Environmental Research and Consultancy Department
Civil Aviation Authority

ERCD REPORT 1401

Noise Exposure Contours for Heathrow Airport 2013

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Prepared by the Civil Aviation Authority on behalf of the Department for Transport, October 2014

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Summary

This report presents the year 2013 average summer day and night noise exposure contours for London Heathrow Airport. Contours have been generated for the night period (2300-0700 local time) for the first time to meet the requirements of the Aviation Policy Framework published in March 2013.

The 57 dBA Leq day contour area for 2013 based on the actual runway modal split was calculated to be 107.3 km^2, 3% smaller than in 2012. However, the population enclosed within the actual 57 dBA Leq day contour increased by 10% to 264,250. The 48 dBA Leq night actual contour area was calculated to be 120.5 km^2, enclosing a population of 421,250.

October 2014

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 2011 Census data (updated for 2013) supplied by CACI Information Services.

Contents

Glossary

AIP Aeronautical Information Publication.

ANCON The UK civil aircraft noise contour model, developed and maintained by ERCD.

ATC Air Traffic Control.

CAA Civil Aviation Authority – the UK's independent specialist aviation regulator.

dB Decibel units describing sound level or changes of sound level.

dBA Units of sound level on the A-weighted scale, which incorporates a frequency weighting approximating the characteristics of human hearing.

DfT Department for Transport (UK Government).

ERCD Environmental Research and Consultancy Department of the Civil Aviation Authority.

ILS Instrument Landing System.

Leq Equivalent sound level of aircraft noise in dBA, often called 'equivalent continuous sound level'. For conventional historical contours this is based on the daily average movements that take place within the 16-hour period (0700-2300 local time) over the 92-day summer period from 16 June to 15 September inclusive.

NPD Noise-Power-Distance.

NPR Noise Preferential Route.

NTK Noise and Track Keeping monitoring system. The NTK system associates radar data from air traffic control radar with related data from both fixed (permanent) and mobile noise monitors at prescribed positions on the ground.

OS Ordnance Survey®, Great Britain's national mapping agency.

SEL The Sound Exposure Level of an aircraft noise event is the steady noise level, which over a period of *one second* contains the same sound energy as the whole event. It is equivalent to the Leq of the noise event normalised to one second.

SID Standard Instrument Departure.

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Executive Summary

This report presents year 2013 average summer day and night noise exposure contours generated for London Heathrow Airport. Night period (2300-0700 local time) contours have been produced for the first time to meet the requirements of the Aviation Policy Framework published in March 2013.

The noise modelling used radar and noise data from the Heathrow Noise and Track Keeping (NTK) system. Mean flight tracks and lateral dispersions for each route, and average flight profiles of aircraft height, speed and thrust for each aircraft type, were calculated using these data.

Analysis of the 2013 summer traffic data for Heathrow revealed that average daily movements for the 16-hour daytime period (1258.8) increased slightly, by 0.3% (2012: 1255.1). There were on average 82.4 movements per 8-hour night over the summer period.

The results showed that the area of the 2013 day actual modal split (74% west / 26% east) 57 dBA Leq contour decreased by 3% to 107.3 km^2 (2012: 110.1 km^2), which is the smallest ever area calculated for Heathrow. However, the population count within the 2013 actual 57 dBA Leq day contour increased by 10% to 264,250. The area changes were primarily the result of the shift in runway modal split to a higher proportion of easterly operations. The relatively large population increases in 2013 were due to a major update of the population database for 2013.

The area of the 2013 day standard modal split (77% west / 23% east) 57 dBA Leq contour increased by 1% to 107.9 km^2 (2012: 106.7 km^2), and the associated population count was 266,050, 12% higher than in 2012.

The area of the 2013 actual 48 dBA Leq night contour was 120.5 km^2, enclosing a population of 421,250.

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1 Introduction

1.1 Background

1.1.1 Each year the Environmental Research and Consultancy Department (ERCD) of the Civil Aviation Authority (CAA) calculates the noise exposure around London Heathrow Airport on behalf of the Department for Transport (DfT). A computer model, ANCON, validated with noise measurements, is used to estimate the noise exposure. The model calculates the emission and propagation of noise from arriving and departing air traffic.

1.1.2 The noise exposure metric used is the Equivalent Continuous Sound Level, or Leq 16-hour (0700-2300 local time), which is calculated over the 92-day summer period from 16 June to 15 September. The background to the use of this index is explained in DORA Report 9023 (**Ref 1**).

1.1.3 Noise exposure is depicted in the form of noise contours, i.e. lines joining places of constant Leq, akin to the height contours shown on geographical maps or isobars on a weather chart. In the UK, Leq noise contours are normally plotted at levels from 57 to 72 dBA, in 3 dB steps.[1] The 57 dBA level denotes the approximate onset of significant community annoyance.

1.1.4 Following the publication of the Aviation Policy Framework in March 2013 (**Ref 2**), there is now a commitment by the DfT to produce night (2300-0700) noise contours on an annual basis for the designated airports. So for the first time this year, 8-hour night Leq contours have also been calculated for Heathrow from 48 to 72 dBA in 3 dB steps in accordance with standard practice.

1.1.5 This report contains small-scale diagrams of the year 2013 Heathrow Leq contours overlaid onto Ordnance Survey® (OS) base maps. Diagrams in Adobe® PDF and AutoCAD DXF format are also available for download from the DfT website[2].

1.1.6 The objectives of this report are to explain the noise modelling methodology used to produce the year 2013 day and night Leq contours for Heathrow Airport, to present the calculated noise contours and to assess the changes from the previous year (**Ref 3**).

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[1] Aircraft noise contours are also produced on behalf of airports for the specific purpose of meeting the requirements of the Environmental Noise (England) Regulations 2006, which implemented Directive 2002/49/EC, Assessment and Management of Environmental Noise, in England. These are based on annual average values and require the use of different parameters (L_{day}, $L_{evening}$, L_{night}, $L_{eq,16hr}$ and L_{den} at 5 dB steps), so it is not possible to draw meaningful conclusions between the two types of contour maps. Further details about Directive 2002/49/EC are available on the Department for Environment, Food and Rural Affairs website at *www.gov.uk/defra* as well as ERCD Reports 1204, 1205 and 1206 (available from *www.caa.co.uk*), which cover Heathrow, Gatwick and Stansted 2011 noise mapping respectively.

[2] www.gov.uk/dft

1.2 Heathrow Airport

1.2.1 Heathrow Airport is situated approximately 13 miles (21 km) west of the city of London. It is surrounded by suburban housing, business premises and mixed-use open land to the north and south, suburban housing and business premises to the east, and several large reservoirs, mixed-use open land, housing and business premises to the west (**Figure 1**).

1.2.2 Heathrow Airport has two runways: Runway 09L/27R to the north, which is 3,901 m long, and Runway 09R/27L to the south, which is 3,660 m long. The landing threshold[3] for Runway 09L is displaced by 306 m. The landing threshold for Runway 09R is also displaced, by 307 m. There are currently five passenger terminals.[4] The layout of the runways, taxiways and passenger terminals in 2013 is shown in **Figure 2**.[5]

1.2.3 In the 2013 calendar year, there were 472,000 aircraft movements (2012: 475,000) at Heathrow Airport, handling 72.4 million passengers (2012: 70.0 million).[6]

[3] The runway threshold marks the beginning of the runway available for landing aircraft. A *displaced* threshold is a runway threshold that is not located at the physical end of the runway. A displaced threshold is often employed to give arriving aircraft sufficient clearance over an obstacle.

[4] Terminal 2 closed for rebuilding work in November 2009 but re-opened in June 2014.

[5] UK AIP (25 Jul 2013) AD 2-EGLL-2-1

[6] Source: Civil Aviation Authority (www.caa.co.uk/airportstatistics)

2 Noise contour modelling methodology

2.1 ANCON noise model

2.1.1 Leq noise contours were calculated with the UK civil aircraft noise model ANCON (version 2.3), which is developed and maintained by ERCD on behalf of the DfT. A technical description of ANCON is provided in R&D Report 9842 (**Ref 4**). The ANCON model is also used for the production of annual contours for Gatwick and Stansted airports, and a number of other UK airports.

2.1.2 ANCON is fully compliant with the latest European guidance on noise modelling, ECAC.CEAC Doc 29 (3rd edition), published in December 2005 (**Ref 5**). This guidance document represents internationally agreed best practice as implemented in modern aircraft noise models.

2.2 Radar data

2.2.1 The noise modelling carried out by ERCD made extensive use of radar data extracted from Heathrow Airport's Noise and Track Keeping (NTK) system. Most large airports have NTK systems, which take data from Air Traffic Control (ATC) radars and combine them with flight information such as call sign, tail number, type and destination. Analyses of departure and arrival flight tracks, and flight profiles, were based on year 2013 summer radar data.

2.3 Flight tracks

2.3.1 Aircraft departing Heathrow are required to follow specific flight paths called Noise Preferential Routes (NPRs) unless directed otherwise by ATC. NPRs were designed to avoid the overflight of built-up areas where possible. They establish a path from the take-off runway to the main UK air traffic routes and form the first part of the Standard Instrument Departure routes (SIDs). The Heathrow SIDs are illustrated in **Figure 3**.

2.3.2 Associated with each NPR is a lateral swathe, which is defined by a pair of lines that diverge at 10 degrees from a point 2,000 m from start-of-roll, leading to a corridor extending 1.5 km either side of the nominal NPR centreline. Within this swathe the aircraft are considered to be flying on-track. The swathe takes account of various factors that affect track-keeping, including tolerances in navigational equipment, type and weight of aircraft, and weather conditions – particularly winds that may cause drifting when aircraft are turning. Aircraft reaching an altitude of 4,000 ft at any point along an NPR may be turned off the route by ATC onto more direct headings to their destinations – a practice known as 'vectoring'. ATC may

also vector aircraft from NPRs below this altitude for safety reasons, including in certain weather conditions (for example, to avoid storms).

2.3.3 Departure and arrival flight tracks were modelled using radar data extracted from the Heathrow NTK system over the 92-day summer period, 16 June to 15 September 2013. Mean flight tracks were calculated from 24-hour data this time since both day and night contours were being produced (in previous years only daytime radar data were employed).

2.3.4 **Figure 4** shows a sample of radar flight tracks from a day in August 2013. In-house radar analysis software was used to calculate mean departure flight tracks and associated lateral dispersions for each NPR/SID. Arrival tracks for Runways 27L, 27R, 09L and 09R were modelled using evenly spaced 'spurs' about the extended runway centrelines. The majority of arriving aircraft joined the centrelines at distances between 14 and 32 km from threshold when Heathrow was operating in westerly mode, and at distances between 11 and 31 km in easterly mode.

2.4 Flight profiles

2.4.1 For each ANCON aircraft type, average flight profiles of height, speed and thrust versus track distance (for departures and arrivals separately) were reviewed and updated where necessary, using year 2013 summer radar data. The engine power settings required for the aircraft to follow the average height and speed profiles were calculated from data describing aircraft performance characteristics within each of the different aircraft type categories.

2.4.2 Daytime flight profiles were generated as in previous years. However, a separate night-time departure profile was also created for the noise dominant aircraft type operating at night (i.e. the B744R[7]), as it was sufficiently different from the daytime profile. All other aircraft types operating at night were modelled with the daytime profiles.

2.4.3 The application of reverse thrust following touchdown was modelled for all ANCON types where applicable. Reverse thrust was included in both the day and night contours.

2.5 Noise emissions

2.5.1 At Heathrow, the NTK system captures data from both fixed and mobile noise monitors around the airport. Noise event data for individual aircraft operations are then matched to operational data provided by the airport. The Heathrow NTK system employs 12 fixed monitors (positioned approximately 6.5 km from start-of-

[7] Boeing 747-400 with Rolls-Royce engines

roll), together with a number of mobile monitors that can be deployed anywhere within the NTK radar coverage area.[8]

2.5.2 The noise data collected are screened by ERCD with reference to several criteria so that only high quality data are used in the analysis. First of all, noise data that lie outside a 'weather window' are discarded. This ensures that the data used are not affected by adverse meteorological conditions such as precipitation and strong winds. Secondly, the maximum noise level of the aircraft event must exceed the noise monitor threshold by at least 10 dB to avoid underestimates of the Sound Exposure Level (SEL). Thirdly, only measurements obtained from aircraft operations that pass through a 60-degree inverted cone, centred at the noise monitor, are retained in order to minimise the effects of lateral attenuation[9] and lateral directivity[10].

2.5.3 The ANCON model calculates aircraft noise using a noise database expressing SEL as a function of engine power setting and slant distance to the receiver – the so-called 'Noise-Power-Distance' (NPD) relationship. The ANCON noise database is continually reviewed and updated with adjustments made annually when measurements show this to be necessary.

2.6 Traffic distributions

2.6.1 The Leq contours are based on the daily average movements that take place during the 16-hour day (0700-2300 local time) and 8-hour night (2300-0700 local time), over the 92-day summer period from 16 June to 15 September inclusive. The source of this information is the NTK system, which stores radar data supplemented by daily flight plans. Traffic statistics from NTK data were cross-checked with runway logs supplied by NATS[11] and close agreement was found.

Daytime traffic distribution by noise class

2.6.2 The average number of daily movements at Heathrow over the 2013 summer day period (1258.8) was 0.3% higher than in the previous year (2012: 1255.1).

2.6.3 **Table 1a** lists the average summer day movements[12] by eight noise classes of aircraft, ranked in ascending order of noise emission, i.e. from least to most noisy,

[8] Further information on the noise monitors can be found in CAP 1149 (**Ref 6**).

[9] Lateral attenuation is the excess sound attenuation caused by the ground surface, which can be significant at low angles of elevation.

[10] Lateral directivity is the non-uniform directionality of sound radiated laterally about the roll axis of the aircraft – this is influenced to a large extent by the positioning of the engines.

[11] NATS is the provider of air traffic control services to Heathrow Airport.

[12] Includes departures and arrivals.

in 2012 and 2013. As in 2012, short-haul 'Chapter 3' and 'Chapter 4'[13] jet aircraft (Noise Class 3) formed the highest proportion of movements (66.5%), and were slightly fewer in number in 2013 (note: an estimated 98% of the aircraft within Noise Class 3 for the 2013 daytime period were compliant with the 'Chapter 4' noise standard).

2.6.4 The numbers of wide-body twin-engine aircraft (Noise Class 4), which comprised 23.5% of the total traffic, were 6% higher in 2013, the only increase out of all the noise classes. There was, however, an 8% decrease in movements within Noise Class 5 (i.e. second generation wide-body 3/4-engine aircraft). The numbers of aircraft in Noise Class 1 were insignificant, and there were no aircraft within Noise Classes 2, 6, 7 and 8.

