

**REPORT OF  
NOISE MONITORING AT BILLINGSHURST  
JULY 2013 TO JUNE 2014**

Client: Gatwick Airport Limited



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## **REPORT OF NOISE MONITORING AT BILLINGSHURST, JULY 2013 TO JUNE 2014**

### **1.0 Introduction**

A mobile Noise Monitoring Terminal (NMT) has been deployed at Billingshurst in West Sussex by Gatwick Airport Ltd from 12 July 2013 to 25 June 2014. This report presents a summary of the results of continuous noise monitoring for this (approximate) 12 month period, which covers a complete seasonal cycle of aircraft movements.

The site is approximately 30 km south west of the airport. The NMT is situated within the grounds of a garden adjacent to a Public House, next to a minor road (B2133) with the highway (A272) about 180m to the north and the highway (A29) about 700m to the west.

Apart from noise from aircraft noise arises from the kitchen fan and from other activity at the Public House and its car park and there was some traffic noise from the minor road (B2133) and the highway (A272).

Towards the end of the monitoring period, on 9th May 2014, the NMT was moved closer to the road and to the Public House, to make way for the erection of a marquee, which was used for weekend entertainment events, which also created some additional noise at the site.

### **2.0 The noise data from the noise monitoring terminal**

The Noise Monitoring Terminal (NMT) gathers data about the number and level of aircraft noise events. Aircraft noise events are bursts of noise which activate the trigger condition, discussed below, and which also correlate with radar tracks from the airport's noise and track keeping system. In addition the NMT also gathers data about the total level of noise at the site, on an hourly basis. The hourly values of total noise are a combination of the noise from the aircraft noise events and from all other noise sources, called residual noise.

The monitor trigger condition was set to operate with a threshold trigger level of 58 dBA to be exceeded for 10 seconds.

Figures 1 and 2 (pages 12 and 13) show typical aircraft tracks for both departures and arrivals from Gatwick, also showing the location of the NMT at Billingshurst.

The monitoring period included the period of ADNID trials (from February to August 2014), and Figures 1A and 1B (page 13) shows departure flight tracks for a typical day of departures to the west during the ADNID trial period and outside the ADNID trial period. ADNID tracks passing close to the NMT at Billingshurst can be seen in Figure 1B.

Flight tracks of departures to the East are not shown, because they do not pass near to the NMT at Billingshurst.

Figure 2A (page 13) shows Arrival flight paths (in red) for a typical day when departures were to the east, also showing tracks for aircraft waiting in the holding areas (to the south).

Figure 2B (page 13) shows Arrival flight paths (in red) for a typical day when departures were to the west; it can be seen that only a relatively small proportion of these pass close to the monitor at Billingshurst.

Further information about the NMT is given in Appendix 1, and a glossary of acoustical terms is given in Appendix 2.

### 3.0 Analysis of noise monitor survey results

The results are discussed in the following sequence: the number of aircraft noise events recorded by the NMT; maximum noise levels of aircraft noise events; the noise climate at the site, including aircraft noise, total noise and residual noise; putting the noise climate into context; and the contribution of different types of aircraft to the aircraft noise level at the site.

The results of the data gathered during the survey are displayed in Figures 3 to 8 below (pages 15 to 18) and are also summarised in the Table in section 6 of this report.

#### 3.1 The number of aircraft noise events

A total of approximately 24,000 aircraft noise events were recorded at the noise monitor during the monitoring period from 12 July 2013 to 25 June 2014. Examination of these data indicated a small but significant number (about 6%) of these events had durations much greater than could be expected from an aircraft noise event. It is considered that the most likely explanation is that these are noise events triggered by aircraft noise but prolonged by other sources of noise, including noise from the wind which continues long after the aircraft has moved away.

It was decided to remove these 'long-duration' events from the data base to be used for subsequent analysis, using a criterion that events with a duration of more than 60 seconds should be removed. This left a data base of about 22,500 aircraft noise events, over the 12 month period, which are the subject of the analysis presented in this report.

The average number events per day for each month shown in Figure 3 (page 14). Most of the recorded events (63%) were due to aircraft arrivals, 21% were due to departing aircraft and about 16% were due to overflights; 95% of the events occurred during the daytime, and 5% at night.

Most of the Arrivals events (98%) were destined for runway 08R, during periods when aircraft were taking off to the East, as shown in Figure 2A (page 13). Most of the Departures events (68%) used the ADNID route with almost all of the remainder (27%) using the BOGNA departure route.

The variation in the number of events recorded from month to month, as shown in Figure 3 (page 14), is in part determined by wind direction, which determines take off direction. The west / east split in runway usage during the period is shown in the Table below, and also in Figure 3:

Month	% westerly	% easterly
July 2013	51	49
August 2013	76	24
September 2013	69	31
October 2013	75	25
November 2013	91	9
December 2013	63	37
January 2014	85	15
February 2014	89	11
March 2014	61	39
April 2014	56	44
May 2014	60	40
June 2014	51	49

The number of aircraft noise events varies, hour by hour, throughout each day. Figure 4 (page 14) shows this variation, including the numbers of arrivals, departures and overflights. It can be seen that, on average over the twelve month period the highest numbers of aircraft noise events per hour recorded at the site occur in the daytime between 07.00 and 09.00 hours (local time).

### 3.2 Maximum noise levels and durations of aircraft noise levels

The maximum noise level,  $L_{ASmax}$ , produced by aircraft noise events over the 12 month period varied, with an average value of 64 dBA and a standard deviation of 2.9 dBA. More than 99.5% of events had a maximum value of less than 76 dBA.

There was no significant difference between the average maximum noise level for arrival, departure and overflights events.

The duration of these aircraft noise events ranged between 10 and 60 seconds, but with an average duration of 28 seconds. The average level of aircraft noise during the events was 60 dBA.

### 3.3 Aircraft altitudes

The average altitudes of the aircraft responsible for the aircraft noise events were: 4800 feet for arrivals, 8800 feet for departures and 17000 feet for overflights. A statistical distribution of altitudes of arriving aircraft is shown in Figure 5 (page 15).

### 3.4 The total noise climate at the site

Figure 6 (page 15) shows the month by month average daytime noise levels of aircraft noise. This is the notional level of aircraft noise which would occur if the all the intermittent bursts of aircraft noise were averaged to give a continuous steady level of noise. Although this average noise level bears little relationship to the aircraft noise as heard, which occurs in short bursts of noise at higher levels rather than as a lower continuous average level, it is, nevertheless, a useful parameter for comparative purposes, and is the internationally accepted method for comparing environmental noise.

Also shown in Figure 6 (page 15) are the average monthly levels of total noise and residual noise at the site, and the average monthly values of maximum noise levels of aircraft noise events, and of background noise ( $L_{AS90}$  values). Figure 7 (page 15) shows similar data for night-time

Figure 6 (page 15) shows that the average level of aircraft noise level ( $LA_{eq}$ ) in the daytime generally varied from month to month between 42 to 49 dBA, with an average value of 45 dBA.

Figure 7 (page 16) shows that the average level of the night-time aircraft noise level ( $LA_{eq}$ ) generally varied from month to month between 25 to 42 dBA, with an average value of 33 dBA.

For the first 10 month of the monitoring period the average level of the total noise at the site was generally about 56 dBA in the daytime and between 48 and 54 dBA at night time, except for the last two months, May and June 2014, when the levels of total noise increased significantly. This increase was probably due to moving the monitor closer to the road and the public house and noise from the marquee, as reported earlier, in section 1.0. The level of

the total noise at the site was, throughout the monitoring period, much higher than the level of aircraft noise; on average, 12 dB higher.

The level of residual noise, which, as explained in Appendix 1 is deduced from the level of total noise and aircraft noise was throughout the monitoring period much higher than the levels of aircraft noise, and usually within 1 dB of the total noise level.

The daytime background noise level ( $L_{AS90}$ ) varied throughout the 12 month period between 41 and 48 dBA in the daytime (average 46 dBA), and between 33 to 39 dBA at night (average 38dBA).

The average of maximum aircraft noise levels was similar during the daytime and at night, within the range 60 dBA to 65 dBA (average 64 dBA).

Figures 6 and 7 (pages 15 and 16) demonstrate that the noise from aircraft noise events at this site, when cumulatively averaged over an extended period of time (of hours, days or months) make only a minor contribution to the total noise level at this site, and that noise from other sources, i.e. the residual noise, makes the major contribution.

However each individual aircraft noise event, whenever it occurs, is likely to be clearly audible and distinguishable from the residual noise because, in addition to being different in character, it results in a noticeable increase in the level of noise over the ambient noise level during each event.

Figure 8 (page 16) shows the variation of average levels of aircraft noise, residual noise, background noise and total noise at the site with hour of day. It can be seen that the aircraft noise levels do not vary much during the daytime period (06.00 to 18.00 hours) but fall during the late evening and night-time, rising again in the early morning. Also shown in Figure 7 (page 16) is the average of maximum aircraft noise levels, which does not vary significantly with hour of day.

