Environmental Research and Consultancy Department
Civil Aviation Authority

ERCD REPORT 1601

Noise Exposure Contours for Heathrow Airport 2015

J Lee
G Cebrian
L Edmonds
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Prepared by the Civil Aviation Authority on behalf of the Department for Transport, January 2017

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Summary

This report presents the year 2015 average summer day and night noise exposure contours for London Heathrow Airport.

The 57 dBA Leq day contour area for 2015 based on the actual runway modal split (78% west / 22% east) was calculated to be 102.5 km^2, 2% smaller than the previous year (2014: 104.9 km^2). The population enclosed decreased by 4% to 258,300 (2014: 270,100).

The 48 dBA Leq night actual modal split (77% west / 23% east) contour area was 111.5 km^2, a decrease of 2% (2014: 114.2 km^2). The enclosed population was 399,100 (2014: 364,400), an increase of 10% from the previous year.

January 2017

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.

Population data used in this report are based on 2011 Census data (updated for 2015) 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 2015 average summer day and night noise exposure contours generated for London Heathrow Airport.

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 2015 summer traffic data for Heathrow revealed that average daily movements for the 16-hour daytime period (1274.5) increased by 1% from the previous year (2014: 1260.6). There were on average 79.7 movements per 8-hour night over the summer period, representing a 0.5% reduction from the previous year (2014: 80.1).

The results showed that the area of the 2015 day actual modal split (78% west / 22% east) 57 dBA Leq contour decreased by 2% to 102.5 km^2 (2014: 104.9 km^2). The population count within the 2015 actual 57 dBA Leq day contour decreased by 4% to 258,300 (2014: 270,100). The area decrease was mainly caused by adjustments made to the noise levels of certain ANCON aircraft types such as the EA38R on departure and the EA320V and EA319V on arrival, following measurements undertaken in 2015. There was also a continued switch to quieter and more modern aircraft, such as the Boeing 787 and Airbus A380. The 4% decrease in population can be largely attributed to the changes in contour shape caused by the significant shift in runway modal split between 2014 (68% west / 32% east) and 2015 (78% west / 22% east).

The area of the 2015 day standard modal split (78% west / 22% east) 57 dBA Leq contour decreased by 4% to 102.5 km^2 (2014: 106.6 km^2), and the associated population count was 258,300, 3% lower than in the previous year (2014: 266,700). The actual and standard modal splits were the same in 2015.

The area of the 2015 night actual modal split (77% west / 23% east) 48 dBA Leq contour was 111.5 km^2, 2% smaller than the year before (2014: 114.2 km^2). The enclosed population of 399,100 represented an increase of 10% (2014: 364,400). The area reduction can be attributed primarily to a decrease in numbers of the noise dominant type, the Boeing 747-400 (with Rolls-Royce engines). The 10% increase in the 48 dBA population count was caused by major changes to the contour shape, which included an extension of the westerly arrival contour lobe over densely-populated areas of west London. This followed a significant shift in the runway modal split in 2015, i.e. 11% more westerly operations compared to 2014.

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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 local time) noise contours on an annual basis for the designated airports. Night-time 8-hour Leq contours have therefore been calculated for Heathrow from 48 to 72 dBA in 3 dB steps in accordance with standard practice. Average summer night contours were first calculated for Heathrow for the year 2013.

1.1.5 This report contains small-scale diagrams of the year 2015 Heathrow Leq contours overlaid onto Ordnance Survey® (OS) base maps. Larger-scale diagrams in Adobe® PDF format and AutoCAD® DXF format contours (for specialist users) are also available for download from the GOV.UK website.[2]

1.1.6 The objectives of this report are to explain the noise modelling methodology used to produce the year 2015 day and night Leq contours for Heathrow Airport, to

[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] https://www.gov.uk/government/publications/noise-exposure-contours-around-london-airports

present the calculated noise contours and to assess the changes from the previous year (**Ref 3**). Long-term trends are also examined.

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 four passenger terminals.[4] The layout of the runways, taxiways and passenger terminals in 2015 is shown in **Figure 2**.[5]

1.2.3 In the 2015 calendar year, there were approximately 474,000 aircraft movements at Heathrow (2014: 473,000) and the airport handled 75.0 million passengers (2014: 73.4 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 1 closed permanently in June 2015.

[5] UK AIP (28 May 2015) 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 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, aircraft registration, aircraft type and destination.

2.2.2 The Heathrow radar feed was upgraded on 4 July 2015 to a new system, which offers a wider area of radar coverage and improved data accuracy. The analyses of departure/arrival flight tracks and flight profiles were based on the higher-quality radar data extracted over the period 4 July to 15 September 2015.

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 NPR/SID routes 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, to avoid storms for example.

2.3.3 Departure and arrival flight tracks were modelled using radar data extracted from the Heathrow NTK system over the period 4 July to 15 September 2015 (see section 2.2.2). Mean flight tracks were calculated from 24-hour data over this period since both day and night contours were being produced.

2.3.4 **Figure 4** shows a sample of radar flight tracks from a day in August 2015. 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 31 km from threshold when Heathrow was operating in westerly mode, and at distances between 14 and 32 km from threshold 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 2015 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 produced for the noise dominant ANCON aircraft type operating at night (see section 2.6.19), the B744R[7], as it was sufficiently different from the daytime profile. All other aircraft types operating at night were modelled with 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

[7] B744R = Boeing 747-400 with Rolls-Royce engines

were matched to operational data provided by the airport. The Heathrow NTK system employs 12 fixed monitors positioned approximately 6.5 km from start-of-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 were screened by ERCD with reference to several criteria so that only reliable data were used in the analysis. First of all, noise data that lay outside a 'weather window' were discarded. This ensured that the data used were not affected by adverse meteorological conditions such as precipitation and strong winds. Secondly, the maximum noise level of the aircraft event had to 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 passed through a 60-degree inverted cone, centred at the noise monitor, were retained in order to minimise the effects of lateral attenuation and lateral directivity.[9]

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 – also known as the '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.