2.6.5 **Figure 5** illustrates the changing distribution of traffic among the 8 noise classes over the period 1988 to 2013 inclusive. The shift towards Chapter 3 & 4 aircraft (i.e. Noise Classes 3 to 5) over the years can be seen, with short-haul jet aircraft (Noise Class 3) dominating the fleet mix.

Night-time traffic distribution by noise class

2.6.6 The average number of movements per 8-hour night was 82.4, the majority of which (70%) were arrivals.

2.6.7 **Table 1b** lists the average summer night movements by 8 noise classes of aircraft, ranked in ascending order of noise emission, i.e. from least to most noisy, in 2013. Wide-body twin-engine aircraft (Noise Class 4) formed the highest proportion of movements (43.3%). (Note: in 2013 an estimated 96% of the aircraft within Noise Class 3 for the night period were compliant with the 'Chapter 4' noise standard).

Daytime traffic distribution by ANCON aircraft type

2.6.8 A more detailed breakdown of the year 2013 average summer day movements, indicating the ANCON types that fall into each noise class, is provided in **Table 2a**.

2.6.9 The largest increase was within Noise Class 3 for the EA320C, up by 29 daily movements (note: ANCON type descriptions can be found in **Table 2a**). This increase was offset partially by a reduction of 25 ERJ movements.

2.6.10 Within Noise Class 4, there were movement increases for the ANCON types B773G (up by 14) and EA33 (up by 13), offset by reductions in the numbers of the B772R (down by 8), B772G (down by 7) and B764 (down by 5).

[13] Aircraft whose certificated noise levels are classified by the ICAO *Standards and Recommended Practices – Aircraft Noise: Annex 16 to the Convention on International Civil Aviation* into 'Chapter 3' and 'Chapter 4' types - these are typically characterised by modern, quieter, high-bypass turbofan aircraft. The Chapter 4 standard is more stringent than the Chapter 3 standard.

2.6.11 There was a notable decrease in Noise Class 5 for the EA346 (down by 16 movements), the B744R (down by 4) and B744P (down by 3). These were offset by increases for ANCON types such as the A380 (+7) and B744G (+4).

2.6.12 **Figure 6a** illustrates the numbers of movements by ANCON aircraft type for the 2013 average summer day. It may be seen that the Airbus A319/A320/A321 aircraft family dominates the movements at Heathrow. In particular, the EA319V and EA320V are the most frequent ANCON aircraft types, each with 215 daily movements respectively, followed by the EA320C with 136 daily movements.

2.6.13 On average there were 60 daily movements of the B744R ANCON type, which is the noise dominant aircraft at Heathrow in terms of departure noise. The B744R contributed the highest level of departure 'noise energy', which is a function of both aircraft noise level and movement numbers. Arrival noise was dominated by the short-haul Airbus aircraft family (e.g. EA319V, EA320V and EA320C).

Night-time traffic distribution by ANCON aircraft type

2.6.14 A more detailed breakdown of the year 2013 average summer night movements, indicating the ANCON types that fall into each noise class, is provided in **Table 2b**.

2.6.15 **Figure 6b** illustrates the numbers of movements by ANCON aircraft type for the 2013 average summer night. Night movements were dominated by the B744R aircraft type with 16 movements. The B772G had the second highest number of movements at 8 per night. Arrivals accounted for 70% of movements at night.

Daytime traffic distribution by SID route

2.6.16 **Figure 7a** shows the distribution of aircraft departures by SID route for the 2013 summer day period, including figures from 2012 for comparison. The percentage loadings on the SIDs were comparable to 2012, with the westerly WOB/BPK SIDs taking the highest proportion of traffic over the summer day period (30%), followed by the westerly DVR/DET SIDs (18%). Decreases of the order of 3-4% were evident on all the westerly SIDs, while increases of up to 7% were seen on the easterly SIDs.

Night-time traffic distribution by SID route

2.6.17 **Figure 7b** shows the distribution of aircraft departures by SID route for the 2013 summer night period. The westerly DVR/DET SIDs took the highest proportion of traffic over the summer night period (32%), followed by the westerly WOB/BPK SIDs (18%).

2.7 Runway modal splits

2.7.1 In general, aircraft will take-off and land into a headwind to maximise lift during take-off and landing. The wind direction, which varies over the course of a year, will therefore have an important influence on the usage of runways[14]. The ratio of westerly (27L/27R) and easterly (09L/09R) operations is referred to as the *runway modal split*.

2.7.2 Two sets of contours have been produced for the year 2013 summer day:

(i) Contours using the 'actual' modal split over the Leq day period; and

(ii) Contours assuming the 'standard' modal split over the Leq day period, i.e. the long-term modal split calculated from the 20-year rolling average; for 2013, this is the 20-year period from 1994 to 2013. Use of the standard modal split enables year-on-year comparisons without the runway usage significantly affecting the contour shape.

2.7.3 The actual and standard daytime modal splits for 2013, together with the previous year, are summarised in the table below:

Heathrow summer day runway modal splits for 2013 and 2012

Modal split scenario	**% west (Runway 27L/27R)**	**% east (Runway 09L/09R)**
Actual 2013	74%	26%
Actual 2012	89%	11%
Standard 2013	77%	23%
Standard 2012	78%	22%

2.7.4 The percentage of westerly movements in 2013 (74%) was 15% lower than in 2012, a significant change following 6 years of consistently high percentages of westerly movements (in the range 83% to 89%). The standard modal split for 2013 had a 1% lower proportion of westerly movements compared to 2012. Historical runway modal splits at Heathrow for the past 20 years are illustrated in **Figure 8**.

2.7.5 At Heathrow, the runway modal split can have an important influence on the area of the 57 dBA Leq contour. In theory, the 57 dBA contour area would be maximised if (all other things being equal) the airport operated solely in westerly mode over the whole summer period. With a decreasing proportion of westerly movements (and hence an increasing proportion of easterly movements), the

[14] It should be noted that at Heathrow, a 'westerly preference' for aircraft operations is employed, which means that the airport will operate in westerly mode even if there is a light tailwind. This is done to reduce the use of easterly SIDs, which tend to overfly more populated areas compared to the westerly SIDs.

57 dBA contour area would become smaller, reaching a theoretical minimum at a runway modal split of around 40% west / 60% east.

2.7.6 The effect of modal split on the contour area appears to be due to two factors: firstly, the interaction between the noise generated from the two separate runways at Heathrow, and secondly, operations in accordance with the 'Cranford Agreement'[15], which places a restriction on departures from Runway 09L when the airport is operating in easterly mode.

2.7.7 Higher proportions of easterly movements at Heathrow would, in theory, help to reduce the 57 dBA contour area. It should, however, be noted that if the proportion of easterly movements were to rise above about 40%, the population count within the 57 dBA contour would start to increase sharply because of the relatively densely populated areas located to the east of the airport.

2.7.8 The night-time actual runway modal split for the 2013 summer period was 77% west / 23% east.

2.8 Topography

2.8.1 The topography around Heathrow Airport was modelled by accounting for terrain height. This was achieved by geometrical corrections for source-receiver distance and elevation angles. Other, more complex effects, such as lateral attenuation from uneven ground surfaces and noise screening/reflection effects due to topographical features, were not taken into account.

2.8.2 ERCD holds OS terrain height data[16] on a 200 m by 200 m grid for the whole of England. Interpolation was performed to generate height data at each of the calculation points on the receiver grid used by the ANCON noise model. The terrain heights in the vicinity of Heathrow Airport are depicted diagrammatically in **Figure 9**.

2.9 Population and 'Points of Interest' databases

2.9.1 Estimates were made of the numbers of people and households enclosed within the noise contours. The population data used in this report are a 2013 update of

[15] The 'Cranford Agreement' was a Government undertaking given at a meeting of the Cranford Residents' and District Amenities Association in 1952, that as far as practicable, the northern runway would not be used for take-offs to the east due to the proximity of Cranford to the east end of the runway. Following public consultation, a decision was made in 2009 by the Government to end the Cranford Agreement. This would allow for the more even spreading of noise around Heathrow. However, new taxiways would need to be built in order to implement the full alternation of easterly operations. The airport operator has applied for planning permission from the London Borough of Hillingdon for these works, but the application was rejected in February 2014.

[16] Meridian™ 2

the latest 2011 Census supplied by CACI Limited[17]. It should be noted that the population database used for the year 2012 contours was a 2012 update of the earlier 2001 Census (i.e. the most up-to-date database available at the time). Within the extent of the 2013 actual modal split 57 dBA contour it was found that the population count using the 2013 population database was 8% higher than that using the previous 2012 database.

2.9.2 The CACI population database contains data referenced at the postcode level. Population and household numbers associated with each postcode are assigned to a single co-ordinate located at the postcode's centroid. The postcode data points and associated population counts for the area around Heathrow Airport are illustrated in **Figure 10**.

2.9.3 Estimates have also been made of the numbers of noise sensitive buildings situated within the daytime contours, using the *InterestMap*™[18] 'Points of Interest' (2013) database. For the purposes of this study, the noise sensitive buildings that have been considered are schools, hospitals and places of worship.

[17] www.caci.co.uk

[18] InterestMap™ is distributed by Landmark Information Group Ltd and derived from Ordnance Survey 'Points of Interest' data.

3 Noise contour results

3.1 Day actual modal split contours

3.1.1 The Heathrow 2013 day Leq noise contours generated with the actual 2013 summer day period runway modal split (74% west / 26% east) are shown in **Figure 11a**. The contours are plotted from 57 to 72 dBA at 3 dB intervals.

3.1.2 The cumulative areas, populations and households within the 2013 day actual modal split contours are provided in the table below:

Heathrow 2013 day actual contours – area, population and household estimates

Leq (dBA)	Area (km^2)	Population	Households
> 57	107.3	264,250	100,200
> 60	58.7	118,450	41,950
> 63	34.6	50,650	17,500
> 66	20.4	14,150	4,700
> 69	9.8	3,450	1,150
> 72	5.3	200	100

Note: Populations and households are given to the nearest 50.

3.1.3 Estimates of the cumulative numbers of noise sensitive buildings within the 2013 day actual modal split contours are provided in the table below:

Heathrow 2013 day actual contours – noise sensitive building estimates

Leq (dBA)	Schools	Hospitals	Places of worship
> 57	167	5	114
> 60	63	0	46
> 63	16	0	15
> 66	7	0	4
> 69	1	0	1
> 72	0	0	0

3.2 Night actual modal split contours

3.2.1 The Heathrow 2013 night Leq noise contours generated with the actual 2013 summer night period runway modal split (77% west / 23% east) are shown in **Figure 11b**. The contours are plotted from 48 to 66 dBA at 3 dB intervals (note: the 69 and 72 dBA contours have been omitted to improve clarity).

3.2.2 The cumulative areas, populations and households within the 2013 night actual modal split contours are provided in the following table:

Heathrow 2013 night actual contours – area, population and household estimates

Leq (dBA)	Area (km^2)	Population	Households
> 48	120.5	421,250	171,600
> 51	70.1	190,800	72,100
> 54	41.3	103,200	35,850
> 57	21.5	48,200	16,250
> 60	11.3	16,700	5,250
> 63	6.0	4,500	1,350
> 66	3.3	1,650	450
> 69	1.9	< 50	< 50
> 72	1.3	0	0

Note: Populations and households are given to the nearest 50.

3.2.3 The 2013 night actual modal split 48 dBA contour enclosed an area of 120.5 km^2 and a population of 421,250.

3.3 Day standard modal split contours

3.3.1 The Heathrow 2013 day Leq noise contours generated with the standard 2013 summer day period runway modal split (77% west / 23% east) are shown in **Figure 12**. The contours are plotted from 57 to 72 dBA at 3 dB intervals.

3.3.2 The cumulative areas, populations and households within the 2013 day standard modal split contours are provided in the following table:

Heathrow 2013 day standard contours – area, population and household estimates

Leq (dBA)	Area (km^2)	Population	Households
> 57	107.9	266,050	101,350
> 60	59.1	118,750	42,150
> 63	34.5	48,400	16,850
> 66	20.4	14,400	4,800
> 69	9.9	3,350	1,100
> 72	5.3	200	100

Note: Populations and households are given to the nearest 50.

3.3.3 Estimates of the cumulative numbers of noise sensitive buildings within the 2013 day standard modal split contours are provided in the table below:

Heathrow 2013 day standard contours – noise sensitive building estimates

Leq (dBA)	Schools	Hospitals	Places of worship
> 57	167	5	114
> 60	64	0	46
> 63	15	0	16
> 66	7	0	4
> 69	1	0	1
> 72	0	0	0

4 Analysis of results

4.1 Day actual modal split contours – comparison with 2012 contours

4.1.1 The Heathrow 2013 day actual modal split Leq contours are compared against the 2012 day actual Leq contours in **Figure 13**. The table below summarises the areas, populations and percentage changes from 2012 to 2013:

Heathrow day actual contours - areas and populations for 2012 and 2013

Leq (dBA)	2012 Area (km^2)	2013 Area (km^2)	Area change (%)	2012 Pop.	2013 Pop.	Pop. change (%)
> 57	110.1	107.3	-3%	239,600	264,250	+10%
> 60	60.4	58.7	-3%	103,500	118,450	+14%
> 63	34.3	34.6	+1%	42,400	50,650	+19%
> 66	20.7	20.4	-1%	13,750	14,150	+3%
> 69	10.3	9.8	-5%	3,600	3,450	-4%
> 72	5.4	5.3	-2%	200	200	0%

Note: The 2012 and 2013 runway modal splits were 89% west / 11% east and 74% west / 26% east respectively.

4.1.2 The 57 dBA contour lobe formed by aircraft on the westerly WOB/BPK SIDs heading to the north-west of the airport retracted noticeably in 2013 - this can be attributed to the 4% reduction in westerly WOB/BPK SID movements in 2013. A similar effect was seen for the contour lobes associated with the westerly DVR/DET and CPT/SAM SIDs. There was an overall 15% reduction in westerly departure movements in 2013.

4.1.3 Because of the much higher (+15%) proportion of easterly departure movements in 2013, the contour lobes associated with the easterly SIDs (e.g. BUZ/BPK and MID/SAM) have expanded.

4.1.4 It can be seen that the eastern tips of the 57 dBA contour have retracted, a result of the lower proportion of westerly arrivals in 2013.