The average levels (rounded to the nearest dB) over the 15 month period for various parts of the 24 hour day are shown below:

	Total noise $L_{Aeq,T}$	Aircraft noise $L_{Aeq,T}$	Residual noise $L_{Aeq,T}$	Background noise level ( $L_{AS90}$ )
Day (16h) (07.00 - 23.00 h)	58	49	57	47
Night (8h) (23.00 - 07.00 h)	55	41	54	35
Day (12 h)* (07.00 - 19.00 h)	58.5	50	58	48
Evening (4 h)* (19.00 - 23.00 h)	56	42	55.5	41
24 hours	57	47	56.5	43

\* The 12 hour day and 4 hour evening periods have been defined as part of the day evening night noise index,  $L_{den}$ , used for noise mapping purposes (and described later in this report).

## 4.0 Putting the noise climate at the site into a wider UK context

### 4.1 Aircraft noise contours

The site at Billingshurst lies well outside (approximately 7 nm or 13 km beyond) the lowest noise prediction contour (57 dBA LAeq16h) the shape of which is published by the Civil Aviation Authority on behalf of the Department of Transport (ERCD Report 1402, Noise Exposure Contours for Gatwick Airport 2013). This is consistent with the 12 month average LAeq16hour value of 49 dBA for this site, as shown in the Table above, which was calculated from data for the period from July 2013 to June 2014. Strictly speaking, because each set of values is based on averages over different time periods and, probably, different modal splits and different mixes of aircraft types, the values obtained from this survey are not directly comparable with the CAA noise contours.

The 57 dBA contour is the lowest contour to be published because in the view of the UK government it denotes the approximate onset of significant daytime community annoyance. The relationship between noise and annoyance is of course not an exact one, and varies according to situation and locations.

In 2011 aircraft noise contours of day evening night level (Lden) were published for Gatwick Airport (ERCD Report 1205, Strategic Noise Maps for Gatwick Airport 2011). The site at Billingshurst lies well outside the lowest contour of 55 dB Lden. As explained previously any comparison between an estimate of Lden based on the noise measurements in this report with the Strategic noise mapping contours should recognise that the two sets of values are based on averages over different time periods, and therefore different numbers of aircraft noise events and, probably, different modal splits and different mixes of aircraft types. The Lden value calculated from aircraft noise measurements at this site over the twelve month period from July 2013 to June 2014 has been estimated as 50 dBA. The Lden value calculated from total noise measurements at this site over the twelve month was estimated as 62 dBA.

### 4.2 The National Noise Incidence survey

National Noise Incidence studies of noise levels in England and Wales were carried out in 1990 and again in 2000 by the Building Research Establishment for Defra. A comparison of the data from the first two studies indicated that although there were some changes, much about the noise climate in England and Wales had not changed significantly over the 10 year period. Therefore the 2000 study remains a good basis for setting the noise levels from this study at Billingshurst into a wider context. The results of the 2000 study, published in 2001, gave a breakdown of the proportion of UK residents exposed to noise, as follows:

Proportion of the population of England and Wales living in dwellings exposed to daytime noise levels (LAeq, 16 hour) in 5 dB bands, in the 2000 National Noise Incidence Study	
5 dB noise exposure level bands*	Proportion in band
Less than 50 dBA	30%
50 dBA < L < 55 dBA	37%
55 dBA < L < 60 dBA	18%
Greater than 60 dBA	15%

\*The noise level exposure bands in the above Table are for 'free field' noise levels, i.e. noise levels unaffected by sound reflections from nearby surfaces. All the noise levels from the NMT at Billingshurst are also free field values.

## Noise Climate at Billingshurst July 2013 to June 2014

Since the 16 hour  $L_{Aeq}$  value of total noise for this site is 58 dBA this puts the site in the 55 to 60 dBA noise exposure band, occupied by 18 % of dwellings in the UK.

It should be noted that this comparison refers to the total noise at this particular site at Billingshurst, which is dominated by residual noise, i.e. noise from sources other than aircraft. The possible sources of noise at the site were described in section 1.0 above.

### 4.3 World Health Organisation Guidance on Community Noise

In 2000 the World Health Organisation issued 'Guidelines for Community Noise' that "general daytime outdoor noise levels of less than 55 dBA are desirable to prevent significant community annoyance" and that "at night, sound pressure levels at the outside façades of living spaces should not exceed 45 dB ( $L_{Aeq}$ ) so that people may sleep with bedroom windows open."

The daytime total noise exposure level during the 12 month monitoring period at this site (58 dB  $L_{Aeq,16hour}$ ) is above the WHO Guidelines of 55 dBA for the daytime, and the night-time total noise exposure level (55 dB  $L_{Aeq,8hour}$ ) is also above the night-time WHO Guideline value of 45 dBA.

### 5.0 **Aircraft types contributing to the aircraft noise level at the site**

5.1 Approximately 200 different aircraft types contributed to the total number of aircraft noise events which occurred during the monitoring period, but most of the events arose from a relatively small number of aircraft types, with four types being responsible for 78% of all aircraft noise events at the site:

- Airbus Industrie A319: 37.5%
- Airbus Industrie A320: 21.2%
- Boeing 737 - 800: 10%
- Boeing 737 - 400: 9.5%

5.2 The Table below lists the 20 aircraft types responsible for more than 98% of all of the aircraft noise events which occurred during the period, showing the number and the % number of events and the average  $L_{ASmax}$  value for each aircraft type, presented in order, with the most frequent type at the top of the list.

List of 20 most frequent aircraft types in order of event numbers:

Aircraft Type	Events	%Events	Avg $L_{max}$
Airbus Industrie A319	8628	37.5%	64.0
Airbus Industrie A320	4881	21.2%	64.0
Boeing 737-800	2294	10.0%	63.5
Boeing 737-400	2191	9.5%	63.6
Airbus A321	895	3.9%	63.7
Boeing 777-200	382	1.7%	64.0
Boeing 747-400	375	1.6%	64.8
De Havilland DHC8-400	341	1.5%	63.6
Boeing 757-200	323	1.4%	63.8
Boeing 767-300	226	1.0%	64.0

## Noise Climate at Billingshurst July 2013 to June 2014

Embraer 190	200	0.9%	63.2
Airbus Industrie A330-200	188	0.8%	64.3
Embraer 175	179	0.8%	63.4
ATR 72	154	0.7%	63.1
Boeing 777-300	126	0.5%	63.5
Boeing 737-300	122	0.5%	63.8
Boeing 787-800 Dreamliner	99	0.4%	63.8
Boeing 757-300	77	0.3%	64.2
Airbus Industrie A330-300	75	0.3%	64.8
Bae 146-200	58	0.3%	64.0

- 5.3 The table below shows the same 20 most frequent aircraft types but rearranged in order of decreasing average maximum aircraft noise event level.

Aircraft Type	Events	%Events	Avg Lmax
Airbus Industrie A330-300	75	0.3%	64.8
Boeing 747-400	375	1.6%	64.8
Airbus Industrie A330-200	188	0.8%	64.3
Boeing 757-300	77	0.3%	64.2
Airbus Industrie A320	4881	21.2%	64.0
Boeing 777-200	382	1.7%	64.0
Airbus Industrie A319	8628	37.5%	64.0
Boeing 767-300	226	1.0%	64.0
Bae 146-200	58	0.3%	64.0
Boeing 737-300	122	0.5%	63.8
Boeing 757-200	323	1.4%	63.8
Boeing 787-800 Dreamliner	99	0.4%	63.8
Airbus A321	895	3.9%	63.7
De Havilland DHC8-400	341	1.5%	63.6
Boeing 737-400	2191	9.5%	63.6
Boeing 777-300	126	0.5%	63.5
Boeing 737-800	2294	10.0%	63.5
Embraer 175	179	0.8%	63.4
Embraer 190	200	0.9%	63.2
ATR 72	154	0.7%	63.1

The average values of  $L_{ASmax}$  displayed in the Tables are for all aircraft noise events for each type of aircraft, i.e. including the relatively small number of departure and overflight events, as well as the predominant number of arrival events. The average values of  $L_{ASmax}$  for arrival and overflight events is, however only slightly different than the average for all events, for example less than 0.5 dB for the most common types of aircraft, Airbus 319 and 320.

- 5.4 Finally the Table below shows the aircraft types which produce the highest average  $L_{ASmax}$  noise levels. It can be seen that for most of these the number of aircraft noise events is very small, and several of them are overflights by helicopters and light aircraft. The helicopter activity is not associated with Gatwick Airport.