2.5.4 The noise levels of a number of ANCON aircraft types were adjusted in the light of the 2015 measurement data. The most significant adjustments were lower noise levels for the EA38R on departure, and the EA320V and EA319V on arrival.[10]

2.6 Traffic distributions

2.6.1 The Leq contours were based on the daily average movements that took 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 was 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.

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[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. *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.

[10] EA38R = Airbus A380 with Rolls-Royce engines; EA320V = Airbus A320 with IAE V2500 engines; EA319V = Airbus A319 with IAE V2500 engines.

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

Daytime traffic distribution by Noise Class

2.6.2 The average number of daily movements at Heathrow over the 2015 summer day period (1274.5) was 1% higher than in the previous year (2014: 1260.6).

2.6.3 **Table 1a** lists the average summer day movements[12] by 8 Noise Classes of aircraft, ranked in ascending order of noise emission, i.e. from least to most noisy, in 2014 and 2015. The 8 Noise Classes, which were previously designated Noise Classes 1-8, have now been renamed as *Noise Classes A-H* respectively, as summarised in the table below. This has been done to avoid possible confusion with the ICAO noise 'Chapters'.[13]

Noise Class description	Previous Noise Class ID (up to 2014)	New Noise Class ID (2015 onwards)
Small propeller	1	A
Large propeller	2	B
Narrow-body (Chapter 3/4)	3	C
Wide-body twins (Chapter 3/4)	4	D
Wide-body 3/4-engine (Chapter 3/4)	5	E
Wide-body 3/4-engine (1st gen.)	6	F
Narrow-body twins (2nd gen.)	7	G
Narrow-body 3/4-engine (1st gen.)	8	H

2.6.4 Noise Class C (narrow-body jet aircraft) formed the highest proportion of movements (66%), with a 2% increase in numbers from 2014. The numbers of wide-body twin-engine aircraft (Noise Class D), which comprised 25% of total traffic, were 1% higher in 2015. There was, however, a 5% decrease in movements within Noise Class E (i.e. wide-body 3/4-engine aircraft), which constituted 9% of total movements.

2.6.5 The numbers of aircraft in Noise Classes A, B and F were insignificant, and there were no aircraft within Noise Classes G and H.

[12] Includes departures and arrivals.

[13] Aircraft certification 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', 'Chapter 4' and 'Chapter 14' types. The Chapter 4 standard (applicable from 2006) is more stringent than the Chapter 3 standard (1977) and typically characterised by modern, quieter, high-bypass turbofan aircraft. The Chapter 14 standard will be applicable to new large aircraft types presented for certification from 2017 and it represents a further level of stringency compared to the Chapter 4 standard.

2.6.6 An estimated[14] 99% of the aircraft in the 2015 summer day period were compliant with the ICAO Chapter 4 noise standard.

2.6.7 **Figure 5** illustrates the changing distribution of traffic among the 8 Noise Classes over the period 1988 to 2015 inclusive. The shift towards Noise Classes C, D and E over the years can be seen, with narrow-body jet aircraft (Noise Class C) dominating the fleet mix.

Night-time traffic distribution by Noise Class

2.6.8 The average number of movements per 8-hour night in 2015 was 79.7, a 0.5% decrease from the previous year (2014: 80.1). The majority of night movements (74%) were arrivals.

2.6.9 **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 2014 and 2015. Wide-body twin-engine aircraft (i.e. Noise Class D), such as the Boeing 777-300, formed the highest proportion of movements (49%).

2.6.10 The second largest grouping was Noise Class E (e.g. Boeing 747-400), with 28% of the total, followed by Noise Class C (e.g. Airbus A320), representing 22% of total movements. There were insignificant numbers in Noise Class A, and no movements by aircraft in Noise Classes B, F, G and H.

2.6.11 An estimated 99% of aircraft in the 2015 summer night period were compliant with the ICAO Chapter 4 noise standard.

Daytime traffic distribution by ANCON aircraft type

2.6.12 A more detailed breakdown of the year 2015 average summer day movements, indicating the ANCON aircraft types that fall into each Noise Class, is given in **Table 2a**.

2.6.13 The largest increase was for the EA320V (Noise Class C), which was up by 33 daily movements (note: ANCON type descriptions can be found in **Table 2a**). This increase was mostly offset by reductions within the same Noise Class of the EA319V (down by 17 per day), the EA320C (down by 6) and the EA321C (also down by 6).

2.6.14 Within Noise Class D, there were significant movement increases for the B788 (up by 9) and the B789 (up by 8). These increases were largely offset by reductions in numbers of the B773G (down by 8) and the B763R (down by 5). The more modern Boeing 787-8/9 aircraft constituted 12% of all Noise Class D movements.

2.6.15 There were notable movement decreases in Noise Class E for the B744R (down by 8), the EA34 (down by 4) and the EA346 (down by 5). These decreases were

[14] The percentage figure is an estimate because in some cases, detailed aircraft information (e.g. engine modifications) was not readily available, so some assumptions had to be made.

partially offset by movement increases for the EA38GP and the EA38R, which were up by 8 and 4 movements respectively. Airbus A380 aircraft were responsible for 31% of all Noise Class E movements, while the Boeing 747-400 accounted for 52%.

2.6.16 **Figure 6a** illustrates the numbers of movements by ANCON aircraft type for the 2015 average summer day. It can be seen that the Airbus A319/320/321 aircraft family dominated the movements at Heathrow. The most frequent types were the EA320V with 270 daily movements (21% of total movements), the EA319V with 180 per day (14% of total movements), the EA320C with 128 per day (10% of total movements) and the EA321V with 96 per day (8% of total movements).

