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Assessment**

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**5.02 ENVIRONMENTAL STATEMENT APPENDIX 13.5 EVIDENCE
REVIEW FOR HEALTH ASSESSMENT**

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Table 4.1: Strength of evidence summary for each health determinant.

1 INTRODUCTION

- 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 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 'The EIA Regulations' require an Environmental Impact Assessment (EIA) to describe and assess the direct and indirect significant effects on population and human health in an appropriate manner, and report the findings in an ES to support an application for development consent.
- 1.1.3 This document provides a review and summary on the links between the health determinants (environmental, social, and economic factors that influence health) and health and wellbeing outcomes. The purpose of the document is to provide an overview of the scientific consensus on the potential health outcomes associated with impacts on health determinants assessed in the **Chapter 13** Health and Community of this ES [TR020001/APP/5.01], based on a review of available primary¹, secondary² and grey³ literature. The evidence presented underpins the qualitative judgements on health outcomes made in the assessment.

¹ A primary source is also called an original source and is any source of information that was created at the time under study. Secondary sources are typically based on primary sources.

² A secondary source is a source that documents an event, period, or issue in history that was produced after the event, period or issue has happened. These include textbooks and literature reviews.

³ Grey literature comprises information produced on all levels of government, academia, business, and industry in electronic and print formats not controlled by commercial publishing. Examples of grey literature include government reports, policy statements and issues papers.

2 SCOPE AND METHODOLOGY

2.1 Scope of the review

- 2.1.1 The purpose of this document is to provide an overview of the scientific consensus on the types of health outcome associated with impacts on health determinants assessed in the health assessment presented in **Chapter 13 Health and Community** of this ES **[TR020001/APP/5.01]**. A literature search has reviewed relevant evidence published between 2014 and October 2022.
- 2.1.2 A comprehensive review of primary evidence is beyond the scope of this health assessment. Therefore, the review is mainly focused on secondary sources, such as systematic reviews, and grey literature, such as government reports and policy statements, that reflect a scientific consensus on the available evidence. Primary literature is referenced where relevant, or where secondary literature has not been found.
- 2.1.3 The spatial scope of the search included collecting evidence from the UK and high-income/developed countries internationally, as these countries are likely to have a comparable public and environmental health legislative and regulatory context.

2.2 Literature sources

- 2.2.1 The following search engines and databases were used in conducting this review:
- a. Google and Google Scholar;
 - b. Biomed Central;
 - c. JSTOR (Journal Storage);
 - d. National Institute for Health and Care Excellence (NICE) Evidence Search;
 - e. PubMed;
 - f. ScienceDirect; and,
 - g. Scientific American.

2.3 Search for evidence on health determinants

- 2.3.1 The topics covered in this review correspond to the health determinants that have been assessed in the health sections of the ES, as set out in the EIA Scoping Report (**Appendix 1.1** and **Appendix 1.2** of the ES **[TR020001/APP/5.05]**) and the 2019 and 2022 Preliminary Environmental Information Reports (PEIRs). These are listed below. Further, under each health determinant, evidence for vulnerable groups⁴ relating to the

⁴ For the purposes of the health assessment of the Proposed Development, 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).

corresponding determinant is provided, where relevant and where evidence is available.

- a. access to open space, recreation, and physical activity;
- b. access to services;
- c. aircraft noise;
- d. employment and income;
- e. housing;
- f. neighbourhood quality (comprising health determinants of landscape and visual, lighting, air quality, noise environment and traffic);
- g. perception and uncertainty; and,
- h. social capital.

2.3.2 The available literature on links between the above determinants and health outcomes is, in general, not explicitly related to infrastructure projects. The search terms used in relation to broad determinants of health included 'health' OR 'wellbeing' OR 'well-being' AND:

- a. green space/greenspace/open space/nature;
- b. physical activity/exercise/active travel/connectivity;
- c. local services/local facilities/neighbourhood services/access to services;
- d. education/training/employment/unemployment/jobs/income/regeneration;
- e. housing/residential/housing market;
- f. neighbourhood quality/visual amenity/air pollution/particulate matter/nitric oxide/noise/aircraft noise/road traffic noise/sense of place/built environment;
- g. perception/uncertainty; and,
- h. social capital/isolation/cohesion.

2.4 Evaluating the strength of evidence

2.4.1 The strength of evidence for health outcomes associated with health determinants has been evaluated and classified as follows:

- a. strong: a wide range of peer-reviewed research studies showing similar associations. The association is widely accepted by the public health community and there is consensus on the specific causal factors, the mechanism of effect and the strength of association;
- b. moderate: a range of peer-reviewed research studies showing similar associations. The association is widely accepted by the public health community, though there may be debate about the specific causal factors, the mechanism of effect and/or the strength of association; or
- c. weak: a few peer-reviewed/non-peer reviewed research studies to suggest an association, or studies showing conflicting findings.

- 2.4.2 It should be noted that weak evidence does not necessarily indicate an absence of association between a health determinant and a health outcome but shows that there is uncertainty in the assessment of the likely effect. Further, while different levels of evidence within the review are useful for the purpose of comparison, lower levels of evidence may still be valid and reliable.