List of noisiest (highest average  $L_{ASmax}$  value) aircraft types:

Aircraft Type	Events	%Events	Avg $L_{max}$
Chinook helicopter (military)	10	0.04%	77.5
Puma helicopter (military)	2	0.01%	74.5
Sikorsky S61 helicopter	1	0.00%	73.9
Boeing 777	2	0.01%	73.0
Lynx helicopter (military)	7	0.03%	69.7
Augusta A109 helicopter	19	0.08%	69.5
Sikorsky S76 helicopter	7	0.03%	69.2
Pilatus PC-31 light aircraft	4	0.02%	67.9
Aerospatiale AS65 helicopter	6	0.03%	67.6
Aerospatiale AS50 helicopter	21	0.09%	67.3

- 5.5 From these three tables it can be seen that, the average maximum noise level ( $L_{ASmax}$ ) of aircraft noise events did not vary significantly with aircraft type for the relatively few aircraft types which make up most of the aircraft noise events, and that although there are some aircraft types which produce significantly higher values of  $L_{ASmax}$  there are only very small numbers of these types of events.

## 6.0 Summary and Conclusions

This report presents the results of noise monitoring at a site in Billingshurst, West Sussex, between 12 July 2013 and 25 June 2014. The site is in a garden within the grounds of a village public house, adjacent to a minor road with a major road about 150 m away. The site receives noise from activities associated with the public house and from road traffic as well as from aircraft overhead.

Most of the recorded aircraft noise events (63%) were due to aircraft arrivals, 21% were due to departing aircraft and about 16% were due to overflights; 95% of the events occurred during the daytime, and 5% at night.

The results show that the aircraft noise at the site arises mainly from aircraft arrivals at runway 08R during periods when aircraft departures were to the east. However the average level of noise from aircraft is much lower than that from residual noise from other sources.

A summary of the main noise related parameters for the site at Billingshurst is shown in the Table below:

The report presents analysis and description of the following aspects of the noise data gathered during the noise monitoring programme: the number of aircraft noise events recorded by the noise monitor; the maximum noise levels of these aircraft noise events; the noise climate at the site, including average levels of aircraft noise, total and residual noise at the site; and the contribution of different types of aircraft to the aircraft noise level at the site.

The variation noise climate parameters (including total noise levels and aircraft noise levels) from hour to hour, between day to night, and from month to month have also been described.

The noise climate at the site has been placed into context by comparisons with the results of the 2000 National Noise Incidence Study, and with World Health Organisation Guidelines for Community Noise.

## Noise Climate at Billingshurst July 2013 to June 2014

Summary of the main noise related parameters (12 month average for the period from 21 June 2013 to 25 June 2014) for the site at Billingshurst:

Survey period	12 June 2013 to 25 June 2014
Aircraft noise event trigger level	58 dBA for 10 seconds
Length of noise monitoring period	12 months (approximately)
Number of aircraft noise events	22,500 (after removal of suspected overlong duration noise contaminated events)
% Arrivals and Departures	63% Arrivals, 21 % Departures, (16% overflights)
% DAY and NIGHT	95% Day, 5% Night
Average maximum noise level of events	64 dBA
Average noise level and duration of aircraft noise events	60 dBA, 28 seconds
Average total noise level	58 dBA (Day); 55 dBA (Night)
Average aircraft noise level	49 dBA (Day); 41 dBA (Night)
Average residual noise level	57 dBA (Day); 54 dBA (Night)
Background noise ( $L_{AS90}$ )	47 dBA (Day); 35 dBA (Night)
Daytime level (12 hours)	58 dBA (Total noise); 50 dBA (aircraft noise)
Evening level (4 hours)	56 dBA (Total noise); 42 dBA (aircraft noise)
Day-evening- night level	62 dBA (Total noise); 50 dBA (aircraft noise)

## Noise Climate at Billingshurst July 2013 to June 2014

Figure 1A: Flight paths for a typical day of departures to the west (in green) together with departure routes for both westerly and easterly departures (in blue). The dark blue marker shows the location of the noise monitor at Billingshurst.

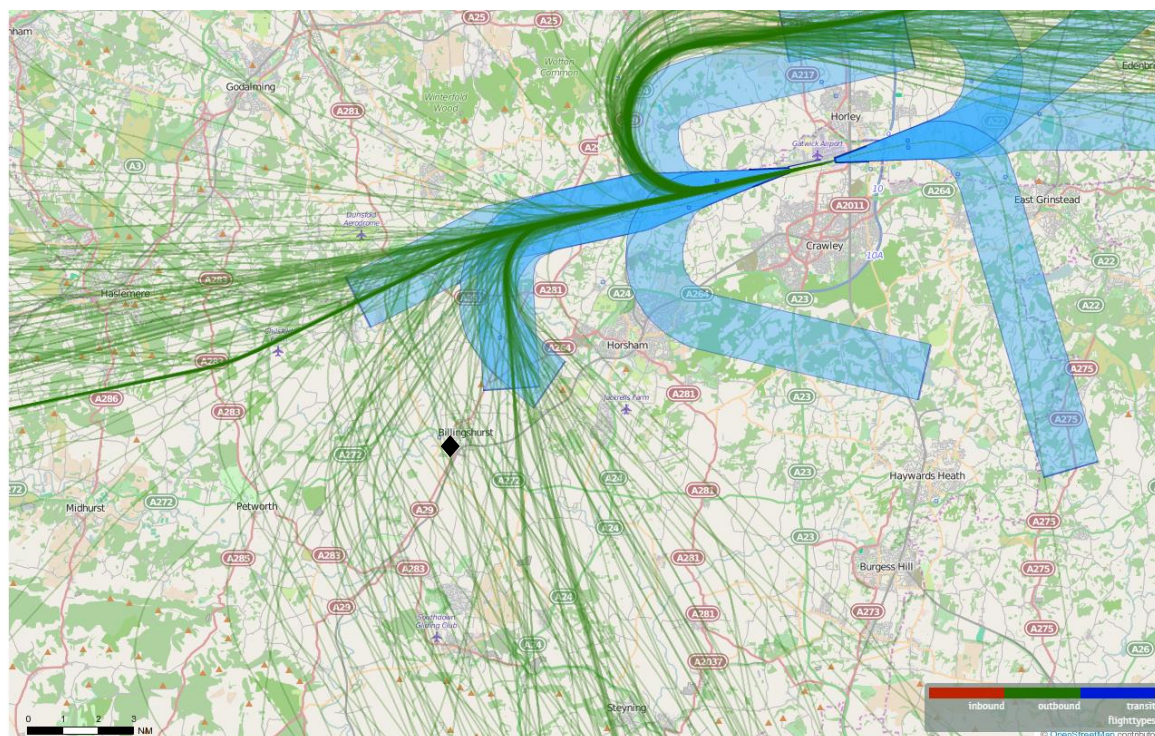
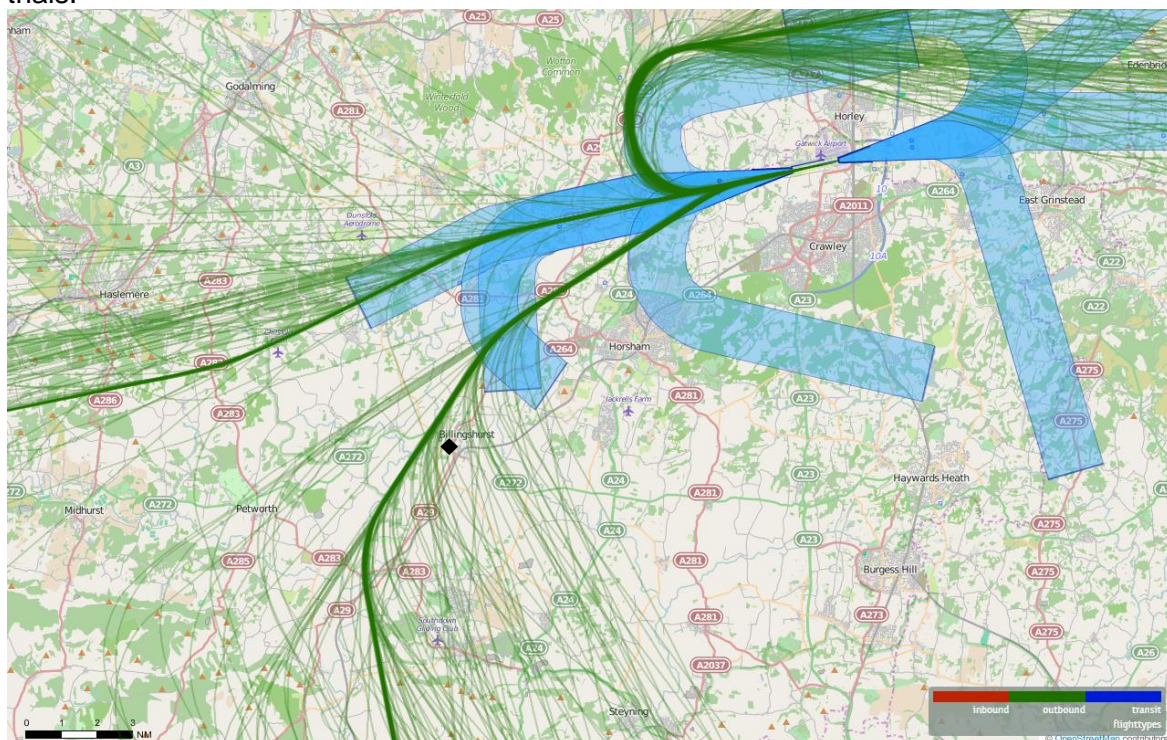


Figure 1B: Flight paths for a typical day of departures to the west during the period of ADNID trials.