2.6.17 There were on average 49 daily movements of the B744R ANCON type, a 14% decrease from 2014, but it still remained the noise dominant aircraft at Heathrow in terms of daytime 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 narrow-body Airbus aircraft family (e.g. EA320V, EA319V and EA320C).

Night-time traffic distribution by ANCON aircraft type

2.6.18 A more detailed breakdown of the year 2015 average summer night movements, indicating the ANCON aircraft types that fall into each Noise Class, is provided in **Table 2b**. The largest decreases were for the EA319V (Noise Class C), B744R (Noise Class E) and B763R (Noise Class D), all three of which had 2 fewer movements per night. The highest increases were for the B773G and EA38R, both up by 2 movements per night.

2.6.19 **Figure 6b** illustrates the numbers of movements by ANCON aircraft type for the 2015 average summer night. The most frequent types were the B773G and B744R, both with 11 movements (each representing 14% of total night movements). Arrivals accounted for 74% of all night movements. The B744R was the noise dominant ANCON aircraft type in the night-time period for departure noise, followed by the B772R. In terms of arrival noise, the B744R was also the dominant type, closely followed by the B773G and EA38R.

Daytime traffic distribution by NPR/SID route

2.6.20 **Figure 7a** shows the percentage distribution of aircraft departures by NPR/SID route for the 2015 summer day period, with distribution figures from 2014 for comparison. The percentage loadings on the routes were comparable to 2014, with the westerly WOB/BPK routes taking the highest proportion of departure traffic over the summer day period (29%), followed by the westerly DET route (20%). Increases of 2-3% were seen on each of the westerly routes. Percentage decreases were found on the easterly routes, with the largest reduction of 4% on the easterly BUZ/BPK routes. The changes in percentage loading on the routes were largely due to the year-on-year variation in the runway modal split, as described in section 2.7.

Night-time traffic distribution by NPR/SID route

2.6.21 **Figure 7b** shows the percentage distribution of aircraft departures by NPR/SID route for the 2015 summer night period, with distribution figures from 2014 for comparison. The westerly DET route had the highest proportion of departure traffic over the summer night period (29%), followed by the westerly WOB/BPK routes (21%). The highest percentage increase of 7% was found on the westerly WOB/BPK routes. There were lower proportions of traffic on most of the easterly routes in 2015, with the largest reduction being for DET, which was down by 6%. The changes in percentage loading on the routes were largely due to the year-on-year variation in the runway modal split, as described in section 2.7.

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.[15] 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 2015 average 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 2015, this is the 20-year period from 1996 to 2015. 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 2015 and the previous year are summarised in the table below:

Heathrow summer day runway modal splits for 2015 and 2014

Modal split scenario	% west (Runway 27L/27R)	% east (Runway 09L/09R)
Actual 2015	78%	22%
Actual 2014	68%	32%
Standard 2015	78%	22%
Standard 2014	77%	23%

[15] 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.

2.7.4 After a relatively high number of easterly days in 2014, the daytime actual modal split reverted to a more typical figure in 2015 (78% west / 22% east), the percentage of westerly movements being 10% higher than in 2014. The 2015 standard and actual modal splits were the same. 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 a significant 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 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 57 dBA 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, the use of Runway 09R for departures and Runway 09L for arrivals for the majority of the time when the airport is operating in easterly mode due to the Cranford Agreement.[16]

2.7.7 Higher proportions of easterly movements at Heathrow would therefore, 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 60%, the population count within the 57 dBA contour would start to increase sharply because of the relatively densely populated areas of London located to the east of the airport.

2.7.8 The night-time actual runway modal split for the 2015 summer period was 77% west / 23% east, an 11% shift from the previous year (2014: 66% west / 34% east). The night-time modal splits for the past 3 years are summarised in the table below:

Heathrow summer night runway modal splits

Year	% west (Runway 27L/27R)	% east (Runway 09L/09R)
2015	77%	23%
2014	66%	34%
2013	77%	23%

[16] 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 applied for planning permission from the London Borough of Hillingdon for these works, but the application was rejected in February 2014. The rejection was subsequently appealed and a Public Inquiry held in June 2015. The outcome of the Inquiry is expected shortly.

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[17] on a 200 metre by 200 metre 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 2015 update of the latest 2011 Census supplied by CACI Limited.[18]

2.9.2 The CACI population database contains data referenced at postcode level. Population and household numbers for each postcode are assigned to a single coordinate 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 Within the extent of the 2015 day actual 57 dBA Leq contour, it was found that the population count using the 2015 population database was 1% higher compared to the 2014 database. Thus the effect of the 2015 population database update was a slight increase in population counts around Heathrow.

2.9.4 Estimates have also been made of the numbers of noise sensitive buildings situated within the daytime contours, using the *InterestMap*™[19] 'Points of Interest' (2015) database. For the purpose of this study, the noise sensitive buildings that have been considered are schools, hospitals and places of worship.

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[17] Meridian™ 2

[18] www.caci.co.uk

[19] 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 2015 day Leq noise contours generated with the actual 2015 summer day period runway modal split (78% west / 22% east) are shown in **Figure 11a**. The contours are plotted from 57 to 72 dBA at 3 dB intervals.

3.1.2 Cumulative estimates of areas, populations and households within the 2015 day actual modal split contours are provided in the table below:

Heathrow 2015 day actual contours – area, population and household estimates

Leq (dBA)	Area (km^2)	Population	Households
> 57	102.5	258,300	101,000
> 60	56.7	119,700	45,600
> 63	32.7	45,900	17,300
> 66	19.4	14,000	5,300
> 69	9.3	3,100	1,200
> 72	5.0	200	100

Note: Populations and households are given to the nearest 100.

