Gatwick Airport Northern Runway Project

Environmental Statement
Appendix 14.9.2: Air Noise Modelling

Book 5

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1 Introduction

1.1 General

1.1.1 This document forms Appendix 14.9.2 of the Environmental Statement (ES) prepared on behalf of Gatwick Airport Limited (GAL). The ES presents the findings of the Environmental Impact Assessment (EIA) process for the proposal to make best use of Gatwick Airport's existing runways and infrastructure (referred to within this report as 'the Project'). The Project proposes alterations to the existing northern runway which, together with the lifting of the current restrictions on its use, would enable dual runway operations. The Project includes the development of a range of infrastructure and facilities which, with the alterations to the northern runway, would enable the airport passenger and aircraft operations to increase. Further details regarding the components of the Project can be found in **ES Chapter 5: Project Description** (Doc Ref 5.1).

1.1.2 This document provides details of the air noise modelling for the Project. Details of relevant legislation, policy and guidance documents can be found in **ES Chapter 14: Noise and Vibration** (Doc Ref. 5.1).

2 Assessment Methodology

2.1 Air Noise Modelling

2019 Historic Contours

2.1.1 The 2019 historic contours were produced using the 20 year rolling average 'standard' modal split (75% west / 25% east) for daytime and the 10 year average modal split for night-time (75% west / 25% east). The contours were modelled with the latest version of ANCON (v2.4). A full description of modelling assumptions can be found in Environmental Research and Consultancy Department (ERCD) Report 2002: Noise Exposure Contours for Gatwick Airport 2019.

2029, 2032, 2038 and 2047 Forecast Contours

2.1.2 Secondary forecast traffic data were provided by ICF for both the future baseline and the Project cases in each assessment year. Future baseline forecasts account for expected future developments in the base case both at the airport and in the surrounding area, as explained elsewhere. Mean departure and arrival flight tracks from the 2019 summer Leq contour analysis were assumed for operations on the main runway. The ICF traffic forecasts provided distributions across the departure routes by aircraft type. For arrivals, the 2019 summer traffic distributions across each approach sub-track by ANCON aircraft type were assumed. The distribution of departures in the summer Leq period across the 9 main departure routes used in the air noise modelling is summarised in Diagram 2.1.1

Diagram 2.1.1: Distribution of Departures in the Summer Leq Period

DAY	Departure Route								
	1	2	3	4	5	6	7	8	9
	26 SAM	08S FD	08 KEN	26 LAM	08 CLN	08 DTY	26 BOG	26 SFD	26 WIZ
2019 Baseline (ERCD Report 2002)	22%	9%	8%	27%	8%	2%	23%	0%	0%
2032 Baseline	23%	7%	7%	23%	8%	2%	20%	0%	8%
2032 NRP	23%	7%	7%	23%	8%	2%	20%	0%	8%

2.1.3 Route 9 (WIZ) is little used at present, but is forecast to be used by about 8% of departures by 2032 in the base case, ie without the Project. Its use is expected to gradually rise to ease growing congestion in the London area. It is not expected to be used at night. The Project is not expected to alter the proportions of aircraft using each route from those for 2032 as shown above, nor in other future years, as assumed in the forecast noise modelling.

2.1.4 Where an aircraft type is modelled by two or more engine variants in the ANCON model (eg Airbus A320), the forecast movements were split according to engine statistics from the 2019 summer period.

2.1.5 RNAV (the newer area navigation system) dispersion (as used in previous Gatwick forecast studies) was modelled for all departure tracks.

2.1.6 Average flight profiles of height, speed and thrust from 2019 Gatwick data were used for existing aircraft types. Noise assumptions for next-generation aircraft types that were not available from the 2019 Gatwick database are summarised in Table 2.1.1.

Table 2.1.1: Next Generation Aircraft Noise Adjustments

Next generation ANCON type	Surrogate ANCON type	Departure adjustment (dB)	Arrival adjustment (dB)
B73710MAX	B738MAX	+1.5	+0.5
B779X	B773G	-3.3	-1.8
EA319NEO	EA319C	-5.2	-2.6

2.1.7 For the forecast contours (with the Project in place), the northern runway was modelled as being available for use by departures of ICAO Code C aircraft types between the hours 06:00-23:00 local time (LT) only. Code C aircraft were apportioned across the two runways as summarised in the table below:

Table 2.1.2: Code C Aircraft Runway Usage

Time period	Westerly mode	Easterly mode
07:00-23:00 LT (day)	90% northern runway/10% main runway	90% northern runway/10% main runway
06:00-07:00 LT (night)	30% northern runway/70% main runway	30% northern runway/70% main runway

2.1.8 ICF provided a traffic data subset for the 1-hour period 06:00-07:00 local time to enable modelling of northern runway departures within the night period. The distribution across the Standard Instrument Departure (SID) route for 06:00-07:00 local time was assumed to be the same as for the whole night period (23:00-07:00 Local Time).

2.1.9 Mean departure and arrival flight tracks from the 2019 summer Leq contour analysis were used for the main runway. Departure tracks for the northern runway were straight along the extended northern runway centre lines until making the turns onto the existing main runway routes.

2.1.10 Runway end coordinates for the northern runway were provided. Start-of-roll locations were assumed to be inset 150 metres from the runway ends, as is the case for the main runway modelling. RNAV dispersion was modelled for all northern runway departure routes.

2.1.11 The following long-term runway modal splits were assumed for average summer day all forecast scenarios:

- Summer day 75% west / 25% east (20-year average).
- Summer night 75% west / 25% east (10-year average).

2.1.12 For annual average noise metrics, L_{den} and L_{night} the following long term runway modal splits were used:

- Annual day 68% west / 32% east (10-year average).
- Annual night 68% west / 32% east (10-year average).

2.1.13 For all the future baseline (no NRP) cases, as a worst case assumption flights operating from the standby runway where not included in the noise model.

2.1.14 The population/household estimates are based on a 2019 population database update of the 2011 Census supplied by CACI Ltd. For the forecast contour scenarios, population and households within the Forge Wood development were accounted for by estimating the Forge Wood area enclosed by each contour and applying a pro-rata adjustment to the total Forge Wood population of 4,703 (1,900 households). Because part of the Forge Wood development has already been built and included in the 2019 population database, their postcodes were removed from the population data to avoid double-counting when the above adjustments were made. No residential populations from any other future development were included in the population estimates.

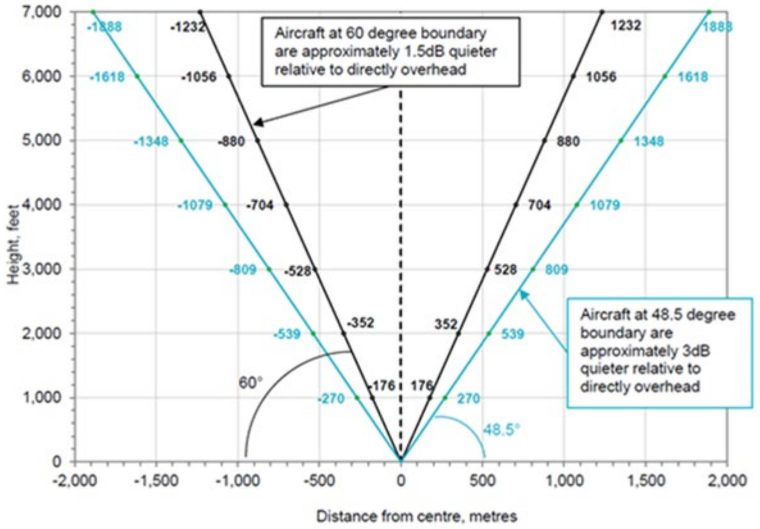
2.2 Overflights Assessment

2.2.1 The methodologies for assessing Airspace Change (CAP1616) adopted for the EIA process require consideration of overflights in two areas.

- Air Noise – 'Overflight' as defined by CAP1498.
- Tranquillity – CAP1616 requires consideration of increased overflights affecting particular areas such as Areas of Outstanding Natural Beauty (AONBs) and National Parks.

2.2.2 Diagram 2.2.1 below shows the CAP1498 definition of 'overflight'. Of the two options GAL has adopted the wider 48.5 degree option which gives higher numbers of overflights. Overflights are capped at a height of 7,000 feet (CAP1616 defines this as above ground level). Hence for this study, flights below 7,000 feet were considered overflights when at an angle of greater than 48.5 degrees from the horizontal.

Diagram 2.2.1: CAP1498 Definition of Overflight



2.2.3 Neither CAP1616 nor CAP1498 give any guidance on how to assess the numbers of overflights statistically, eg over what times of day and above what lower threshold value. The method presented here adopts a cautious lower threshold of one overflight per average summer 24 hour day and, in consultation with the wider EIA team, considers all flights in the day or night equally.

2.2.4 The analysis used the 92 day (noise modelling) average summer day and analysed the summer season for 2019 using 45,000 flights from 7 days (Monday to Sunday) of easterly and 7 days of westerly operations. The results were weighted to reflect the Gatwick 2019 average summer east/west runway % modal split (25/75).

2.2.5 Each flight track was overlaid on a digital terrain map to establish its height above the ground and the overflight zone it creates below. Whilst departures generally climb without dipping, some arrivals flight tracks dip below a height above ground of 7,000 feet, raise above and dip below again, usually because the terrain is rising below. The analysis captured these overflights correctly.

2.2.6 The study area was developed so as to cover the area within which there is at least one Gatwick overflight. This resulted in a circular study area with a diameter of 70 miles centred at Gatwick Airport. There are Gatwick overflights outside this area, but mostly above 7,000 feet and those below 7,000 feet were present at frequencies of less than one per average summer day.

2.2.7 To give an indication of the effect of the Project, some simplifying assumptions were used to ensure a worst case assessment. The number of Gatwick flights was first grown from the 2019 baseline to the 2032 baseline. Westerly departures were then reallocated to allow 8% to use Route 9 (WIZ) as is expected in the 2032 baseline. These 8% were taken from the Route 7 (BOG) and Route 4 (LAM) as expected in the 2032 baseline. This created the 2032 baseline Gatwick overflight density map. Non-Gatwick overflights were not grown from 2019. Since there will inevitably be some increases in non-Gatwick flights as well as Gatwick flights prior to 2032, this is considered a reasonable worst case simplifying assumption, ie it will not understate the additional effect of the Project. Adding Gatwick and non-Gatwick overflights gave the 2032 baseline overflight density map.

2.2.8 The largest effect of the Project in terms of increasing flight numbers in the busy summer period is forecast to be in 2032 when there would be increases of approximately 10% at night and 19% in the day compared to the 2032 baseline. As a conservative approximation the 24 hour flight numbers were increased by 20%.

2.2.9 As a simplifying assumption all flights were modelled on the main runway, which implies an approximation in the flight densities calculated because a proportion (see above) of departures will be shifted 200 m to the Northern Runway. Hence the overflight density analysis is not accurate near the airport, as reflected in the 1 km grid size adopted for quantification. This is considered a reasonable approximation because:

- overflights close to the airport are discussed separately with reference to this particular movement of departures 200 m north as depicted in Figure 14.9.30 of **ES Chapter 14: Noise and Vibration** (Doc Ref. 5.1); and
- the overflight density analysis is required to provide information up to 35 nautical miles from the airport in the areas further from the airport, beyond the noise contours, where noise data is not provided, and in these areas where aircraft are much higher, the error in the approximation is small.

