Environmental Research and Consultancy Department
Directorate of Airspace Policy
Civil Aviation Authority

ERCD Report 0601

Noise Exposure Contours for Heathrow Airport 2005

D J Monkman
D P Rhodes
J Deeley

Prepared by the Civil Aviation Authority on behalf of the Department for Transport, London, December 2006

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SUMMARY

This report describes the calculations of the aircraft noise exposure around London Heathrow Airport for the year 2005 and compares both the input data and the resulting contours, together with the areas and populations within the contours, with those for 2004.

Prepared by the CAA on behalf of the Department for Transport, December 2006

The authors of this report are employed by the Civil Aviation Authority. The work reported herein was carried out on behalf of the Department for Transport.

Any views expressed are not necessarily those of the Secretary of State for Transport.

Population data used in this report are based on 2001 Census data (updated in 2003 and 2004) supplied by CACI Information Services.

EXECUTIVE SUMMARY

For every year, the Environmental Research and Consultancy Department (ERCD) of the Civil Aviation Authority estimates the noise exposures around the London Airports (Heathrow, Gatwick and Stansted) on behalf of the Department for Transport (DfT). The magnitude and extent of the aircraft noise around these airports are depicted on maps by *contours* of constant aircraft noise index (Leq) values. The contours are generated by a computer model validated with noise measurements, which calculates the emissions and propagation of noise from arriving and departing air traffic.

This report presents the results for London Heathrow Airport for the year 2005 and compares both the air traffic information and the noise contours with those for 2004. As for 2004, the 2005 contours shown in this report take into account the topography around Heathrow by accounting for terrain height in the modelling process.

Estimates of the populations within the 2004 contours are based on the 2001 census (updated by CACI in 2003), populations within the 2005 contours are also based on the 2001 census but updated by CACI in 2004.

The average daily aircraft movement rate during the Leq period was 1.1% lower in 2005 than in 2004. The actual modal split of runway direction in 2005 was 71% west - 29% east compared with 81% west – 19% east in 2004. The standard modal split (20 year average) in 2005 was 76% west – 24% east.

Relative to 2004, the total area within the 2005 terrain adjusted 57 dBA Leq (16-hour) contour decreased by 0.2% and the population within this contour increased by 5%.

CONTENTS **Page No**

1 INTRODUCTION

1.1 The amount of aircraft noise experienced by people living around London (Heathrow) Airport during the summer (mid June – mid September) of each year is estimated by the Environmental Research and Consultancy Department of the Civil Aviation Authority on behalf of the Department for Transport (DfT). The noise exposure measure is the Equivalent Continuous Sound Level, Leq (16-hour) in dBA. The background to the use of this index is explained in DORA Report 9023 (Ref 1). The method by which noise maps, or contours of Leq, are prepared using the ANCON Noise Model is described in DORA Report 9120 and R&D Report 9842 (Refs 2 and 3). Following work into updating European noise modelling guidance, which has culminated in an updated ECAC Document 29[1] ('Methodology for Computing Noise Contours around Civil Airports'), the ANCON model itself was also amended prior to production of the 2005 contours.

1.2 The updated ANCON Noise Model (version 2.3) now incorporates revised algorithms for an improved lateral attenuation adjustment. These revised lateral attenuation algorithms, together with other improvements to the ANCON noise model are described in a separate document (Ref 4). The effects of the changes on the 2005 contours are discussed in paragraph 3.2.2 but more detailed comparisons of the effects of the changes on the contours are given in Reference 4. Technical terms used here are described in those references.

1.3 This report contains small scale (1:200,000) diagrams of the 2005 Heathrow Leq contours. Contours overlaid on Ordnance Survey (OS) digital maps, or in AutoCad DXF format, are available for download from the Department for Transport website at www.dft.gov.uk. Additionally, printed contours overlaid on OS maps to scale 1:50,000 are available for purchase from the Department for Transport, Aviation Environmental Division, Zone 1/22, Great Minster House, 76 Marsham Street, London, SW1P 4DR, telephone 020 7944 5494, e-mail address aed@dft.gsi.gov.uk.

1.4 This report provides supporting information and compares both the aircraft operations and the resulting noise contours with those for 2004 (Ref 5).

1.5 New analyses of radar and noise data were undertaken in 2005, and the calculations incorporate revised mean tracks and associated dispersions for departing aircraft, together with revised 'spurs' to model the arrival flight track dispersion. Height/speed departure and arrival profiles have also been updated for each aircraft type where the data has shown this to be necessary.

1.6 To remove the effect of year-on-year weather fluctuations on aircraft operations in order to clarify underlying trends, two sets of contours for 2005 have been generated; (i) the *actual* modal split and (ii) the "*standard"* modal split. In 2005 the actual modal split was 71% west - 29% east compared to 81% west – 19% east in 2004. For 2004 the standard modal split was 77% west - 23% east (based on the 20 year Leq period average 1985 to 2004 inclusive); for 2005 the standard modal split was 76% west – 24% east (based on the 20 year Leq period average 1986 to 2005 inclusive). This report compares actual and standard contours for 2004 and 2005.

1.7 As in 2004, the 2005 contours shown in this report take into account the topography around Heathrow by accounting for terrain height in the modelling process. This was achieved by geometrical corrections for source-receiver distance and elevation angles, other more complex effects such as lateral attenuation from uneven ground

[1] ECAC Document 29 3rd Edition was approved by the Directors General in December 2005 and published on the ECAC web site (www.ecac-ceac.org) in July 2006. ERCD played a major role in the production of the proposal, in particular the formulation and implementation of revised algorithms for an improved lateral attenuation adjustment.

surfaces and noise screening/reflection effects due to topographical features were not taken into account. ERCD holds terrain height data[2] obtained from Ordnance Survey on a 200m by 200m grid for England and Wales. Interpolation was performed to generate height data at each of the calculation points on the 100m by 100m receiver grid for use by the ANCON noise model.

