministry of Housing, Communities & Local Government (2019) English Indices of Deprivation 2019

Ref.5 Office for Health Improvement & Disparities (2019) Local Authority Health Profile Reports

Ref.6 Office for Health Improvements and Disparities. [accessed 2022] Mental Health and Wellbeing Joint Strategic Needs Assessments (JSNAs) Luton, Central Bedfordshire, Hertfordshire and Buckinghamshire.

Ref.7 Eddie Holmes, LBC (2022). This is Luton.

Ref.8 Public Health England (2018). Trends in morbidity and risk factors.

Ref.9 Public Health England (2018). Inequalities in health.

Ref.10 Public Health England (2018). Wider determinants of health.

Ref.11 UK Government (2010), Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure

Ref.12 UK Government (2014). Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet.

Ref.13 Brink.M., Schäffer B., Pieren R., Wunderli J M (2017), Conversion between noise exposure indicators Leq24h, LDay, LEvening, LNight, Ldn and Lden: Principles and practical guidance

Ref.14 Babisch (2006) Transportation Noise and Cardiovascular Risk, Review and Synthesis of Epidemiological Studies, Dose-Effect Curve and Risk Estimation", WaBoLu-Hefte 01/06. Umweltbundesamt.

Ref.15 Department for Transport (2022) Noise Workbook - Aviation

Ref.16 Harding A-H (2011) Quantifying the links between environmental noise related hypertension and health effects'

Ref.17 M. Basner and S. McGuire (2018). WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep, International Journal of Environmental Research and Public Health 2018, 15, 519; doi:10.3390/ijerph15030519

Ref.18 World Health Organisation. (2018). Environmental Noise Guidelines for the European Region.

Ref.19 Guski R, Schreckenberg D, Schuemer R (2017). WHO environmental noise guidelines for the European Region: a systematic review on environmental noise and annoyance. Int J Environ Res Public Health. 14(12). pii:1539

Ref.20 Ricardo Energy & Environment. 2019. Air Quality damage cost update 2019. Report for Defra.

Ref.21 Moorcroft and Barrowcliffe. et al. (2017) Land-use Planning & Development Control: Planning for Air Quality. v1.2, 2017. Institute of Air Quality Management, London.

Ref.22 Ordnance Survey. Products. AddressBase Plus, 2021. (Online).

Ref.23 Office for Health Improvement & Disparities Public Health Profiles. Accessed via Fingertips - Public Health Data.

Ref.24 Office for Health Improvement & Disparities (2014) Estimating Local Mortality Burdens Associated with Particulate Air Pollution.