# Noise Climate at Billingshurst July 2013 to June 2014

Figure 2A: Arrival flight paths (in red) for a typical day of departures to the east, also showing tracks for aircraft waiting in the holding areas (to the south). The dark blue marker shows the location of the noise monitor at Billingshurst.

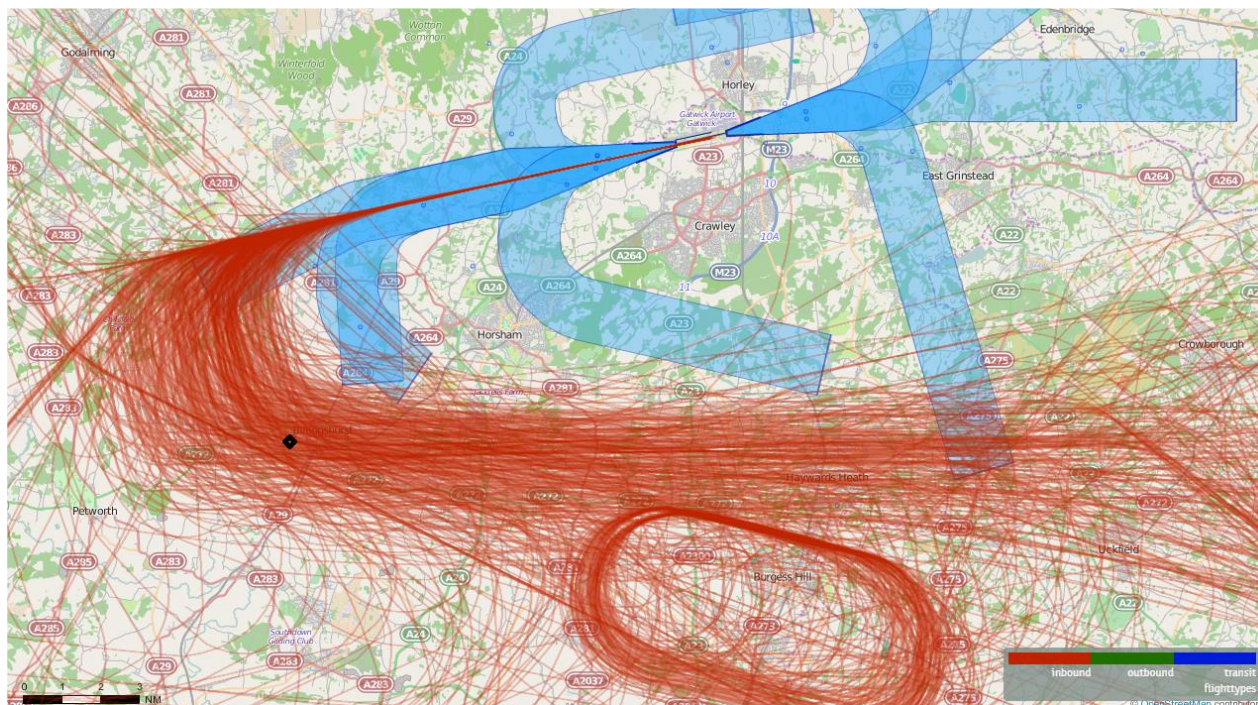
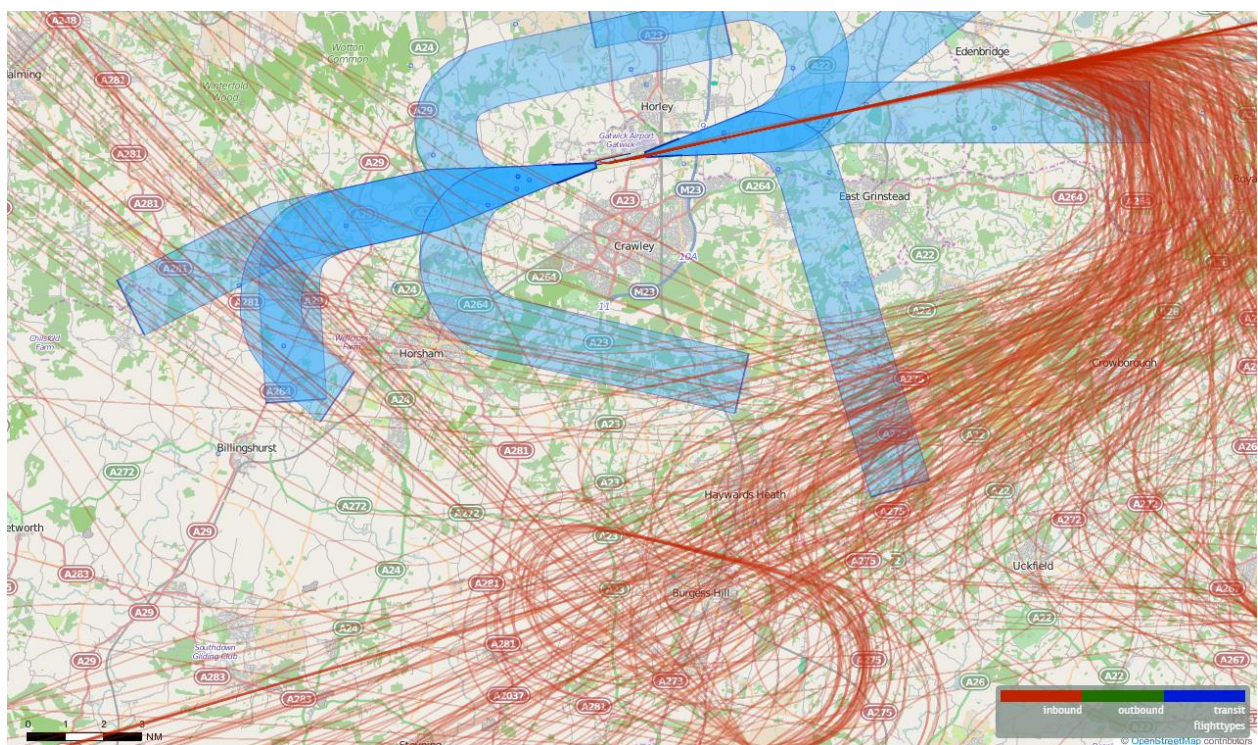
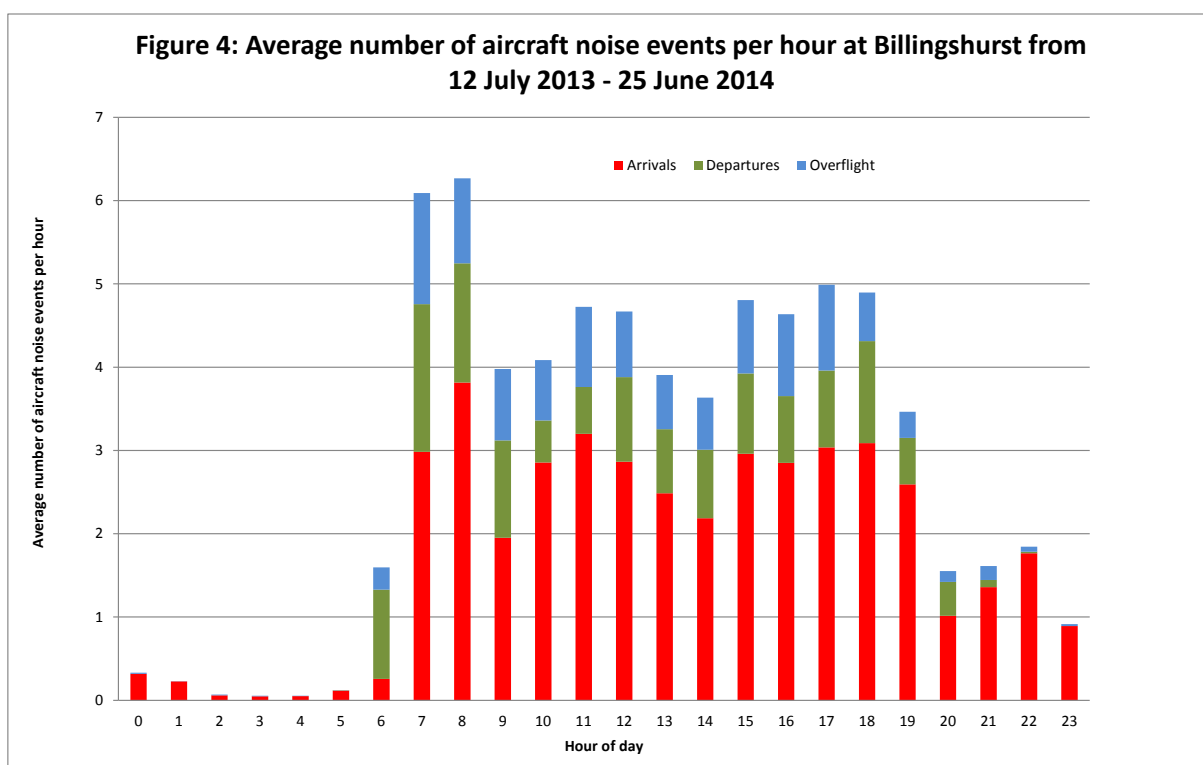
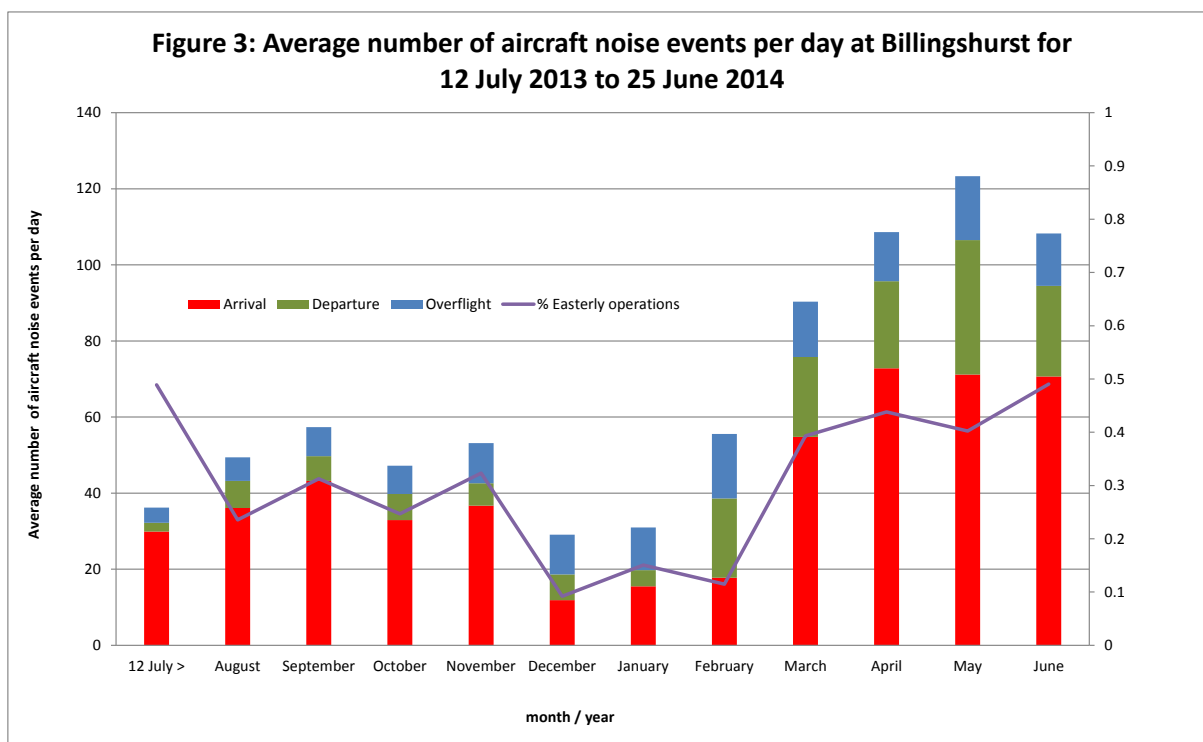