2 AIRCRAFT OPERATIONS

2.1 Flight Tracks

2.1.1 The 2005 calculations were based on updated mean tracks and track dispersions for all outbound routes from Runways 27L, 27R, 09R and 09L (see Figure 1 for route designations). These were determined from radar data (extracted from the airport's Noise and Track Keeping (NTK) monitoring system) for the summer of 2005. As in 2004, there were some departures from Runway 09L during the 2005 Leq period (1.04% of the total easterly departures) and mean tracks and track dispersions were defined for these operations.

2.1.2 Radar measurements of arrival tracks between the stacks and Runways 27L, 27R, 09L and 09R confirmed that the continued use of evenly spaced 'spurs' remained a realistic method for modelling the dispersion of arrival tracks about the extended runway centre lines. The majority of aircraft joined the centre lines at distances greater than 12 kilometres – only a very small number joined at shorter distances.

2.2 Flight Profiles and Noise Emissions

2.2.1 For 2005, the average flight profiles of height and speed versus track distance for each aircraft type were reviewed, and updated where necessary, for both departures and arrivals. For the 2005 calculations, two additional aircraft types (the Embraer E-170 and the B777-300G) were added to the database. Noise event levels were then determined from a database expressing SEL[3] as a function of engine power setting and slant distance to the receiver – the so-called 'noise-power-distance (NPD)' relationship. The engine power settings required for the aircraft to follow the measured average height and speed profiles were calculated from data describing aircraft performance characteristics within each of the different aircraft type categories.

2.2.2 Following extensive noise measurements of arrivals to Heathrow (and Gatwick and Stansted) in 2005, the Airbus A320 family of aircraft have had their noise levels increased slightly (by about 1dB) at distances ranging from 8 to 20 kilometres from the landing runway threshold.

2.3 Traffic Distribution by Aircraft Type and Route

2.3.1 The aircraft movements conventionally used to determine Leq are the daily averages of those which take place in the 16-hour day, 0700-2300 local time, during the 92-day period 16 June to 15 September inclusive. Table 1, which displays the distribution of movements by aircraft type, shows that the 2005 average Leq (16-hour) day movement rate was 1.1% lower than in 2004. Traffic levels during the summer 2005 Leq period were affected by 3 days of industrial action and possibly by the terrorist attacks in central London on the 7th July.

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2 Meridian® 2 data revised 2005.

3 Sound Exposure Level in dBA; a measure of noise event level which accounts for both the duration and intensity of noise.

2.3.2 Table 2 compares the distribution of aircraft departures by route for 2004 and 2005. The percentages of use of each runway direction - the "modal split" - for 2005 were 71% west - 29% east compared to 81% west – 19% east in 2004.

2.3.3 The table below lists the 'average summer day' movements by eight noise classes of aircraft (ranked in ascending order of noise emission, i.e. from least to most noisy) during 2004 and 2005. Table 1 and Figure 2 (at the end of the Report) state which specific aircraft types fall into which categories.

NOISE CLASS	AIRCRAFT	AVERAGE NUMBER 2004	AVERAGE NUMBER 2005	PERCENTAGE OF TOTAL 2005 MOVEMENTS	CHANGE AS PERCENTAGE OF TOTAL 2004 MOVEMENTS
	PROPELLER AIRCRAFT				
1	Small props	0.3	0.4	0.0	0.0
2	Large props	9.8	9.3	0.7	0.0
	CHAPTER 3 JETS				
3	Short-haul	852.2	841.1	67.4	-0.9
4	Wide-body twins	230.8	228.7	18.3	-0.2
5	2nd gen wide body multis*	161.7	161.9	13.0	0.0
	LARGE CHAPTER 2/3 JETS				
6	1st gen wide-body multis*	7.6	6.4	0.5	-0.1
	2 nd GENERATION TWIN JETS				
7	Narrow body twins (including Chapter 2 and hushkitted versions)	0.0	0.4	0.0	0.0
	1 st GENERATION JETS				
8	Narrow body multis (including hushkitted versions)	0.6	0.5	0.0	0.0
	TOTAL MOVEMENTS	1263.0	1248.7	100.0**	-1.1**

* Multi-engined (3 or 4) aircraft
** May not sum exactly due to rounding

2.3.4 It can be seen from the above table that the average numbers in each noise class for 2005 are very similar to those for 2004, the largest difference being short haul Chapter 3 jets (noise class 3) which fell from 852.2 per day in 2004 to 841.1 per day in 2005.

2.3.5 Figure 2 illustrates the changing distribution of traffic among these noise classes over the twenty-two years from 1984 to 2005[4] inclusive.

[4] The 1990 to 2005 percentages shown in Figure 2 relate to the average 16 hour Leq-day; before 1990 the percentages relate to the average 12 hour NNI-day (0700-1900 Local Time). Also, the percentages before 1992 are based on departures only, from 1992 they relate to total movements.

3 NOISE CONTOURS

3.1 'Actual' contours

3.1.1 The actual Leq contours for 2005 (i.e. those depicting actual terrain adjusted average mode Leq exposures), from 57 to 72 dBA in steps of 3dB, are overlaid on a background map in Figure 3. In Figure 4, three of these, for 57, 63 and 69 dBA Leq, are compared with the actual contours for 2004. Immediately apparent from Figure 4 is the effect on the contours due to the change in modal split. The 2005 contours associated with westerly departures have generally decreased whilst those associated with easterly departures have increased reflecting the 10% change in modal split between the two years.

3.1.2 The total areas and populations[5] enclosed by each of the contours are listed below:

Leq LEVEL dBA	AREA SQ KM		PERCENTAGE CHANGE	POPULATION 000's		PERCENTAGE CHANGE
	2004 ACTUAL	2005 ACTUAL		2004 ACTUAL (2003 CACI data)	2005 ACTUAL (2004 CACI data)	
>57	117.4	117.2	-0.2	239.7	251.7	+5.0
>60	66.7	64.4	-3.4	105.3	110.5	+4.9
>63	40.3	39.1	-3.0	55.9	51.8	-7.3
>66	24.4	23.7	-2.9	21.0	16.4	-21.9
>69	13.3	12.4	-6.8	5.7	3.9	-31.6
>72	6.5	6.5	0.0	1.5	0.8	-46.7

Percentage changes in contour areas and populations are not necessarily the same because the contours differ in shape as well as size.