4.1.5 Relative to 2012, the areas of most of the 2013 contours have decreased (with the exception of the 63 dBA level) by up to 5%. This can be attributed to the 15% higher percentage of easterly movements in 2013, which tends to reduce the Heathrow contour area (as explained in section 2.7.5). This effect outweighed the 0.3% increase in total movements and changes to the fleet mix (see section 4.2.5).

4.1.6 The 2013 population count for the 57 dBA contour level increased significantly despite the area reduction, largely due to the major update to the population database for 2013.

4.2 Day standard modal split contours – comparison with 2012 contours

4.2.1 The Heathrow 2013 day standard modal split Leq contours are compared against the 2012 standard Leq contours in **Figure 14**. The table below summarises the areas, populations and percentage changes from 2012 to 2013:

Heathrow day standard contours - areas and populations for 2012 and 2013

Leq (dBA)	2012 Area (km^2)	2013 Area (km^2)	Area change (%)	2012 Pop.	2013 Pop.	Pop. change (%)
> 57	106.7	107.9	+1%	237,350	266,050	+12%
> 60	58.7	59.1	+1%	105,800	118,750	+12%
> 63	34.3	34.5	+1%	42,000	48,400	+15%
> 66	20.5	20.4	0%	12,850	14,400	+12%
> 69	10.0	9.9	-1%	3,200	3,350	+5%
> 72	5.3	5.3	0%	200	200	0%

Note: The 2012 and 2013 standard runway modal splits were 78% west / 22% east and 77% west / 23% east respectively.

4.2.2 It can be seen that both the eastern end (near Barnes) and the western tip (over Windsor) of the 2013 standard 57 dBA contours extend slightly further than in 2012. This was caused by changes to the fleet mix in 2013, which saw a large increase in EA320C arrival movements (+15.1) not being significantly offset by reductions in arrival movements of the quieter ERJ aircraft (-12.7).

4.2.3 The contour lobe formed by departures on the westerly DVR/DET SIDs contracted in 2013. Overall daily movements on the DVR/DET SIDs reduced by 2% in 2013, which included a significant decrease in EA346 departures.

4.2.4 The contour lobe associated with westerly CPT/SAM SID movements also retracted in 2013 as overall movements dropped by 6% (excluding the effects of runway modal split changes) on the CPT/SAM routes in 2013.

4.2.5 The 2013 57 dBA contour area was 1% larger compared to 2012, reflecting changes to the fleet mix such as those mentioned in section 4.2.2. At the higher contour levels, there were area increases and decreases of up to 1%; however, corresponding population changes were mostly higher than would have been expected as a consequence of the major population database update for 2013.

4.2.6 The standardised contours normally provide a clearer indication than the actual contours of ‘fleet noise level’ changes from year to year because they minimise the effect of any difference between the ratios of westerly to easterly operations.

The 57 dBA standard contour results indicate that the actual modal split contour would have been marginally larger had there not been the significant increase in easterly mode operations in 2013.

4.2.7 As explained in section 2.7.5, the runway modal split can affect the area enclosed by the contours. The actual and standard modal splits were similar in 2013, with the standard contour having a slightly higher area (by 0.6%). However, looking at the previous year's results, which had a larger difference in modal splits, the actual 57 dBA Leq contour (modal split 89% west / 11% east) enclosed an area of 110.1 km^2, whereas the 57 dBA Leq standard 2012 contour (modal split 78% west / 22% east) had a 3% smaller area at 106.7 km^2.

4.3 Day noise contour historical trend

4.3.1 **Figure 15** shows how the 57 dBA Leq day actual modal split contour has changed in area and population terms since 1988 by comparison with the total annual (365-day) aircraft movements. (Actual modal split data are used in this figure because standard modal split contours were not produced prior to 1995).

Movement trend

4.3.2 Against the trend of a general decrease in contour area, the number of aircraft movements has risen steadily most years up until 2007, with a major trough occurring in 1991, the year of the First Gulf War. The annual movement figure for 2001 was slightly lower than the preceding year and reflected the disruption to traffic following the terrorist attacks on 11 September 2001. The total annual movement figure for 2005 was 2% higher than that for 2004 compared with the 1% decrease for the 16-hour average summer Leq day. Movements during the summer 2005 period were affected by three days of industrial action in August and possibly by the terrorist attacks in central London on 7 July 2005. A separate analysis showed that total movements in July and August of 2005 were less than those for the same months in 2004.

4.3.3 The total annual movements in 2006 were 0.2% lower than in 2005. Traffic levels during the summer 2006 Leq period were affected by new tighter security restrictions, which were introduced in mid-August 2006. Flights at Heathrow were also disrupted in December 2006 by heavy fog.

4.3.4 Annual traffic levels rose by 1% in 2007, but fell in 2008 by 0.6% – this may be attributed to the economic downturn and fluctuating oil price. (Note: over the summer period only, traffic levels increased by 0.5%). In 2009, traffic levels dropped further, by 3%, as the global recession continued to impact upon the aviation industry.

4.3.5 Aircraft movements fell in 2010 for the third year in a row, this time by 2%, as a result of adverse winter weather conditions, the volcanic ash crisis in April and

industrial action in May. (However, it should be noted that over the summer period only, movements were up by 3%).

4.3.6 Annual traffic levels in 2011 staged a marked recovery from the falls seen in the previous three years, with an increase of 6% back to a level close to the last peak seen in 2007. Traffic levels dropped back slightly by about 1% in both 2012 and 2013.

Area and population trend

4.3.7 The contour area figures give a better indication of the actual noise than the population figures because the latter are more susceptible to the runway modal split. 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). Also, percentage changes in contour areas are not necessarily accompanied by similar changes in enclosed population because the contours may be different in shape as well as size, and movement of contour lines from year to year, especially in or around relatively highly populated areas, can cause a disproportionate change in enclosed population. The recorded increase in enclosed population between 1998 and 1999 reflected demographic changes that occurred between the 1991 Census and the subsequent update.

4.3.8 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.

4.3.9 From 2004 to 2008, the 57 dBA contour area at Heathrow was relatively steady, within a range from 117 to 123 km^2. However, in 2009 the contour area fell below this range to 112.5 km^2, and dropped even further in 2010 to 108.3 km^2. The 2011 area saw a marginal increase to 108.8 km^2 as traffic levels rose slightly over the summer period. The area in 2012 increased slightly to 110.1 km^2, caused mainly by a significant increase in the proportion of westerly mode operations. However, the contour area in 2013 reduced to 107.3 km^2, the smallest ever area calculated for Heathrow, as runway usage shifted significantly in favour of easterly operations.

4.3.10 Between 2001 and 2009 the population count within the 57 dBA contour fluctuated between approximately 240,000 and 269,000. In 2010, the population count dropped below this range to its lowest ever value of 229,000. In line with the increase in contour area, the population increased to 243,000 in 2011, before dropping by 2% to 239,600 in 2012. In 2013 there was a significant rise in population, the result of a major update to the population database.

5 Conclusions

5.1 Year 2013 average summer 16-hour day and 8-hour night Leq noise exposure contours have been generated for Heathrow Airport using the ANCON noise model.

5.2 The results show that the 2013 day actual modal split 57 dBA Leq contour area decreased by 3% to 107.3 km^2 (2012: 110.1 km^2), the smallest ever area calculated for Heathrow. This can be attributed primarily to the 15% higher proportion of easterly operations in 2013. However, the population count within the 2013 actual 57 dBA Leq contour increased by 10% compared to 2012 to 264,250, largely due to a major update to the population database for 2013.

5.3 The 2013 day standard modal split 57 dBA Leq contour area was 107.9 km^2, 1% higher than in 2012 (2012: 106.7 km^2). The population count within the 2013 day standard 57 dBA Leq contour was also significantly higher, by 12%, at 266,050.

5.4 Night-time Leq contours for 2013 have been produced for the first time. The actual modal split 48 dBA night contour enclosed an area of 120.5 km^2 with a population of 421,250.

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Table 1a Heathrow 2012 and 2013 average summer day movements by noise class

Noise Class	Description	2012 movements	2013 movements	Percentage of total 2013 movements	Change
PROPELLER AIRCRAFT					
1	Small propeller aircraft	0.0	< 0.1	< 0.1%	0.0 (*)
2	Large propeller aircraft	0.2	0.0	0.0%	-0.2 (*)
CHAPTER 3/4 JETS **					
3	Short-haul aircraft	840.9	837.5	66.5%	-3.4 (-0.4%)
4	Wide-body twin-engine aircraft	277.3	295.3	23.5%	+18.0 (+6%)
5	2nd generation wide-body 3,4-engine aircraft	136.5	126.0	10.0%	-10.5 (-8%)
LARGE CHAPTER 2/3 JETS					
6	1st generation wide-body 3,4-engine aircraft	< 0.1	0.0	0.0%	0.0 (*)
2nd GENERATION TWIN JETS					
7	Narrow-body twin-engine aircraft *(including Ch.2 and hushkitted versions)*	0.0	0.0	0.0%	0.0 (*)
1st GENERATION JETS					
8	Narrow-body 3,4-engine aircraft	0.1	0.0	0.0%	-0.1 (*)
	TOTAL	1255.1	**1258.8**	100%	**+3.8 (+0.3%)**

* Percentage changes not shown due to low numbers and limited data resolution.

** An estimated 98% of *Noise Class 3* aircraft in the 2013 daytime period met the 'Chapter 4' noise standard (2012: 96%).

Note: Totals may not sum exactly due to rounding.

Table 1b Heathrow 2013 average summer night movements by noise class

Noise Class	Description	2013 movements	Percentage of total 2013 movements
PROPELLER AIRCRAFT			
1	Small propeller aircraft	0.1	0.1%
2	Large propeller aircraft	0.0	0.0%
CHAPTER 3/4 JETS *			
3	Short-haul aircraft	18.4	22.4%
4	Wide-body twin-engine aircraft	35.7	43.3%
5	2nd generation wide-body 3,4-engine aircraft	28.2	34.2%
LARGE CHAPTER 2/3 JETS			
6	1st generation wide-body 3,4-engine aircraft	0.0	0.0%
2nd GENERATION TWIN JETS			
7	Narrow-body twin-engine aircraft *(including Ch.2 and hushkitted versions)*	0.0	0.0%
1st GENERATION JETS			
8	Narrow-body 3,4-engine aircraft	0.0	0.0%
	TOTAL	**82.4**	100%

* An estimated 96% of *Noise Class 3* aircraft in the 2013 night-time period met the 'Chapter 4' noise standard.

Note: Totals may not sum exactly due to rounding.

Table 2a Heathrow 2012 and 2013 average summer day movements by ANCON aircraft type

Aircraft type	Noise class	ANCON type	2012	2013	Change
Small twin-turboprop	1	STT	0.0	< 0.1	0.0
Large twin-turboprop	2	LTT	0.2	0.0	-0.2
Boeing 717	3	B717	0.0	0.1	+0.1
Boeing 737-300/400/500	3	B733	17.7	11.7	-6.0
Boeing 737-600/700	3	B736	22.1	23.5	+1.4
Boeing 737-800/900	3	B738	25.4	19.0	-6.4
Boeing 757-200 (RB211-535C engines)	3	B757C	1.4	1.0	-0.4
Boeing 757-200 (RB211-535E4/E4B engines)	3	B757E	19.4	15.9	-3.5
Boeing 757-200 (PW2037/2040 engines)	3	B757P	0.3	0.2	-0.1
Boeing 757-300	3	B753	0.7	0.0	-0.7
BAe 146/Avro RJ	3	BA46	6.5	1.8	-4.7
Airbus A318	3	EA318	5.6	3.2	-2.4
Airbus A319 (CFM-56 engines)	3	EA319C	50.5	49.3	-1.2
Airbus A319 (IAE-V2500 engines)	3	EA319V	210.3	214.6	+4.3
Airbus A320 (CFM-56 engines)	3	EA320C	107.0	136.1	+29.1
Airbus A320 (IAE-V2500 engines)	3	EA320V	209.6	214.7	+5.1
Airbus A321 (CFM56 engines)	3	EA321C	34.5	40.9	+6.4
Airbus A321 (IAE-V2500 engines)	3	EA321V	89.7	93.7	+4.0
Executive Business Jet (Chapter 3)	3	EXE3	1.8	0.3	-1.5
Bombardier Regional Jet 100/200	3	CRJ	< 0.1	0.0	0.0
Bombardier Regional Jet 900	3	CRJ900	1.1	2.1	+1.0
Embraer 135/145	3	ERJ	25.4	< 0.1	-25.4
Embraer 170	3	ERJ170	< 0.1	< 0.1	0.0
Embraer 190	3	ERJ190	3.5	3.3	-0.2
Fokker 100	3	FK10	4.0	4.7	+0.7
McDonnell Douglas MD80 series	3	MD80	4.5	1.4	-3.1
Boeing 767-200	4	B762	0.2	0.9	+0.7
Boeing 767-300 (GE CF6-80 engines)	4	B763G	15.5	15.9	+0.4
Boeing 767-300 (PW4000 engines)	4	B763P	11.2	12.8	+1.6
Boeing 767-300 (RR RB211 engines)	4	B763R	40.9	45.1	+4.2
Boeing 767-400	4	B764	16.4	11.4	-5.0
Boeing 777-200 (GE GE90 engines)	4	B772G	40.0	33.2	-6.8
Boeing 777-200 (PW PW4000 engines)	4	B772P	10.8	9.3	-1.5
Boeing 777-200 (RR Trent 800 engines)	4	B772R	54.2	46.1	-8.1
Boeing 777-200LR/300ER (GE GE90 engines)	4	B773G	48.7	62.4	+13.7
Boeing 777-300 (RR Trent 800 engines)	4	B773R	0.6	0.0	-0.6
Boeing 787-8/9/10	4	B788	0.0	6.9	+6.9
Airbus A300	4	EA30	3.6	3.7	+0.1
Airbus A310	4	EA31	0.6	0.4	-0.2
Airbus A330	4	EA33	34.7	47.3	+12.6
Airbus A340-200/300	5	EA34	9.4	10.4	+1.0
Airbus A340-500/600	5	EA346	34.2	18.7	-15.5
Airbus A380 (Engine Alliance GP7000 engines)	5	EA38GP	5.7	9.2	+3.5
Airbus A380 (RR Trent 900 engines)	5	EA38R	7.5	10.8	+3.3
Boeing 747-400 (GE CF6-80F engines)	5	B744G	8.1	12.2	+4.1
Boeing 747-400 (PW PW4000 engines)	5	B744P	7.5	4.5	-3.0

Aircraft type	Noise class	ANCON type	2012	2013	Change
Boeing 747-400 (RR RB211 engines)	5	B744R	64.0	60.2	-3.8
Boeing 747SP	5	B747SP	< 0.1	0.0	0.0
McDonnell Douglas MD-11	5	MD11	0.0	< 0.1	0.0
Boeing 747-100/200/300	6	B747	< 0.1	0.0	0.0
Boeing 727 (Chapter 3)	8	B727	< 0.1	0.0	0.0
Ilyushin Il-62	8	IL62	< 0.1	0.0	0.0
		TOTAL	1255.1	**1258.8**	**+3.7 (+0.3%)**

Note: Totals may not sum exactly due to rounding.