3 Summary of Noise Management System

3.1 Introduction

3.1.1 Gatwick Airport has a comprehensive noise management system, as reported in the Noise Action Plan that is updated and reviewed by DfT every five years. The system follows the ICAO balanced approach that consists of four main elements:

- noise at source;
- land use planning;
- operating procedures; and
- operating restrictions.

3.1.2 This section summarises the ongoing noise management activities under each of these headings.

3.2 Noise at Source

3.2.1 ICAO establishes International Standards, recommended practices and procedures regarding the technical areas of aviation, including aircraft noise. The standards, once adopted, are put into effect by each ICAO member state in its own country.

3.2.2 An important pillar of the Balanced Approach to Aircraft Noise Management is the reduction of noise at source. Aircraft noise ("noise at source") has been controlled since the 1970s by the setting of noise limits for aircraft in the form Standards and Recommended Practices (SARPs) contained in Annex 16 to the Convention on International Civil Aviation (the "Chicago Convention"). This continues to be the case today. Noise provisions appear in Volume I of Annex 16. The primary purpose of noise certification is to ensure that the latest available noise reduction technology is incorporated into aircraft design and that this is demonstrated by procedures that are relevant to day-to-day operations. This aims to ensure that noise reductions offered by technology are reflected in reductions around airports.

3.2.3 The first noise standard was developed by the ICAO Committee on Aircraft Noise in 1971 and became applicable in 1973, setting noise limits as a direct function of Maximum Take-off Mass (MTOM) in order to recognize that heavier aeroplanes, which were of greater transport capability, produce more noise than lighter aeroplane types. This is the Chapter 2 Noise Standard contained in Annex 16, Volume I.

3.2.4 In the years following the introduction of Chapter 2, much higher bypass ratio jet engines were introduced into service. Not only did this new technology deliver improved fuel efficiency, but it also resulted in reductions in engine noise. This allowed for the ICAO noise standard to be made more stringent and in 1977 the Chapter 3 Noise Standard was added to Annex 16, Volume I. In the following years, further noise reduction technologies were incorporated into engine and airframe designs which led to incremental improvements in aircraft noise performance, which resulted in progressively further increases in the stringency of noise standards as reflected in Annex 16, Volume I, Chapter 4 and Chapter 14.

3.2.5 Over time it has become common parlance when discussing aviation noise to refer to civil jet aircraft by which chapter of Annex 16 Volume 1 they sit in. The adoption of progressively more stringent standards has encouraged the phase out of noisier aircraft meeting the noise standards of earlier Chapters. Chapter 2 aeroplanes have been banned from operating within the EU since 1st April 2002, unless they are granted specific exemptions. The vast majority of civil aircraft now operating therefore fall within Chapters 3 and 4, and are much quieter than the previous Chapter 2 aircraft types. As yet, there is no agreed date for the phase out of Chapter 3 aircraft.

3.2.6 All new aircraft manufactured from 2006 onwards must meet the requirements of Chapter 4. The standard for Chapter 4 has been set at 10 dB quieter than Chapter 3. This is based on an aggregate of reductions in noise measured at three standardised locations close to an airport, so that noise levels experienced at any one location on the ground will be about one-third of this quieter, ie about 3 dB. During the process of agreeing the Chapter 4 standard, the industry discussed a stricter level at 18 dB (aggregate) below the current Chapter 3, which would have reflected best available technology. This now forms the basis of Chapter 14 standard adopted in 2014 by the ICAO Council. This represented a new noise standard for jet and propeller-driven aeroplanes which is Chapter 4 minus 7 dB (Chapter 3, -17 dB). This new, more stringent standard will be the mainstay ICAO Standard for subsonic jet and propeller-driven aeroplane noise for the coming years. It is applicable to new aeroplane types submitted for certification on or after 31 December 2017, and on or after 31 December 2020 for aircraft less than 55 tonnes in mass.

3.2.7 The Chapter 14 noise standard is expected to drive the continued reduction in aircraft noise emissions and lead to long term reductions in the number of people affected by aircraft noise.

3.2.8 GAL operates a system of aircraft landing charges that are based on each aircraft's noise levels measured under ICAO certification processes. Each type of aircraft is placed into one of five noise categories according to the margin by which it is quieter is than the ICAO Chapter 3 Standard. These landing charges for the summer season are given in Table 3.2.1. Winter season charges are lower. Higher landing charges are used to incentivise airlines to fly quieter aircraft.

Table 3.2.1: Gatwick Airport Summer Season Landing Charges

Noise Category	Chapter 3 Margin dB	Day Charge £	Night Charge £
Chapter 14 Minus	>=23	£17.45	£458.25
Chapter 14 Base	20 to 23	£21.82	£572.80
Chapter 14 High	17 to 20	£26.19	£687.37
Chapter 4	10 to 17	£43.65	£1,145.62
Chapter 3 and below	<=10	£87.28	£2,291.25
Unmodified A320 Family		£872.85	£2,291.25

3.3 Land Use Planning

3.3.1 Land use planning is largely the responsibility of relevant local planning authorities. Gatwick Airport works with local authorities and provides noise exposure information to assist them.

3.3.2 Guidance on the planning of new noise sensitive development, such as housing, near airports is found in most local authority local planning guidance. Following the repeal of national guidance on the subject, the Institute of Acoustics, Chartered Institute of Environmental Health and the Association of Noise Consultants produced 'Professional Practice Guidance (ProPG) Planning and Noise: New Residential Development (May 2017)', which promotes good acoustics design to achieved suitable design standards in new housing in existing noisy environments including near airports. Under the Noise Management Board's work programme Gatwick Airport has worked with local authorities to promote good land use planning and held a workshop sharing experiences in November 2017. The Noise Management Board has included in its 2021 work plan a project to work with local authorities to help improve land use planning with regards new noise sensitive developments affected by noise from the airport. (See https://www.gatwickairport.com/business-community/aircraft-noise-airspace/engagement/noise-management-board/ for more details of the Noise Management Board).

3.4 Operating Procedures

3.4.1 A range of noise controls relating directly to aircraft operations are set out in statutory notices and are published in the Gatwick Aerodrome Aeronautical Information Publication (AIP) and elsewhere as appropriate. These include the following.

3.4.2 Departures:

- After take-off the aircraft shall be operated in such a way that it is at a height of not less than 1,000 ft above aerodrome level at 6.5 km from the start of roll as measured along the departure track of that aircraft.
- After taking off the aircraft shall avoid flying over the congested areas of Horley and Crawley.

3.4.3 Arrivals:

- Between the hours of 23:30 (local) and 06:00 (local), inbound aircraft, whether or not making use of the ILS (instrument landing system) localiser and irrespective of weight or type of approach, shall not join the centre-line below 3,000 ft (Gatwick QNH[1]) closer than 10 nm (nautical miles) from touchdown.
- Before landing at the aerodrome the aircraft shall maintain as high an altitude as practicable and shall not fly over the congested areas of Crawley, East Grinstead, Horley and Horsham at an altitude of less than 3,000 ft (Gatwick QNH) nor over the congested area of Lingfield at an altitude of less than 2,000 ft (Gatwick QNH).
- Additionally, pilots are requested to avoid the use of reverse thrust after landing, unless required for safe operation of the aircraft, between 23:00 and 06:00 (local time). This is to minimise disturbance in areas adjacent to the airport.

3.4.4 Gatwick Airport has defined 'noise preferential' routes (NPR's) as one way used to reduce exposure to noise for people living near airports. Such routes are chosen because they direct aircraft, where possible, over less densely populated areas. Gatwick Airport's Flight Performance Team monitor compliance with the NPRs using the Noise and Track Keeping system, providing quarterly report to the Noise and Track Monitoring Advisory Group (NaTMAG). The FPT also investigate complaints of aircraft flying off track.

3.4.5 Continuous Descent Operation (CDO) is an important tool for reducing the noise of aircraft approaching airports. It involves starting a continuous steady descent, from 6,000 ft or higher, rather than following a number of short descents to set 'cleared' altitudes where level segments are flow before finally joining the 3° approach glide-slope from below, as is normally required by Air Traffic Control.

3.4.6 The CDO technique results in lower noise levels on the ground through two effects:

- 1. the CDO flight-path is always higher than in the traditional stepped approach - being further from the ground also results in lower noise levels; and
- 2. by keeping the aircraft on a continuous descent, the overall engine power levels are kept lower, generating less noise than if the aircraft were required to fly level.

3.4.7 GAL raised the level at which a CDO is measured to 7,000 ft in 2016 and is exploring ways to raise this further through work with the Noise Management Board.

3.4.8 Additional noise reductions may be achieved by using a Low Power/Low Drag (LPLD) procedure. In this, the aircraft is flown in a 'clean' condition (ie with no flap or wheels deployed) as long as possible, consistent with safety, this can result in lower noise levels when the aircraft are close to the ground. The Noise Management Board is also carrying out a project to investigate if noise levels due to landing gear deployment can be further reduced.

3.4.9 GAL operates a system of Departure Noise Limits in which all aircraft leaving the airport are measured at a set of locations about 3 km from the airport, and airlines are fined if they exceed defined noise limits as follows:

- Day (07:00-23:00 hour) L_{max} 94 dB
- Shoulder (23:00-23:30 and 06:00-07:00 hours) L_{max} 89 dB
- Night (23:00 to 06:00 hours) L_{max} 87 dB.

3.4.10 Departure noise limits are the responsibility of the DfT and have applied at Gatwick since 1959, and were last reduced in 2001.

3.4.11 Airlines are fined £500 if their aircraft exceed these limits by up to 3 dB, and £1,000 if they exceed by more than 3 dB.

3.4.12 Departure noise limits are intended to incentivise good operational procedures on departure, ie flying a given aircraft as quietly as possible. In 2021 GAL carried out a review of compliance with these limits and is proposing changing the limits to increase the incentive to fly good departure procedures. Section 14.8 of **ES Chapter 14: Noise and Vibration** (Doc Ref. 5.1) discusses this proposal.

3.5 Noise Insulation Scheme

3.5.1 The current Gatwick NIS was based on an L_{eq16hr} 60 dB contour with 15 km extensions to cover areas under the extended runway centreline. At the time of introduction, this was seen as one of the

[1] QNH (no acronym) – when set to QNH, an altimeter reads the altitude above mean sea level.

most innovative schemes in the UK and exceeded Government policy that noise insulation should be provided at levels of $L_{eq\ 16hr}$ 63 dB.

3.5.2 The current NIS scheme provides a £4,300 plus VAT grant to spend on acoustic windows and doors at the owners' discretion. Homeowners can also buy additional windows and doors at heavily discounted rates from the suppliers of the NIS products and can therefore use the scheme to undertake further home improvements if they wish. An enhanced NIS has been developed for the Northern Runway Project and is described in Section 14.8 of **ES Chapter 14: Noise and Vibration** (Doc Ref. 5.1).