Relative to 2004, the areas within the 2005 actual 57 to 69 dBA Leq contours decreased ranging from 6.8% at 69 dBA Leq to 0.2% at 57 dBA Leq. At 72 dBA Leq the area was unchanged. Based on the updated 2004 CACI data, the population enclosed within the actual 2005 57 dBA Leq contour increased by 5.0% (using the earlier 2003 CACI data would have yielded an increase of 5.4%).

[5] The population estimates shown in this Report are based on 2001 census data (updated by CACI Ltd in 2003 and 2004). Note also that area and population figures presented in this Report are cumulative.

3.2 '**Standard' contours**

3.2.1 In Figure 5 the standard terrain adjusted 2005 contours (57, 63 and 69 dBA Leq) are compared with those for 2004. This shows what the noise exposures would have been if the 2004 and 2005 modal splits had mirrored the 20-year rolling average. The 2004 standard contours were based on the 20 year average modal split from 1985 to 2004 inclusive of 77% west - 23% east; those for 2005 were based on the 20 year average modal split from 1986 to 2005 inclusive which was 76% west - 24% east. The associated contour areas and populations are displayed below:

Leq LEVEL dBA	AREA SQ KM		PERCENTAGE CHANGE	POPULATION 000's		PERCENTAGE CHANGE
	2004 STANDARD	2005 STANDARD		2004 STANDARD (2003 CACI data)	2005 STANDARD (2004 CACI data)	
>57	116.3	118.4	+1.8	240.1	254.4	+6.0
>60	66.1	65.0	-1.7	107.3	107.7	+0.4
>63	40.3	39.1	-3.0	57.6	51.5	-10.6
>66	24.4	23.7	-2.9	20.8	16.3	-21.6
>69	13.1	12.6	-3.8	5.3	4.0	-24.5
>72	6.5	6.6	+1.5	1.4	0.9	-35.7

3.2.2 The standard contours normally provide a clearer indication than the actual contours of 'fleet noise level' changes because they minimise the effect of any difference between the ratios of westerly to easterly operations for the two years**.** Figure 5 shows that the 2004 and 2005 standard contours are, generally, very similar in both size and shape. The 2005 standard 57 dBA Leq contour associated with westerly departures on the Dover (DVR) route has elongated slightly reflecting the increase in departures (on westerly days) on this route. The same contour associated with westerly arrivals has also expanded slightly relative to 2004 reflecting the 1 dB increase in noise levels to the Airbus A320 family of aircraft at distances greater than 8 kilometres from threshold. For 2005, there has also been a slight 're-distribution' of noise to the sides of the runways (most noticeable to the northern side of Runway 27R). This is a consequence of the revised lateral attenuation algorithms, together with the other improvements, used for the 2005 contours (ANCON Version 2.3). The effects of the changes on the 2005 contours due to the updated model are discussed in more detail in Reference 4.

3.2.3 Relative to 2004, the area within the standard 2005 57 dBA Leq contour increased by 1.8%. Based on the 2004 CACI data the population within the 57 dBA Leq contour increased by 6.0% (using the earlier 2003 CACI population data would have yielded an increase of 6.2%).

4 HEATHROW TRAFFIC AND NOISE: HISTORICAL TRENDS

4.1 Figure 6 shows how the average mode 57 dBA Leq contours, based on actual modal splits, have changed since 1988 by comparison with the *total annual* aircraft movements.

4.2 The area figures give a better indication of the actual noise than the population figures because the latter are more susceptible to the 'modal split' between easterly and westerly operations[6]. This is particularly noticeable in 1995 which had an atypical modal split of 54% west – 46% east (compared with the 20-year average of 77% west – 23% east for that year). The recorded increase in enclosed population

[6] Actual modal split data are used in this figure because contours based on standard modal split are a relatively recent innovation and data prior to 1995 are not available.

between 1998 and 1999 reflected demographic changes that occurred between the 1991 census and the subsequent update.

4.3 The sharp rate of decline in contour area recorded in the late eighties and early nineties has diminished. The area reductions in 2000 and 2001 reflect reduced numbers of Concorde movements in those years (2.5 per day in 2000 and 0.1 per day in 2001). This followed the grounding of Concorde after the crash at Paris, Charles de Gaulle airport in July 2000. Concorde movements in 2002 and 2003 never reached the level of 1999. The dashed line on the figure shows what the 2003 areas and populations would have been had there been no movements by Concorde in the Leq period for that year. In October 2003 Concorde was retired from service so there were no movements by Concorde in 2004.

4.4 Against the trend of a general decrease in contour area, the number of aircraft movements has risen steadily each year, the only trough occurring in 1991, the year of the Gulf War. The annual movement figure for 2001 was slightly lower than the preceding year and reflects the disruption to traffic following the events of 11 September 2001. The total annual movement figure for 2005 was 1.7% higher than that for 2004 compared with the 1.1% decrease for the 16 hour average summer Leq day. As previously stated, movements during the summer period were affected by 3 days of industrial action in August and possibly by the terrorist attacks in central London on the 7th July. A separate analysis has shown that total movements in July and August of 2005 were less than those for the same months in 2004.