Table 2b Heathrow 2013 average summer night movements by ANCON aircraft type

Aircraft type	Noise class	ANCON type	Movements
Small twin-turboprop	1	STT	0.1
Boeing 737-300/400/500	3	B733	0.6
Boeing 737-600/700	3	B736	< 0.1
Boeing 737-800/900	3	B738	0.8
Boeing 757-200 (RB211-535C engines)	3	B757C	0.4
Boeing 757-200 (RB211-535E4/E4B engines)	3	B757E	1.2
Airbus A319 (CFM-56 engines)	3	EA319C	1.5
Airbus A319 (IAE-V2500 engines)	3	EA319V	4.1
Airbus A320 (CFM-56 engines)	3	EA320C	4.4
Airbus A320 (IAE-V2500 engines)	3	EA320V	1.9
Airbus A321 (CFM56 engines)	3	EA321C	1.0
Airbus A321 (IAE-V2500 engines)	3	EA321V	2.2
Executive Business Jet (Chapter 3)	3	EXE3	< 0.1
Bombardier Regional Jet 900	3	CRJ900	< 0.1
Embraer 135/145	3	ERJ	0.1
Embraer 170	3	ERJ170	< 0.1
Embraer 190	3	ERJ190	< 0.1
McDonnell Douglas MD80 series	3	MD80	< 0.1
Boeing 767-200	4	B762	< 0.1
Boeing 767-300 (GE CF6-80 engines)	4	B763G	1.6
Boeing 767-300 (PW4000 engines)	4	B763P	1.0
Boeing 767-300 (RR RB211 engines)	4	B763R	4.4
Boeing 767-400	4	B764	1.1
Boeing 777-200 (GE GE90 engines)	4	B772G	8.1
Boeing 777-200 (PW PW4000 engines)	4	B772P	1.8
Boeing 777-200 (RR Trent 800 engines)	4	B772R	4.8
Boeing 777-200LR/300ER (GE GE90 engines)	4	B773G	7.4
Boeing 787-8	4	B788	0.4
Airbus A300	4	EA30	0.7
Airbus A330	4	EA33	4.3
Airbus A340-200/300	5	EA34	1.3
Airbus A340-500/600	5	EA346	4.4
Airbus A380 (Engine Alliance GP7000 engines)	5	EA38GP	0.8
Airbus A380 (RR Trent 900 engines)	5	EA38R	4.7
Boeing 747-400 (GE CF6-80F engines)	5	B744G	0.4
Boeing 747-400 (PW PW4000 engines)	5	B744P	1.0
Boeing 747-400 (RR RB211 engines)	5	B744R	15.6
		TOTAL	**82.4**