3.1.3 The 2015 day actual 57 dBA Leq contour enclosed an area of 102.5 km^2 and a population of 258,300.

3.1.4 Estimates of the cumulative numbers of noise sensitive buildings within the 2015 day actual contours are provided in the table below:

Heathrow 2015 day actual contours – noise sensitive building estimates

Leq (dBA)	Schools	Hospitals	Places of worship
> 57	148	3	116
> 60	59	0	45
> 63	17	0	17
> 66	6	0	5
> 69	0	0	1
> 72	0	0	0

3.2 Night actual modal split contours

3.2.1 The Heathrow 2015 night Leq noise contours generated with the actual 2015 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 from the diagram for clarity).

3.2.2 Cumulative estimates of the areas, populations and households within the 2015 night actual modal split contours are provided in the following table:

Heathrow 2015 night actual contours – area, population and household estimates

Leq (dBA)	Area (km^2)	Population	Households
> 48	111.5	399,100	162,800
> 51	67.2	193,800	75,900
> 54	37.5	91,400	34,700
> 57	19.0	42,300	15,900
> 60	9.6	14,000	5,100
> 63	5.0	2,600	900
> 66	2.7	400	100
> 69	1.7	< 100	< 100
> 72	1.2	0	0

Note: Populations and households are given to the nearest 100.

3.2.3 The 2015 night actual 48 dBA Leq contour enclosed an area of 111.5 km^2 and a population of 399,100.

3.3 Day standard modal split contours

3.3.1 The Heathrow 2015 day Leq noise contours generated with the standard 2015 summer day period runway modal split (78% west / 22% east) are shown in **Figure 12**. The contours are plotted from 57 to 72 dBA at 3 dB intervals. The standard modal split contours were the same as the actual modal split contours in 2015 because of the identical modal splits.

3.3.2 Cumulative estimates of the areas, populations and households within the 2015 day standard modal split contours are provided in the following table:

Heathrow 2015 day standard contours – area, population and household estimates

Leq (dBA)	Area (km^2)	Population	Households
> 57	102.5	258,300	101,000
> 60	56.7	119,700	45,600
> 63	32.7	45,900	17,300
> 66	19.4	14,000	5,300
> 69	9.3	3,100	1,200
> 72	5.0	200	100

Note: Populations and households are given to the nearest 100.

3.3.3 The 2015 day standard 57 dBA Leq contour enclosed an area of 102.5 km^2 and a population of 258,300.

3.3.4 Estimates of the cumulative numbers of noise sensitive buildings within the 2015 day standard contours are provided in the table below:

Heathrow 2015 day standard contours – noise sensitive building estimates

Leq (dBA)	Schools	Hospitals	Places of worship
> 57	148	3	116
> 60	59	0	45
> 63	17	0	17
> 66	6	0	5
> 69	0	0	1
> 72	0	0	0

4 Analysis of results

4.1 Day actual modal split contours – comparison with 2014 contours

4.1.1 The Heathrow 2015 day actual modal split Leq contours are compared against the 2014 day actual Leq contours in **Figure 13a**. The table below summarises the areas, populations and percentage changes from 2014 to 2015:

Heathrow day actual contours - area and population estimates for 2014 and 2015

Leq (dBA)	2014 Area (km^2)	2015 Area (km^2)	Area change (%)	2014 Pop.	2015 Pop.	Pop. change (%)
> 57	104.9	102.5	-2%	270,100	258,300	-4%
> 60	57.3	56.7	-1%	121,800	119,700	-2%
> 63	33.8	32.7	-3%	47,100	45,900	-3%
> 66	19.5	19.4	-1%	12,400	14,000	+13%
> 69	9.4	9.3	-1%	3,300	3,100	-6%
> 72	5.1	5.0	-2%	300	200	-33%

Note: The 2014 and 2015 day actual runway modal splits were 68% west / 32% east and 78% west / 22% east respectively.

4.1.2 The effects of the 10% higher proportion of westerly movements in 2015 can be seen in the extensions to the 57 dBA contour lobes that are associated with the westerly WOB/BPK, CPT/GOG and DET SIDs, and also in the lengthening of the westerly arrival contour lobes over central London. Conversely, the contour lobes formed by easterly departures on the BUZ/BPK SIDs that turn to the north and the multiple easterly SIDs turning to the south have retracted. The arrival contour tip over Windsor, resulting from easterly approaches on the northern runway, has also moved inwards because of the lower percentage of easterly movements.

4.1.3 Relative to 2014, the areas of the 2015 contours have decreased by 1-3%. The 2% reduction in the 57 dBA contour area was mainly due to noise adjustments made to some of the ANCON aircraft types such as the EA38 on departure and the EA320V on arrival, for which measurements undertaken in 2015 indicated lower noise levels. There was also a switch to quieter, more modern aircraft such as the Boeing 787 and Airbus A380. The area decreases would have been even greater had there also not been a higher percentage of westerly operations in 2015.

4.1.4 The 2015 population count for the 57 dBA contour decreased by 4%, with the changes in contour shape having the largest influence on the population count. Retractions of the contour from areas such as Windsor and especially between Feltham and Twickenham more than offset the population gains due to the extension of the westerly arrival contour lobes over London.

4.1.5 Percentage changes in contour area are not necessarily accompanied by similar changes in enclosed population because of the uneven distribution of populations around the airport.