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Noise Exposure Contours for Heathrow Airport 2004
ERCD Report 0501, August 2005,

Table 1:

DISTRIBUTION OF HEATHROW AVERAGE DAILY AIRCRAFT MOVEMENTS BY TYPE (0700-2300 LOCAL TIME, 16 JUNE - 15 SEPTEMBER)

AIRCRAFT TYPE(S)	NOISE CLASS	AVERAGE NUMBER 2004	AVERAGE NUMBER 2005	PERCENTAGE OF TOTAL 2005 MOVEMENTS	CHANGE AS PERCENTAGE OF TOTAL 2004 MOVEMENTS
Small Props	1	0.3	0.4	0.0	0.0
Large Props	2	9.8	9.3	0.7	0.0
B737-300, 400, 500	3	42.2	34.6	2.8	-0.6
B737-600, 700	3	15.4	15.6	1.2	0.0
B737-800, 900	3	22.0	21.7	1.7	0.0
B757E (RB211-535E4, E4B)	3	58.3	59.1	4.7	+0.1
B757C (RB211-535C)	3	1.5	0.8	0.1	-0.1
B757P (Pratt and Whitney)	3	2.1	1.4	0.1	-0.1
BAe146	3	6.9	3.6	0.3	-0.3
A318	3	1.9	0.6	0.0	-0.1
A319C (CFM-56)	3	15.9	20.0	1.6	+0.3
A319V (IAE-V2500)	3	184.9	194.7	15.6	+0.8
A320C (CFM-56)	3	135.5	134.8	10.8	-0.1
A320V (IAE-V2500)	3	153.5	141.3	11.3	-1.0
A321C (CFM-56)	3	64.1	61.3	4.9	-0.2
A321V (IAE-V2500)	3	80.0	96.2	7.7	+1.3
Business Jet (Ch 3)	3	4.9	4.4	0.4	0.0
Bombardier Regional Jet 100/200	3	15.3	7.6	0.6	-0.6
Bombardier Regional Jet 700	3	4.1	4.3	0.3	0.0
Embraer EMB 135/145	3	5.5	12.7	1.0	+0.6
Embraer E-170**	3	0.0	0.4	0.0	0.0
F100	3	8.7	1.6	0.1	-0.6
MD80	3	25.2	23.6	1.9	-0.1
MD90	3	4.3	0.8	0.1	-0.3
B767-200	4	0.8	1.9	0.2	+0.1
B767-300G (General Electric)	4	14.6	13.2	1.1	-0.1
B767-300P (Pratt and Whitney)	4	14.2	10.5	0.8	-0.3
B767-300R (Rolls Royce)	4	48.1	45.0	3.6	-0.2
B777-200G (General Electric)	4	30.9	29.9	2.4	-0.1
B777-200P (Pratt and Whitney)	4	14.2	19.0	1.5	+0.4
B777-200R (Rolls Royce)	4	54.2	55.2	4.4	+0.1
B777-300G (General Electric)**	4	0.0	0.3	0.0	0.0
B777-300R (Rolls Royce)	4	5.1	4.8	0.4	0.0
A300	4	15.9	12.6	1.0	-0.3
A310	4	8.4	6.2	0.5	-0.2
A330	4	24.4	30.1	2.4	+0.5
B747-400G (General Electric)	5	26.8	26.2	2.1	0.0
B747-400P (Pratt and Whitney)	5	24.2	21.9	1.8	-0.2
B747-400R (Rolls Royce)	5	64.5	64.6	5.2	0.0
B747SP	5	1.6	1.2	0.1	0.0
A340-200/300	5	32.5	33.2	2.7	+0.1
A340-500/600	5	8.5	11.5	0.9	+0.2
MD11	5	3.6	3.3	0.3	0.0
B747-100*	6	0.3	0.3	0.0	0.0
B747-200, 300 (Ch 3)	6	5.8	5.2	0.4	0.0
DC10	6	1.3	0.9	0.1	0.0
Tristar	6	0.2	0.0	0.0	0.0
B737-200 (Ch3)	7	0.0	0.4	0.0	0.0
B727 (Ch 3)	8	0.3	0.2	0.0	0.0
Tu154M*	8	0.3	0.3	0.0	0.0
TOTAL MOVEMENTS		1263.0	1248.7	100.0***	-1.1***

* In 2004 and 2005 all Chapter 3 versions
** New type for 2005
*** May not sum exactly due to rounding

Table 2:

PERCENTAGE OF HEATHROW AVERAGE DAILY AIRCRAFT DEPARTURES BY ROUTE*
(0700-2300 LOCAL TIME, 16 JUNE - 15 SEPTEMBER)

WESTERLY DEPARTURE ROUTE	PERCENTAGE OF TOTAL DEPARTURES 2004	PERCENTAGE OF TOTAL DEPARTURES 2005	CHANGE (% OF TOTAL)
WOB/BPK	34.7	30.8	-3.9
DVR/DET	17.3	15.9	-1.4
MID	15.5	12.4	-3.1
CPT/SAM	13.5	11.9	-1.6
PERCENTAGE WEST	81.0	71.0	-10.0
EASTERLY DEPARTURE ROUTE	PERCENTAGE OF TOTAL DEPARTURES 2004	PERCENTAGE OF TOTAL DEPARTURES 2005	CHANGE (% OF TOTAL)
BUZ/BPK	8.5	12.3	+3.8
DVR/DET	3.8	6.4	+2.6
MID/SAM	4.6	6.7	+2.1
CPT	2.1	3.6	+1.5
PERCENTAGE EAST	19.0	29.0	+10.0

* See Figure 1.