3 SUMMARY OF EVIDENCE

3.1 Access to open space, recreation, and physical activity

Access to open space and recreation

- 3.1.1 A review by Public Health England (PHE) (Ref. 1) concluded that *‘living in a greener environment can promote and protect good health, and aid in recovery from illness and help with managing poor health. People who have greater exposure to greenspace have a range of more favourable physiological outcomes. Greener environments are also associated with better mental health and wellbeing outcomes including reduced levels of depression, anxiety, and fatigue, and enhanced quality of life for both children and adults. Greenspace can help to bind communities together, reduce loneliness, and mitigate the negative effects of air pollution, excessive noise, heat, and flooding’*.
- 3.1.2 An evidence review by the World Health Organisation (WHO) (Ref. 2) in 2016 showed that urban green spaces (parks, vegetation, and street trees) have beneficial effects on health, such as improved mental health, reduced cardiovascular morbidity, obesity and risk of type 2 diabetes, and improved pregnancy outcomes. Natural spaces also support and facilitate social interaction, providing indirect benefits for mental health by increased sense of community belonging (Ref. 3).
- 3.1.3 A systematic review in 2020, based on fourteen studies, found that there was a positive association between exposure to green space and mental health and wellbeing in adolescents (Ref. 4). A 2017 review of literature examining the association between access to green space and the mental wellbeing of children concluded that access to green spaces promoted attention and memory, fostered supportive social groups and self-discipline and improved symptoms of attention deficit hyperactivity disorder (Ref. 5).
- 3.1.4 A 2017 study found a positive relationship between access to green spaces and mental wellbeing, including in places with a nature focus and spaces designed for recreational and sporting activity (Ref. 6). A 2019 study (Ref. 7) showed that an increase in one hectare of greenspace within 300m of residents was associated with a statistically significant increase in life satisfaction, worth and happiness. An evidence review by Natural England (Ref. 8) found evidence that people with poorer health tend to benefit more from physical activity in natural environments.

Vulnerable groups

- 3.1.5 A PHE report (Ref. 1) notes that *“disadvantaged groups appear to gain a larger health benefit and have reduced socioeconomic-related inequalities in health when living in greener communities”*. This is consistent with Mitchell and Popham (2008) who found that living in areas with green spaces is associated with significantly less income-related health inequality, weakening the effect of deprivation on health (Ref. 9). They found that in greener areas, all-cause mortality rates are only 43% higher for deprived groups, compared to 93% higher in less green areas. In conclusion, vulnerable groups accrue greater

benefit from living in greener communities and open space should be used as a tool to narrow the health inequalities in populations.

Strength of evidence

- 3.1.6 Based on the criteria set out in **Section 2.4**, the evidence linking access to open space to health and wellbeing is strong.

Physical activity

- 3.1.7 A factsheet published by the WHO (Ref. 10) states that *“physical activity has significant health benefits and contributes to the prevention of non-communicable diseases”*. These benefits are identified as reduced risk of hypertension, coronary heart disease, stroke, diabetes, breast and colon cancer, depression and the risk of falls, improved bone and functional health, and weight control. The WHO also states that *“beyond exercise, any other physical activity that is done during leisure time, for transport to get to and from places, or as part of a person’s work, has a health benefit. Further, both moderate- and vigorous-intensity physical activity improve health.”*
- 3.1.8 A 2020 systematic review of reviews and meta-analyses (Ref. 11) found that physically active older adults are at reduced risk of all cause and cardiovascular mortality, breast and prostate cancer, fractures, recurrent falls, functional limitation and cognitive decline, dementia, Alzheimer’s disease, and depression. Another systematic review and meta-analysis (Ref. 12) of 150 Cochrane systematic reviews published between 2000 and 2019 found physical activity was associated with a 13% reduction in mortality and an improvement in quality of life. Another systematic review and meta-analysis (Ref. 13) assessing objective physical activity found a 40% decreased risk for mortality in individuals in the highest category of light, moderate to vigorous and total physical activity compared to the lowest.
- 3.1.9 A literature review of studies from various countries examining the relationship between physical activity and happiness (Ref. 14) showed that as little as 10 minutes of physical activity per week resulted in increased levels of happiness. A systematic review undertaken by the Department of Health and Human Services (Ref. 15) in the US, noted that a major finding of the evidence was that regular physical activity reduced the risk of clinical depression and depressive symptoms among people both with and without clinical depression. Physical activity was also found to reduce the severity of those symptoms irrespective of number of depressive symptoms. The review also found that perceived quality of life is improved by regular physical activity.
- 3.1.10 A cross-sectional and longitudinal study (Ref. 16) found that walking had positive associations with psychological and social wellbeing, strolling in nature with emotional and social wellbeing and endurance training with subjective health. A systematic review and meta-analysis (Ref. 17) of 42 studies including 37,408 individuals found a significant protective effect of physical activity on depression
- 3.1.11 A 2013 literature review focused on the health benefits of active travel by Saunders et al. (Ref. 18) determined that, although there is no clear evidence in

the effectiveness of active travel in reducing obesity, there has been a rise in the prevalence of obesity which has occurred in parallel with a decline in active travel in the past 30-40 years. Data from a report by the National Obesity Observatory in 2011 (Ref. 19) suggests a number of factors impact active travel including access to fitness facilities, distance to destinations, land use, urban walkability scores, safety, availability of equipment and the provision of footpaths.

- 3.1.12 A 2014 study commissioned by the Royal Society for the Prevention of Accidents (Ref. 20) suggested that road safety inventions can encourage physical activity by reducing the level of risk posed to vulnerable road users. The study noted that that *“road safety has a much wider impact on health than just preventing injuries. This is because some forms of travel (i.e., walking and cycling), and the provision for them, bring more health benefits for individuals and society than others. However, the way that people travel is influenced by concerns about actual or perceived safety; effective intervention to reduce road danger can encourage more people to travel by these active, health-promoting modes.”* A 2019 study on walkable neighbourhoods and the incidence of diabetes (Ref. 21) found that people living in walkable neighbourhoods tend to be more physically active and less likely to be obese.