3.6 Operating Restrictions

3.6.1 Operating restrictions may be necessary for some airports where noise mitigation is required, and other methods prove to be insufficient. In this respect, as part of the "Balanced Approach", operating restrictions may be applied to aircraft whose noise emissions are marginally below the Chapter 3 limits. Strict rules apply for the introduction of operating restrictions to ensure fair competition across Europe and maintain the efficiency of the EU aviation network.

3.6.2 Night Restrictions are in place at Gatwick, set by the DfT that limit the type of aircraft, number of flights and provide a total noise Quota Count during the 6.5 hour night period from 23:30 to 06:00 in the summer and winter seasons as follows:

- Summer Movements Limit 11,200
- Summer Quota Points 5,150
- Winter Movements Limit 3,250
- Summer Quota Points 1,785

3.6.3 Gatwick works with its airline customers to stay within these limits and reports compliance to the Noise and Track Monitoring Advisory Group.

4 Assessment Results

4.1 Air Noise Contours

4.1.1 This section gives the noise contour areas and population count results from noise modelling. It is divided into two sections, the first for the Central Case Fleet, the second for the Slower Transition Fleet.

Central Case Fleet

4.1.2 Table 4.1.1 to Table 4.1.16 give the noise contour areas and population count results from noise modelling 2029, 2032, 2038 and 2047 for the two primary L_{eq} day and night metrics and two supplementary noise metrics N65 and N60, for the central case fleet forecasts. The central fleet forecast is considered the most likely rate of fleet transition based on current assumptions regarding the airlines' fleet procurement programmes and business models. The slower transition fleet (see results below) supposes the rate of fleet transition is delayed by about five years, particularly owing to uncertainties due to Covid (**ES Appendix 14.9.5: Air Noise Envelope Background** (Doc Ref 5.3) gives further details). In each table the 2019 base case, assessment year base case and assessment year with the Project results are given.

Table 4.1.1: 2029 $L_{eq\ 16\ hour}$ Day, Central Case

Leq, 16hr dB	Area (km^2)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>51	136.0	120.1	126.0	24,050	21,000	20,100
>54	74.0	62.4	66.8	9,850	8,200	8,800
>57	38.7	32.5	34.4	2,550	2,000	2,200
>60	22.4	18.9	20.2	1,450	1,100	1,200
>63	12.6	10.6	11.6	500	500	600
>66	6.7	5.5	6.3	250	200	200
>69	3.5	2.9	3.5	100	100	0

Table 4.1.2: 2029 $L_{eq\ 8\ hour}$ Night, Central Case

Leq, 8hr dB	Area (km^2)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>45	159.4	139.8	141.5	27,650	23,700	23,700
>48	90.3	77.4	78.5	12,100	10,100	10,500
>51	46.5	38.6	39.3	5,550	4,300	4,400
>54	24.8	21.3	21.9	1,550	1,300	1,400
<55	22.6	17.7	18.2	1,250	1,000	1,100
>57	14.0	11.9	12.4	750	500	500
>60	7.4	6.3	6.7	300	300	300
>63	3.8	3.2	3.5	150	200	200
>66	2.1	1.7	2.0	0	0	0
>69	1.3	1.0	1.3	0	0	0

Table 4.1.3: 2029 N65 Day, Central Case

N65 Day	Area (km^2)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>20	149.9	121.5	128.4	24,100	20,400	20,700
>50	97.7	87.3	90.6	14,600	12,800	14,000
>100	72.7	60.4	62.6	9,500	7,200	8,200
>200	50.8	42.7	43.6	5,750	4,800	5,200
>500	2.4	3.4	2.8	100	100	100

Table: 4.1.4: 2029 N60 Night, Central Case

N60 Night	Area (km^2)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>10	204.2	188.1	190.4	33,850	30,700	30,700
>20	126.8	119.6	120.3	15,250	14,400	14,200
>50	56.4	55.2	55.9	7,600	7,400	7,500
>100	2.7	2.8	2.2	150	100	100

Table: 4.1.5: 2032 $L_{eq\ 16\ hour}$ Day, Central Case

$L_{eq,\ 16hr}$ dB	Area (km^2)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>51	136.0	107.3	125.1	24,050	16,100	18,800
>54	74.0	54.1	66.1	9,850	6,700	9,000
>57	38.7	28.4	33.3	2,550	1,800	2,200
>60	22.4	16.6	19.4	1,450	900	1,200
>63	12.6	9.2	11.3	500	400	500
>66	6.7	4.7	6.2	250	200	200
>69	3.5	2.5	3.3	100	100	0

Table 4.1.6: 2032 $L_{eq\ 8\ hour}$ Night, Central Case

$L_{eq,\ 8hr}$ dB	Area (km^2)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>45	159.4	124.6	136.2	27,650	18,800	21,600
>48	90.3	67.8	75.1	12,100	8,900	9,900
>51	46.5	33.6	37.5	5,550	3,600	4,400
>54	24.8	18.7	20.8	1,550	1,000	1,300
>55	22.6	15.5	17.4	1,250	900	1,000
>57	14.0	10.5	12.0	750	500	500
>60	7.4	5.5	6.5	300	300	300
>63	3.8	2.8	3.4	150	100	200
>66	2.1	1.5	2.0	0	0	0
>69	1.3	0.9	1.3	0	0	0

Table 4.1.7: 2032 N65 Day, Central Case

N65 Day	Area (km^2)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>20	149.9	106.2	113.4	24,100	15,300	17,400
>50	97.7	75.4	83.0	14,600	10,900	13,300
>100	72.7	53.5	60.4	9,500	6,200	9,300
>200	50.8	39.6	42.6	5,750	4,500	5,100
>500	2.4	3.2	3.9	100	100	100

Table 4.1.8: 2032 N60 Night, Central Case

N60 Night	Area (km^2)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>10	204.2	176.4	185.0	33,850	28,900	29,600
>20	126.8	112.9	118.0	15,250	13,700	14,000
>50	56.4	53.2	59.3	7,600	7,000	8,200
>100	2.7	2.6	2.9	150	100	100

Table 4.1.9: 2038 $L_{eq\ 16\ hour}$ Day, Central Case

$L_{eq,\ 16hr}$ dB	Area (km^2)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>51	136.0	96.5	113.7	24,050	13,000	16,500
>54	74.0	47.6	58.7	9,850	5,700	7,500
>57	38.7	25.2	29.9	2,550	1,600	1,800
>60	22.4	14.8	17.6	1,450	700	1,000
>63	12.6	8.3	10.3	500	300	500
>66	6.7	4.1	5.6	250	200	200
>69	3.5	2.2	3.0	100	100	0

Table 4.1.10: 2038 $L_{eq\ 8\ hour}$ Night, Central Case

$L_{eq,\ 8hr}$ dB	Area (km^2)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>45	159.4	115.3	125.8	27,650	15,700	18,300
>48	90.3	61.9	68.7	12,100	8,100	8,900
>51	46.5	30.6	34.2	5,550	3,300	4,000
>54	24.8	17.1	19.1	1,550	1,000	1,100
>55	22.6	14.2	16.0	1,250	800	900
>57	14.0	9.7	11.0	750	400	500
>60	7.4	5.0	6.0	300	300	300

$L_{eq, 8hr}$ dB	Area (km²)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>63	3.8	2.5	3.1	150	100	100
>66	2.1	1.4	1.8	0	0	0
>69	1.3	0.9	1.2	0	0	0

Table 4.1.11: 2038 N65 Day, Central Case

N65 Day	Area (km²)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>20	149.9	94.3	102.2	24,100	13,400	15,200
>50	97.7	61.0	69.7	14,600	9,000	11,600
>100	72.7	50.3	56.2	9,500	6,000	8,700
>200	50.8	37.6	39.8	5,750	4,300	4,600
>500	2.4	3.1	3.9	100	100	100

Table 4.1.12: 2038 N60 Night, Central Case

N60 Night	Area (km²)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>10	204.2	169.1	176.8	33,850	27,900	28,200
>20	126.8	109.4	113.4	15,250	12,900	13,700
>50	56.4	53.7	58.5	7,600	7,100	8,000
>100	2.7	2.6	2.7	150	100	100

Table 4.1.13: 2047 $L_{eq\ 16\ hour}$ Day, Central Case

$L_{eq, 16hr}$ dB	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>51	136.0	96.2	112.9	24,050	12,800	16,400
>54	74.0	47.4	58.3	9,850	5,600	7,300
>57	38.7	25.2	29.7	2,550	1,600	1,800

$L_{eq,\ 16hr}$ dB	Area (km^2)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>60	22.4	14.8	17.6	1,450	700	1,000
>63	12.6	8.3	10.3	500	300	500
>66	6.7	4.2	5.6	250	200	200
>69	3.5	2.2	3.0	100	100	0

Table 4.1.14: 2047 $L_{eq\ 8\ hour}$ Night, Central Case

$L_{eq,\ 8hr}$ dB	Area (km^2)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>45	159.4	114.7	125.2	27,650	15,600	18,200
>48	90.3	61.6	68.5	12,100	8,000	8,800
>51	46.5	30.5	34.2	5,550	3,300	4,000
>54	24.8	17.1	19.1	1,550	1,000	1,100
>55	22.6	14.2	16.0	1,250	800	900
>57	14.0	9.7	11.1	750	400	500
>60	7.4	5.0	6.0	300	300	300
>63	3.8	2.5	3.1	150	100	100
>66	2.1	1.4	1.8	0	0	0
>69	1.3	0.8	1.2	0	0	0

Table 4.1.15: 2047 N65 Day, Central Case

N65 Day	Area (km^2)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>20	149.9	95.1	102.9	24,100	13,700	15,300
>50	97.7	62.1	70.6	14,600	9,400	11,700
>100	72.7	50.9	56.7	9,500	6,000	8,700
>200	50.8	37.8	40.0	5,750	4,300	4,700

N65 Day	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>500	2.4	3.1	3.9	100	100	100

Table 4.1.16: 2047 N60 Night, Central Case

N60 Night	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>10	204.2	169.0	176.9	33,850	27,900	28,400
>20	126.8	109.5	113.6	15,250	12,900	13,700
>50	56.4	52.6	58.2	7,600	7,100	8,000
>100	2.7	2.5	2.7	150	100	100

Slower Transition Fleet

4.1.3 Table 4.1.17 to Table 4.1.32 give the noise contour areas and population count results from noise modelling 2029, 2032, 2038 and 2047 for the two primary Leq day and night metrics and supplementary N65 and N60 noise metrics, for the slower transition fleet forecasts. In each table the 2019 base case, assessment year base case and assessment year with the Project results are given.