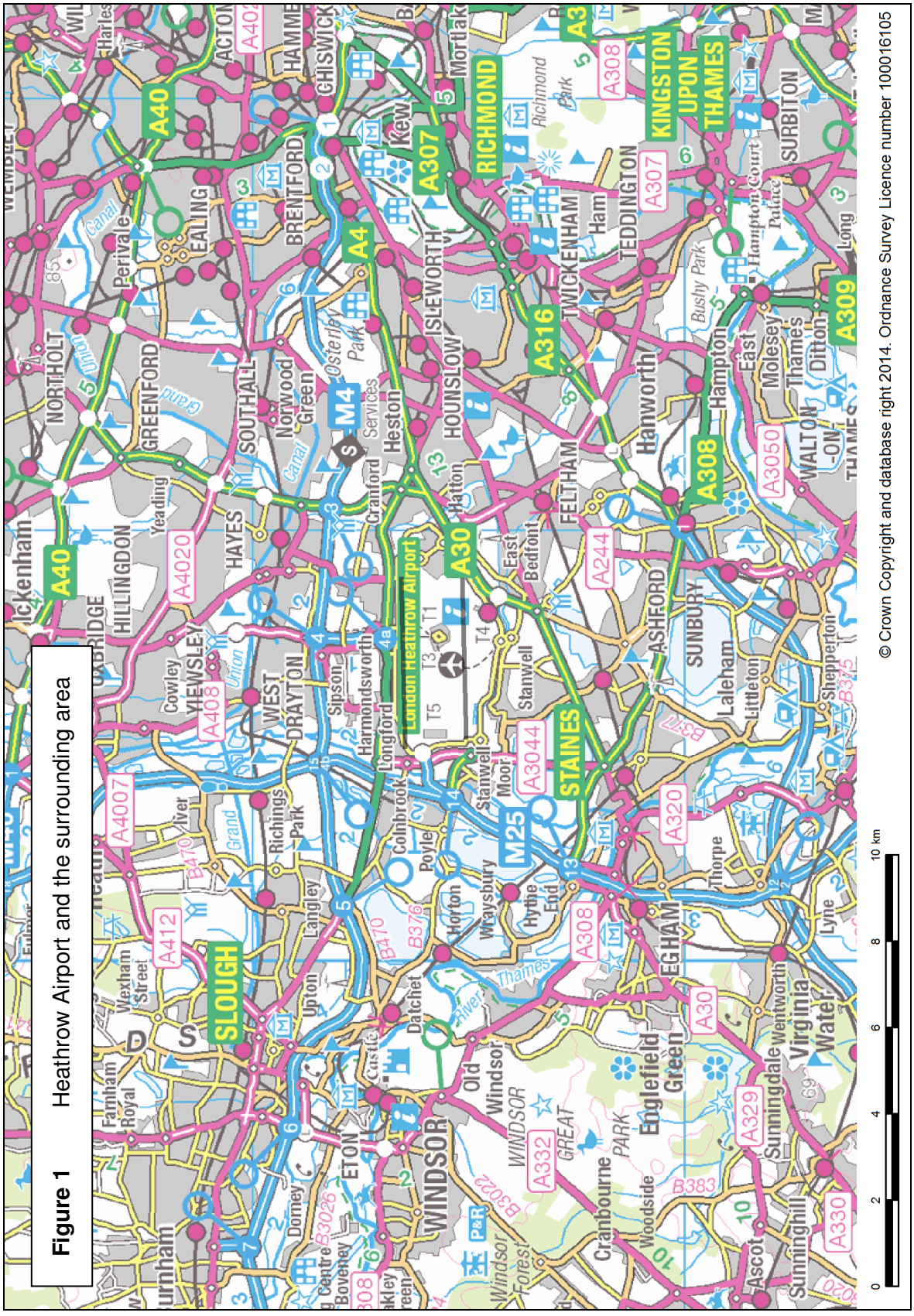


Figure 1 Heathrow Airport and the surrounding area

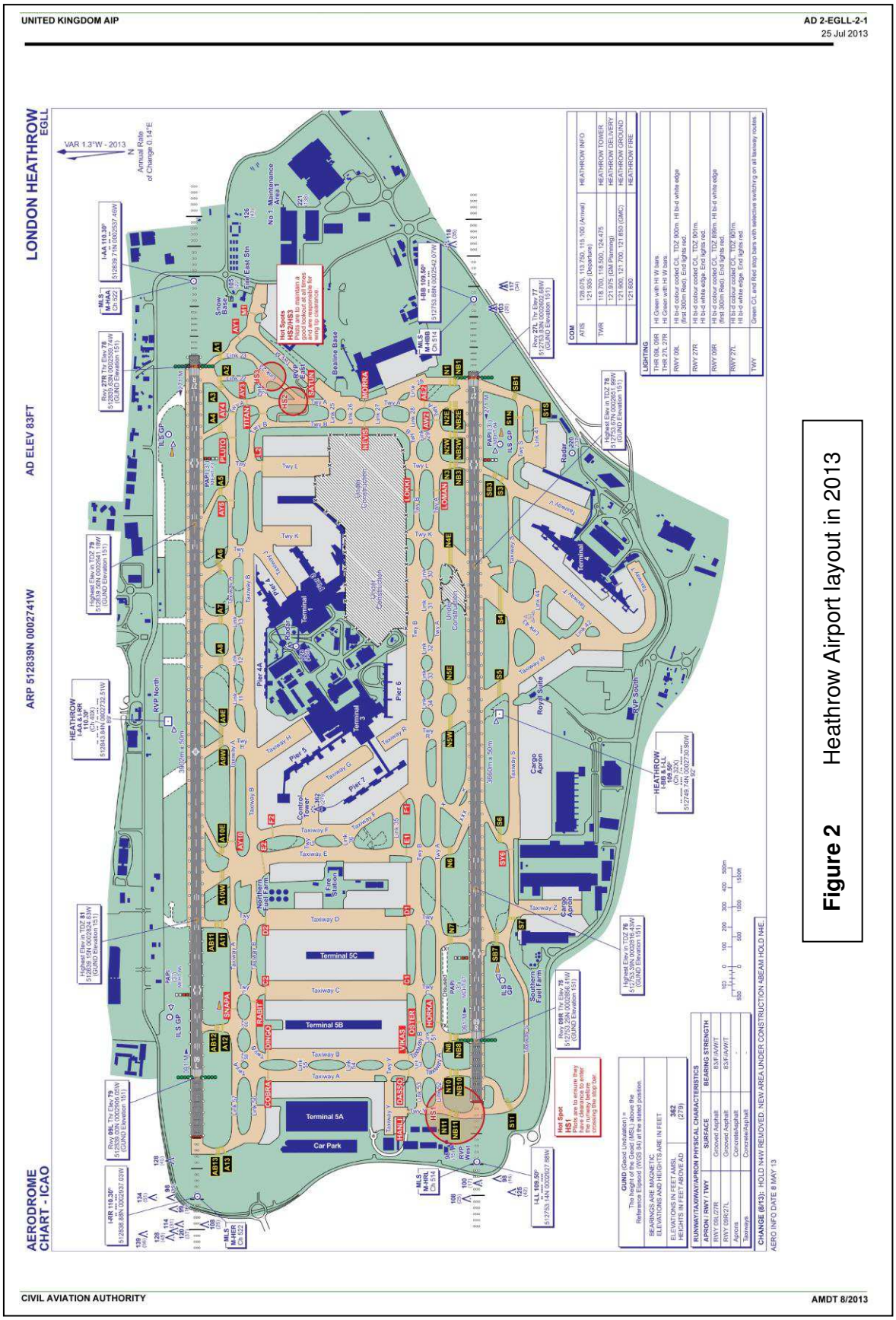


Figure 2 Heathrow Airport layout in 2013

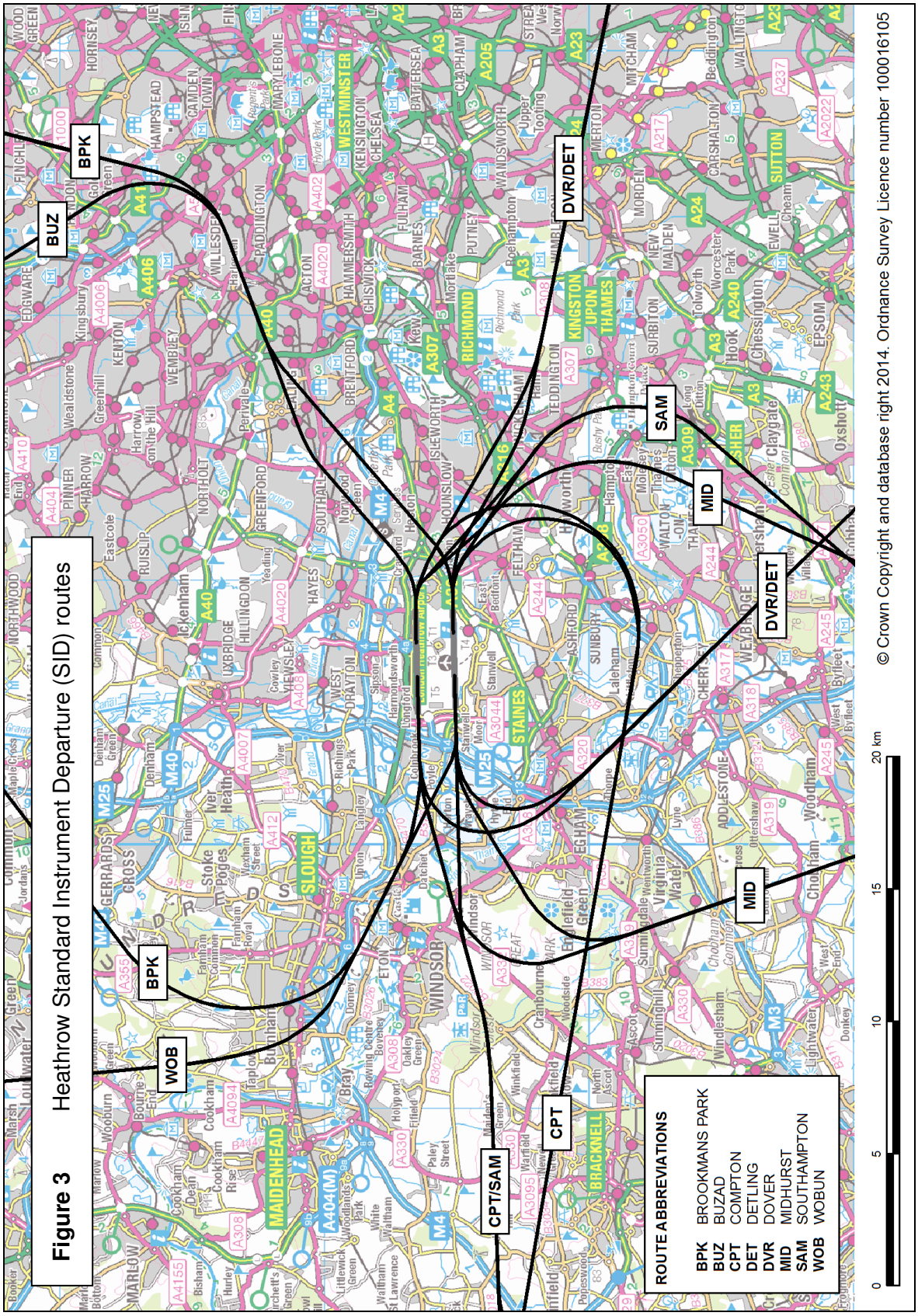


Figure 3 Heathrow Standard Instrument Departure (SID) routes

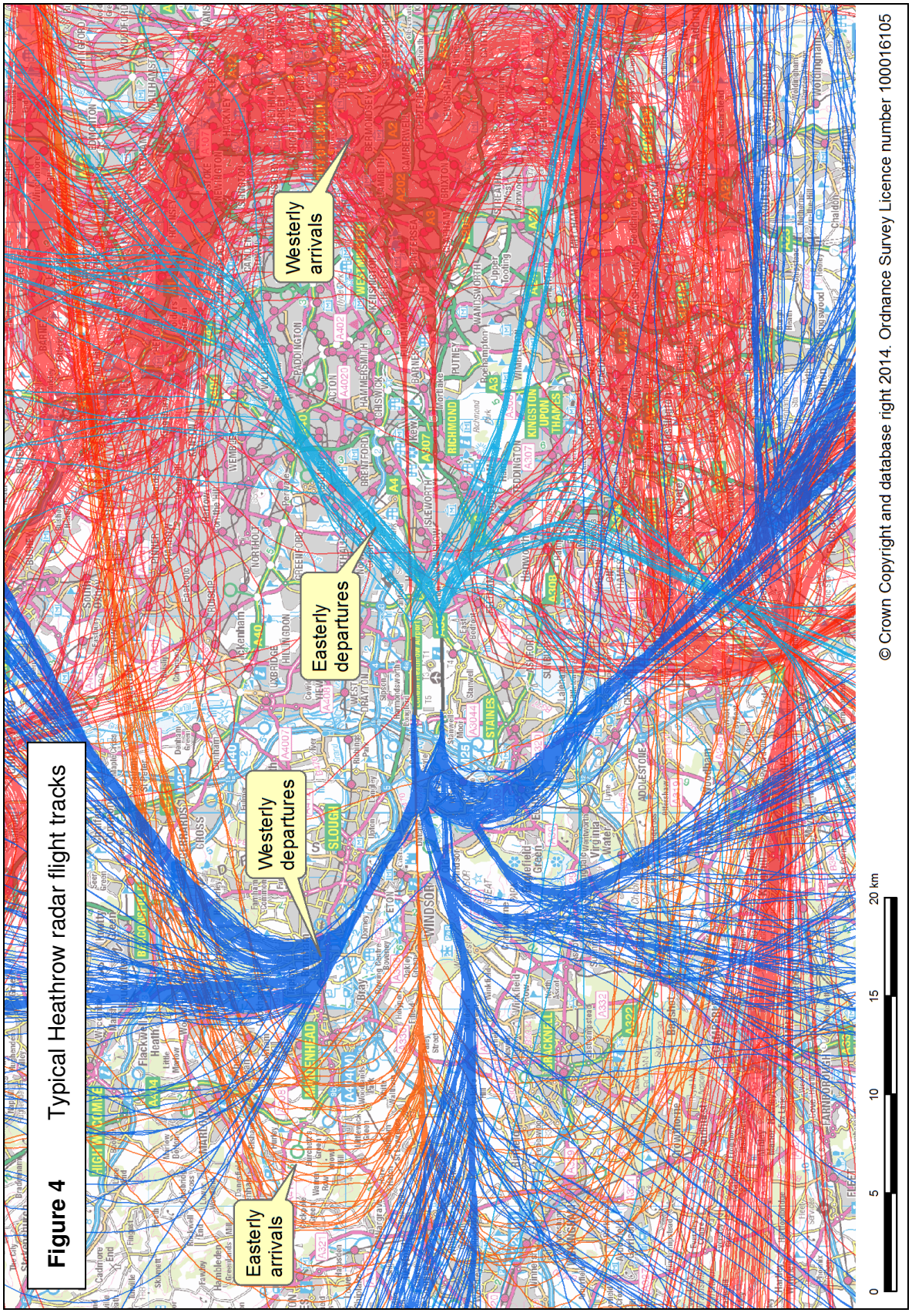
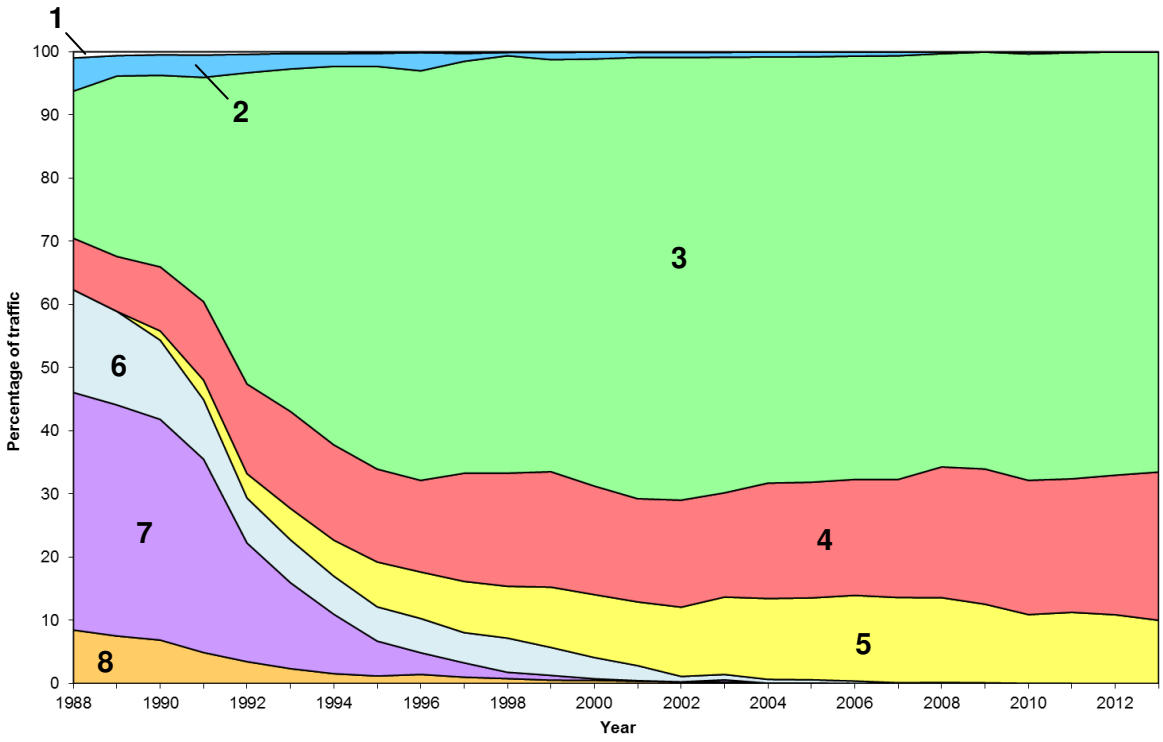


Figure 4 Typical Heathrow radar flight tracks

Figure 5 Heathrow noise class trend 1988-2013



Note: The percentages from 1990 onwards 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.

Key to noise classes

Propeller aircraft
1 Small props, e.g. single/twin piston and turboprop light aircraft
2 Large props, e.g. 2- and 4-propeller transports, e.g. ATR-42, BAe ATP

Chapter 3/4 jets
3 Short-haul, e.g. Airbus A319, A320, A321
4 Wide-body twins, e.g. Boeing 767, Boeing 777
5 2nd generation wide-body 3/4-engine aircraft, e.g. Airbus A380, Boeing 747-400

Large Chapter 2/3 jets
6 1st generation wide-body 3/4-engine aircraft, e.g. Boeing 747-200

2nd generation twin jets
7 Narrow body twins (including hushkitted versions), e.g. Boeing 737-200

1st generation jets
8 Narrow body 3/4-engine aircraft (including hushkitted versions), e.g. Boeing 727

Figure 6a Heathrow 2013 average summer day movements by ANCON type

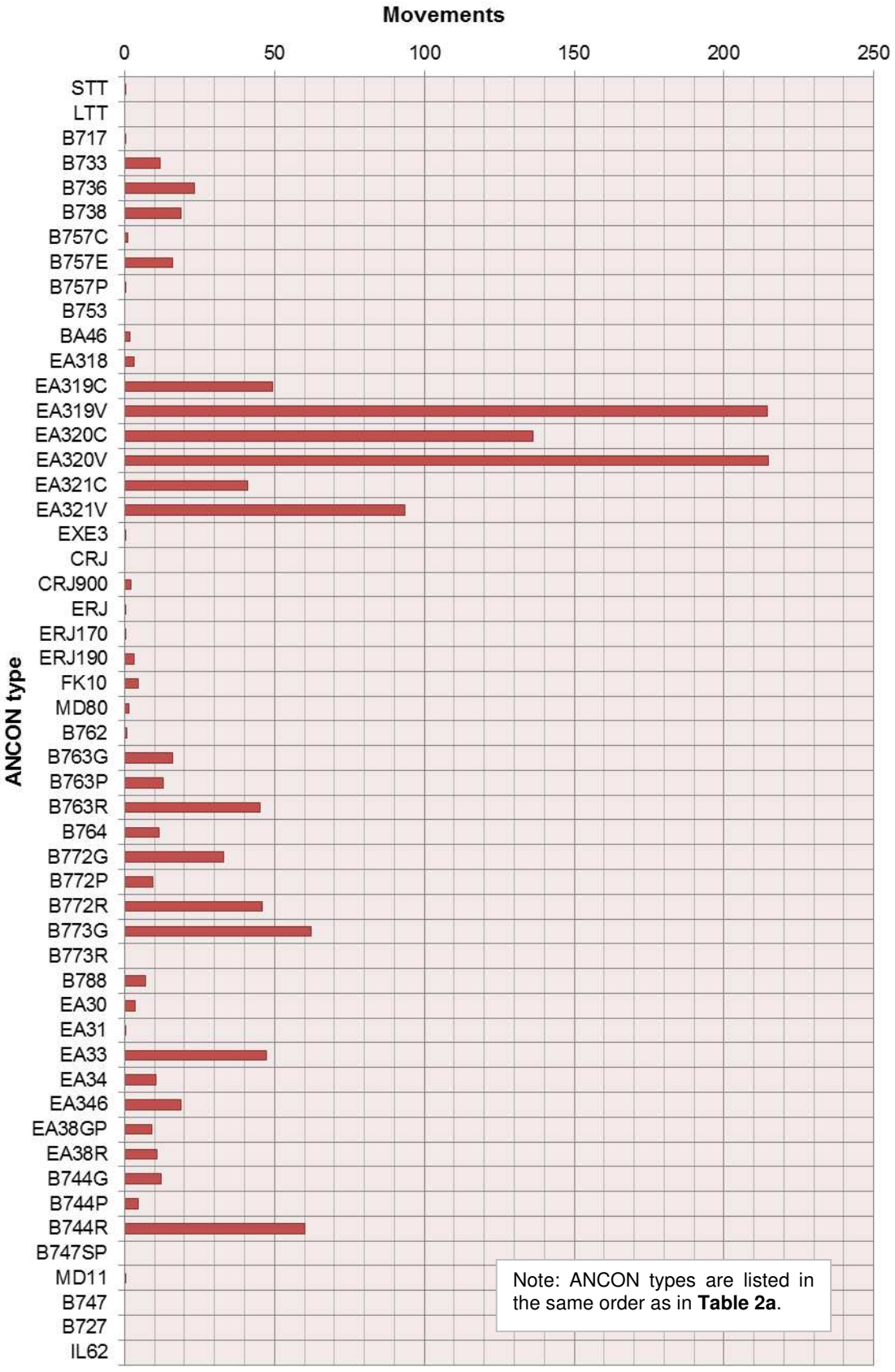
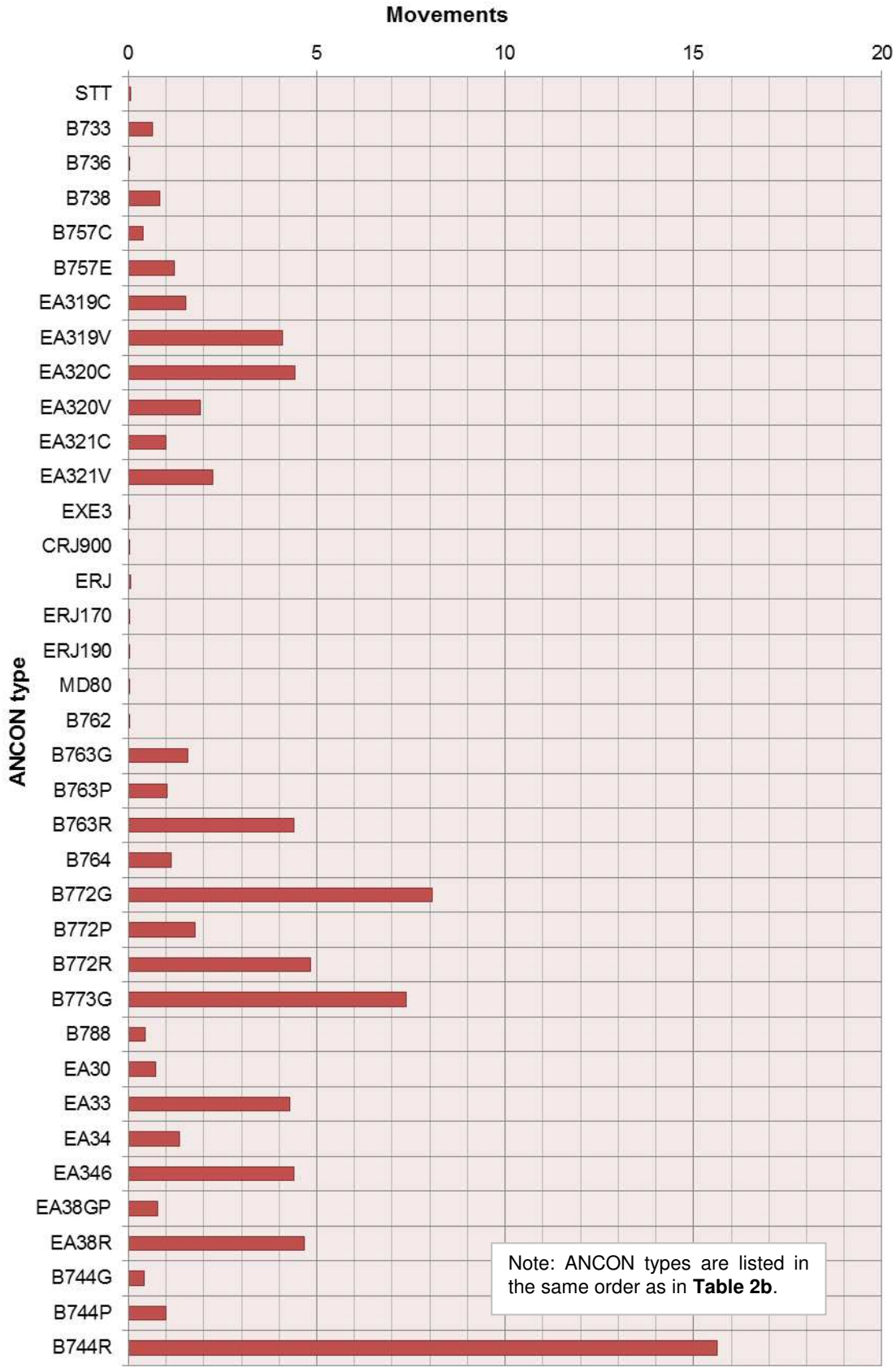
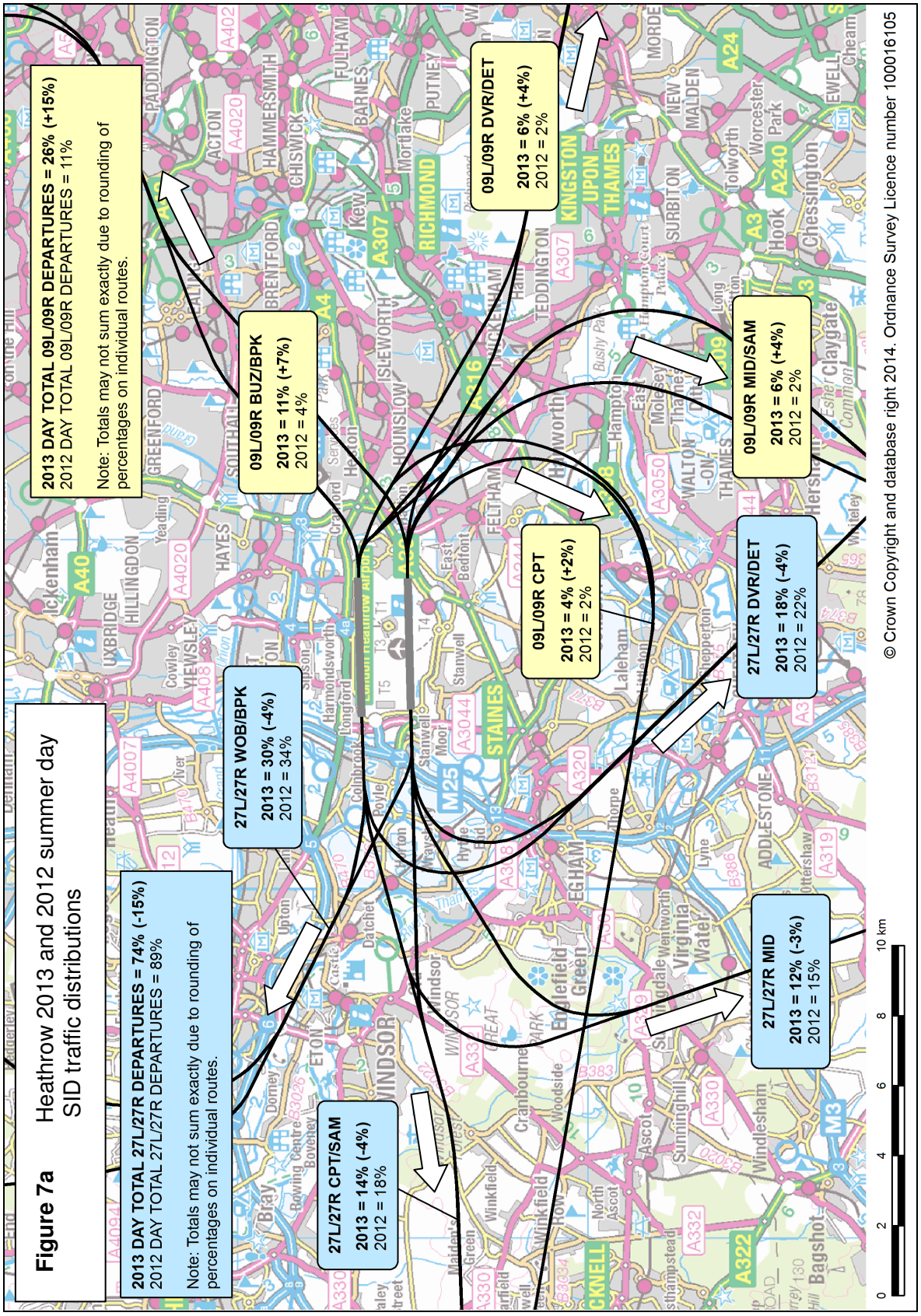