Vulnerable groups

- 3.1.13 Although all groups are shown to benefit from regular exercise, the benefits to children and the elderly are particularly emphasised. The importance of exercise for children is highlighted in terms of benefits in building up bone density, avoidance of weight gain, links to health status in later life, and in establishing habits, which may be more difficult to begin in later life (Ref. 22 and 23). The benefits for the elderly include retention of mobility, cognitive function, and independence (Ref. 22).
- 3.1.14 A report by PHE (Ref. 24) has reported that people with lower socioeconomic status, older people, people with disabilities, women, minority ethnic groups (specifically Bangladeshi and Pakistani women), and lesbian, bisexual, transgender people are particularly vulnerable to physical inactivity (Ref. 25).

Strength of evidence

- 3.1.15 Based on the criteria set out in **Section 2.4**, the evidence linking physical activity to health and wellbeing is strong.

3.2 Access to services

- 3.2.1 Access to services and community facilities can affect health and wellbeing through access to treatment and care, basic needs such as food retail and banking, and access to social networks. This is often referred to as social infrastructure, defined in the 2021 London Plan (Ref. 13.26) as *“a range of services and facilities that meet local and strategic needs and contribute towards a good quality of life. It includes health provision, education, community, play, youth, recreation, sports, faith, and emergency facilities”*. The London Health Urban Development Unit (Ref. 13.27) has identified access to

public services and social infrastructure as a key determinant of health and wellbeing.

- 3.2.2 A 2018 Australian study (Ref. 13.28) compared spatial data on social infrastructure with subjective wellbeing (assessed using the Personal Wellbeing Index (Ref. 13.29) in over 7,000 residents and found evidence that increases in both the accessibility and mix of social infrastructure were associated with better health and wellbeing outcomes. The types of infrastructure considered in the study included community centres, sports, recreation and leisure centres, places of culture such as cinemas, libraries, museums and art galleries, educational establishments, and early year and out of school childcare facilities, and a range of health and social care amenity centres.

Vulnerable groups

- 3.2.3 A publication on the health of rural communities by the Local Government Association and PHE (2017) (Ref. 30) stated that *“many of the factors contributing to health risks in rural communities relate to the wider social determinants of health as well as to access to health and care services”*. This document notes that rural areas have worse access in terms of distance to health, public health and care services, and that service use decreases with increasing distance.

Strength of evidence

- 3.2.4 Based on the criteria set out in **Section 2.4**, the evidence linking access to services to health and wellbeing is weak.

3.3 Employment and income

- 3.3.1 The WHO identifies a list of health determinants (Ref. 31) that combine to affect the health of individuals and communities. Included in this list is *“income and social status - higher income and social status are linked to better health. The greater the gap between the richest and poorest people, the greater the differences in health”*.
- 3.3.2 The Marmot Review, first published in 2010 (Ref. 32), was commissioned by the Department of Health to investigate health inequalities in England and focused on correlations between health and socio-economic status. The Review stated that *“being in good employment is protective of health. Conversely, unemployment contributes to poor health”*. An updated review published in 2020 (Ref. 33), identified a fall in life expectancy in the decade 2010-2020 in the most deprived communities outside London for women and in some regions for men. The report linked this to *“the conditions in which people are born, grow, live, work and age and inequities in power, money and resources – the social determinants of health”*. It reinforced the conclusions from the previous report on the social gradient of health, stating that *“there are clear socioeconomic gradients in preventable mortality. The poorest areas have the highest preventable mortality rates, and the richest areas have the lowest.”*
- 3.3.3 PHE’s Health Profile for England (2018) (Ref. 34) presents research and analysis on the effects of income, work and the labour market on health. In

relation to income, the report states that *“many physical and mental health outcomes improve incrementally as income rises. Income is related to life expectancy, disability free life expectancy, self-reported health, and a range of biomarkers. The relationship operates through a variety of mechanisms. Financial resources determine the extent to which a person can both invest in goods and services which improve health and purchase goods and services which are bad for health. Low incomes can also prevent active participation in social life and day to day activities, affecting feelings of self-worth and status”*. On the effects of work itself, the report states that: *“on the whole, work is good for mental and physical health. In addition to the health benefits associated with an adequate wage, work can provide valuable social interactions, a place to develop and practice skills, and a sense of social participation and contribution to society”*. The report presents data on mental health, stating that *“in financial year 2016 to 2017, 4.5% of the population reported low life satisfaction, but this varied considerably by employment status. Low life satisfaction among the unemployed was almost four times higher than among the employed, while for the economically inactive it was over twice as high”*. The health effects associated with income and socio-economic status encompass a range of physical and mental health outcomes.

- 3.3.4 A Briefing by the British Medical Association (2017) (Ref. 35) stated that *“most long-term conditions are more common in adults from lower socio-economic groups, including the working poor, such as diabetes, chronic obstructive pulmonary disease, arthritis and hypertension. For example, two-fifths of adults in England aged 45 to 64 with below-average incomes have a limiting long-term illness, more than twice the rate of adults of the same age with above-average incomes. Multimorbidity is also more common among deprived populations”*. A 2017 report by the Mental Health Foundation (Ref. 36) found that three in four people living in the lowest household income bracket report having experienced a mental health problem, compared to six in ten of the highest household income bracket.
- 3.3.5 The PHE Health Profile for England (Ref. 34) states that *“educational attainment is strongly linked with health behaviours and outcomes. Better-educated individuals are less likely to suffer from long term diseases, to report themselves in poor health, or to suffer from mental conditions such as depression or anxiety. Education provides knowledge and capabilities that contribute to mental, physical, and social wellbeing. Educational qualifications are also a determinant of an individual’s labour market position, which in turn influences income, housing and other material resources associated with health”*.
- 3.3.6 A 2020 study comparing life-course trajectories of employment quality and health in the U.S. (Ref. 37) found that people who were less educated had poorer employment and worse self-rated health. The prevalence of poor/fair self-rated health and moderate mental illness was greatest among individuals who were minimally attached, returning to the labour force, and precariously employed. Another study used data from 26 Organisation for Economic Co-operation and Development (OECD) countries to assess associations between education and health indicators (Ref. 13.38). This found that adults with higher

educational attainment had better health and lifespans compared to less educated adults.