4.2 Night actual modal split contours – comparison with 2014 contours

4.2.1 The Heathrow 2015 night actual modal split Leq contours are compared against the 2014 night actual Leq contours in **Figure 13b** (note: for clarity, only the 48, 54 and 60 dBA contour levels are shown in the diagram). The table below summarises the areas, populations and percentage changes from 2014 to 2015:

Heathrow night actual contours - area and population estimates for 2014 and 2015

Leq (dBA)	2014 Area (km^2)	2015 Area (km^2)	Area change (%)	2014 Pop.	2015 Pop.	Pop. change (%)
> 48	114.2	111.5	-2%	364,400	399,100	+10%
> 51	66.4	67.2	+1%	179,700	193,800	+8%
> 54	36.0	37.5	+4%	76,200	91,400	+20%
> 57	18.6	19.0	+2%	34,800	42,300	+22%
> 60	9.6	9.6	0%	10,500	14,000	+33%
> 63	5.1	5.0	-2%	2,200	2,600	+18%
> 66	2.8	2.7	-4%	200	400	+100%
> 69	1.7	1.7	0%	< 100	< 100	(n/a)
> 72	1.2	1.2	0%	0	0	(-)

Note: The night actual runway modal splits were 66% west / 34% east in 2014 and 77% west / 23% east in 2015.

4.2.2 The effects of the 11% increase in westerly mode operations in 2015 are evident in the night contours. For example, the 48 dBA westerly arrival contour lobe has expanded over London, and conversely, the easterly arrival contour over Windsor has retracted. The contour lobe formed from easterly departures turning to the south has also reduced in size. The significant reduction of the departure contour lobe over Egham was due to a combination of factors: (a) approximately 10% fewer overall movements on the 27L/27R DET SIDs in 2015 (and in particular, 25% fewer B744R departures), and (b) a shift in westerly departure traffic back onto the northern runway in 2015 (following the northern runway resurfacing works in 2014), which meant that a higher proportion of aircraft flew at a greater height over the Egham area on the DET SIDs in 2015.

4.2.3 There was a noticeable northwards shift in the 2015 noise contours as a whole. This was due to a return to more typical (i.e. 50:50) north-south runway distributions in the 2015 night period as mentioned above, following the completion of the resurfacing works on the northern runway in 2014.

4.2.4 The 48 dBA contour area decreased by 2%, but both percentage increases and decreases of up to 4% were found at the higher contour levels. The area changes can be attributed partly to changes to the fleet mix, which included a notable

reduction of 2 movements per night for the noise dominant ANCON aircraft type, the B744R.

4.2.5 The 48 dBA population count increased by 10% in 2015 - this was largely due to changes to the contour shape caused by the 11% shift in runway modal split in favour of westerly operations. A large increase in the population count due to the lengthening of the westerly arrival contour lobe over densely-populated parts of west London was only partially offset by contour retractions in the vicinity of Twickenham, Feltham, Egham and Windsor.

4.3 Day standard modal split contours – comparison with 2014 contours

4.3.1 The Heathrow 2015 day standard modal split Leq contours are compared against the 2014 day standard Leq contours in **Figure 14**. The table below summarises the areas, populations and percentage changes from 2014 to 2015:

Heathrow day standard contours - area and population estimates for 2014 and 2015

Leq (dBA)	2014 Area (km^2)	2015 Area (km^2)	Area change (%)	2014 Pop.	2015 Pop.	Pop. change (%)
> 57	106.6	102.5	-4%	266,700	258,300	-3%
> 60	58.2	56.7	-3%	120,500	119,700	-1%
> 63	33.7	32.7	-3%	46,000	45,900	0%
> 66	19.9	19.4	-3%	13,400	14,000	+4%
> 69	9.6	9.3	-3%	3,600	3,100	-14%
> 72	5.1	5.0	-2%	200	200	0%

Note: The 2014 and 2015 day standard runway modal splits were 77% west / 23% east and 78% west / 22% east respectively.

4.3.2 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 effects of any differences between the ratios of westerly to easterly operations.

4.3.3 The 57 dBA contour area in 2015 was 4% smaller than in 2014. As explained previously, this was mainly due to adjustments made to the noise levels of some of the ANCON aircraft types to reflect the 2015 monitoring data; in particular, the EA38R on departure and EA320V on arrival were quieter in 2015. There was also a switch to quieter, more modern aircraft such as the Boeing 787 and Airbus A380. Area decreases were also seen at all the other contour levels.

4.3.4 The population count within the 57 dBA contour was 3% lower than in 2014, which was consistent with the area decrease. At the higher levels, there was no particular pattern to the changes in population.

4.4 Day noise contour historical trend

4.4.1 **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

4.4.2 Against the trend of a general decrease in contour area, the number of annual aircraft movements had mostly risen steadily 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.

4.4.3 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.

4.4.4 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, traffic levels increased by 0.5%). In 2009, traffic levels dropped further, by 3%, as the impacts of the global recession upon the aviation industry took hold.

4.4.5 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. (Note: over the summer period, movements were up by 3%).

4.4.6 Annual movements 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. Movements dropped slightly in 2012, but since then, traffic levels have been relatively flat.

Area and population trend

4.4.7 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.

4.4.8 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 from 2004 onwards.

4.4.9 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 as the global recession hit the aviation industry, 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 decreased in both 2013 and 2014 as runway usage shifted significantly in favour of easterly operations. Then in 2015, despite a return to a more typical percentage of westerly operations, the 57 dBA area dropped further to a new low, as noise levels for some ANCON aircraft types were adjusted to take into account the latest monitoring data, and the fleet mix continued its switch to quieter, more modern aircraft.

4.4.10 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 in 2011, the population increased to 243,000, 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, which used the 2011 Census data for the first time. Populations for 2014 were slightly higher than in 2013 in spite of a reduction in area, mainly because of changes to the contour shape. In 2015, the population count fell in line with the reduction in contour area.