Figure 6b Heathrow 2013 average summer night movements by ANCON type





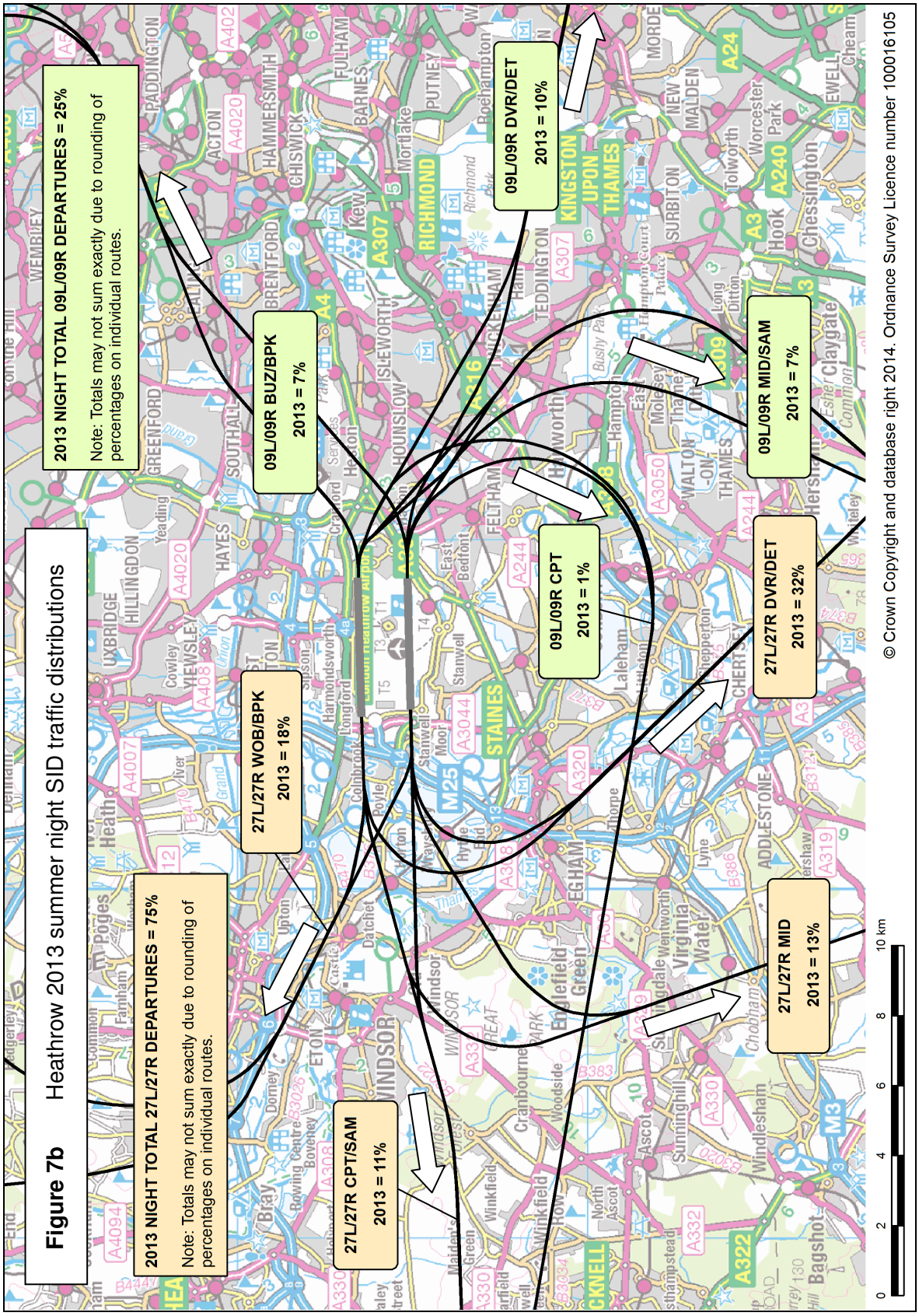
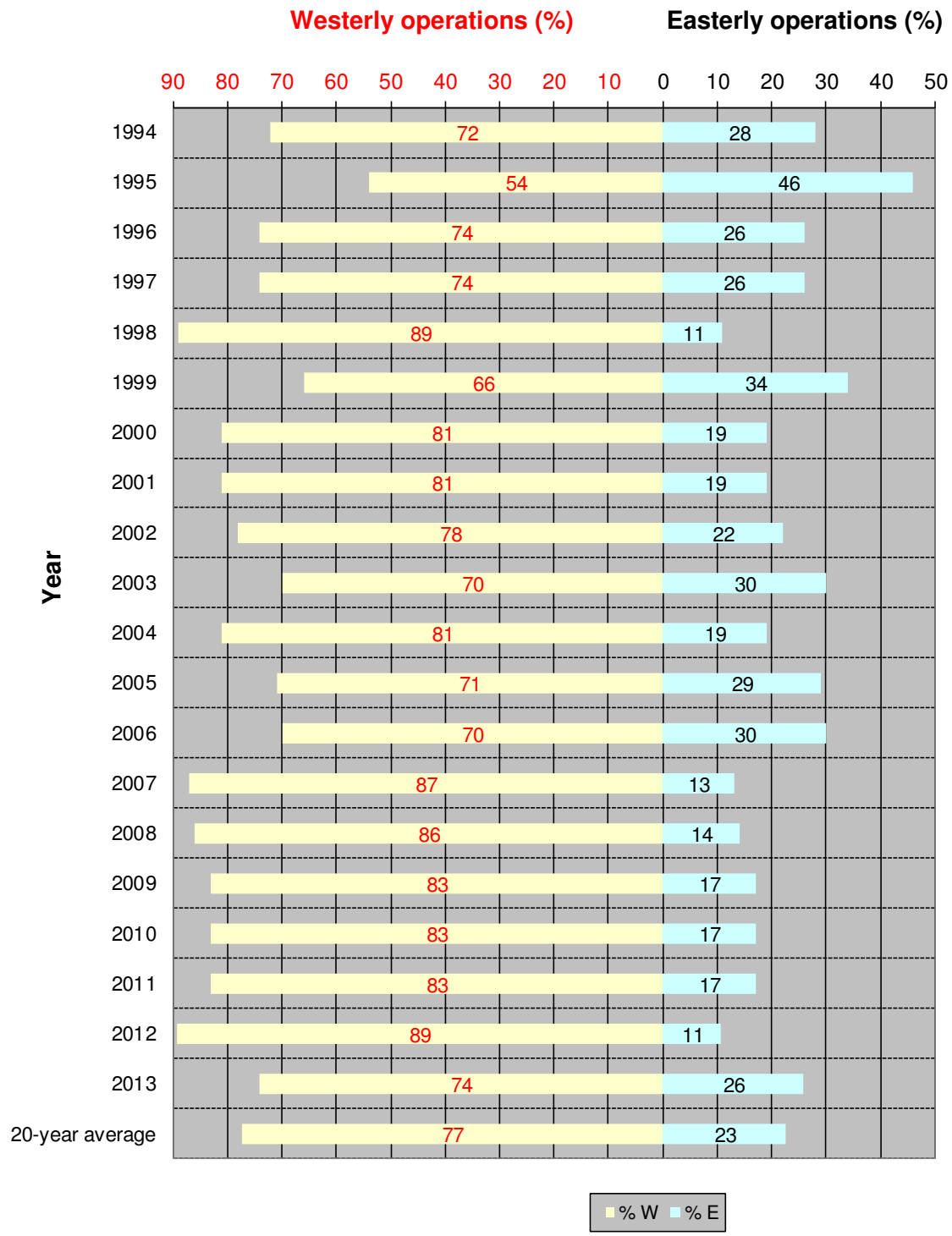