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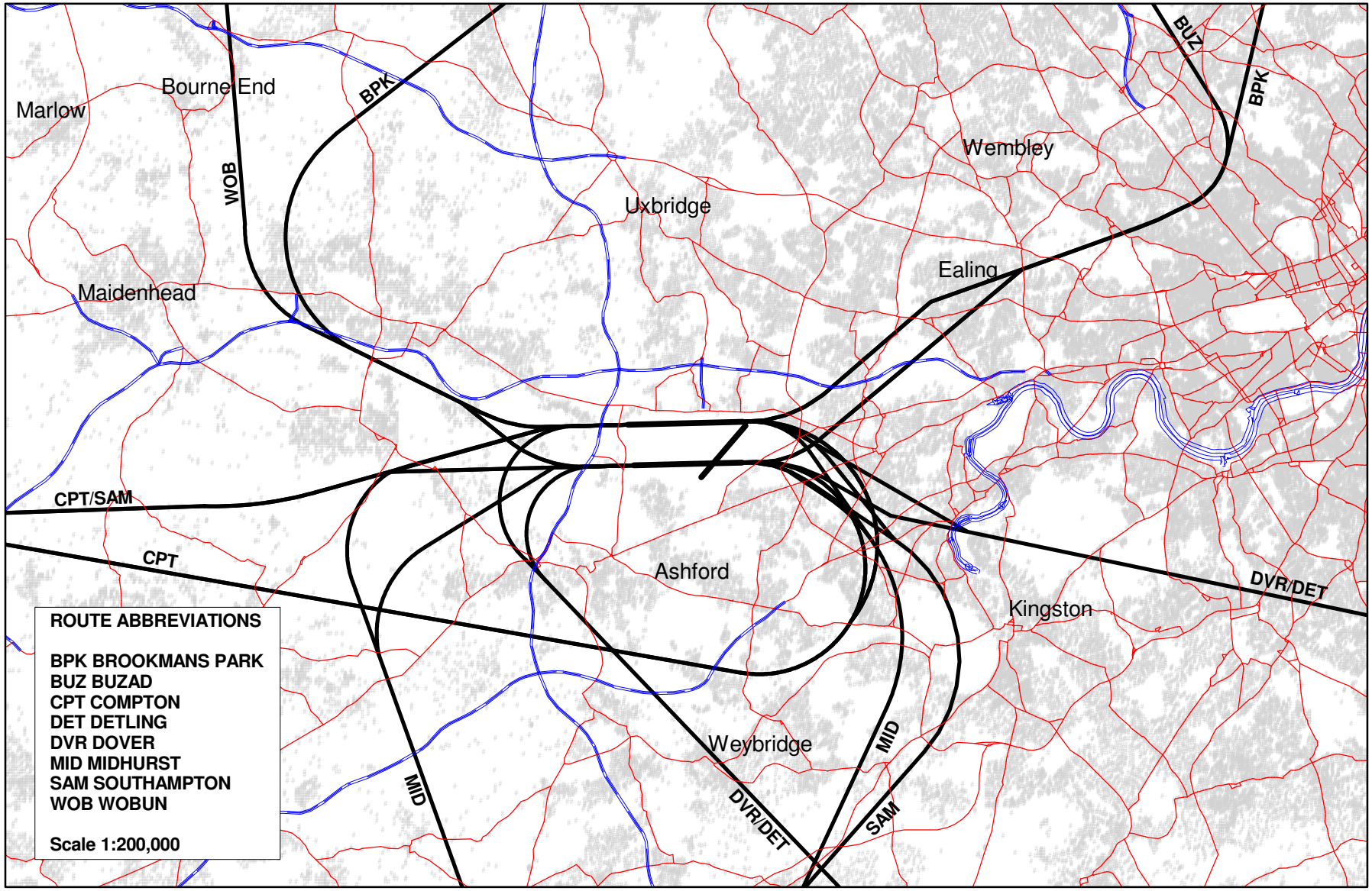
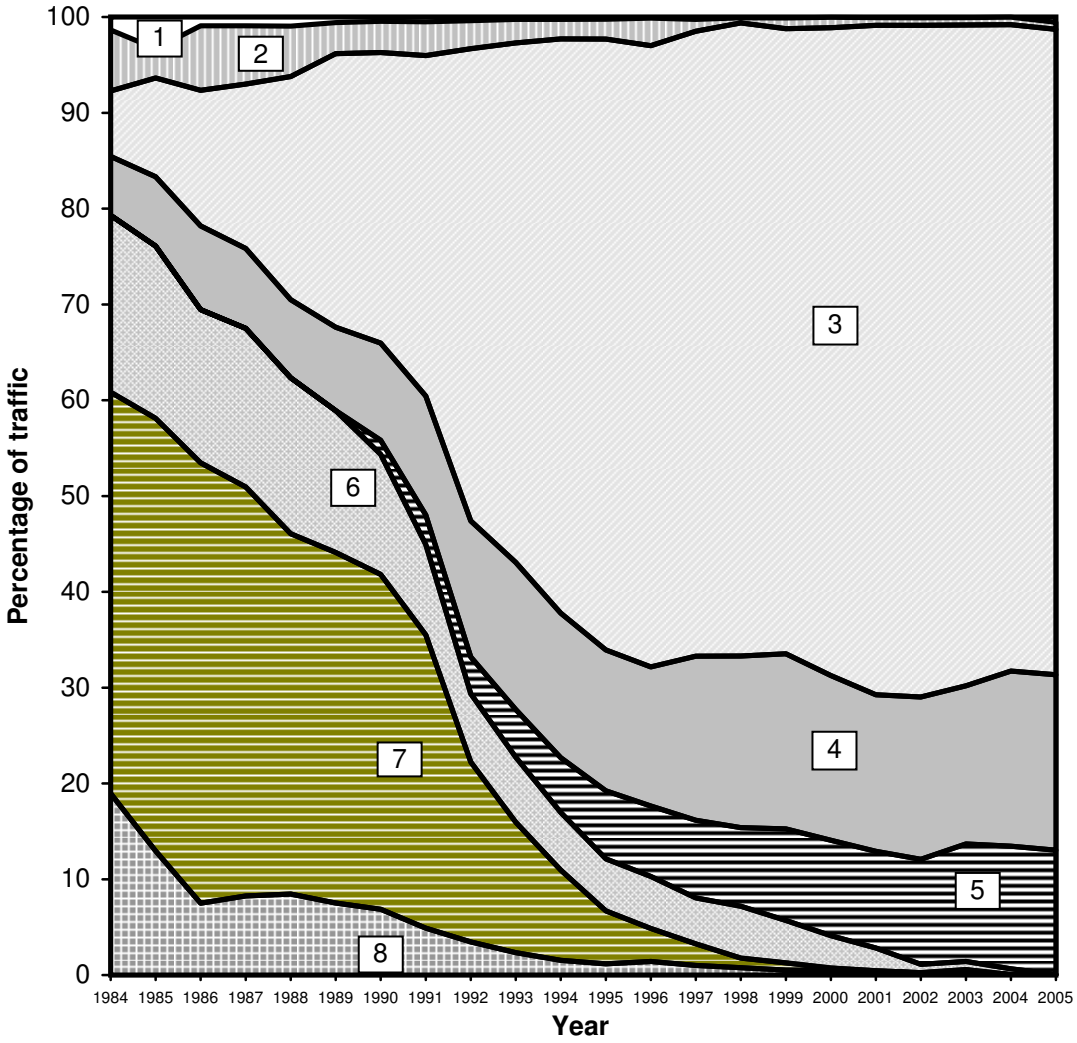