5 Conclusions

5.1 Year 2015 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 2015 day actual modal split (78% west / 22% east) 57 dBA Leq contour area decreased by 2% to 102.5 km^2 (2014: 104.9 km^2). This is the lowest area ever calculated for Heathrow. Total daytime movements were 1% higher in 2015 compared to 2014. The area decrease was mainly the result of adjustments to the noise characteristics of some of the ANCON types such as the EA38R on departure and EA320V on arrival, which noise measurement data indicated were quieter in 2015. There was also a switch to quieter, more modern aircraft such as the Boeing 787 and Airbus A380. The population count within the 2015 actual 57 dBA Leq contour decreased by 4% to 258,300 (2014: 270,100), mainly due to changes in the contour shape.

5.3 The 2015 day standard modal split (78% west / 22% east) 57 dBA Leq contour area was 102.5 km^2, 4% smaller than in 2014 (106.6 km^2). The standard and actual daytime modal splits for 2015 were the same. The area reduction can be attributed to the same reasons as described above for the actual mode contours. The population count within the 2015 day standard 57 dBA Leq contour was 258,300, 3% lower than in the previous year (2014: 266,700).

5.4 Night-time Leq contours have also been produced. The 2015 night actual modal split (77% west / 23% east) 48 dBA Leq contour enclosed an area of 111.5 km^2 (2014: 114.2 km^2), with a population of 399,100 (2014: 364,400). Total night-time movements in 2015 were 0.5% lower than in 2014. The 2% area reduction in 2015 for the 48 dBA contour can be partly attributed to some changes to the fleet mix, especially the decrease of 2 movements per night for the noise dominant B744R ANCON aircraft type. The 48 dBA population count increase of 10% in 2015 was due to changes to the contour shape, in particular the extension of the westerly arrival contour lobe over west London, which resulted from a significant shift in the runway modal split.

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Table 1a Heathrow 2014 and 2015 average summer day movements by Noise Class

Noise Class	Description	2014 movements	2015 movements	Percentage of total 2015 movements	Change
PROPELLER AIRCRAFT					
A	Small propeller aircraft	0.0	< 0.1	0%	0.0 (*)
B	Large propeller aircraft	< 0.1	0.2	0%	+0.2 (*)
CHAPTER 3/4 JETS					
C	Narrow-body aircraft	820.5	836.8	66%	+16.3 (+2%)
D	Wide-body twin-engine aircraft	316.3	320.0	25%	+3.7 (+1%)
E	Wide-body 3,4-engine aircraft	123.7	117.5	9%	-6.2 (-5%)
LARGE CHAPTER 2/3 JETS					
F	1st generation wide-body 3,4-engine aircraft	< 0.1	< 0.1	0%	0.0 (*)
2nd GENERATION TWIN JETS					
G	Narrow-body twin-engine aircraft *(including Ch.2 and hush-kitted versions)*	0.0	0.0	0%	0.0 (*)
1st GENERATION JETS					
H	Narrow-body 3,4-engine aircraft *(including hush-kitted versions)*	0.0	0.0	0%	0.0 (*)
	TOTAL	1260.6	**1274.5**	100%	**+13.9 (+1%)**

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

Notes:
- Totals may not sum exactly due to rounding.
- An estimated 99% of aircraft in the 2015 daytime period met the ICAO Chapter 4 noise standard.

Table 1b Heathrow 2014 and 2015 average summer night movements by Noise Class

Noise Class	Description	2014 movements	2015 movements	Percentage of total 2015 movements	Change
		PROPELLER AIRCRAFT			
A	Small propeller aircraft	0.2	< 0.1	0%	-0.2 (*)
B	Large propeller aircraft	< 0.1	0.0	0%	0.0 (*)
		CHAPTER 3/4 JETS			
C	Narrow-body aircraft	19.7	17.8	22%	-1.9 (-10%)
D	Wide-body twin-engine aircraft	36.9	39.3	49%	+2.4 (+7%)
E	Wide-body 3 or 4-engine aircraft	23.3	22.7	28%	-0.6 (-3%)
		LARGE CHAPTER 2/3 JETS			
F	1st generation wide-body 3 or 4-engine aircraft	0.0	0.0	0%	0.0 (*)
		2nd GENERATION TWIN JETS			
G	Narrow-body twin-engine aircraft *(including Ch.2 and hush-kitted versions)*	0.0	0.0	0%	0.0 (*)
		1st GENERATION JETS			
H	Narrow-body 3 or 4-engine aircraft *(including hush-kitted versions)*	0.0	0.0	0%	0.0 (*)
	TOTAL	80.1	**79.7**	100%	**-0.4 (-0.5%)**

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

Notes:
- Totals may not sum exactly due to rounding.
- An estimated 99% of aircraft in the 2015 night-time period met the ICAO Chapter 4 noise standard.

Table 2a Heathrow 2014 and 2015 average summer day movements by ANCON aircraft type