Figure 7b Heathrow 2013 summer night SID traffic distributions

Figure 8 Heathrow average summer day runway modal splits 1994-2013



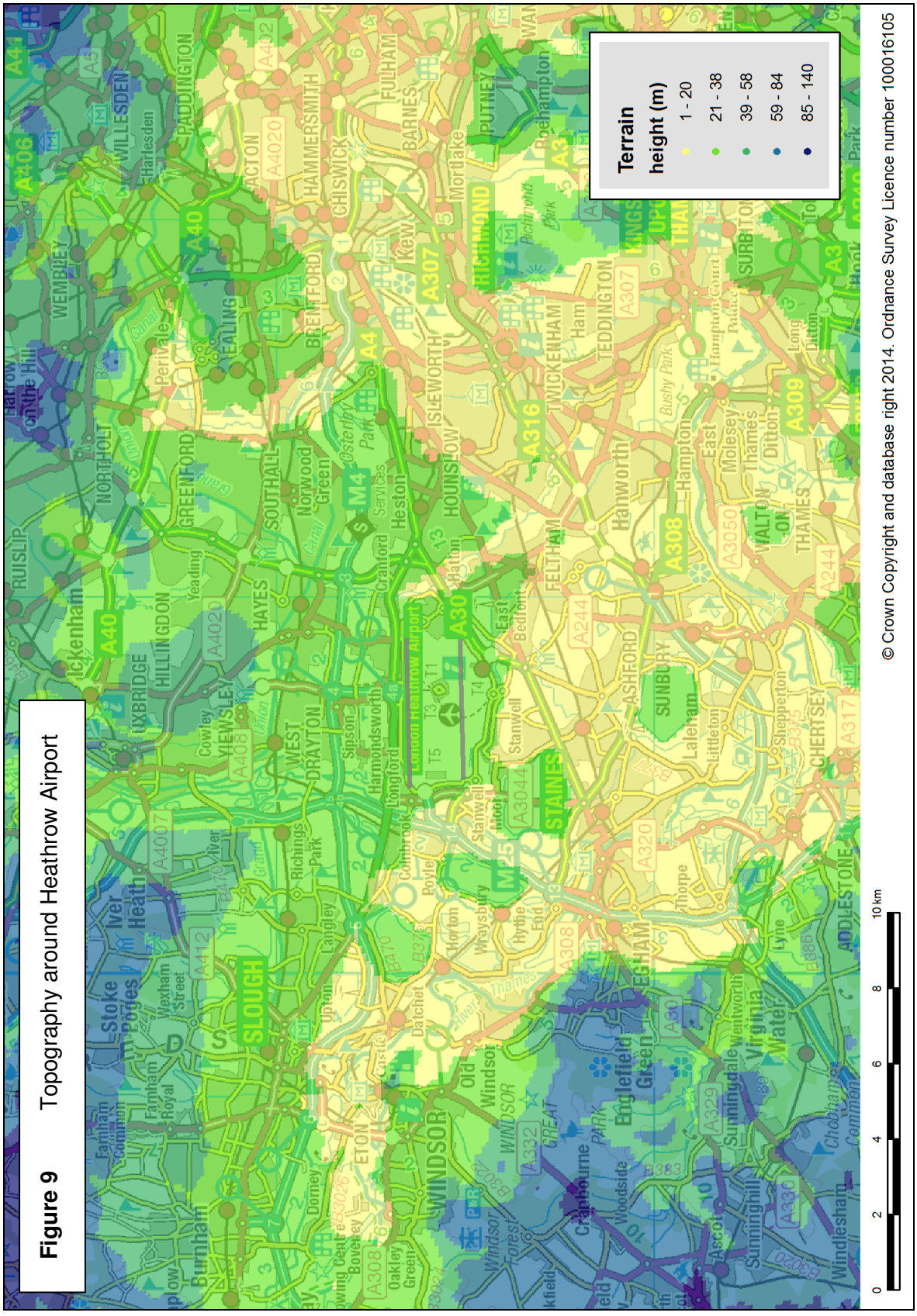


Figure 9 Topography around Heathrow Airport

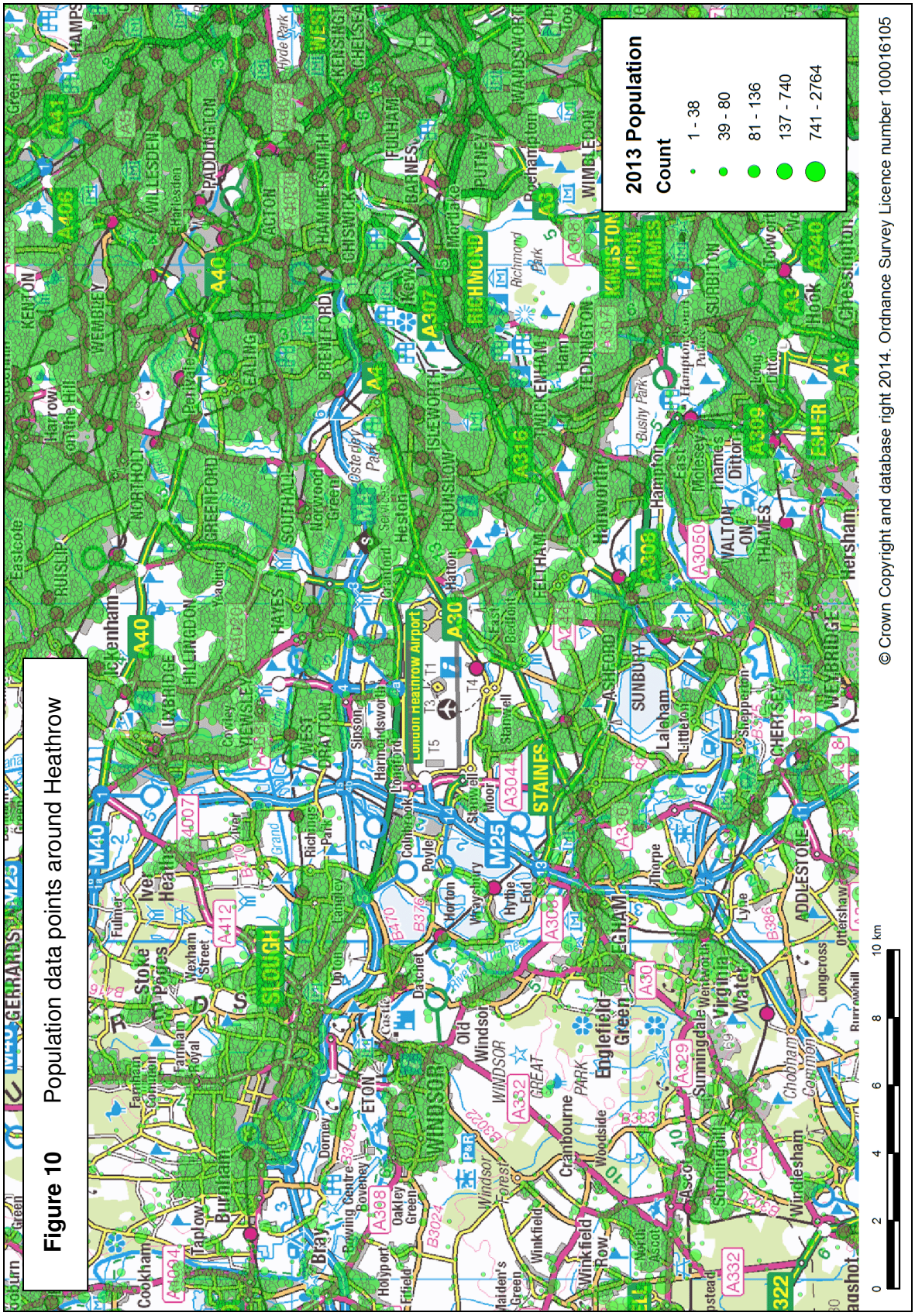
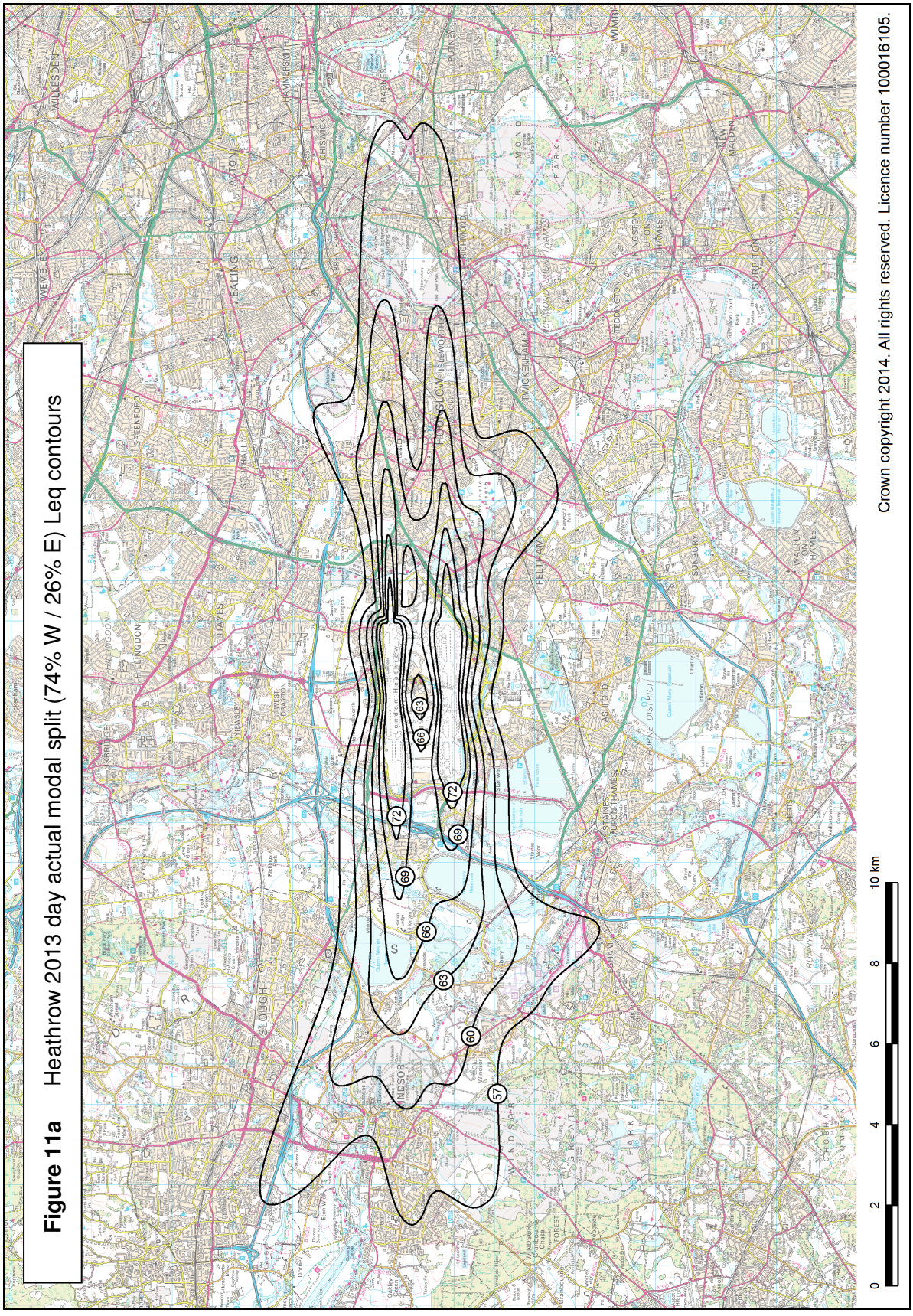