- 3.3.7 A number of studies have identified the detrimental effects of shift work on health. Shift and/or night work generally decreases the time spent sleeping, and it disrupts the circadian time structure. In the long run, this desynchronisation is detrimental to health, as underscored by a large number of epidemiological studies that have uncovered elevated rates of several diseases, including cancer, diabetes, cardiovascular risks, obesity, mood disorders and age-related macular degeneration (Ref. 39, Ref. 40).

Vulnerable groups

- 3.3.8 A scoping study (Ref. 41) investigating the impact of unemployment and precarious employment on the health of young people demonstrated that there is evidence that young people are especially vulnerable to health problems when unemployed or working in precarious conditions.
- 3.3.9 Furthermore, supporting these findings, a recently published systematic review (Ref. 42) commissioned by the Public Health Agency of Sweden found an association between unemployment among young people and poor mental health.
- 3.3.10 These findings are indicative that young people are particularly vulnerable to the negative health effects resulting from unemployment.

Strength of evidence

- 3.3.11 Based on the criteria set out in **Section 2.4**, the evidence linking income and employment to health and wellbeing is strong.

3.4 Housing

- 3.4.1 There is evidence linking housing quality and tenure with mental and physical health. According to the 2011/12 Subjective Well-being Annual UK Population Survey (Ref. 13.43), 80% of those who owned their property reported 'medium' or 'high' levels of life satisfaction, compared with 67.8% of those who rented. Of those in rented accommodation, 6 out of 10 reported 'low' satisfaction with life, compared with 1 in 5 of those who owned their accommodation outright or with a mortgage. The Annual Population Survey dataset covering the period between January 2014 to December 2016 shows that people reporting the poorest personal well-being are more likely to rent their home and less likely to have a mortgage (Ref. 44).
- 3.4.2 A systematic review in 2019 (Ref. 45) suggested that prior exposure to housing disadvantage (overcrowding, mortgage delinquency, housing mobility, housing tenure, subjective perceptions of inadequate housing, eviction, and physical housing conditions) may impact mental health later in life.
- 3.4.3 A 2015 study of the effects of relocation at older age on cognitive function (Ref. 46) showed that involuntary residential relocation has a negative impact on wellbeing, including increased stress and isolation, particularly for older people.

Strength of evidence

- 3.4.4 Based on the criteria set out in **Section 2.4**, the evidence linking the status and condition of housing to health and wellbeing is moderate.

3.5 Neighbourhood quality

- 3.5.1 Neighbourhood quality is determined by the character and attractiveness of the public realm within a neighbourhood. This includes noise, air quality, landscape, visual and light and traffic and transport impacts. The neighbourhood quality section of the health assessment considers the mental wellbeing effects resulting from the impacts of the Proposed Development on the quality and amenity of the physical environment in which people live their day to day lives.

Noise environment

- 3.5.2 According to the WHO (Ref. 47), *“excessive noise seriously harms human health and interferes with people’s daily activities at school, at work, at home and during leisure time. It can disturb sleep, cause cardiovascular and psychophysiological effects, reduce performance and provoke annoyance responses and changes in social behaviour”*.
- 3.5.3 A European Commission publication in 2015 (Ref. 48) cited evidence that *“living in a quiet area has a positive impact on health. A study assessed quality of life for people living in quiet and noisy locations and found that those who lived in quiet locations – particularly in rural areas – had a better quality of life”*.
- 3.5.4 The 2018 WHO guidelines on Environmental Noise for the European Region (Ref. 49) undertook a series of systematic reviews synthesising exposure and associated impacts on health to develop a set of guidelines to protect human health. Recommendations were formulated based on the strength of evidence from various noise sources including road traffic, railway, aircraft, wind turbine and leisure noise. The systematic reviews concluded that there was evidence for an association between aircraft noise and sleep disturbance, annoyance, reading skills and oral comprehension in children and cognitive impairment, with suggestive but weaker evidence for effects on cardiovascular disease and mental health.
- 3.5.5 A review commissioned in 2020 by Department of Environment, Food and Rural Affairs (Defra) (Ref. 50) considered how evidence has changed since the publication of the WHO Environmental Noise Guidelines. This found associations between noise and medication use and interview measures of depression and anxiety. Associations with some cancer outcomes were also observed, although the quality of evidence across studies remains low for these outcomes.

Vulnerable groups

- 3.5.6 A literature review by van Kamp and Davies in 2013 (Ref. 51) looked at 62 papers published from April 2006 to April 2011, which included the impact of environmental noise on the health of vulnerable people, including primary school children, young adolescents, preschool children, the elderly, and children

with autism, asthma, and attention deficit hyperactivity disorder. A more recent report published by European Environment Agency in 2020 (Ref. 52) adds that shift workers, noise sensitive individuals, pregnant woman, and socio-economically disadvantaged individuals are also particularly vulnerable to noise. Both reviews agree, that while vulnerable groups of people may be more at risk from exposure to environmental noise than healthy adults, there is comparatively little research focusing on the adverse health effects of noise on vulnerable people.