Table 4.1.17: 2029 $L_{eq\ 16\ hour}$ Day, Slower Transition Case

$L_{eq,\ 16hr}$ dB	Area (km²)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>51	136.0	128.5	134.9	24,050	24,100	23,500
>54	74.0	69.1	73.3	9,850	9,200	9,500
>57	38.7	35.9	37.8	2,550	2,400	2,700
>60	22.4	20.9	22.2	1,450	1,200	1,300
>63	12.6	11.8	12.8	500	500	600
>66	6.7	6.2	7.0	250	200	300
>69	3.5	3.2	3.9	100	100	-

Table 4.1.18: 2029 $L_{eq\ 8\ hour}$ Night, Slower Transition Case

$L_{eq,\ 8hr}$ dB	Area (km²)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>45	159.4	148.3	150.1	27,650	26,600	26,500
>48	90.3	82.9	84.1	12,100	11,100	11,200
>51	46.5	42.0	42.9	5,550	5,000	5,100
>54	24.8	23.2	23.9	1,550	1,400	1,400
<55	22.6	19.3	19.9	1,250	1,200	1,200
>57	14.0	13.1	13.6	750	600	700
>60	7.4	6.9	7.4	300	300	300
>63	3.8	3.5	3.9	150	200	200
>66	2.1	1.9	2.2	0	-	-

Table 4.1.19: 2029 N65 Day, Slower Transition Case

N65 Day	Area (km²)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>20	149.9	140.0	149.1	24,100	29800	32,800
>50	97.7	90.7	94.8	14,600	13100	15,100
>100	72.7	66.7	68.8	9,500	8000	8,700
>200	50.8	43.6	46.9	5,750	5100	5,500
>500	2.4	3.5	2.9	100	100	100

Table: 4.1.20: 2029 N60 Night, Slower Transition Case

N60 Night	Area (km²)			Population		
	2019 Base	2029 Base	2029 with Project	2019 Base	2029 Base	2029 with Project
>10	204.2	188.1	200.0	33,850	32,700	32,900
>20	126.8	119.6	123.9	15,250	15,100	14,800
>50	56.4	55.2	56.1	7,600	7,400	7,600
>100	2.7	2.8	2.9	150	100	100

Table: 4.1.21: 2032 $L_{eq\ 16\ hour}$ Day, Slower Transition Case

$L_{eq,\ 16hr}$ dB	Area (km²)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>51	136.0	125.8	146.7	24,050	23,500	26,400
>54	74.0	67.1	80.5	9,850	9,100	10,900
>57	38.7	34.9	40.6	2,550	2,200	3,900
>60	22.4	20.3	23.6	1,450	1,200	1,400
>63	12.6	11.5	13.8	500	500	600
>66	6.7	6.0	7.6	250	200	300
>69	3.5	3.1	4.2	100	100	100

Table 4.1.22: 2032 $L_{eq\ 8\ hour}$ Night, Slower Transition Case

$L_{eq,\ 8hr}$ dB	Area (km²)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>45	159.4	143.9	157.4	27,650	25,400	28,500
>48	90.3	80.1	88.0	12,100	10,800	11,900
>51	46.5	40.3	45.2	5,550	4,700	5,400
>54	24.8	22.3	24.8	1,550	1,300	1,500
>55	22.6	18.5	20.7	1,250	1,100	1,200
>57	14.0	12.5	14.2	750	500	700
>60	7.4	6.6	7.7	300	300	300
>63	3.8	3.3	4.1	150	200	200
>66	2.1	1.8	2.3	0	-	-
>69	1.3	1.1	1.5	0	-	-

Table 4.1.23: 2032 N65 Day, Slower Transition Case

N65 Day	Area (km²)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>20	149.9	136.4	151.0	24,100	28,300	32,200
>50	97.7	89.4	97.5	14,600	12,900	15,200

N65 Day	Area (km^2)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>100	72.7	64.5	72.9	9,500	7,700	11,000
>200	50.8	44.3	48.0	5,750	5,000	5,500
>500	2.4	3.5	4.3	100	100	100

Table 4.1.24: 2032 N60 Night, Slower Transition Case

N60 Night	Area (km^2)			Population		
	2019 Base	2032 Base	2032 with Project	2019 Base	2032 Base	2032 with Project
>10	204.2	193.0	207.7	33,850	31,500	33,800
>20	126.8	121.6	127.3	15,250	14,700	15,200
>50	56.4	55.3	62.0	7,600	7,400	8,500
>100	2.7	2.7	3.2	150	100	100

Table 4.1.25: 2038 $L_{eq\ 16\ hour}$ Day, Slower Transition Case

$L_{eq,\ 16hr}$ dB	Area (km^2)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>51	136.0	107.4	125.7	24,050	16,300	19,200
>54	74.0	54.4	66.8	9,850	6,800	8,900
>57	38.7	28.8	33.8	2,550	1,800	2,200
>60	22.4	16.8	19.8	1,450	1,000	1,200
>63	12.6	9.4	11.6	500	400	500
>66	6.7	4.8	6.3	250	200	300
>69	3.5	2.5	3.4	100	100	-

Table 4.1.26: 2038 $L_{eq\ 8\ hour}$ Night, Slower Transition Case

$L_{eq,\ 8hr}$ dB	Area (km^2)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>45	159.4	124.3	136.1	27,650	18,700	21,700
>48	90.3	67.9	75.2	12,100	1,800	9,900
>51	46.5	33.9	37.7	5,550	3,600	4,600
>54	24.8	18.9	21.0	1,550	1,000	1,300
>55	22.6	15.7	17.5	1,250	900	1,000
>57	14.0	10.6	12.1	750	500	500
>60	7.4	5.6	6.6	300	300	300
>63	3.8	2.8	3.4	150	100	200
>66	2.1	1.5	2.0	0	-	-
>69	1.3	0.9	1.3	0	-	-

Table 4.1.27: 2038 N65 Day, Slower Transition Case

N65 Day	Area (km^2)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>20	149.9	108.5	116.7	24,100	15,600	17,700
>50	97.7	74.7	82.7	14,600	10,800	13,200
>100	72.7	54.0	60.6	9,500	6,300	9,400
>200	50.8	39.6	42.7	5,750	4,400	5,100
>500	2.4	3.2	4.0	100	100	100

Table 4.1.28: 2038 N60 Night, Slower Transition Case

N60 Night	Area (km^2)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>10	204.2	175.7	184.4	33,850	29,000	30,000
>20	126.8	112.7	118.0	15,250	13,700	14,100
>50	56.4	52.4	58.3	7,600	7,000	8,000

N60 Night	Area (km²)			Population		
	2019 Base	2038 Base	2038 with Project	2019 Base	2038 Base	2038 with Project
>100	2.7	2.6	2.9	150	100	100

Table 4.1.29: 2047 $L_{eq\ 16\ hour}$ Day, Slower Transition Case

$L_{eq,\ 16hr}$ dB	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>51	136.0	103.5	121.9	24,050	15,300	18,100
>54	74.0	51.7	63.7	9,850	6,300	8,700
>57	38.7	27.2	32.2	2,550	1,600	2,100
>60	22.4	16.1	18.9	1,450	900	1200
>63	12.6	9.2	11.3	500	400	500
>66	6.7	4.8	6.3	250	200	300
>69	3.5	2.6	3.5	100	100	0

Table 4.1.30: 2047 $L_{eq\ 8\ hour}$ Night, Slower Transition Case

$L_{eq,\ 8hr}$ dB	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>45	159.4	124.4	136.7	27,500	18,200	21,800
>48	90.3	67.3	74.9	12,200	8,700	9,900
>51	46.5	33.4	37.5	5,400	4,000	4,700
>54	24.8	18.6	20.8	1,500	1,000	1300
>55	20.6	15.5	17.4	1,250	900	1000
>57	14.0	10.7	12.2	800	500	500
>60	7.4	5.7	6.8	300	300	300
>63	3.8	2.9	3.6	200	100	200
>66	2.1	1.6	2.1	0	0	0
>69	1.3	1.0	1.3	0	0	0

Table 4.1.31: 2047 N65 Day, Slower Transition Case

N65 Day	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>20	149.9	104.0	113.1	24,100	15,300	17500
>50	97.7	71.0	79.8	14,600	10,300	13100
>100	72.7	55.2	62.1	9,500	6,600	9,500
>200	50.8	40.5	42.8	5,750	4,400	5,100
>500	2.4	3.3	4.0	100	100	100

Table 4.1.32: 2047 N60 Night, Slower Transition Case

N60 Night	Area (km²)			Population		
	2019 Base	2047 Base	2047 with Project	2019 Base	2047 Base	2047 with Project
>10	204.2	178.9	188.1	33,850	29,800	29,700
>20	126.8	114.6	119.2	15,250	15,800	16,000
>50	56.4	53.2	59.8	7,600	7,100	8,700
>100	2.7	2.6	2.8	150	100	100

Lden and LNight

4.1.4 Table 4.1.33 to Table 4.1.36 give the noise contour areas and population count results from noise modelling in 2038 and 2047, for the annual average L_{den} and L_{Night} noise metrics, for the central case and slower transition fleet forecasts.

Table 4.1.33: 2038 (Standard Mode) Annual L_{den} and L_{night} Baseline Noise Levels (1)

Noise Metric	Noise Contour Area (km²)	Population
L_{den}:		
>55 dB	66.1 - 73.7	8,600 - 9,700
>60 dB	21.8 - 24.5	1,300 - 1,400
>65 dB	8.5 - 9.5	400 - 500
>70 dB	2.7 - 3.1	100 - 100
>75 dB	1.1 - 1.2	0 - 0
L_{night}:		
>45 dB	84.4 - 91.6	10,900 - 12,100

Noise Metric	Noise Contour Area (km²)	Population
>50 dB	27.1 - 30.1	1,700 - 2,300
>55 dB	10.6 - 11.6	500 - 500
>60 dB	3.5 - 3.9	200 - 200
>65 dB	1.3 - 1.4	0 - 0
>70 dB	0.6 - 0.6	0 - 0

(1) Ranges cover the central case fleet noise modelling and the slower transition fleet noise modelling

Table 4.1.34: 2038 (Standard Mode) Annual L_{den} and L_{night} With Project Noise Levels [(1)]

Noise Metric	Noise Contour Area (km²)	Population
L_{iden}:		
>55 dB	78.6 - 86.4	10,500 - 11,500
>60 dB	25.6 - 28.6	1,600 - 1,800
>65 dB	10.5 - 11.5	500 - 500
>70 dB	3.6 - 4.1	100 - 200
>75 dB	1.5 - 1.7	0 - 0
L_{night}:		
>45 dB	94 - 101.8	12,400 - 13,400
>50 dB	30.7 - 33.9	2,900 - 3,300
>55 dB	12.1 - 13.3	500 - 600
>60 dB	4.3 - 4.8	200 - 200
>65 dB	1.7 - 1.8	0 - 0
>70 dB	0.8 - 0.9	0 - 0

(1) Ranges cover the central case fleet noise modelling and the slower transition fleet noise modelling

Table 4.1.35: 2047 (Standard Mode) Annual L_{den} and L_{night} Baseline Noise Levels [(1)]

Noise Metric	Noise Contour Area (km²)	Population
L_{den}:		
>55 dB	66.8 - 78.7	8,800 - 10,400
>60 dB	22.1 - 25.7	1,400 - 1,600
>65 dB	8.7 - 10.5	400 - 500
>70 dB	2.8 - 3.7	100 - 200
>75 dB	1.1 - 1.5	0 - 0

Noise Metric	Noise Contour Area (km²)	Population
L_{night}:		
>45 dB	84.1 - 93.8	10,800 - 12,300
>50 dB	27.1 - 30.8	1,500 - 3,000
>55 dB	10.6 - 12.2	500 - 500
>60 dB	3.4 - 4.3	200 - 200
>65 dB	1.3 - 1.7	0 - 0
>70 dB	0.6 - 0.8	0 - 0

(1) Ranges cover the central case fleet noise modelling and the slower transition fleet noise modelling

Table 4.1.36: 2047 (Standard Mode) Annual L_{den} and L_{night} with Project Noise Levels (1)

Noise Metric	Noise Contour Area (km²)	Population
L_{den}:		
>55 dB	73 - 85.4	9,600 - 11,300
>60 dB	23.9 - 27.9	1,400 - 1,700
>65 dB	9.6 - 11.6	400 - 500
>70 dB	3.2 - 4.2	100 - 200
>75 dB	1.3 - 1.8	0 - 0
L_{night}:		
>45 dB	91.6 - 102.4	12,000 - 13,500
>50 dB	29.7 - 33.7	2,700 - 3,500
>55 dB	11.7 - 13.4	500 - 600
>60 dB	4 - 5	200 - 200
>65 dB	1.5 - 1.9	0 - 0
>70 dB	0.7 - 1	0 - 0

(1) Ranges cover the central case fleet noise modelling and the slower transition fleet noise modelling

4.2 Representative Community Locations

4.2.1 Table 4.2.1 to Table 4.2.7 give detailed results of noise modelling at each of the seven representative community locations, for the central case. In each table the noise levels at this location are given for easterly, westerly and average mode operation. Results are given for the two primary noise metrics Leq day and night and the two supplementary N65 and N60 noise metrics and for the following cases:

- 2019 Base;
- 2032 Base;
- 2032 with Project;
- 2032 with Project - 2032 Base; and
- 2032 with Project - 2019 Base.