Figure 2B: Arrival flight paths (in red) for a typical day of departures to the west,

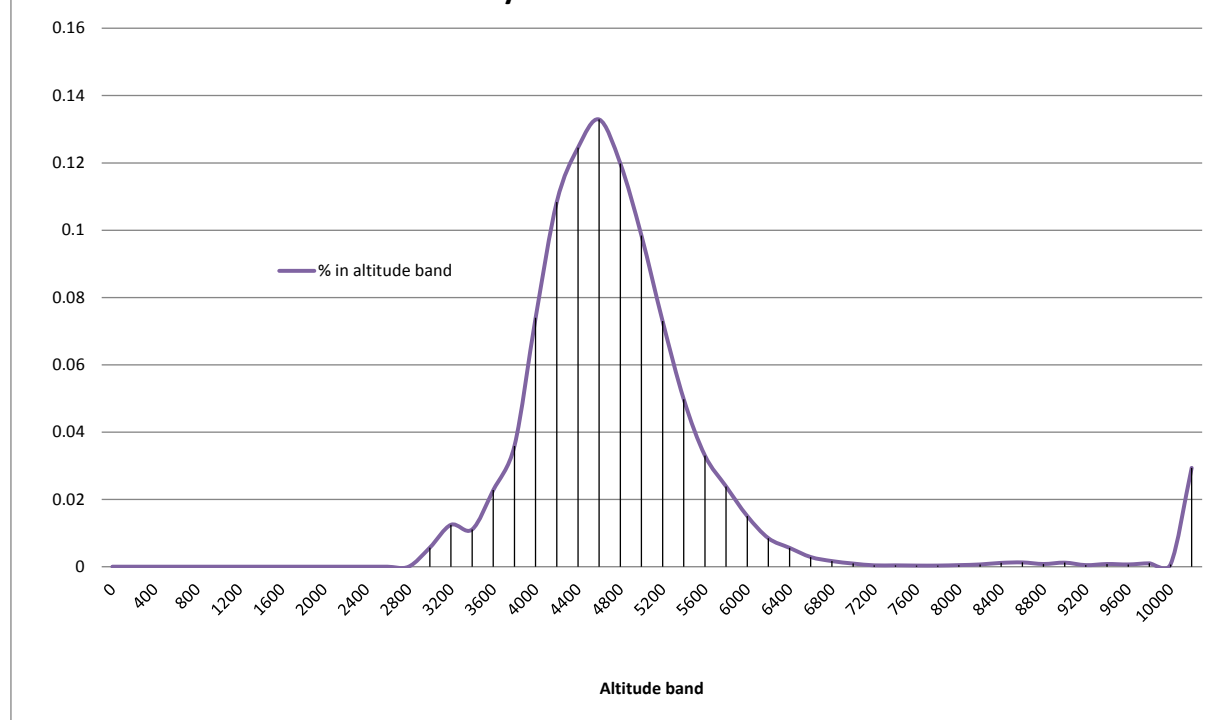


# Noise Climate at Billingshurst July 2013 to June 2014

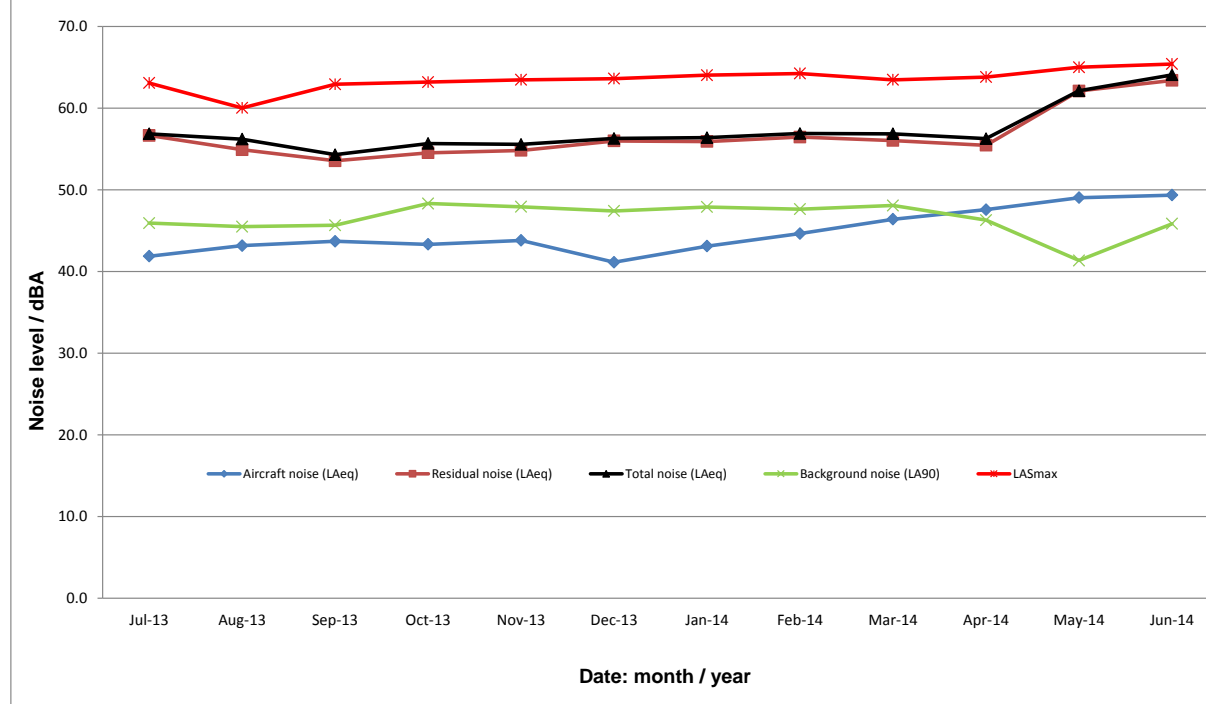


# Noise Climate at Billingshurst July 2013 to June 2014

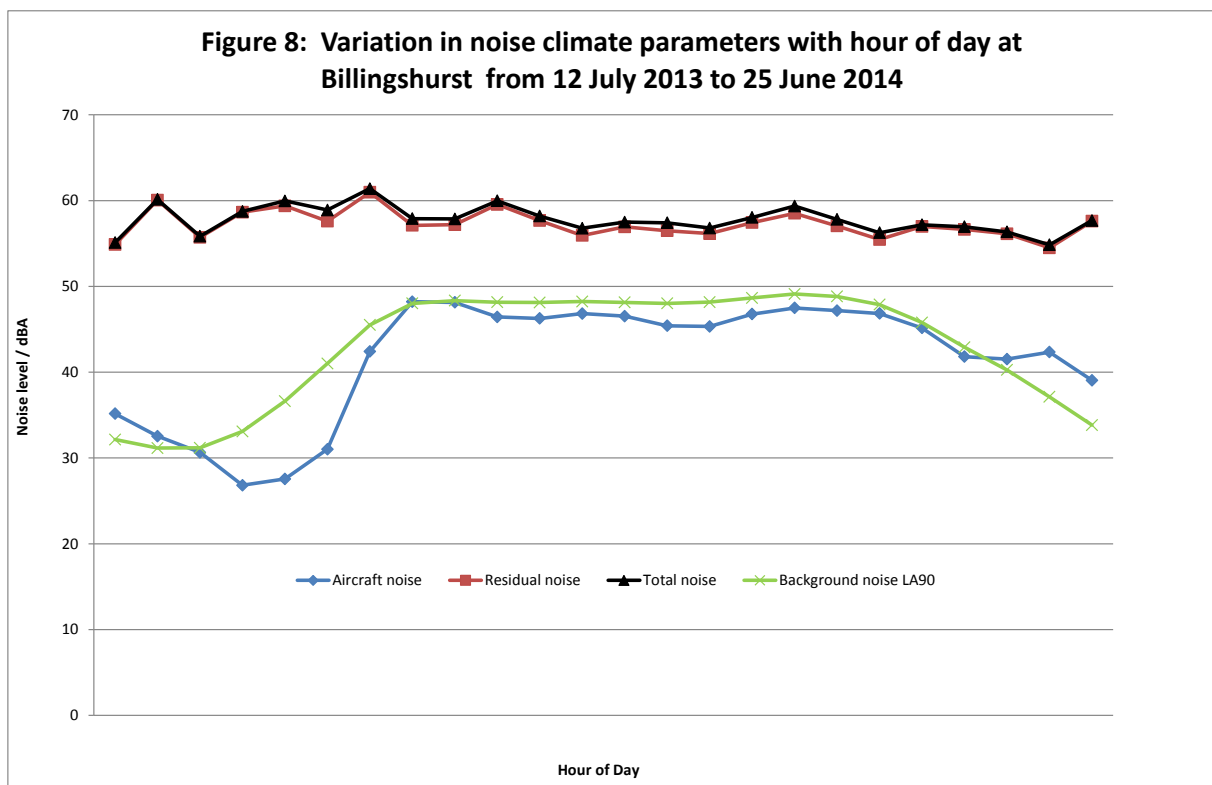
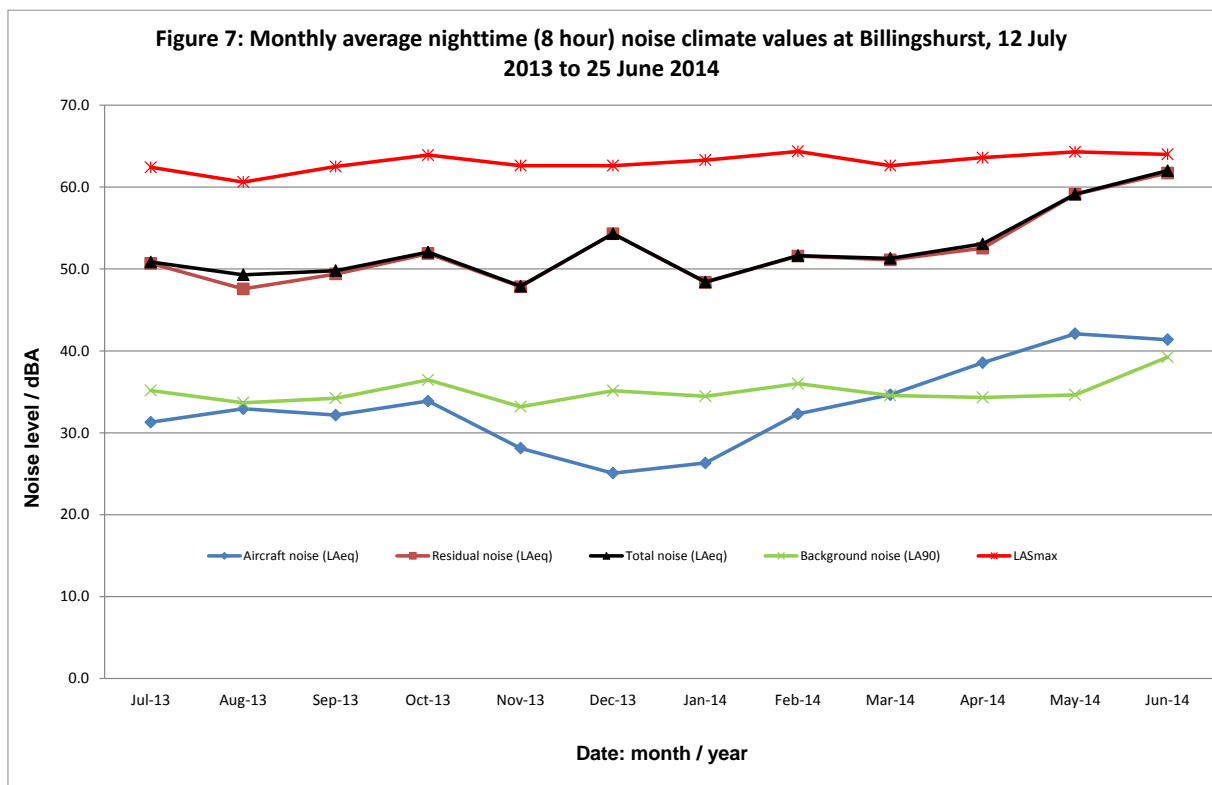
**Figure 5: Altitude bands of arriving aircraft only at Billingshurst  
12 July 2014 to 25 June 2014**



**Figure 6: Monthly average daytime (16 hour) noise climate values at Billingshurst, 12 July  
2013 to 25 June 2014**



# Noise Climate at Billingshurst July 2013 to June 2014



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## APPENDIX 1

### DATA FROM THE NOISE MONITORING TERMINAL



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## Appendix 1

### Data from the Noise Monitoring Terminal

The NMT records all noise regardless of its source. It has, however, the facility to capture and show separately all noise events that meet particular pre-set conditions. This facility is used to capture noise events likely to arise from aircraft flying near to the monitor. The pre-set condition used for this study is that the noise must exceed a level of 58 dBA for a minimum duration of 10 seconds. This is arrived at following preliminary noise measurements at the site, and is broadly similar to conditions set for other such studies. It is of course likely that noise arising from activities other than aircraft using Gatwick Airport will occasionally cause noise events to be captured.

To determine which of all those events are due to aircraft using Gatwick Airport their 'noise to track' matching software compares all captured noise events with Gatwick Airport's air traffic radar tracks. Noise events that are matched to aircraft are combined to provide a measure of 'aircraft noise' and noise events that are not matched to aircraft are included with 'all other noise' (i.e. that noise which is not captured as noise events, because it fails to meet the capture conditions of being above 58dBA for 10 seconds), and is called residual noise.

Therefore wherever reference is made to aircraft noise events within this document it should be understood that these relate only to aircraft using Gatwick airport. Any noise arising from aircraft travelling to or from any other airport will be included as residual noise.

The selection of the threshold conditions (noise level and time period) which trigger the capture of a noise event is a compromise judgement designed to include as much of the noise from passing aircraft as possible whilst at the same time excluding, as far as possible, noise from other sources. For this survey a threshold trigger level 58 dBA for a duration of at least 10 seconds was used.