Aircraft type	Noise Class	ANCON type	2014	2015	Change
Small twin-piston propeller	A	STP	0.0	< 0.1	0.0
Large twin-turboprop	B	LTT	< 0.1	0.2	+0.2
Boeing 717	C	B717	0.2	0.2	0.0
Boeing 737-300/400/500	C	B733	5.9	7.1	+1.2
Boeing 737-600/700	C	B736	24.5	22.7	-1.8
Boeing 737-800/900	C	B738	19.1	23.4	+4.3
Boeing 757-200 (RB211-535C engines)	C	B757C	0.8	0.7	-0.1
Boeing 757-200 (RB211-535E4/E4B engines)	C	B757E	8.0	9.7	+1.7
Boeing 757-200 (PW2037/2040 engines)	C	B757P	0.3	1.3	+1.0
Boeing 757-300	C	B753	< 0.1	1.2	+1.2
BAe 146/Avro RJ	C	BA46	2.2	2.1	-0.1
Bombardier CRJ100/200	C	CRJ	0.0	0.1	+0.1
Bombardier CRJ900	C	CRJ900	1.7	2.0	+0.3
Airbus A318	C	EA318	1.9	2.0	+0.1
Airbus A319 (CFM56 engines)	C	EA319C	58.8	54.8	-4.0
Airbus A319 (IAE V2500 engines)	C	EA319V	197.4	180.0	-17.4
Airbus A320 (CFM56 engines)	C	EA320C	133.7	128.1	-5.6
Airbus A320 (IAE V2500 engines)	C	EA320V	237.7	270.2	+32.5
Airbus A321 (CFM56 engines)	C	EA321C	28.9	23.2	-5.7
Airbus A321 (IAE V2500 engines)	C	EA321V	89.1	95.6	+6.5
Embraer ERJ 135/145	C	ERJ	0.1	< 0.1	-0.1
Embraer E-170	C	ERJ170	0.0	1.5	+1.5
Embraer E-190	C	ERJ190	2.0	4.6	+2.6
Executive Business Jet (Chapter 3)	C	EXE3	0.6	0.5	-0.1
Fokker 100	C	FK10	7.5	6.0	-1.5
McDonnell Douglas MD-80 series	C	MD80	0.1	0.0	-0.1
Boeing 767-200	D	B762	< 0.1	< 0.1	0.0
Boeing 767-300 (GE CF6-80 engines)	D	B763G	18.7	19.9	+1.2
Boeing 767-300 (PW PW4000 engines)	D	B763P	18.9	17.1	-1.8
Boeing 767-300 (RR RB211 engines)	D	B763R	36.1	31.5	-4.6
Boeing 767-400	D	B764	9.1	6.6	-2.5
Boeing 777-200 (GE GE90 engines)	D	B772G	32.7	32.9	+0.2
Boeing 777-200 (PW PW4000 engines)	D	B772P	10.1	10.4	+0.3
Boeing 777-200 (RR Trent 800 engines)	D	B772R	35.5	34.2	-1.3
Boeing 777-200LR/300ER (GE GE90 engines)	D	B773G	86.8	78.9	-7.9
Boeing 787-8 Dreamliner	D	B788	21.4	30.7	+9.3
Boeing 787-9 Dreamliner	D	B789	0.0	8.0	+8.0
Airbus A300	D	EA30	3.6	3.3	-0.3
Airbus A310	D	EA31	0.5	0.5	0.0
Airbus A330	D	EA33	43.0	46.0	+3.0
Boeing 747-400 (GE CF6-80F engines)	E	B744G	11.2	10.0	-1.2
Boeing 747-400 (PW PW4000 engines)	E	B744P	2.1	2.7	+0.6
Boeing 747-400 (RR RB211 engines)	E	B744R	56.9	48.8	-8.1
Boeing 747SP	E	B747SP	< 0.1	< 0.1	0.0
Boeing 747-8	E	B748	0.2	< 0.1	-0.2
Airbus A340-200/300	E	EA34	7.4	3.4	-4.0

Aircraft type	Noise Class	ANCON type	2014	2015	Change
Airbus A340-500/600	E	EA346	21.5	16.1	-5.4
Airbus A380 (Engine Alliance GP7000 engines)	E	EA38GP	9.2	16.8	+7.7
Airbus A380 (RR Trent 900 engines)	E	EA38R	15.1	19.5	+4.4
Boeing 747-100/200/300	F	B747	< 0.1	< 0.1	0.0
		TOTAL	1260.6	**1274.5**	**+13.9 (+1%)**

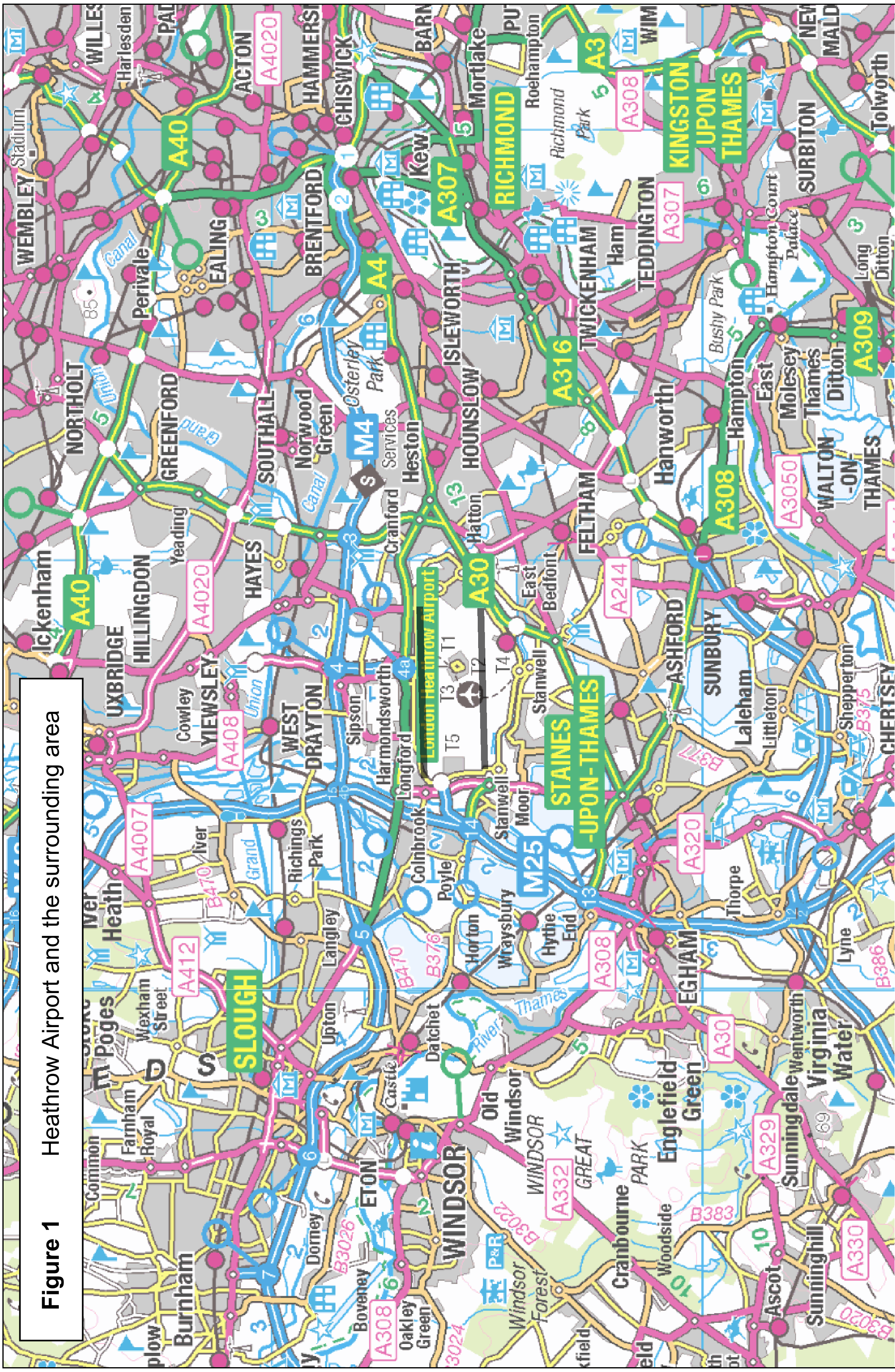
Note: Totals may not sum exactly due to rounding.