Table 4.2.1: Rusper Primary School (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	52.2	45.5	20	32	52.9	45.8	26	42	48.4	44.6	0	1
2032 Base	50.5	44.1	5	25	51.1	44.4	7	33	47.7	43.2	0	0
2032 with Project	50.8	44.6	5	26	51.3	44.9	7	34	48.5	43.5	0	0
2032 with Project - 2032 Base	0.3	0.5	0	1	0.2	0.5	0	2	0.8	0.3	0	0
2032 with Project - 2019 Base	-1.4	-0.9	-14	-6	-1.6	-0.9	-19	-8	0.1	-1.1	0	-1

Table 4.2.2: Charlwood Village Infant School (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	55.3	48.8	124	36	55.9	49.2	158	45	53.3	47	23	10
2032 Base	52.9	46.9	30	41	53.3	47.3	38	52	51.4	45.4	4	9
2032 with Project	53.4	47.4	78	48	53.6	47.7	102	61	52.8	46.2	7	11
2032 with Project - 2032 Base	0.5	0.5	49	7	0.3	0.4	64	8	1.4	0.8	2	1
2032 with Project - 2019 Base	-1.9	-1.4	-46	12	-2.3	-1.5	-56	16	-0.5	-0.8	-16	1

Table 4.2.3: Lingfield Primary School (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	55.6	52	240	66	56.4	53	286	82	51.6	45	102	19
2032 Base	55.1	50.8	238	59	56	51.8	301	72	50.1	43.2	49	21
2032 with Project	55.9	51.2	291	64	56.8	52.2	367	76	50.9	44.1	64	25
2032 with Project - 2032 Base	0.8	0.4	53	5	0.8	0.4	66	5	0.8	0.9	16	4
2032 with Project - 2019 Base	0.3	-0.8	51	-3	0.4	-0.8	81	-6	-0.7	-0.9	-38	6

Table 4.2.4: Chiddingstone Church of England School (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	50.8	47.1	5	30	51.8	48.2	6	38	44.5	38.5	1	5
2032 Base	50.6	46	2	26	51.6	47.1	2	34	43.3	37.2	1	1
2032 with Project	51.4	46.4	2	28	52.4	47.4	2	36	44.2	38	1	2
2032 with Project - 2032 Base	0.8	0.4	0	2	0.8	0.3	0	3	0.9	0.8	0	1

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2032 with Project - 2019 Base	0.6	-0.7	-3	-2	0.6	-0.8	-4	-2	-0.3	-0.5	-1	-3

Table 4.2.5: Capel Pre-School (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	53.5	47.2	110	15	54.7	48.2	146	20	44	40.2	0	0
2032 Base	51.6	45.5	96	15	52.6	46.5	128	21	43.4	38.8	0	0
2032 with Project	52.8	46.4	122	18	53.9	47.4	163	25	44.1	39.1	0	0
2032 with Project - 2032 Base	1.2	0.9	27	3	1.3	0.9	36	4	0.7	0.3	0	0
2032 with Project - 2019 Base	-0.7	-0.8	13	4	-0.8	-0.8	17	5	0.1	-1.1	0	0

Table 4.2.6: Willow Tree Pre-School, Ifield (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	51.6	45.1	11	13	51.5	45.1	11	14	51.7	45.3	11	9
2032 Base	48.9	43	2	9	48.8	42.9	2	13	49.4	43.5	2	0
2032 with Project	48.3	43.2	2	8	47.7	43	2	10	49.6	43.9	2	0
2032 with Project - 2032 Base	-0.6	0.2	0	-2	-1.1	0.1	0	-3	0.2	0.4	0	0
2032 with Project - 2019 Base	-3.3	-1.9	-9	-5	-3.8	-2.1	-9	-4	-2.1	-1.4	-9	-9

Table 4.2.7: Barnfield Community Care Home, Horley (Central Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	51.7	45.4	5	14	50.9	44.8	0	8	53.4	46.7	19	33
2032 Base	49.6	43.7	1	12	49.1	43.2	0	0	51	45	4	48
2032 with Project	50.3	44.3	5	13	49	43.5	0	0	52.7	45.9	22	53
2032 with Project - 2032 Base	0.7	0.6	5	1	-0.1	0.3	0	0	1.7	0.9	18	6
2032 with Project - 2019 Base	-1.4	-1.1	1	-1	-1.9	-1.3	0	-8	-0.7	-0.8	3	20

4.2.2 Table 4.2.8 to Table 4.2.14 give detailed results of noise modelling at each of the seven representative community locations, for the slower transition fleet case. In each table the noise levels at this location are given for easterly, westerly and average mode operation. Results are given for the two primary Leq day and night noise metrics and the two supplementary N65 and N60 noise metrics and for the following cases:

- 2019 Base;
- 2032 Base;
- 2032 with Project;
- 2032 with Project - 2032 Base; and
- 2032 with Project - 2019 Base.

Table 4.2.8: Rusper Primary School (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	52.2	45.5	20	32	52.9	45.8	26	42	48.4	44.6	0	1
2032 Base	51.8	45.2	18	30	52.5	45.6	24	39	48.3	43.9	0	0
2032 with Project	52	45.6	16	32	52.7	46	21	43	49	44.2	0	0
2032 with Project - 2032 Base	0.2	0.4	-2	2	0.2	0.4	-2	3	0.7	0.3	0	0
2032 with Project - 2019 Base	-0.2	0.1	-4	0	-0.2	0.2	-5	1	0.6	-0.4	0	-1

Table 4.2.9: Charlwood Village Infant School (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	55.3	48.8	124	36	55.9	49.2	158	45	53.3	47	23	10
2032 Base	54.6	48.2	92	42	55	48.7	115	52	52.9	46.5	23	10
2032 with Project	55.2	48.8	140	49	55.5	49.2	167	61	54.3	47.3	58	13
2032 with Project - 2032 Base	0.6	0.6	48	7	0.5	0.5	53	8	1.4	0.8	35	3
2032 with Project - 2019 Base	-0.1	0	16	13	-0.4	0	10	16	1	0.3	34	3

Table 4.2.10: Lingfield Primary School (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	55.6	52	240	66	56.4	53	286	82	51.6	45	102	19
2032 Base	55.6	51.3	250	59	56.4	52.3	306	72	51.3	44.5	83	21
2032 with Project	56.4	51.7	304	64	57.2	52.7	370	77	52.2	45.3	103	25
2032 with Project - 2032 Base	0.8	0.4	53	5	0.8	0.4	64	5	0.9	0.8	21	4
2032 with Project - 2019 Base	0.8	-0.3	63	-3	0.8	-0.3	84	-6	0.6	0.3	1	6

Table 4.2.11: Chiddingstone Church of England School (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	50.8	47.1	5	30	51.8	48.2	6	38	44.5	38.5	1	5
2032 Base	50.9	46.5	3	27	51.9	47.5	4	36	44.7	38.6	1	3
2032 with Project	51.7	46.8	4	30	52.6	47.8	5	38	45.6	39.3	1	4
2032 with Project - 2032 Base	0.8	0.3	1	2	0.7	0.3	1	3	0.9	0.7	0	1
2032 with Project - 2019 Base	0.9	-0.3	-1	0	0.8	-0.4	-1	0	1.1	0.8	-1	0

Table 4.2.12: Capel Pre-School (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	53.5	47.2	110	15	54.7	48.2	146	20	44	40.2	0	0
2032 Base	52.6	46.8	96	15	53.7	47.9	127	21	43.8	39.4	0	0
2032 with Project	53.9	47.7	122	19	55	48.8	163	25	44.6	39.7	0	0
2032 with Project - 2032 Base	1.3	0.9	27	3	1.3	0.9	36	4	0.8	0.3	0	0
2032 with Project - 2019 Base	0.4	0.5	13	4	0.3	0.6	17	5	0.6	-0.5	0	0

Table 4.2.13: Willow Tree Pre-School, Ifield (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	51.6	45.1	11	13	51.5	45.1	11	14	51.7	45.3	11	9
2032 Base	50.8	44.5	9	12	50.6	44.4	9	15	51.2	44.8	9	4
2032 with Project	50.2	44.7	10	11	49.7	44.5	10	14	51.3	45.2	10	4
2032 with Project - 2032 Base	-0.6	0.2	1	-1	-0.9	0.1	1	-2	0.1	0.4	1	1
2032 with Project - 2019 Base	-1.4	-0.4	-1	-1	-1.8	-0.6	-1	0	-0.4	-0.1	-1	-4

Table 4.2.14: Barnfield Community Care Home, Horley (Slower Transition Fleet Case)

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2019 Base	51.7	45.4	5	14	50.9	44.8	0	8	53.4	46.7	19	33
2032 Base	51.1	44.8	6	14	50.4	44.2	0	4	52.7	46.3	22	46
2032 with Project	51.7	45.3	21	16	50.4	44.5	0	4	54.3	47.2	84	53

Case	Average Summer Day				Westerly Flights				Easterly Flights			
	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night	$L_{eq, 16hr}$	$L_{eq, 8hr}$	N65 day	N60 night
2032 with Project- 2032 Base	0.6	0.5	15	2	0	0.3	0	1	1.6	0.9	62	7
2032 with Project- 2019 Base	0	-0.1	16	2	-0.5	-0.3	0	-4	0.9	0.5	65	20

4.3 Noise Sensitive Buildings

4.3.1 The table below shows the predicted $L_{eq\ 16hr}$ day noise levels in the base case and 2032 Project central cases at 21 schools, 1 hospital, 18 places of worship and 7 community buildings that are predicted to be within the $L_{eq\ 16hr}$ day 51 dB noise contour in 2032 with the Project.