- 3.5.7 An evidence review (Ref. 53) of social inequalities in environmental noise exposure in WHO European region found higher noise exposures in groups with lower socioeconomic position. A study in London, looking to quantify socioeconomic and ethnic inequalities found for aircraft noise, individuals with the highest household income, white ethnicity, and lowest income deprivation group were more likely to be exposed to aircraft noise (Ref. 54).

Strength of evidence

- 3.5.8 Based on the criteria set out in **Section 2.4**, the evidence linking noise to health and wellbeing is strong.

Air quality

- 3.5.9 The WHO recognises outdoor air pollution as a major environmental health problem for all countries including high-income countries (Ref. 55). Guidance from PHE states that epidemiological studies have shown that long-term exposure to air pollution (over years or a lifetime) reduces life expectancy, due to cardiovascular and respiratory diseases and lung cancer. Short-term exposure (over hours or days) to increased levels of air pollution can also have a range of health effects, including effects on lung function, asthma, as well as increases in respiratory and cardiovascular hospital admissions, and mortality (Ref. 56).
- 3.5.10 A PHE review (Ref. 57) of interventions to improve outdoor air quality and public health found evidence that air pollution is the largest environmental risk to the health of the public in the UK. The review found that:
- a. it is estimated that between 28,000 and 36,000 deaths each year are attributed to human-made air pollution;
 - b. there is a close association with cardiovascular and respiratory disease, including lung cancer;
 - c. there is emerging evidence that other organs may also be affected, with possible effects on dementia, low birth weight and diabetes; and,
 - d. it concluded that the most impactful interventions would be those that reduce emissions of air pollution at source.

Vulnerable groups

- 3.5.11 Defra (Ref. 58) found that in England that there is a tendency for higher relative mean annual concentrations of nitrogen dioxide (NO₂) and particulate matter (PM₁₀) in the most deprived areas of the country. This distribution can largely be

explained by the high urban concentrations driven by road transport sources, and the higher proportion of deprived communities in urban areas. If exceedances of National Air Quality Standards are considered, the correlation between poor air quality and deprivation is stronger, showing that when the most polluted areas are considered, the greatest burden is on the most deprived communities, and very little on the least deprived.

- 3.5.12 The review also identifies age as a key indicator of susceptibility to air pollution: 'children and elderly groups [are] deemed more susceptible to certain health impacts'. A similar report in 2017 (Ref. 59) assessing London air pollution exposure in 2013 found that populations living in most deprived areas are on average more exposed to poor air quality (NO₂ and PM₁₀) than less deprived areas. However, there is wide variation in pollution concentration values across the social gradient and inequalities in air pollution exposure are predicted to reduce by 2020 because of new policies aiming to reduce road transport emissions. Further, proportionally more people have been found to be exposed to exceedances of the NO₂ EU limit value in areas with a high proportion of Black/African/Caribbean/Black British and Other ethnic groups.
- 3.5.13 A PHE (Ref. 57) report has stated that children, older people, and people with chronic health problems such as pre-existing cardiovascular and respiratory conditions are the most vulnerable to air pollution.
- 3.5.14 According to the Lancet Commission on pollution and health (Ref. 60) children are at high risk of pollution related disease and even extremely low-dose exposures to pollutants during windows of vulnerability in utero and in early infancy can result in disease, disability, and death in childhood and across their lifespan. Research has shown that exposure to particulate matter affects children's lung development, including deficits in lung function (Ref. 57, 61).

Strength of evidence

- 3.5.15 Based on the criteria set out in **Section 2.4**, the evidence linking air quality to health and wellbeing is strong.

Visual amenity

- 3.5.16 A study in 2015 (Ref. 62) sought to quantify the relationship between environmental aesthetics and human health by comparing geographic data against self-rated health. This found that *"inhabitants of more scenic environments report better health, across urban, suburban and rural areas, even when taking core socioeconomic indicators of deprivation into account, such as income, employment and access to services."*
- 3.5.17 A Position Statement published by the Landscape Institute in 2013 (Ref. 63) looked at evidence linking the quality of places with health and wellbeing across a range of environmental, social and lifestyle determinants. This document cited evidence to suggest that health and wellbeing are influenced positively by a variety of factors including the perceived attractiveness of the environment.

Vulnerable groups

- 3.5.18 A 2020 literature review (Ref. 64) assessed the association between neighbourhood aesthetics and childhood obesity, physical activity, and active transport to school in individuals aged <18 years from 25 studies. Two thirds (75%) of studies reported non-significant associations between neighbourhood aesthetics and physical activity and weight whereas half (50%) of studies showed that neighbourhood aesthetics is associated with active transport to schools. This suggests that the findings are mixed, and more research is needed to understand the epidemiological relationship.
- 3.5.19 A literature review (Ref. 65) assessing the association between the built environment and physical activity in the elderly found that aesthetically pleasing scenery such as greenery is positively associated with physical activity in the individuals over 65 years of age.

Strength of evidence

- 3.5.20 Based on the criteria set out in **Section 2.4**, the evidence linking visual amenity to health and wellbeing is weak.