Figure 1: London Heathrow Airport Standard Instrument Departure Routes



Propeller aircraft:

1 Small props: Single and twin pistons and turboprop light, business and commuter aircraft

2 Large props: 2- & 4-propeller transports; eg SF340 BAe-ATP, ATR42, F50, HS748, Saab 2000, Electra, Hercules, Viscount, Vanguard

Chapter 3 jets:

3 Short-haul: eg A320, BAe146, B717, B737-300, B757, F100, MD80, RJ50, re-engined narrow-bodies, some business jets

4 Wide-body twins: A300, A310, A330, B767, B777

5 2nd gen. wide-body multis*: A340, MD11, B747-400

Large Chapter 2/3 jets:

6 1st gen. wide-body multis* (Chapter 2 & 3): 'Classic' 747, Tristar, DC-10, An124, IL76, IL86

2nd generation twin jets:

7 Narrow body twins (including hushkitted versions): eg F28,, BAC 1-11, DC-9, B737-200 other business jets

1st generation jets & Concorde: (including hushkitted versions)

8 eg Trident, 707, DC-8, B727, IL62, Tu154

* Multi = 3- or 4- engined aircraft

Figure 2: Noise Class of Heathrow aircraft 1984 - 2005

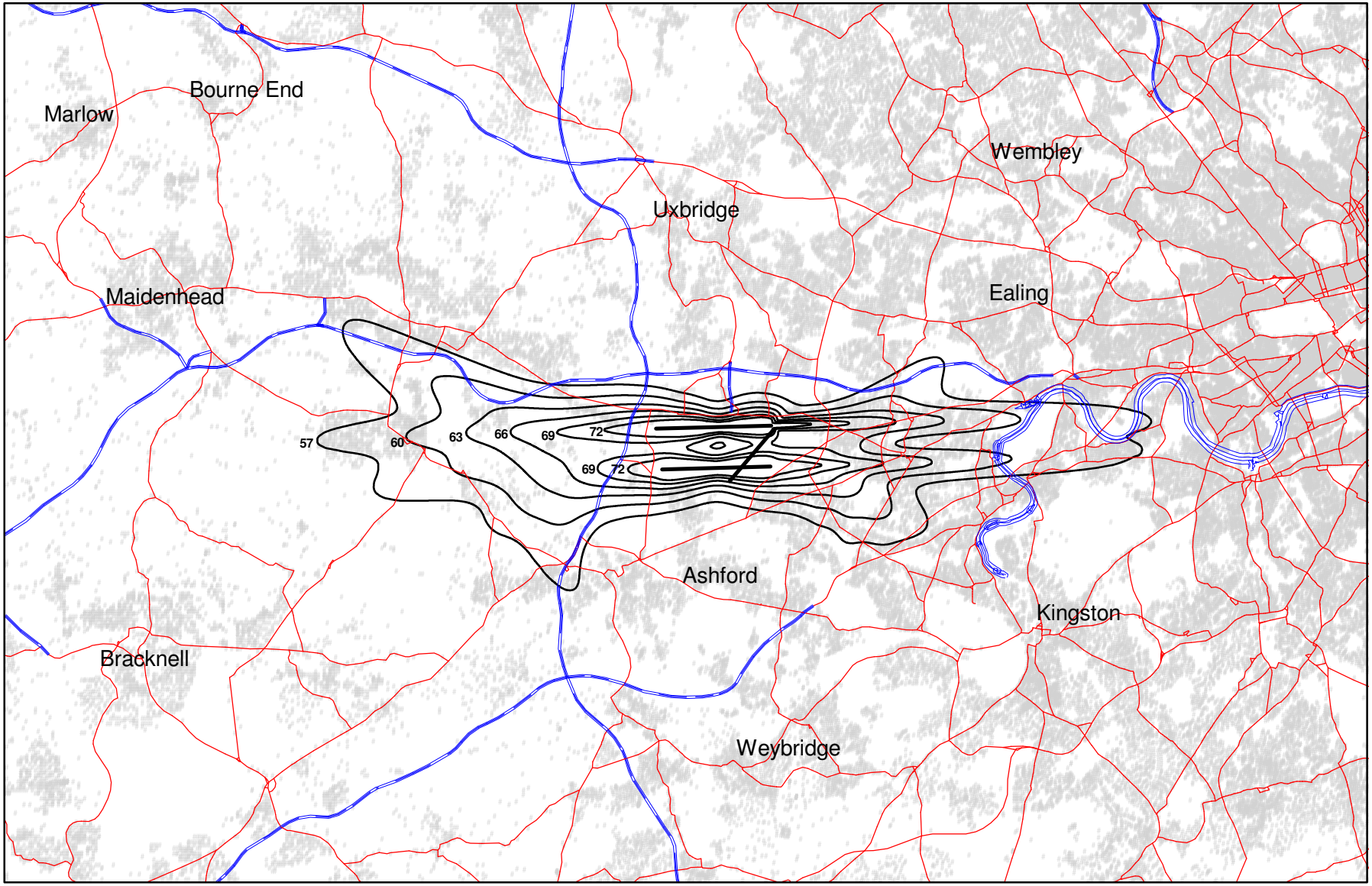


Figure 3: Heathrow actual 2005 average mode (71% west-29% east) terrain adjusted 16hr Leq on population map