Table 4.3.1: Noise Sensitive Buildings, $L_{eq\ 16hr}$ day Noise Levels and Changes (Central Case)

Name	Postcode	2019	2032 Baseline	2032 with Project	2032 with Project-2019 Base	2032 with Project-2032 Base
Schools						
44 Acorn Cottage Cranbrook Nursery Ltd	RH6 9TE	60.4	58.7	58.7	-1.7	0.0
25 Aurora Redehall School	RH6 9QA	56.4	54.9	56.1	-0.3	1.2
8 Brookfield Day Nursery	RH10 9TR	54.5	51.8	52.5	-2.0	0.7
6 Capel Pre School	RH5 5JX	53.5	51.6	52.8	-0.7	1.2
47 Charlwood House Day Nursery	RH11 0QA	66.3	64.3	60.8	-5.5	-3.5
2 Charlwood Village Primary School	RH6 0DA	55.3	52.9	53.4	-1.9	0.5
7 Chiddingstone Nursery	TN8 7AD	51.0	<51	51.6	0.6	-
42 Childcare & Learning Ltd	RH6 9SW	58.9	57.1	56.9	-2.0	-0.2
41 Cranbrook Nursery	RH6 9TE	59.7	58.0	58.0	-1.7	0.0
5 Forge Wood Primary School	RH10 3SW	53.1	51.1	50.4	-2.7	-0.7
3 Hever Church of England Voluntary Aided Primary School	TN8 7NH	52.5	52.3	53.1	0.6	0.8
43 Kid Co Ltd	RH6 9SW	59.4	57.6	57.4	-2.0	-0.2
24 Lingfield College	RH7 6PH	55.6	55.1	55.9	0.3	0.8
21 Lingfield Primary School	RH7 6HA	55.6	55.1	55.9	0.3	0.8
27 Marsh Green Pre-school	TN8 5QR	54.2	53.9	54.6	0.4	0.7
4 Scott Broadwood C of E Infant School	RH5 5JX	53.6	51.6	52.9	-0.7	1.3
22 St Piers School (Young Epilepsy)	RH7 6PW	55.6	55.1	55.9	0.3	0.8
46 The Little House Montessori	RH6 9RG	65.4	64.7	65.4	0.0	0.7
9 The Stables Nursery School	RH19 2LF	52.3	51.9	52.7	0.4	0.8
26 Wee One's Day Nursery & Pre School	RH7 6HD	55.2	54.8	55.6	0.4	0.8
23 Young Epilepsy (The National Centre for Young People with Epilepsy)	RH7 6PW	55.6	55.1	55.9	0.3	0.8
Hospitals						
1 Edenbridge & District War Memorial Hospital	TN8 5DA	52.8	52.6	53.3	0.5	0.7

Name	Postcode	2019	2032 Baseline	2032 with Project	2032 with Project-2019 Base	2032 with Project-2032 Base
Places of Worship						
29 Chapel (Private)	RH7	55.5	55.0	55.8	0.3	0.8
14 Gurdwara Sri Guru Singh Sabha Temple	RH11 0NU	53.7	51.5	50.5	-3.2	-1.0
11 John the Baptist church, Okewood	RH5 5GT	52.0	<51	51.3	-0.7	-
31 Kingdom Hall of Jehovah's Witnesses	TN8	54.2	53.8	54.6	0.4	0.8
30 Providence Chapel	RH6	55.7	53.2	53.7	-2.0	0.5
49 St Bartholomew C of E Church Rectory	RH6 9RG	65.7	65.0	65.7	0.0	0.7
32 St Bernard's Church	RH7 6EZ	56.0	55.5	56.3	0.3	0.8
10 St John the Baptist's Church, Capel	RH5	53.4	51.4	52.7	-0.7	1.3
33 St John's Church	TN8	54.2	53.9	54.6	0.4	0.7
20 St Mary Magdalene Church	RH12 4PX	53.4	51.6	51.9	-1.5	0.3
48 St Michael and All Angels' Church	RH11 0PQ	65.6	63.7	62.5	-3.1	-1.2
40 St Nicholas' Church	RH6 0EE	56.0	53.7	54.7	-1.3	1.0
13 St Peter's C of E Church	TN8 7NH	52.5	52.3	53.1	0.6	0.8
38 The Chapel	RH6 0DQ	57.9	55.5	56.8	-1.1	1.3
28 The Church of St Peter & St Paul	RH7 6BP	55.2	54.8	55.6	0.4	0.8
36 The London Temple	RH7 6HW	57.2	56.4	57.2	0.0	0.8
50 Touchwood Chapel	RH6	68.6	67.4	68.1	-0.5	0.7
Community Buildings						
15 Gurjar Hindu Union	RH11 0AF	53.8	51.5	50.3	-3.5	-1.2
18 Hever Village Hall	TN8 7NH	52.6	52.4	53.2	0.6	0.8
37 Lingfield & Dormansland Community Centre	RH7 6AB	56.2	55.7	56.4	0.2	0.7
45 Newchapel Hall	RH7 6HR	60.2	59.6	60.4	0.2	0.8
16 Okewood Hill Village Hall	RH5 5PU	54.7	53.0	53.9	-0.8	0.9
17 Parish Hall	RH6 0DS	55.2	53.0	53.8	-1.4	0.8
12 The Ellens Green Memorial Hall	RH12 3AS	52.5	51.1	51.9	-0.6	0.8
Heritage Assets						
52 Lowfield Heath Windmill	RH6 0EQ	57.9	55.7	57.7	-0.2	2.0
51 Thunderfield Castle site	RH6 9PP	52.9	51.1	52.3	-0.6	1.2

4.3.2 The table below shows the predicted $L_{eq\ 16hr}$ day noise levels in the base case and 2032 Project slower transition fleet case at 21 schools, 1 hospital, 18 places of worship and 7 community buildings.

Table 4.3.2: Noise Sensitive Buildings, $L_{eq\ 16hr}$ day Noise Levels and Changes (Slower Transition Fleet Case)

Name	Postcode	2019	2032 Baseline	2032 with Project	2032 with Project-2019 Base	2032 with Project-2032 Base
Schools						
44 Acorn Cottage Cranbrook Nursery Ltd	RH6 9TE	60.4	59.9	59.9	-0.5	0.0
25 Aurora Redehall School	RH6 9QA	56.4	55.9	57.1	0.7	1.2
8 Brookfield Day Nursery	RH10 9TR	54.5	53.7	54.4	-0.1	0.7
6 Capel Pre School	RH5 5JX	53.5	52.6	53.9	0.4	1.3
47 Charlwood House Day Nursery	RH11 0QA	66.3	65.6	62.6	-3.7	-3.0
2 Charlwood Village Primary School	RH6 0DA	55.3	54.6	55.2	-0.1	0.6
7 Chiddingstone Nursery	TN8 7AD	51.0	51.1	51.9	0.9	0.8
42 Childcare & Learning Ltd	RH6 9SW	58.9	58.4	58.2	-0.7	-0.2
41 Cranbrook Nursery	RH6 9TE	59.7	59.2	59.2	-0.5	0.0
5 Forge Wood Primary School	RH10 3SW	53.1	52.6	52.0	-1.1	-0.6
3 Hever Church of England Voluntary Aided Primary School	TN8 7NH	52.5	52.6	53.4	0.9	0.8
43 Kid Co Ltd	RH6 9SW	59.4	58.9	58.7	-0.7	-0.2
24 Lingfield College	RH7 6PH	55.6	55.6	56.4	0.8	0.8
21 Lingfield Primary School	RH7 6HA	55.6	55.6	56.4	0.8	0.8
27 Marsh Green Pre-school	TN8 5QR	54.2	54.2	55.0	0.8	0.8
4 Scott Broadwood C of E Infant School	RH5 5JX	53.6	52.6	54.0	0.4	1.4
22 St Piers School (Young Epilepsy)	RH7 6PW	55.6	55.6	56.4	0.8	0.8
46 The Little House Montessori	RH6 9RG	65.4	65.3	65.9	0.5	0.6
9 The Stables Nursery School	RH19 2LF	52.3	52.3	53.1	0.8	0.8
26 Wee One's Day Nursery & Pre School	RH7 6HD	55.2	55.2	56.0	0.8	0.8
23 Young Epilepsy (The National Centre for Young People with Epilepsy)	RH7 6PW	55.6	55.6	56.4	0.8	0.8
Hospitals						

Name	Postcode	2019	2032 Baseline	2032 with Project	2032 with Project-2019 Base	2032 with Project-2032 Base
1 Edenbridge & District War Memorial Hospital	TN8 5DA	52.8	52.9	53.6	0.8	0.7
Places of Worship						
29 Chapel (Private)	RH7	55.5	55.5	56.3	0.8	0.8
14 Gurdwara Sri Guru Singh Sabha Temple	RH11 0NU	53.7	53.1	52.2	-1.5	-0.9
11 John the Baptist church, Okewood	RH5 5GT	52.0	51.4	52.4	0.4	1.0
31 Kingdom Hall of Jehovah's Witnesses	TN8	54.2	54.2	55.0	0.8	0.8
30 Providence Chapel	RH6	55.7	54.9	55.5	-0.2	0.6
49 St Bartholomew C of E Church Rectory	RH6 9RG	65.7	65.6	66.3	0.6	0.7
32 St Bernard's Church	RH7 6EZ	56.0	56.0	56.8	0.8	0.8
10 St John the Baptist's Church, Capel	RH5	53.4	52.4	53.8	0.4	1.4
33 St John's Church	TN8	54.2	54.2	55.0	0.8	0.8
20 St Mary Magdalene Church	RH12 4PX	53.4	52.9	53.1	-0.3	0.2
48 St Michael and All Angels' Church	RH11 0PQ	65.6	65.1	64.1	-1.5	-1.0
40 St Nicholas' Church	RH6 0EE	56.0	55.3	56.4	0.4	1.1
13 St Peter's C of E Church	TN8 7NH	52.5	52.6	53.4	0.9	0.8
38 The Chapel	RH6 0DQ	57.9	57.2	58.5	0.6	1.3
28 The Church of St Peter & St Paul	RH7 6BP	55.2	55.2	56.0	0.8	0.8
36 The London Temple	RH7 6HW	57.2	57.0	57.8	0.6	0.8
50 Touchwood Chapel	RH6	68.6	68.2	68.9	0.3	0.7
Community Buildings						
15 Gurjar Hindu Union	RH11 0AF	53.8	53.1	52.1	-1.7	-1.0
18 Hever Village Hall	TN8 7NH	52.6	52.7	53.5	0.9	0.8
37 Lingfield & Dormansland Community Centre	RH7 6AB	56.2	56.1	56.9	0.7	0.8
45 Newchapel Hall	RH7 6HR	60.2	60.1	60.9	0.7	0.8
16 Okewood Hill Village Hall	RH5 5PU	54.7	54.1	54.9	0.2	0.8
17 Parish Hall	RH6 0DS	55.2	54.5	55.5	0.3	1.0
12 The Ellens Green Memorial Hall	RH12 3AS	52.5	52.0	52.8	0.3	0.8

Name	Postcode	2019	2032 Baseline	2032 with Project	2032 with Project-2019 Base	2032 with Project-2032 Base
Heritage Assets						
52 Lowfield Heath Windmill	RH6 0EQ	57.9	57.2	59.2	1.3	2.0
51 Thunderfield Castle site	RH6 9PP	52.9	52.3	53.5	0.6	1.2

5 Sensitivity Tests

5.1 Runway Modal Split

5.1.1 The ratio of westerly (ie Runway 26) and easterly (ie Runway 08) operations is referred to as the runway modal split. In the summer daytime of 2019 this was 73% westerly and 27% easterly, and in the night-time it was 72% westerly and 28% easterly. Because wind conditions vary from year to year, so does modal split. In 2019 the long term average day and night 'standard' modal split 2019 was 75/25 and this modal split has been used in the baseline and all forecast years used in this assessment.