Traffic and transport

- 3.5.21 Traffic and transport can affect traveller stress and road safety. A study undertaken in 2017 by the University of the West of England (Ref. 66), examined the impacts of commuting on the wellbeing of over 26,000 employed people in England between 2009/10 and 2014/15 as part of 'The Commuting and Wellbeing Study'. The study found that for every extra minute of commute time, job satisfaction and leisure time reduced, and stress was increased.
- 3.5.22 According to a Department for Transport report (Ref. 67), there were 1,580 reported road deaths in 2020, a decrease of 14% compared to the previous year. It is important to note that considerable reductions in casualties were observed for the months March to June following the government's response to the coronavirus pandemic. This trend coincides with changes in traffic volumes observed during the months of lockdown and reduction is likely related to the coronavirus pandemic. The rate of fatalities per billion vehicle miles remained stable at 5.1 while the overall casualty rate per billion vehicle miles decreased by 2%. The 2019 report (Ref. 68) identifies vulnerable road users (pedestrians, cyclists, and motorcyclists) as having much higher casualty rates per mile travelled in comparison with the other road user groups. Casualty rates per billion passenger miles for these groups are 1,640, 4,891 and 5,015 respectively, compared with 195 and 45 for car and heavy goods vehicle (HGV) occupants in 2019. The report states that overall goods vehicle casualties decreased by 2% from 5,071 in 2018 to 4,985 in 2019. Data for 2020 was not available but updated statistics will be included in the 2021 report. Further, recent data on the number of vulnerable road user casualties involving HGVs were not found in the 2019 or 2020 review. According to the Government's Transport Analysis Guidance, fear of accidents is highest when speed, flow and the HGV content are high. However, the rate of fatal or serious accidents

involving HGV is reducing significantly due to improved awareness and safety measures (Ref. 69).

Strength of evidence

- 3.5.23 Based on the criteria set out in **Section 2.4**, the evidence linking traffic and transport to health and wellbeing is strong.

3.6 Aircraft noise

- 3.6.1 Research has been undertaken to assess the levels at which aircraft noise exposure can lead to the health effects on amenity (annoyance), cardiovascular diseases such as acute myocardial infarction (AMI), sleep disturbance, children's learning and mental health, wellbeing, and quality of life (Ref. 70).

Annoyance

- 3.6.2 Loss of amenity or annoyance is commonly used within European and UK policy to measure the quality-of-life impact of environmental noise exposure on communities around airports (Ref. 71).
- 3.6.3 A survey on noise attitudes by the Civil Aviation Authority examined evidence on attitudes to aviation noise around airports in England, including the effects of aviation noise on annoyance, wellbeing, and health (Ref. 72). It found that the level of noise exposure that leads to significant community annoyance has fallen from 57 decibels (dB) LAeq 16h⁵ (in a previous survey) to 54 dB LAeq16h; evidence that people's average level of annoyance was associated with average Summer day noise exposure, LAeq,16h; and evidence that non-acoustic factors such as noise sensitivity, approximated social grade, and expectations (both prior to moving to an area exposed to aircraft noise and in the future) influence reported aircraft noise annoyance.
- 3.6.4 A 2018 report explored the recent research into the state of knowledge on the effects of aircraft noise and annoyance responses (Ref. 73). It concluded that there has been a change in annoyance responses, with people now more highly annoyed by aircraft noise than 30 years ago.

Cardiovascular disease

- 3.6.5 Aircraft noise at high levels can be considered a stressor on the body, and research has found an association between high levels of aircraft noise and an increased risk of developing cardiovascular disease (CVD) (Ref. 74). Cardiovascular disease includes all the diseases of the heart and circulation including Coronary Heart Disease, Angina, heart failure, stroke, AMI – also known as heart attack. It is hypothesized that noise exposure influences cardiovascular disease via a stress response which increases cardiovascular risk factors such as blood pressure, blood lipids, blood glucose and ultimately manifest in disease (Ref. 75).
- 3.6.6 Various studies have found links between exposure to aircraft noise and cardiovascular disease such as AMI, coronary heart disease and cardiovascular

⁵ A-weighted equivalent continuous sound level in decibels measured for 16 hours.

disease risk factors such as hypertension and diabetes (Ref. 76, 77, 78). This includes large scale and novel studies (Ref. 79, 80, 81, 82, 83) and studies around airports such as Heathrow (Ref. 84, 85, 86).

Sleep disturbance

- 3.6.7 Aircraft noise is intermittent in nature and exposure to it during the night may result sleep disturbance. Noise-induced sleep disturbance can be subjective (i.e. self-reported) or objective, such as awakenings measures using polysomnography which can measure changes to sleep structure such as changes to sleep stages, arousals in heart rate, and body movements (Ref. 87).
- 3.6.8 Meta-analysis research into objective sleep disturbance has found that there was no significant differences in awakening probability at the same LA_{smax} indoor level across aircraft, road, and rail sources (Ref. 88). However, there was a 31-34% increase in odds for awakening for a 10dB increase in noise from each source.
- 3.6.9 Meta-analysis research into subjective sleep disturbance has found that no association was found with noise for studies which asked about sleep in general (with no reference to noise) but for studies that asked about how noise affects sleep, a 10dB increase in noise was associated with 1.93 (95%CI 1.60-2.33) increase in disturbance for aircraft noise (Ref. 88).

Mental health, wellbeing, and quality of life

- 3.6.10 Exposure to noise around airports has been linked to impacts on mental health, wellbeing, and quality of life. Mental health, wellbeing and quality of life outcomes are thought to indicate stress-related symptoms or illness associated with environmental noise exposure.
- 3.6.11 Overall, there is evidence for an effect of aircraft noise on a range of adult mental health, wellbeing, and quality of life outcomes (Ref. 89, 90, 91, 92) however, it has to be acknowledged that many of the studies are not methodologically robust (Ref. 93) nor do all studies support the relationship across mental health, wellbeing, and quality of life outcomes. The WHO review concluded that that there was evidence for an association of aircraft noise exposure on interview measures of depressive and anxiety disorders; on medication intake for anxiety and depression; and hyperactivity disorders in children. However, the review suggested there was no evidence for an association of aircraft noise on self-reported health and quality of life; and emotional and conduct disorders in children.