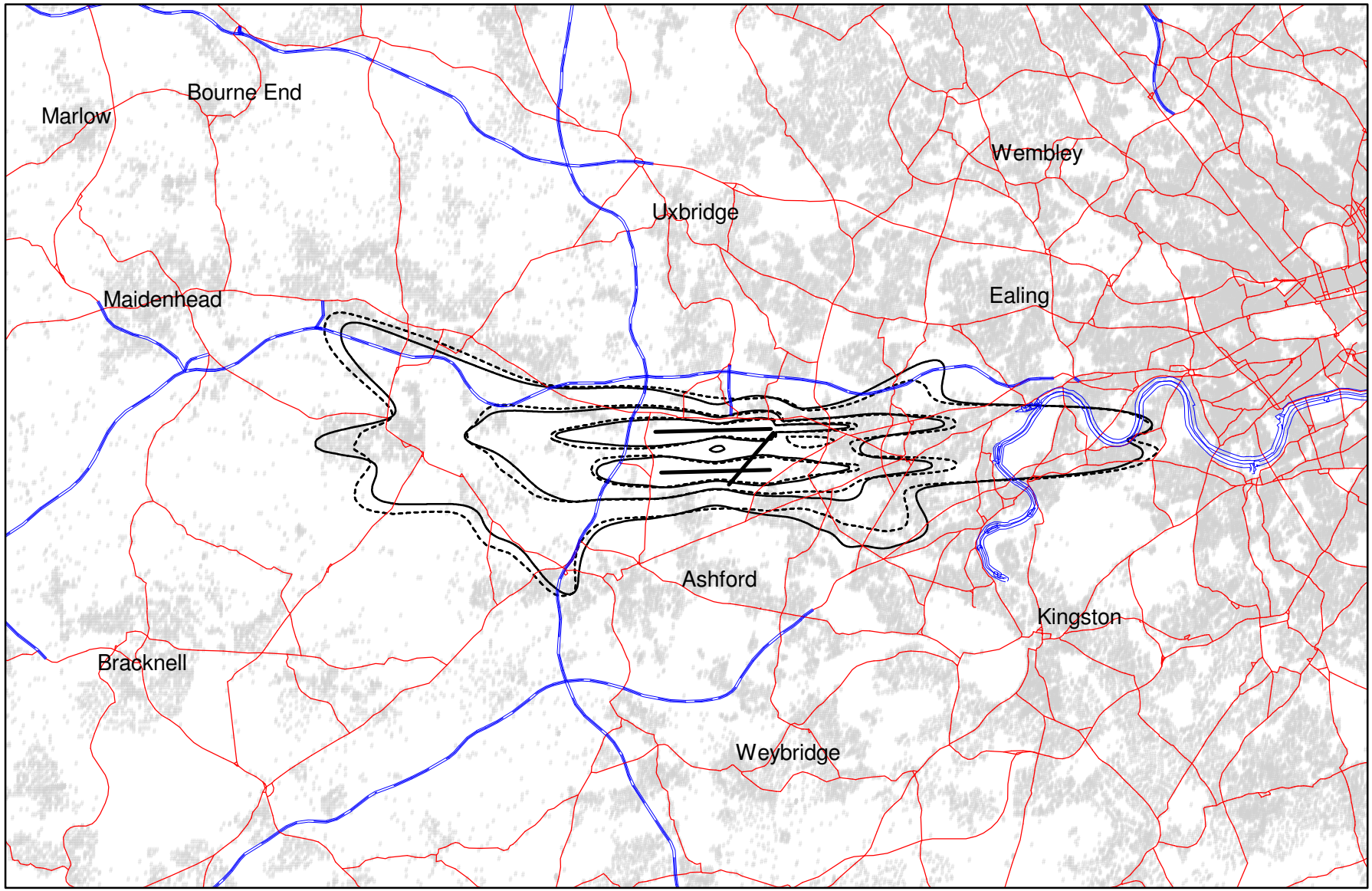


Figure 4: Heathrow actual 57, 63 and 69 Leq contours - 2004 dotted (81% west-19% east) - 2005 solid (71% west-29% east)