5.1.2 The results of modelling for variations in runway modal split are shown in Table 5.1.1.

Table 5.1.1: 2029 Runway Modal Split Sensitivity Tests, Summary

	90W/10E	80W/20E	70W/30E	60W/40E	50W/50E
$L_{eq\ 16hr}$ Day 51dB Area	135.9	135.4	134.8	133.6	132.1
$L_{eq\ 16hr}$ Day 51dB Population	19,400	20,500	22,200	23,200	23,700
$L_{eq\ 8hr}$ Night 45 dB Area	148.2	148.4	147.8	146.8	145.6
$L_{eq\ 8hr}$ Night 45 dB Population	23,900	24,700	24,600	24,700	25,100

6 WebTAG

6.1 Results

6.1.1 The CAA noise modelling team carried out a WebTAG assessment for air noise using the 2029 and 2047 noise modelling results for the Project. The results are provided in the table below.

6.1.2 There has been an error, which the CAA has confirmed, in the DfT Workbook for some time, which has been uncorrected. The noise Workbook in WebTAG has been used for many years now for roads and railways. More recent aviation policy has defined the Lowest Observable Adverse Effects Levels (LOAEL) for aviation as $L_{eq\ 16hr}$ day 51 dB and $L_{eq\ 8hr}$ night 45 dB. In response to the policy defining LOAEL for aviation noise, the DfT added a sensitivity test for aviation to exclude the analysis of levels below $L_{eq\ 16hr}$ 51 dB. Unfortunately, in doing so they also excluded the analysis of levels below $L_{eq\ 8hr}$ night 51 dB which wrongly changed the night noise element. The CAA confirmed this as an error [2] and provided the WebTAG workbook results as follows.

Table 6.1.1: WebTAG Noise Appraisal

	Central Case Fleet **Sensitivity test excluding impacts below 51 dB (for aviation proposals only) Corrected**	**Slower Transition Fleet** **Sensitivity test excluding impacts below 51 dB (for aviation proposals only) Corrected**
Net present value of change in noise (£, 2010 prices):	-£9,904,117	-£11,525,688
Net present value of impact on sleep disturbance (£, 2010 prices):	-£3,301,796	-£4,190,678
Net present value of impact on amenity (£, 2010 prices):	-£4,675,410	-£5,205,079
Net present value of impact on Acute Myocardial infarction (AMI) (£, 2010 prices):	-£45,292	-£46,572
Net present value of impact on stroke (£, 2010 prices):	-£45,292	-£830,588
Net present value of impact on dementia (£, 2010 prices):	-£1,131,492	-£1,252,772

*positive value reflects a **net benefit** (ie a reduction in noise)

6.1.3 A number of assumptions are made in order to complete the workbook. There is an assumption that for the 42 years beyond 2047 noise levels are assumed constant in order to arrive at a 60 year discounted appraisal result. This is unlikely and more so for night noise given the night noise restrictions which are expected to prevail. The sleep disturbance costs are less than half the total. This is shown in the night noise contours changing less than day contours because of the assumption that the northern runway would not be used routinely between 23:00 and 06:00 hours.

6.1.4 It is noted that health effects can arise in individuals below the LOAEL, so WebTAG can under-estimate health effects. For further discussion of health outcomes see **ES Chapter 18: Health and Wellbeing** (Doc Ref. 5.1).

[2] Email from CAA, ERCD to Mitchell Environmental Ltd, 4 April 2021

7 Physiological Sleep Disturbance Assessment

7.1 Introduction

7.1.1 The UK Health Security Agency commented as follows on the PIER:

- UKHSA welcomes the Applicant's use of a variety of noise metrics which represent averaged and maximum levels, number of noise event metrics and overflights, split into appropriate time periods. We encourage the Applicant to use the single-event level data (expressed as Lmax) to carry out a physiological sleep disturbance (awakenings) assessment using the exposure response relationship from the WHO-commissioned systematic review published in 2018 [Basner, M. and S. McGuire, WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Effects on Sleep. Int J Environ Res Public Health, 2018. 15(3)]

7.1.2 In response a physiological sleep disturbance assessment has been carried out using modelled L_{max} aircraft noise levels for an average summer night (23:00-07:00 hours) with the Project compared to those in the baseline in 2032, the anticipated year of greatest noise impact. The methodology adopted follows that described in the WHO-commissioned systematic review published in the International Journal of Environmental Research and Public Health 2018 by Mathias Basner and Darah McGuire of the Division of Sleep and Chronobiology, Department of Psychiatry, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA 19104, USA. The method, as applied to this project is described below.

7.1.3 The WHO-commissioned systematic review published in 2018 gives a dose response relationship for the probability of an awakening due to a given L_{max} level of aircraft noise in a 90 second period at night. This offers a method of assessing sleep disturbance in term of specific peak noise levels and the numbers of them, rather than considering more generic relationships between sleep effects and accumulated L_{eq} noise levels. This dose/response relationship is applied to the population exposure to L_{max} noise levels across the study area with and without the Project to arrive at an estimate of the additional number of awakenings due to the Project. In order to understand the results it is important to understand what is meant by an 'awakening', and also how the dose/response relationship was derived.

7.2 Sleep Disturbance Noise Dose Response Relationship

7.2.1 Sleep is a biological imperative and an active process that serves several vital functions. Undisturbed sleep of sufficient length is essential for daytime alertness and performance, quality of life, and health. Noise has been shown to fragment sleep, reduce sleep continuity, and reduce total sleep time. The epidemiologic evidence that chronically disturbed or curtailed sleep is associated with the negative health outcomes mentioned above is overwhelming. For these reasons, noise-induced sleep disturbance is considered one of the most important non-auditory effects of environmental noise exposure.

7.2.2 The effects of noise on sleep have been widely studied around the world. The WHO-commissioned literature search resulted in a total of 336 identified relevant papers published between 2000 and about 2015. The main methods of studying the effects of noise on sleep are as follows:

- **polysomnography**, which is the simultaneous measurement of (at least) brain electrical potentials (electroencephalogram, EEG), eye movements (electrooculogram, EOG), and muscle tone (electromyogram, EMG).
- **Actigraphy** which infers sleep or awake from wrist movements measured with a watch-like device.
- **Signalled awakenings** where participants are asked to push a button whenever they wake up during the night.
- **Reported sleep disturbance** where subjects are asked to report their sleep quality the following morning.

7.2.3 Unsurprisingly these methods yield different findings. Polysomnography is considered the gold standard. It measures changes in sleep state, most of which are not recalled by the subject, but nonetheless affect the quality of sleep and its restorative value in maintaining health.

7.2.4 Sleep research uses the following sleep stages:

- Awake
- Stage 1 Superficial sleep
- Stage 2
- Stage 3 Deep or slow wave sleep (SWS)
- Stage 4 Deep or slow wave sleep (SWS)
- Rapid Eye Movement (REM)

7.2.5 An '*awakening*' is defined as a move from deep Stage 4 or REM sleep to a Stage 1 or awake. It is important to note that as we sleep we change sleep stage numerous times and 'awaken' for all manner of reasons, e.g., temperature, humidity, light levels, and internal reasons such as sleep disorders, health conditions, bad dreams etc. Whether or not noise will disturb sleep also depends on situational effects, eg depth of sleep phase, background noise level, and individual factors (e.g. noise sensitivity) moderators. A healthy adult briefly awakens about 20 times during an eight hour night and most of these awakenings are too short to be remembered the next morning.

7.2.6 It is currently unclear how many additional noise-induced awakenings are acceptable and without consequences for sleep recuperation and health, especially given the large inter-individual differences in the susceptibility to noise.

7.2.7 Subjects exposed to noise usually habituate. For this reason the systematic review focussed on field studies, where lower rates of disturbance and found than in laboratories where research is easier to conduct. In order to derive does/response functions between the L_{max} levels of individual noise events and the probability of awakenings studies using the gold standard method, polysomnography where reviewed. After rating and sifting for various forms of bias, the study used for L_{max} noise event analysis was the STRAIN study conducted by the German Aerospace Centre (DLR) between September 2001 and November 2002. It included 64 residents between the ages of 18 to 61 years (average age 38 years, 55% female) who lived around Cologne-Bonn Airport. 430 subject nights (61 subjects) of data were analysed.

7.2.8 The research method analysed subjects' responses to noise events within 90 second windows. Individuals do not only awaken during the night due to noise events but also spontaneously. Even for low noise levels the probability of sleep stage transitions to awake or Stage 1 within a 90 second window was found to be 7.7% (consistent with the general finding stated above of about 20 awakenings in an 8 hour night).

7.2.9 The dose/response relationship identified is shown in Diagram 7.2.1 along with the equivalent relationships for road and rail traffic derived from related studies. The relationship is for the probability of additional sleep stage change to awake or Stage 1 within a 90 second period following a noise event quantified in $L_{Amax,S}$ dBs.