The following information is recorded for each noise event: date, time, duration, maximum noise level ( $L_{ASmax}$ ) and SEL values, and, in addition, for aircraft noise events, event type (arrival/departure), departure route, runway used, and aircraft type.

In addition to gathering data about noise events the NMT also collects and stores information on an hourly basis about the total level of noise at the site from all sources (including that from aircraft movements), including individual noise events.

Because the noise level is usually not constant, but varies continuously throughout each hour it is necessary to describe the total noise level statistically in terms of a measure of the average noise level throughout the hour (and called the hourly continuous equivalent noise level,  $L_{Aeq}$ ) and also in terms of a series of hourly percentile levels. The most important of these is the  $L_{AS90}$ , which is the noise level exceeded for 90% of each hour. This level of noise is conventionally taken to be a measure of the background noise level for each hour, and is the more or less constant level of noise which underlies the variations caused by various transient sources including aircraft.

By using the Single Event Noise Level (SEL) for each aircraft noise event it is possible to calculate the average, or equivalent aircraft noise level ( $L_{Aeq}$ ) due to aircraft noise events over a period of time (hour, day or month). Although this average noise level

bears little relationship to the aircraft noise as heard, which occurs in short bursts of noise at higher levels rather than as a lower continuous average level, it is, nevertheless, a useful parameter for comparative purposes, and is an internationally agreed parameter for the measurement of environmental noise, including aircraft noise.

#### Residual noise levels

Since the NMT also records hourly  $L_{Aeq}$  values of the total noise from the site it is possible, by subtracting the aircraft noise level from the total noise level (using the decibel (or logarithmic) subtraction process which is appropriate in this case) to calculate the remaining component of the total noise, i.e. the residual noise level.

The residual noise is a combination of the noise from residual noise events (i.e. those captured noise events which did not match with aircraft movements) and from other residual noise, not captured as noise events, i.e. all other noise recorded by the monitor that did not exceed the trigger level for the required minimum time period.

It is therefore possible that the residual noise could also include some noise from aircraft arriving at, or departing from Gatwick, as well as from overflights, which was below the trigger level. Conversely it will sometimes be possible that some non-aircraft noise, i.e. residual noise might be captured as part of aircraft noise event. This could happen for example if a burst of residual noise occurred at the same time as an aircraft was passing overhead.

The first possibility, i.e. residual noise being counted as aircraft noise will lead to an increase in reported residual noise levels, and the second possibility, i.e. of residual noise being counted as aircraft noise, will lead to an increase in reported levels of aircraft noise level. Previous investigations have shown that in both cases these effects on the reported levels are small, and not considered to be significant, and are incorporated within the levels of uncertainty reported below.

#### Combined Uncertainty

This report includes results from calculations made using average noise measurement values from the 12 month monitoring period of aircraft noise level ( $L_{Aeq,T}$ ), total noise level ( $L_{Aeq,T}$ ), residual noise level ( $L_{Aeq,T}$ ), background noise level ( $L_{AS90}$ ) and maximum noise level (of aircraft noise events),  $L_{ASmax}$ .

Taking into account all the causes of variability that affect the values of these parameters, including, for example: weather conditions affecting sound propagation, variability of the noise emission and flight tracks of individual aircraft noise events, the accuracy of the noise level measurements produced by the NMT, it is considered that the estimated combined uncertainty is +/- 2 dB.

## APPENDIX 2

### GLOSSARY OF ACOUSTIC TERMS



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## GLOSSARY OF TERMS

This glossary is presented in two parts. The first part contains definitions relating specifically to the context of this report, followed, in the second part, by a more general glossary of acoustic terms.

### Definitions relating specifically to the context of this Report:

**ADNID** is a SID (Standard Instrument Departure) technical departure route trial which diverges left of the runway centreline by 21 degrees after only 1.6nm whereas the R-NAV (Radio Navigation) BOGNA SID maintains the runway centreline for 8.1nm before tracking to the south.

### Aircraft noise contours

Two types of aircraft noise contours have been produced; those based on the average daytime aircraft noise levels ( $L_{Aeq16hour}$ ), and those based on the  $L_{den}$  parameter, introduced for noise mapping purposes

$L_{Aeq16hour}$  aircraft noise contours have been produced annually and displayed on the Defra website for many years (approximately since 1990, when they replaced NNI contours) for various UK airports, including Heathrow, Gatwick and Edinburgh. The latest contours which are available are for the year 2010.

### $L_{den}$ contours

The 24 hour day-evening-night noise index ( $L_{den}$ ) has been introduced by the EU for noise mapping purposes. This index is based on average levels of aircraft noise ( $L_{Aeq}$  values) throughout the day but with a weighting penalty of 5 dB applied to noise in the evening (19.00 hours to 23.00 hours) and a 10 dB penalty at night-time (23.00 hours to 07.00 hours).

All UK airports have been required to produce Action Plans based on  $L_{den}$  aircraft noise contours as part of the Noise mapping exercise. Accordingly contours of  $L_{den}$  were produced for the year 2006 (ERCD Report 0708) to meet the requirements of the first round noise mapping exercise Under EU Directive 2002/49/EC.  $L_{night}$  ( $L_{Aeq,8hour}$ ),  $L_{day}$  and  $L_{evening}$  contours were also produced as part of this exercise.

The  $L_{Aeq16hour}$  contours are based on the average summer day, where 'summer' is the 92-day period from 16 June to 15 September, and 'day' is the 16-hour period 0700-2300 (local time). They are produced in 3 dB steps from 57 dBA to 72 dBA. The 2006  $L_{den}$  contours were produced in 5 dB steps with the lowest (outermost contour) being for  $L_{den}$  of 55 dBA and were based on data for an average day over the whole year (2006).

**Aircraft Noise events** Noise events which have been matched by the airport's noise and track keeping system to radar tracks in the vicinity of the NMT from aircraft arriving at or departing from Gatwick airport.

## Noise Climate at Billingshurst, July 2013 to June 2014

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**Aircraft noise level** The average noise level derived from aircraft noise events, aggregated into hourly, daily or monthly average (LAeq) values.

**ANOMS/ Casper BV** Airport Noise and Operations Monitoring System. The software data analysis system (incorporating the NTK system) which was in use at the airport until March 2013. The ANOMS system has been replaced by the Casper BV noise and track keeping system, which came into operation on 1 April 2013.

### Applied Acoustic Design (AAD)

Acoustic consultants retained by Gatwick Airport Ltd.

**Average L<sub>ASmax</sub> level** The arithmetic average of the L<sub>ASmax</sub> values of all the events (of a particular type i.e. either aircraft noise or community noise) which occur over a particular period of time (eg hour, day or month).

### Building Research Establishment

A former government organisation, now privately owned, which conducts research on noise. Carried out the National Noise Incidence Study for Defra in 2000.

**Defra** UK government Department for Environment Food and Rural Affairs, which has responsibility for aspects of policy relating to environmental noise

### Flight Performance Team

The unit within Gatwick Airport which monitors all aircraft movements to ensure compliance with Department for Transport noise regulations relating to track keeping, noise abatement and night flights, and which also provides a means of investigating and responding to complaints and enquiries from the public.

### Instrument Landing System (ILS)

An instrument landing system (ILS) is a ground-based instrument approach system that provides precision guidance to an aircraft approaching and landing on a runway, using a combination of radio signals and, in many cases, high-intensity lighting arrays to enable a safe landing during instrument meteorological conditions, such as low ceilings or reduced visibility due to fog, rain, or blowing snow. The standard glide-slope path is 3° downhill to the approach-end of the runway.

### National Noise Incidence Study 2000

A study carried out by the Building Research Establishment for Defra based on a survey of noise levels outside 1020 dwellings in England and Wales in 2000, and extended to the whole of the UK in 2001, giving proportions of the population exposed to various levels of environmental noise.

A second National Noise Incidence study was carried out in 2000. A comparison of the data from the two studies indicated that although there were some changes, much about the noise climate in England and Wales had not changed significantly over the 10 year period. Therefore the 2000 study remains a good basis for setting the noise levels from this study at Leigh into a wider context.

#### National Planning Policy Framework

On 27th March 2012 the National Planning Policy Framework replaced all previous planning guidance including PPG24 (see below). However Local Authorities which have an adopted Core Strategy, which refers to PPG24, have 12 months to incorporate guidance on transport noise into their Core Strategy and during those 12 months it is generally considered that PPG24 can still be relied upon as the main guidance for transport related noise issues.

#### Noise event

A burst of noise at a high level which satisfies the noise event capture conditions for a particular NMT, i.e. which exceeds the pre-set trigger noise level (in this report 58 dBA) for a pre-set time interval (in this report 10 seconds).