Children's learning

- 3.6.12 A range of learning outcomes and cognitive abilities have been studied in relation to environmental noise which include reading comprehension, short-term, long-term memory, working memory and attention skills. It is hypothesized that noise impairs children's learning directly or via teacher and pupil frustration, learned helplessness (low motivation to learn), increased arousal, distraction, and interference with interactions between teachers and pupils (Ref. 94, 95, 96, 97).

- 3.6.13 A systematic review of the field undertaken by the WHO (Ref. 98), found that several studies demonstrate a statistically significant association between higher aircraft noise exposure at school or home and poorer reading comprehension (Ref. 99, 100, 101, 102, 103, 104). There is also some evidence for an association of aircraft noise and standardised test scores (SATs) (Ref. 105). There is evidence to suggest that becoming newly exposed to aircraft noise exposure impacts on children's reading test performance (Ref. 103). There is evidence to suggest that interventions to reduce noise exposure at school improve children's reading test performance (Ref. 104) and SATs performance (Ref. 105).

Other health outcomes

- 3.6.14 Recent years have seen a rapid increase in the number and quality of papers examining the associations between environmental noise and health. A recent systematic review has considered the evidence for an association between environmental noise on a range of birth outcomes (Ref. 106). The review found evidence for associations between aircraft noise and preterm birth, low birth weight and congenital anomalies however, the quality of the evidence was considered low, indicating a need for further studies with more robust exposure assessment and assessment of confounding factors. Publications since this systematic review reach a similar conclusion with evidence for small associations that are not demonstrated for all outcomes or that attenuate with adjustment for air pollution (Ref. 107, 108, 109).
- 3.6.15 Several studies have been published which examine the association between environmental noise and risk factors for cardiovascular disease including metabolic factors such as Type II diabetes (Ref. 110, 111, 112, 113) and obesity. A recent meta-analysis estimated that a 5dB increase in aircraft noise exposure was associated with a 17% increase in risk for Type II diabetes and road traffic with a 7% increase in risk (Ref. 113).

Vulnerable groups

- 3.6.16 Vulnerable groups listed in **Section 3.5.6 – Section 3.5.7** also apply here. Additionally, studies in Sweden and France have suggested that men may be more vulnerable to the effects of aircraft noise on hypertension (Ref. 114 - 115). It has been speculated that these gender difference might be explained by the fact that men generally have more advanced atherosclerosis than women of the same age, with levels increasing after menopause for women (Ref. 116). This may mean that 'noise increases the risk of hypertension primarily among persons whose vascular system is already challenged by some degree of atherosclerosis.' (Ref. 116). Women may be more vulnerable to the effects of aircraft noise as one study found an effect for women on cortisol (Ref. 117), although this gender difference was not replicated in the Discussion on the Effects of Aircraft Noise Affecting Health (DEBATS) study (Ref. 118). It has been hypothesized that those with existing mental ill-health and with high noise sensitivity may be more vulnerable to the effects of aircraft and road traffic noise (Ref. 119, 120, 121). Those with existing ill-health (mental health and physical health symptoms) report greater levels of aircraft noise annoyance and may be more vulnerable to the effects of aircraft noise (Ref. 122).

Strength of Evidence

3.6.17 Based on the criteria set out in **Section 2.4**, the evidence linking noise to health and wellbeing is strong.

3.7 Perception and uncertainty

3.7.1 There is evidence that supports the assertion that uncertainty and negative perception constitutes a stressor (Ref. 123). It has been reported that concern about a potential environmental health hazard can affect mental, physical, and emotional well-being. However, the effects of anxiety and stress arising from awareness of a potential environmental hazard are not systematically reported nor easily measured (Ref. 124). It has been recommended that *“estimation of community anxiety and stress should be included as part of every risk or impact assessment of proposed plans that involve a potential environmental hazard”* (Ref. 124).

3.7.2 An analysis of public consultation feedback received during both the 2019 and 2022 Statutory Consultation revealed concerns about the Proposed Development which may give rise to a range of feelings such as stress, worry and uncertainty including:

- a. concerns over existing and potential future increase in noise pollution, in particular night-time noise, impacts on noise levels in schools, and worsened mental health from proposed increases in 05:00 and overnight flights;
- b. concerns about expectations of increased traffic in the local area and impacts on journey times, safety and air quality (it is noted that **Chapter 18** Traffic and Transportation of the ES [TR020001/APP/5.01] shows that there would be no significant traffic impacts);
- c. concerns about expectations of increased traffic through Stevenage, Hitching and Baldock to access the airport from the east of England (it is noted that **Chapter 18** Traffic and Transportation of the ES [TR020001/APP/5.01] reports that there would be no significant traffic impacts);
- d. concerns over the potential health effects of air pollution (it is noted that the air quality assessment finds (**Chapter 7** of the ES [TR020001/APP/5.01]) that the Proposed Development would have no significant impact on air quality during construction and operation);
- e. concerns that the proposals do not go far enough to mitigate impacts on communities in the surrounding areas and that inequalities within Luton are not meaningfully reflected in the proposal;
- f. concern about greenhouse gas emissions as a direct threat to human health;
- g. concerns about the release of carbon from ground that was historically used as a council tip;
- h. monetary concerns regarding potential increases in car drop off and pick up prices, and potential reductions in the value of proximate homes; and

- i. concerns about general disruption during construction, and whether this would deter people away from using the airport.

Strength of evidence

- 3.7.3 Based on the criteria set out in **Section 2.4**, the evidence linking perception and uncertainty to health and wellbeing is weak.