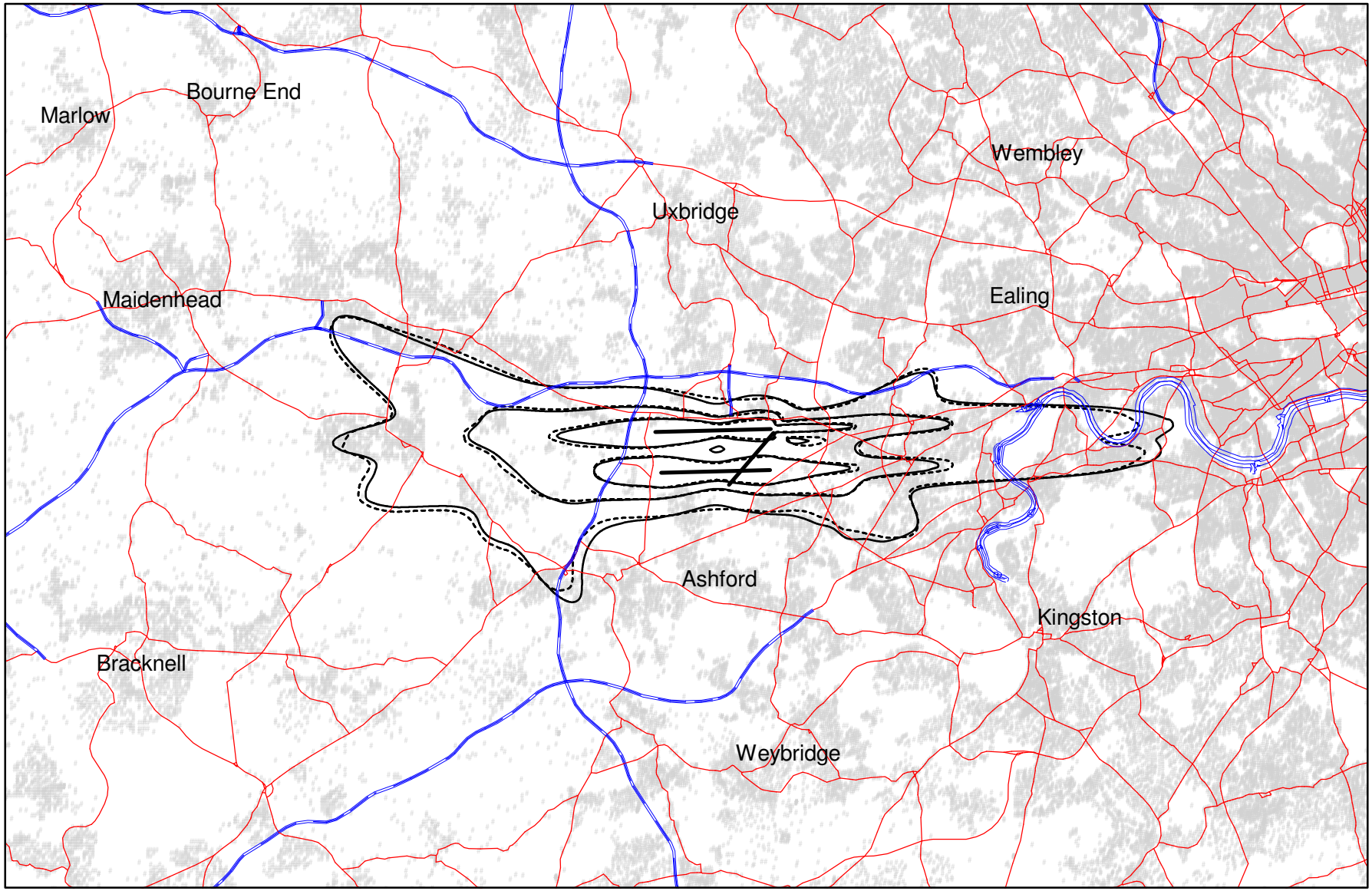


Figure 5: Heathrow standard 57, 63 and 69 Leq contours - 2004 dotted (77% west-23% east) - 2005 solid (76% west-24% east)

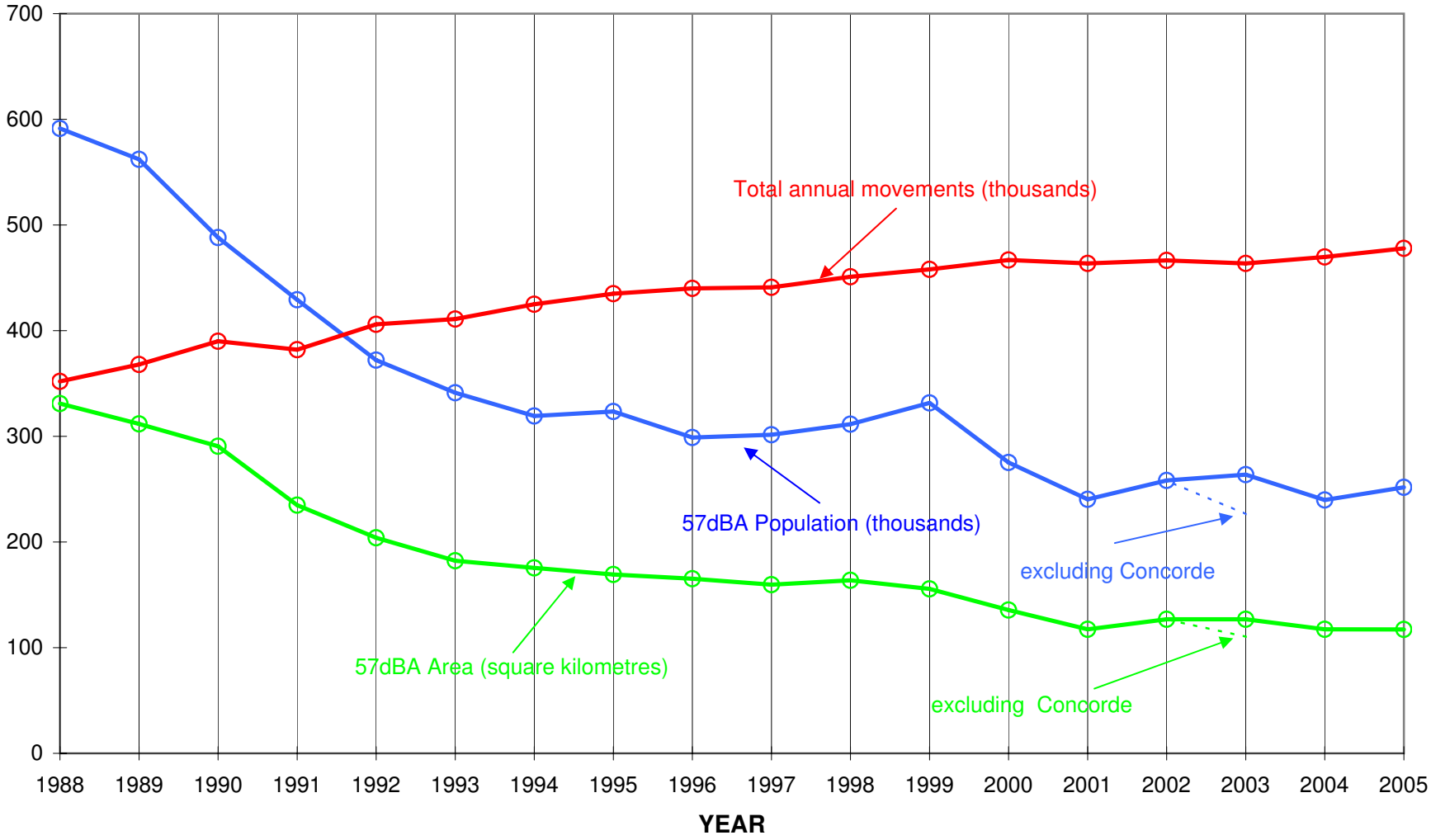


Figure 6: Heathrow traffic and noise 1988 - 2005