Noise events are detected, captured and stored by the NMT, and following subsequent processing by the NTK system are classified in this report as either aircraft noise events or community noise events

#### Noise Monitoring Terminal (NMT)

The noise measurement and analysis system installed at each site consisting of a precision grade sound level meter (Larson Davis type 870) inside a weather proof and tamper proof metal cabinet connected to an outdoor microphone located at a height of approximately 3.5 m above ground level.

#### NTK system Noise and Track Keeping system.

A software system able to match noise events recorded by the NMTs with aircraft tracks.

#### PPG24 Planning Policy Guidance Note 24:Planning and Noise

A document issued by the UK government Department for the Environment in 1994 which gives guidance to local authorities and others on noise and planning.

On 27th March 2012 the National Planning Policy Framework (see above) replaced all previous planning guidance including PPG24..

#### Residual noise

All noise arriving at the NMT microphone apart from aircraft noise events, i.e. comprising residual noise events and all other noise which does not satisfy the trigger conditions for capture as a noise event.

## Residual Noise events

Those noise events which have not been matched by the NTK system to aircraft tracks using Gatwick Airport in the vicinity of the NMT.

## Statistical frequency Analysis (of $L_{ASmax}$ noise levels)

An analysis of a group of  $L_{ASmax}$  values giving the numbers of events (or percentages of total numbers) at different dBA levels

**Total noise** All noise arriving at the NMT microphone, i.e. not only including all noise events (both aircraft and residual) but also all other noise which does not satisfy the trigger conditions for capture as a noise event.

**Total noise level** The average or continuous equivalent level ( $L_{Aeq}$ ) of the total noise at the site, recorded each hour by the NMT, which may also be aggregated into daily or monthly values.

**Total noise climate** The level of the total noise at the NMT microphone varies with time. Over a particular period of time e.g. one hour, this variation may be described in terms of a number of different noise indices including the average or equivalent noise level, maximum and minimum noise level values and various percentile levels.

Such a description constitutes the noise climate at the site over that period of time.

The NMT records the following total noise indices every hour:  
 $L_{Aeq}$ ,  $L_{ASmax}$ ,  $L_{AS10}$ ,  $L_{AS50}$ ,  $L_{AS90}$  and  $L_{AS99}$ .

## World Health Organisation (WHO)

Issued 'Guidelines for Community Noise' in 2000.

## A general Glossary of acoustic Terms:

**A-weighting** A method of producing a single figure measure of a broad band noise (as opposed to the 8 or 9 figures which make up an octave band spectrum) which takes into account, in an approximate way at least, the frequency response of the human hearing system. The idea is that sound levels measured in this way should give an indication of the loudness of the sound.

## A-weighted sound pressure level (dBA).

The value of the sound pressure level, in decibels, measured using an A-weighting electronic circuit built into the sound level meter. The vast majority of noise measurements are carried out in this way.

Day, evening, night level,  $L_{den}$

An index of environmental noise based on average noise levels ( $L_{Aeq}$ ) throughout the 24 hour period, but with a weighting factor of 5 dBA added to evening noise levels (19.00 to 23.00 hours), and a weighting of 10 dB added to night-time noise levels (23.00 to 07.00 hours). It is the noise index used in the UK Noise mapping exercise commissioned by Defra in response to the European Union Directive on Environmental Noise in 2002.

Decibel scale

The decibel scale is the scale on which sound pressure levels are commonly measured. It is a logarithmic scale and is used for convenience to compress the audible range of sound pressures into a manageable range, from 0 dB to 140 dB. The zero of the scale, 0 dB, corresponds to the notional threshold of hearing, 0.00002 Pa, and the upper limit, 140 dB, corresponds to 20 Pa, which would cause immediate damage to the ear.

Equivalent continuous sound level ( $L_{Aeq,T}$ ), also called the Average noise level.

The  $L_{Aeq,T}$  represents a measure of the 'average' sound level over the measurement period. It corresponds to the steady continuous level of sound which, over the same period of time, T, would contain the same amount of (A-weighted) sound energy as the time varying noise.

This is the most common method of measuring time varying noise, and within certain limits gives the best correlation with human response to noise, for example with annoyance.

Frequency

The frequency of a musical note is what gives it its pitch. It is the number of cycles of the fluctuating sound pressure which occur each second, and is measured in cycles per second, Hertz (Hz). The human ear can detect frequencies in the range 20 to 20000 Hz.

Most noises are a mixture of all frequencies, called broad-band noise.

$L_{AS90,T}$

This is the most commonly used of many possible statistical measures of a time varying noise. It is the 90<sup>th</sup> percentile of the statistical noise level distribution, or, more simply, the noise level that is exceeded for 90% of the measurement time (T). Thus over one hour for example it represents the noise level which is exceeded for all but (the quietest) six minutes of that hour.

It is commonly used as a measure of the background noise in any given situation, against which the level of any new, potentially intrusive source of noise is often compared. Background noise itself often varies with time and so the  $L_{A90,T}$  is almost universally used as the best measure of the 'more or less always present' noise level which underlies short term variations from other sources of noise.

Although it is more usual to measure LA90 using the F weighting, the Slow weighting has been used for the data in this report, i.e. LAS90. It is not considered that the use of the S weighting will make any

significant difference to the LA90 values in this case. (See under Time Weighting, Fast(F) and Slow(S)) below.

#### Maximum sound pressure level ( $L_{ASmax,T}$ )

This is the highest value of the time weighted sound pressure level, (measured using the A frequency weighting and the Slow time weighting) which occurred during the measurement period, T. It is commonly used to measure the effect of very short duration bursts of noise, such as for example sudden bangs, shouts, car horns, emergency sirens etc. which audibly stand out from the general level of, say, traffic noise, but because of their very short duration, maybe only a very small fraction of a second, may not have any effect on the  $L_{Aeq,T}$  value.

In the context of this report the  $L_{ASmax}$  value for each aircraft noise event and community noise event is monitored

In this report, in line with standard practice for aircraft noise measurement, the Slow (S) time weighting has been used for measurement of maximum levels of aircraft noise, hence reference is made to  $L_{ASmax}$ . (See under Time Weighting, Fast(F) and Slow(S)) below.

Noise Unwanted sound

Octave band spectra In order to investigate the frequency content of broad band sounds, called its frequency spectrum, measurements of sound pressure are carried out over a range of frequency bands. The most common method is to split the audio frequency range into 8 or 9 octave bands. An octave is a frequency range from one particular frequency to double that frequency.

Octave band measurements are not referred to in this report.

#### Percentile noise level, ( $L_{ASN}$ , where N is a number between 0 and 100)

The noise level which is exceeded for N% of the measurement period. For example, a value of  $L_{A10,1hour}$  of 57 dBA means that in that hour the noise level was at or above 57 dBA for 6 minutes (i.e. 10% of an hour), or alternatively, was at or below 57 dBA for 54 minutes.

#### Sound exposure level (SEL)

This is a measure of the A-weighted sound energy used to describe single noise events such as the passing of a train or aircraft; it is the A-weighted sound pressure level which, if occurring over a period of one second, would contain the same amount of A-weighted sound energy as the event.

SEL values for events may be used to calculate the average noise level over a period of time (hour, day or month)

**Sound pressure**      sound is a disturbance or fluctuation in air pressure, and sound pressure, measured in Pascals (Pa), is used as a measure of the magnitude of the sound. The human ear can detect sound pressures in the range from 0.00002 Pa to 20 Pa. This is an enormously wide range and so for convenience sound pressures are commonly measured on a decibel (dB) scale.

**Time varying noise**      When the level of noise varies with time, as is often the case, for example with noise from road traffic, various measures or noise indices as they are called are used to give a single figure description of the noise over a given period of time. The three most commonly used noise indices are the  $L_{Aeq,T}$ , the  $L_{A90,T}$  and the  $L_{Amax,T}$  values.

In all three cases the 'L' stands for the level of the sound in decibels, the 'A' for the fact that it is the A- weighted value, and the 'T' for the time period over which the noise is measured, for example 5min, 1 hour, 24 hour etc.

**Time weighting (Fast (F) and Slow (S))**

An exponential function of time, of a specified time constant, that weights the square of the instantaneous sound pressure. (Defined in BS EN 61672 – 1:2003).

There are two time constants defined in BS EN 61672 – 1:2003, designated Fast (F) and Slow (S), and noise indices such as the maximum, or percentile noise levels which are based on instantaneous time-weighted sound pressure should indicate which time weighting has been used in the measurement.

In this report, in line with standard practice for aircraft noise measurement, the Slow (S) time weighting has been used for measurement of maximum levels of aircraft noise, hence reference is made to  $L_{ASmax}$ . Because the sound level meter cannot measure using both Fast and Slow weightings simultaneously this necessarily means that the 90th percentile values have also been measured using the S weighting, hence reference is made to  $L_{AS90}$ . Although it is more usual to measure  $L_{A90}$  using the F weighting, it is not considered that the use of the S weighting will make any significant difference to the  $L_{A90}$  values in this case.