Figure 10 Population data points around Heathrow



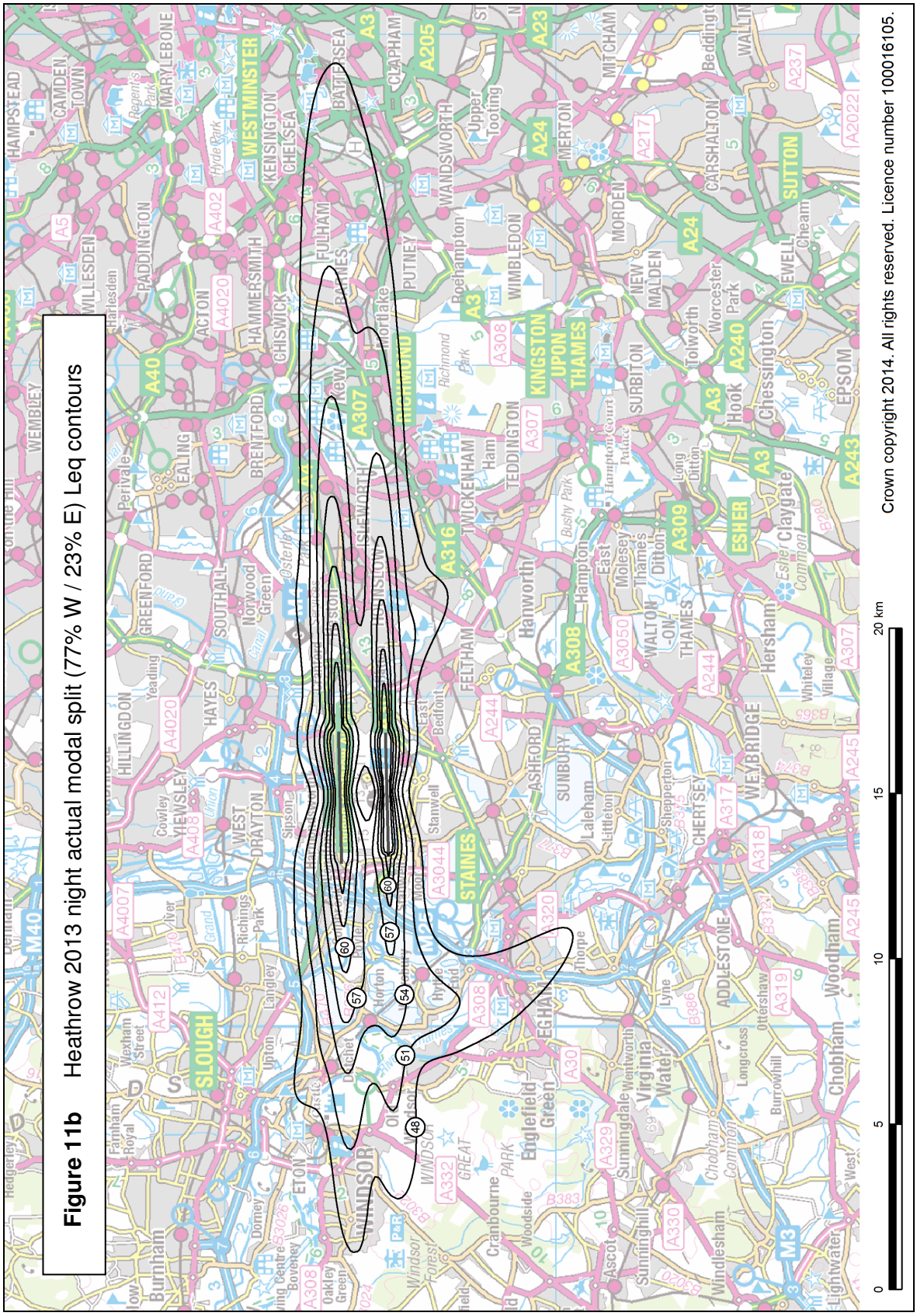


Figure 11b Heathrow 2013 night actual modal split (77% W / 23% E) Leq contours

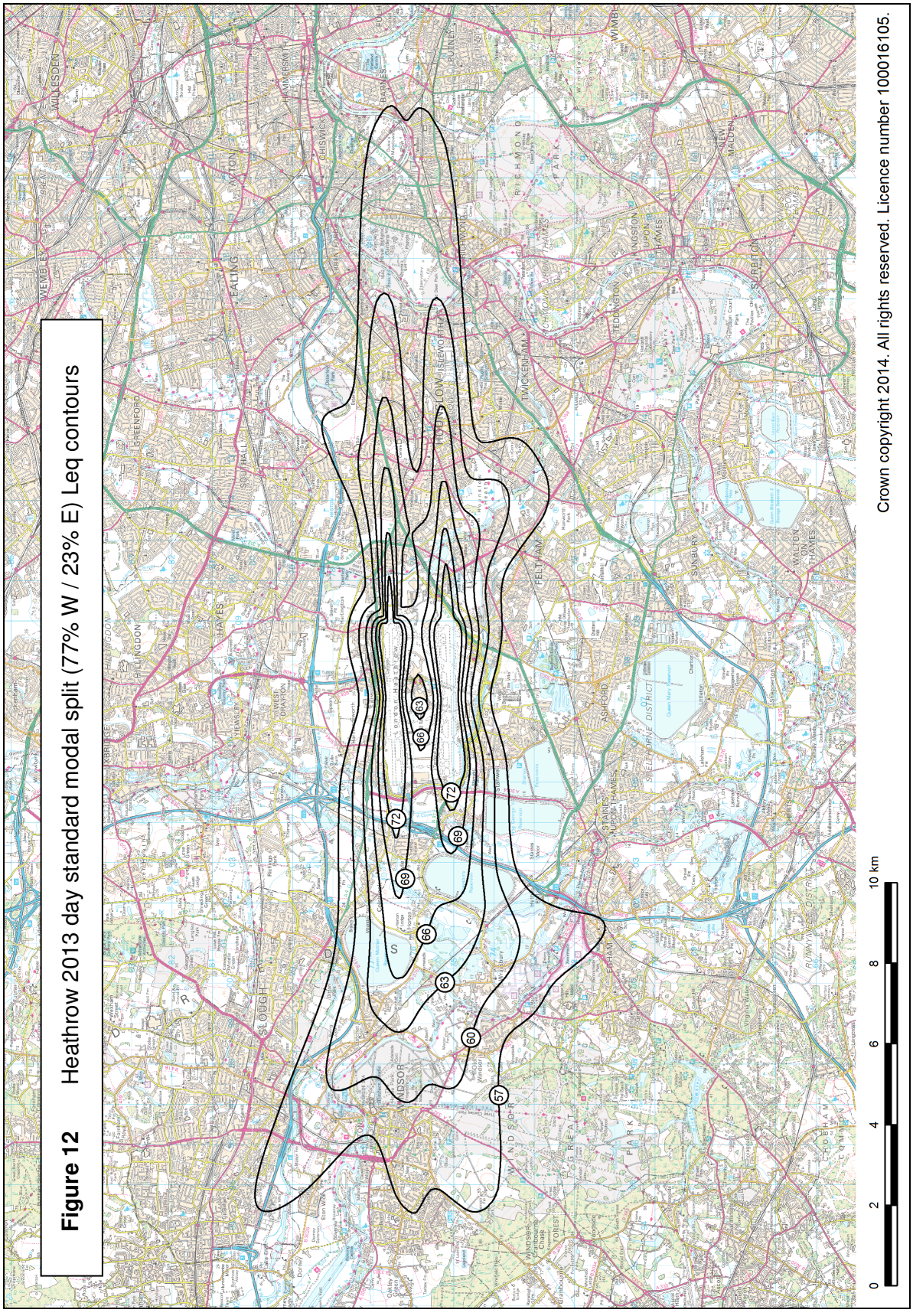


Figure 12 Heathrow 2013 day standard modal split (77% W / 23% E) Leq contours

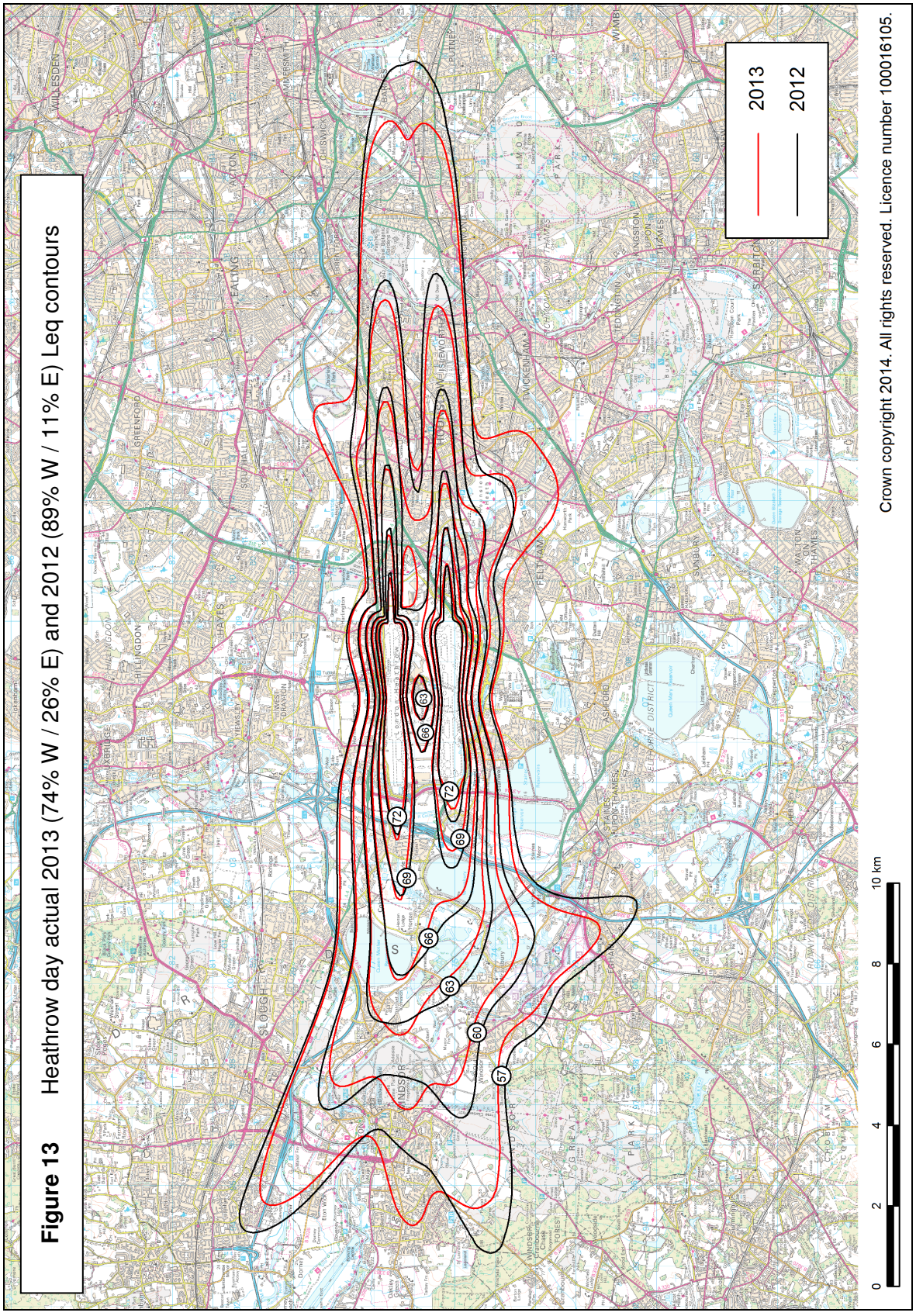


Figure 13 Heathrow day actual 2013 (74% W / 26% E) and 2012 (89% W / 11% E) Leq contours

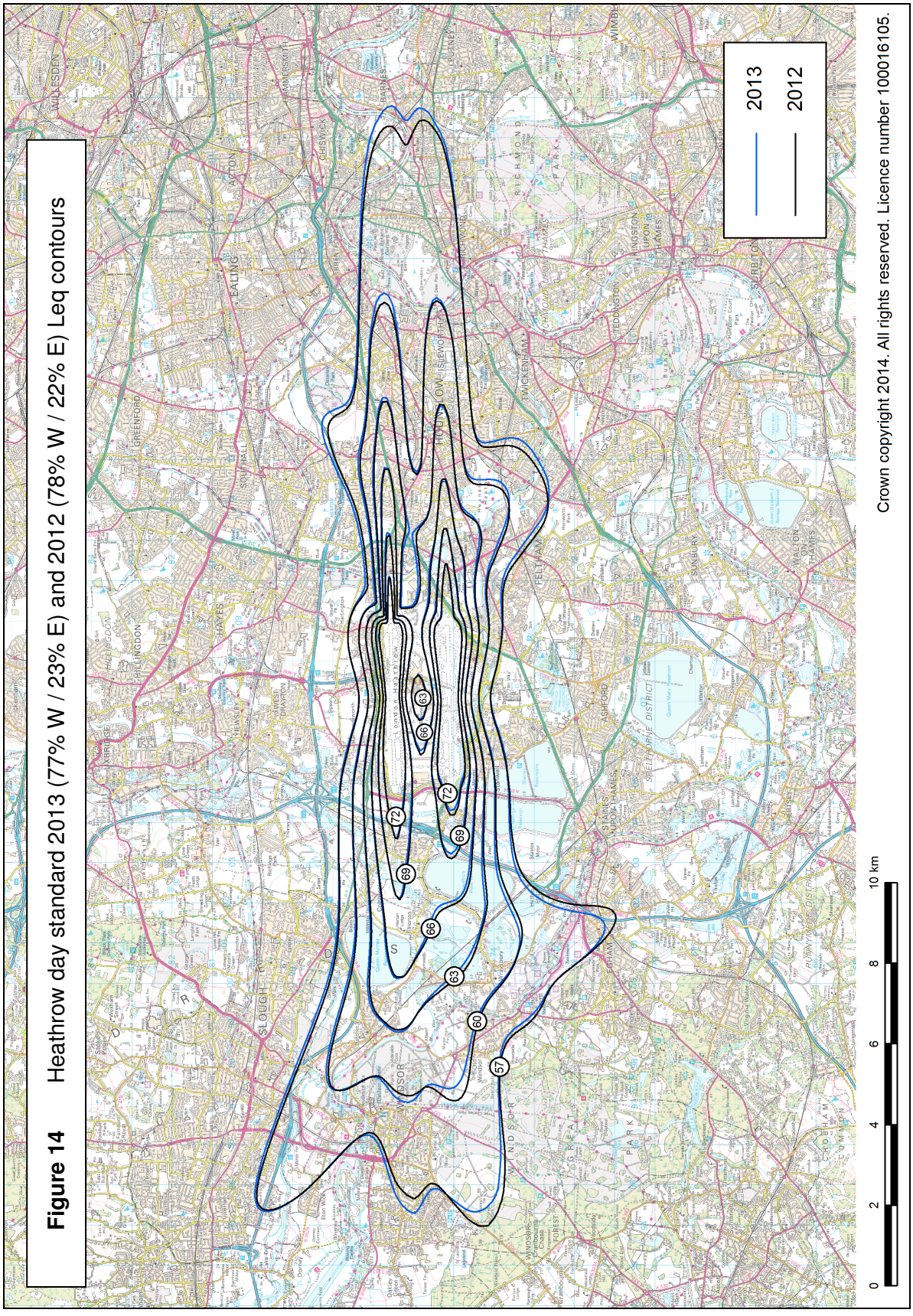


Figure 14 Heathrow day standard 2013 (77% W / 23% E) and 2012 (78% W / 22% E) Leq contours

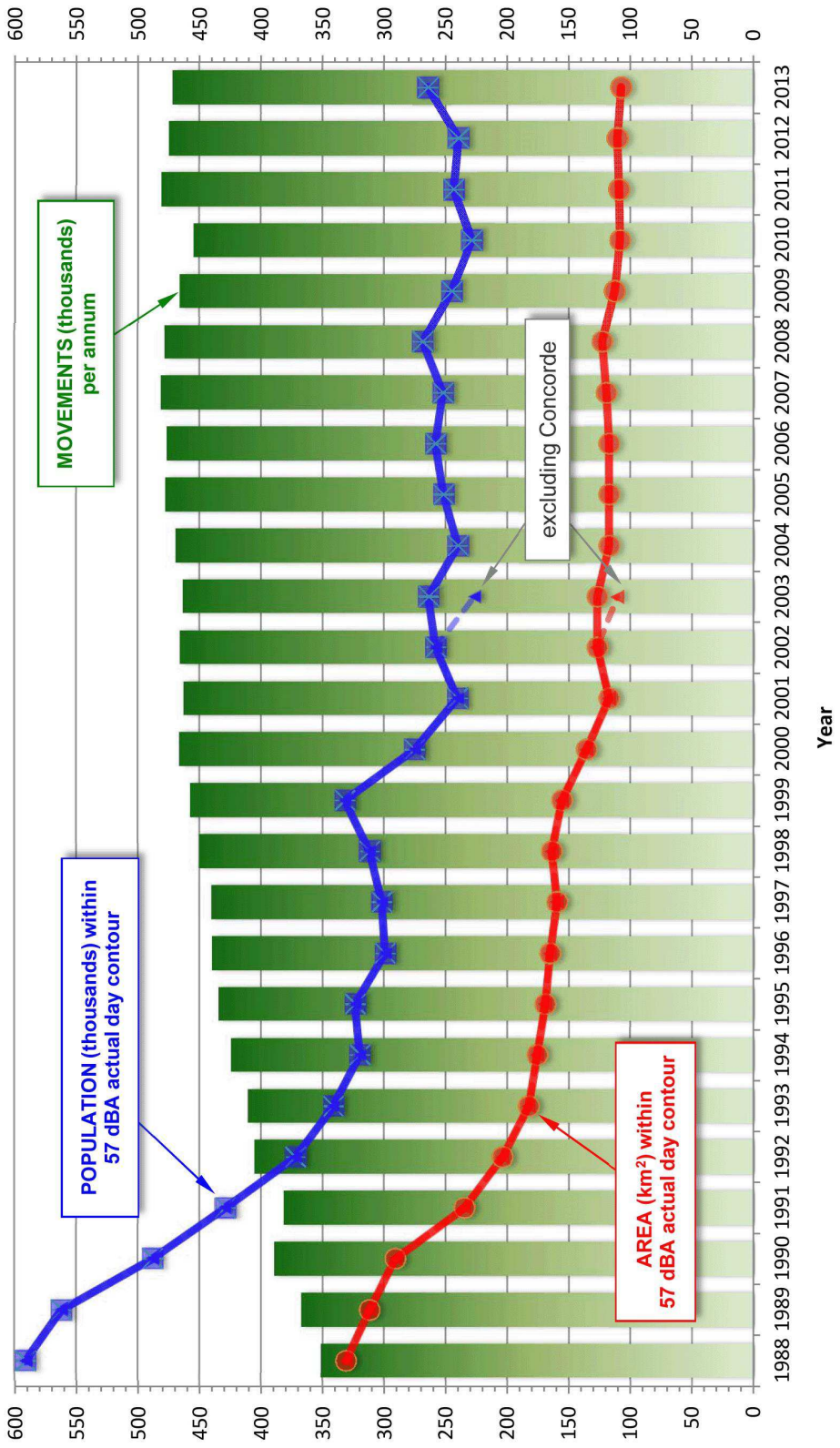


Figure 15 Heathrow annual traffic and summer day Leq noise contour area/population trend 1988-2013