Diagram 7.2.1: WHO 2018 Systematic Review, Probability of Awakenings

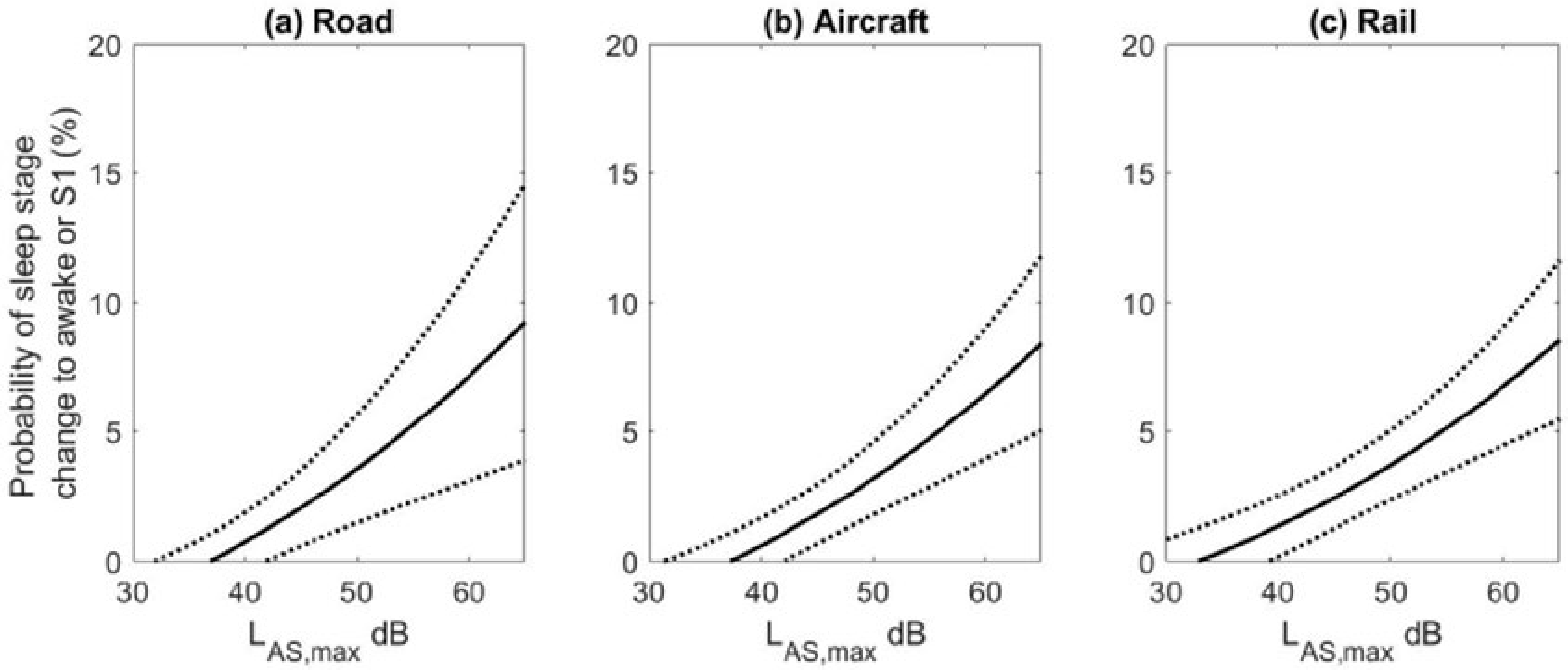


Figure 6. Probability of additional sleep stage changes to awake or S1 in a 90 s time window following noise event onset depending on the maximum indoor sound pressure level ($L_{AS,max}$) for (a) road (STRAIN and DEUFRAKO, N = 94 subjects); (b) aircraft (STRAIN, N = 61); and (c) rail noise (DEUFRAKO, N = 33). 95% confidence intervals (dashed lines). Results are for the three unadjusted models.

7.2.10 The equation for the probability of additional awakening to sleep Stage 1 or awake for aircraft noise is: -3.0918 – 0.0449x (L_{max}) + 0.0034x (L_{Max})^2.

7.2.11 The systematic review notes that while studies using polysomnography for the measurement of sleep may have low information bias, they suffer from high selection bias. These studies often only include healthy individuals without sleep disorders. Due to the high methodological expense, sample sizes are typically low. Therefore, the results may not be representative of the effects of noise on sleep in the general population. However, the focus on generally healthy individuals acts to underestimate the actual population health effect, whilst the exclusion of those with sleep disorders acts to overestimate the actual population health effect. The study represents the best estimate from the scientific literature chosen by the WHO-commissioned systematic review and such selection bias issues are commonly acknowledged as an acceptable limitation when applying research findings to practical applications.

7.3 Population Exposure and Awakening Methodology

7.3.1 Modelling of L_{max} noise levels at night was carried out by ERCD in the same way as for Number Above (N60 and N65) modelling. Noise levels were modelled at the postcode centre points across the study area as used in the WebTAG analysis. Modelling was carried out for the 2032 average summer night air traffic forecasts, for the base case and with Project case. Both the Central Case and Slow Transition Fleet (STF) case fleets were modelled, as was the 2019 baseline for reference. The numbers of L_{max} noise events at each postcode per night were reported by ERCD in 5 dB bands from 60 to 80 dB, with a lower cut-off of 10 events applied as used by ERCD for N60 modelling. This set the study area to the 2019 N60 10 contour extent, that encompasses approximately 34,000 people. Whilst there may be sleep disturbance outside this, it is likely to be small compared to in areas closer to the airport where there are many more noise events and at higher noise levels, and it reflects the limitations on the accuracy of the ANCON model.

7.3.2 ANCON models noise levels outside, whereas the dose/response relationship reported above is for internal noise levels. In order to provide a conservative estimate of additional awakenings due to the Project, internal noise levels were estimated by assuming all bedroom windows were partially open, so an outside to inside level difference of 15 dB was taken off the predicted external noise levels. In practice even on hot summer nights some windows will be closed, so this assumption leads to over-estimate of sleep disturbance.

7.3.3 Using the dose/response relationship reported above and the population at each postcode centre point, the total number of awakenings to sleep Stage 1 or awake due to all aircraft L_{max} levels during the night were calculated for the Project case and the baseline.

7.4 Results

7.4.1 In the study area of 34,000 people, as described above each person is likely to experience about 20 awakenings without considering the effect of aircraft noise, implying 680,000 awakenings each night.

7.4.2 The numbers of awakenings estimated due to aircraft noise are as follows:

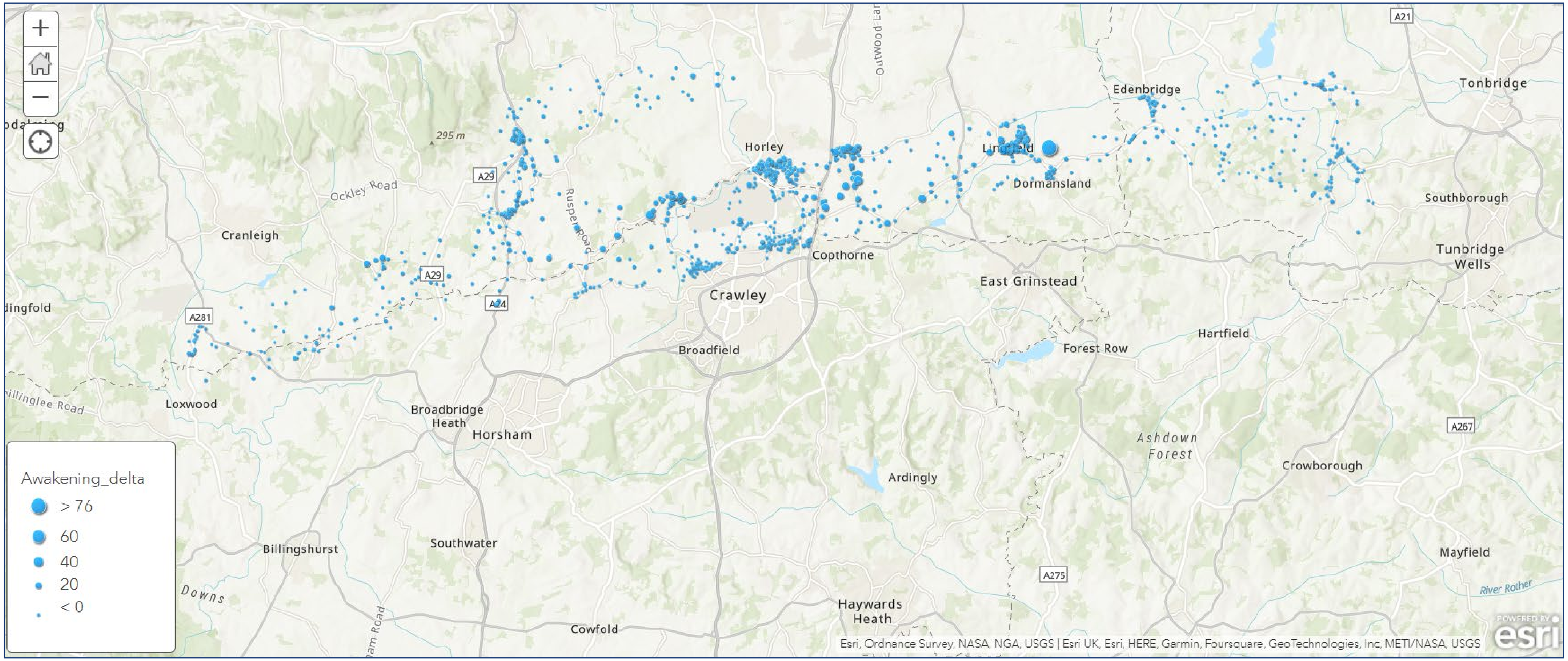
- 2019 base 32,317
- 2032 Central Case base 26,508
- 2032 Central Case with Project 29,560
- 2032 STF Case base 29,061
- 2032 STF Case with Project 32,843

7.4.3 In the Central Case, in 2032 the effect of the Project is to increase awakenings due to aircraft noise by 3,052 from 26,508 to 29,560 per night, but still below the 2019 base of 32,317. These figures compare to the underlying total awakening for all other reasons in the affected community of approximately 680,000 per night. The effect of aircraft noise from the Project is an increase of 0.4% on underlying awakenings in the community.

7.4.4 In the Slow Transition Fleet Case, in 2032 the effect of the Project is to increase awakenings due to aircraft noise by 3,782 from 29,061 to 32,843 per night, and 526 above the 2019 base of 32,317. These figures compare to the underlying total awakening for all other reasons in the affected community of approximately 680,000 per night. The effect of aircraft noise from the Project is an increase of 0.6% on underlying awakenings in the community.

7.4.5 The methodology adopted for this study is statistical so it is valid for the overall effect over general populations, and cannot be used to predict the effects on individuals. These effects vary considerably between individuals. However, it is of interest to see geographically where effects will tend to be largest within local communities and how great those effects are likely to be in the worst affected areas. Diagram 7.4.1 shows the distribution of additional awakenings due the Project in 2032 versus the 2032 baseline, with the Slower Transition Fleet case.

Diagram 7.4.1: Distribution of Additional Awakenings due the Project in 2032 Versus 2032 Baseline, Slow Transition Fleet



7.4.6 Over the whole study area of 34,000 people, in the STF case the effect of the Project is to increase awakenings in 2032 (compared to the baseline in 2032) by 3,782, ie an average of 0.11 additional awakening per person. The extent of increased awakenings will be higher where the additional flights are closest to populations.

7.4.7 In 2032 the number of flights in an average summer 8 hour night is forecast to increase due to the Project by 12 from 125 to 137. The area where these additional 12 flights will create the highest noise levels over an average summer night is under the departure route from the Northern Runway in the Ifield Road area, south of Charlwood. There is a relatively small population here who will experience these 12 additional flights, and the higher noise levels of the flights moved northwards from the main runway, with noise levels over a range of L_{max} levels. The modelling shows that when the effect of the change in L_{max} levels here is summed across all aircraft, each person on average would experience 0.8 additional awakenings per night. This is because, even at relatively high L_{max} noise levels the probability of an awakening is small. For example, some of the noisiest aircraft in this area will have external noise levels in the range L_{max} 75-80 dB for which the probability of awakening is about 7%. 12 additional noise events with a probability of an awaking of 7% each would give a total probability of awakening of 84% or less than one awakening per night. Elsewhere where noise levels are lower, the increase in the number of awakenings per person will be lower than this.

This is a statistical result, and does not predict the effects of individuals, but it does indicate that even at the worst affected locations, where noise levels will increase the most as a result of the Project, there is likely to be less than one additional awakening per summer night per person as a result of the Project, in the population in that area overall. As noted in the methodology section above, it is currently unclear how many additional noise-induced awakenings are acceptable and without consequences for sleep recuperation and health. But, in the context described above, that an average healthy person awakens about 20 times a night for various reasons not connected with noise, an increase of less than one awakening per night in the busy summer season as a result of the Project seems likely to have a small health effect.