3.8 Social capital

- 3.8.1 A 2014 Office for National Statistics (ONS) paper, Measuring Social Capital (Ref. 125), provides the following definition of social capital: *“in general terms, social capital represents social connections and all the benefits they generate. The benefits for people having these social connections can occur either at an individual level (for example, through family support) or at a wider collective level (for example, through volunteering). Social capital is also associated with values such as tolerance, solidarity, or trust. These are beneficial to society and are important for people to be able to cooperate.”*
- 3.8.2 The ONS has looked at social capital as part of its Measuring National Well-being (MNW) programme. This programme identifies four aspects of social capital, based on work undertaken by Scrivens et al. in 2013 for the OECD (Ref. 126). These aspects are:
- a. personal relationships;
 - b. social network support;
 - c. civic engagement and trust; and,
 - d. cooperative norms.
- 3.8.3 The 2014 ONS paper includes a review of academic studies on social capital and its effects on health. The evidence suggests that social capital makes a positive contribution to a range of well-being aspects such as personal well-being, health, and crime rates, and that these benefits occur at individual, community, regional and national level. In the same paper, the ONS cites evidence to suggest that *“people with a good range and frequency of social contact report higher levels of life satisfaction and happiness, but also better mental health. However, people with poorer health, particularly mental health, have been reported to have significantly smaller social networks. Personal relationships are important for individual well-being but can also have positive outcomes for firms and organisations, and at a community level”*. The evidence also suggests that *“more socially isolated people are more at risk of risky behaviours such as smoking, drinking, physical inactivity and poor diet”*.
- 3.8.4 A systematic review (Ref. 127) on social capital and multiple health outcomes carried out in 2019 found evidence to suggest a positive correlation between social capital and mental and physical health, and that social capital contributes to lower mortality. The analysis found that it was difficult to assess whether an increase in health outcome was due to an increase in social capital, which limits the ability to understand whether and how social capital interventions can improve health. Another 2019 systematic review (Ref. 128) of studies assessing

social capital and physical health (most frequently self-reported health and mortality) identified mixed findings. The study suggested that social capital may be an important protective factor for some physical health outcomes, but that more research is needed to draw conclusions on the associations.

- 3.8.5 A systematic review conducted in 2020 (Ref. 129) found positive associations between social cohesion and several population health outcomes including physical activity, health weight and depression. A 2020 meta-analysis of studies into the relationship between social capital and health (Ref. 130) found significant positive associations between social capital types (cognitive, structural, bonding, bridging, linking) and health outcomes such as mortality, disease/illness, and depression. It was noted that, although significant, the effects were consistently very small.
- 3.8.6 A publication on the health of rural communities by the Local Government Association and PHE (2017) (Ref. 30) identifies *“community support, isolation and social exclusion”* as a key factor in determining health. This document notes that: *“rural social networks are breaking down with a consequent increase in social isolation and loneliness, especially among older people. The fact that social isolation influences health outcomes in its own right suggests that this and the emotional and mental wellbeing of people in rural areas is an important and hitherto neglected area in the promotion of public health.”*

Vulnerable groups

- 3.8.7 An article published in the International Journal for Equity in Health by Uphoff et al in 2013 (Ref. 131) describes social capital, at an individual level, as focusing on personal resources that emerge from social networks where individuals have good access to information, services, and support. The article argues that cultural and socioeconomic aspects can act as a barrier to social capital. For example, some types of social capital may only be beneficial to those who have access to them through sufficient economic capital, such as expensive sports clubs.
- 3.8.8 A systematic review of social capital in children and adolescents found that social capital generated at both the family and community level can influence mental health and behavioural problems in young people, of importance is the young person’s own network of social support (Ref. 132). Young people also *“accrue indirect benefit from their parents having wider and higher quality social support networks”*
- 3.8.9 Some population groups are believed to be at particular risk of social exclusion, including Black, Asian and Minority Ethnic (BME) groups, disabled people, lone parents, older people, carers, asylum seekers and refugees and ex-offenders (Ref. 133).

Strength of evidence

- 3.8.10 Based on the criteria set out in **Section 2.4**, the evidence linking social capital to health and wellbeing is moderate.

4 STRENGTH OF EVIDENCE SUMMARY

4.1.1 **Table 4.1** shows the strength of evidence linking each health determinant to health and wellbeing based on the criteria set out in **Section 2.4**.

Table 4.1: Strength of evidence summary for each health determinant.

Health determinant	Strength of evidence
Access to open, recreation and physical activity	-
Access to open space and recreation	Strong
Physical activity	Strong
Access to services	Weak
Employment and income	Strong
Housing	Moderate
Neighbourhood quality	-
Visual amenity	Weak
Air quality	Strong
Noise environment	Strong
Traffic and Transport	Strong
Aircraft noise	Strong
Perception and uncertainty	Weak
Social capital	Moderate

GLOSSARY AND ABBREVIATIONS

Term	Definition
AMI	Acute Myocardial Infarction
CVD	Cardiovascular disease
dB	Decibels
DEBATS Study	Discussion on the Effects of Aircraft Noise Affecting Health Study
Defra	Department for Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
ES	Environmental Statement
Health Determinants	The economic and social conditions that influence individual and group differences in health status.
HGV	Heavy goods vehicle
LAeq16h	A-weighted equivalent continuous sound level in decibels measured for 16 hours
NICE	National Institute for Health and Care Excellence
NO ₂	Nitrogen dioxide
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
PEIR	Preliminary Environmental Information Report
PHE	Public Health England
PM ₁₀	Particulate matter
SATs	standardised test scores
WebTAG	Web-based Transport Analysis Guidance
WHO	World Health Organisation

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