Table 2b Heathrow 2014 and 2015 average summer night movements by ANCON aircraft type

Aircraft type	Noise Class	ANCON type	2014	2015	Change
Small twin-piston propeller	A	STP	0.1	< 0.1	-0.1
Small twin-turboprop	A	STT	0.1	0.0	-0.1
Large twin-turboprop	B	LTT	< 0.1	0.0	0.0
Boeing 737-300/400/500	C	B733	0.6	0.6	0.0
Boeing 737-600/700	C	B736	0.1	0.1	0.0
Boeing 737-800/900	C	B738	0.8	0.9	+0.1
Boeing 757-200 (RB211-535C engines)	C	B757C	0.5	0.4	-0.1
Boeing 757-200 (RB211-535E4/E4B engines)	C	B757E	0.5	0.4	-0.1
Boeing 757-200 (PW2037/2040 engines)	C	B757P	< 0.1	0.8	+0.8
Bombardier CRJ100/200	C	CRJ	0.0	< 0.1	0.0
Airbus A319 (CFM56 engines)	C	EA319C	2.4	1.8	-0.6
Airbus A319 (IAE V2500 engines)	C	EA319V	4.5	2.3	-2.2
Airbus A320 (CFM56 engines)	C	EA320C	3.6	4.1	+0.5
Airbus A320 (IAE V2500 engines)	C	EA320V	2.5	3.3	+0.8
Airbus A321 (CFM56 engines)	C	EA321C	1.4	1.4	0.0
Airbus A321 (IAE V2500 engines)	C	EA321V	2.5	1.5	-1.0
Embraer ERJ 135/145	C	ERJ	< 0.1	0.0	0.0
Embraer E-190	C	ERJ190	0.1	0.1	0.0
Executive Business Jet (Chapter 3)	C	EXE3	< 0.1	0.1	0.0
McDonnell Douglas MD-80 series	C	MD80	< 0.1	0.0	0.0
Boeing 767-300 (GE CF6-80 engines)	D	B763G	1.6	1.1	-0.5
Boeing 767-300 (PW PW4000 engines)	D	B763P	2.5	2.8	+0.3
Boeing 767-300 (RR RB211 engines)	D	B763R	2.8	1.1	-1.7
Boeing 767-400	D	B764	1.3	< 0.1	-1.3
Boeing 777-200 (GE GE90 engines)	D	B772G	7.1	7.3	+0.2
Boeing 777-200 (PW PW4000 engines)	D	B772P	1.4	1.1	-0.3
Boeing 777-200 (RR Trent 800 engines)	D	B772R	4.1	5.0	+0.9
Boeing 777-200LR/300ER (GE GE90 engines)	D	B773G	8.4	10.8	+2.4
Boeing 787-8 Dreamliner	D	B788	2.7	3.0	+0.3
Boeing 787-9 Dreamliner	D	B789	0.0	1.0	+1.0
Airbus A300	D	EA30	0.7	0.8	+0.1
Airbus A330	D	EA33	4.4	5.3	+0.9
Boeing 747-400 (GE CF6-80F engines)	E	B744G	0.5	0.2	-0.3
Boeing 747-400 (PW PW4000 engines)	E	B744P	0.3	0.5	+0.2
Boeing 747-400 (RR RB211 engines)	E	B744R	12.7	10.8	-1.9
Boeing 747-8	E	B748	< 0.1	0.0	0.0
Airbus A340-200/300	E	EA34	0.9	1.2	+0.3
Airbus A340-500/600	E	EA346	3.4	3.1	-0.3
Airbus A380 (Engine Alliance GP7000 engines)	E	EA38GP	0.8	0.8	0.0
Airbus A380 (RR Trent 900 engines)	E	EA38R	4.6	6.2	+1.6
		TOTAL	80.1	**79.7**	**-0.4 (-0.5%)**

Note: Totals may not sum exactly due to rounding.

Figure 1 Heathrow Airport and the surrounding area



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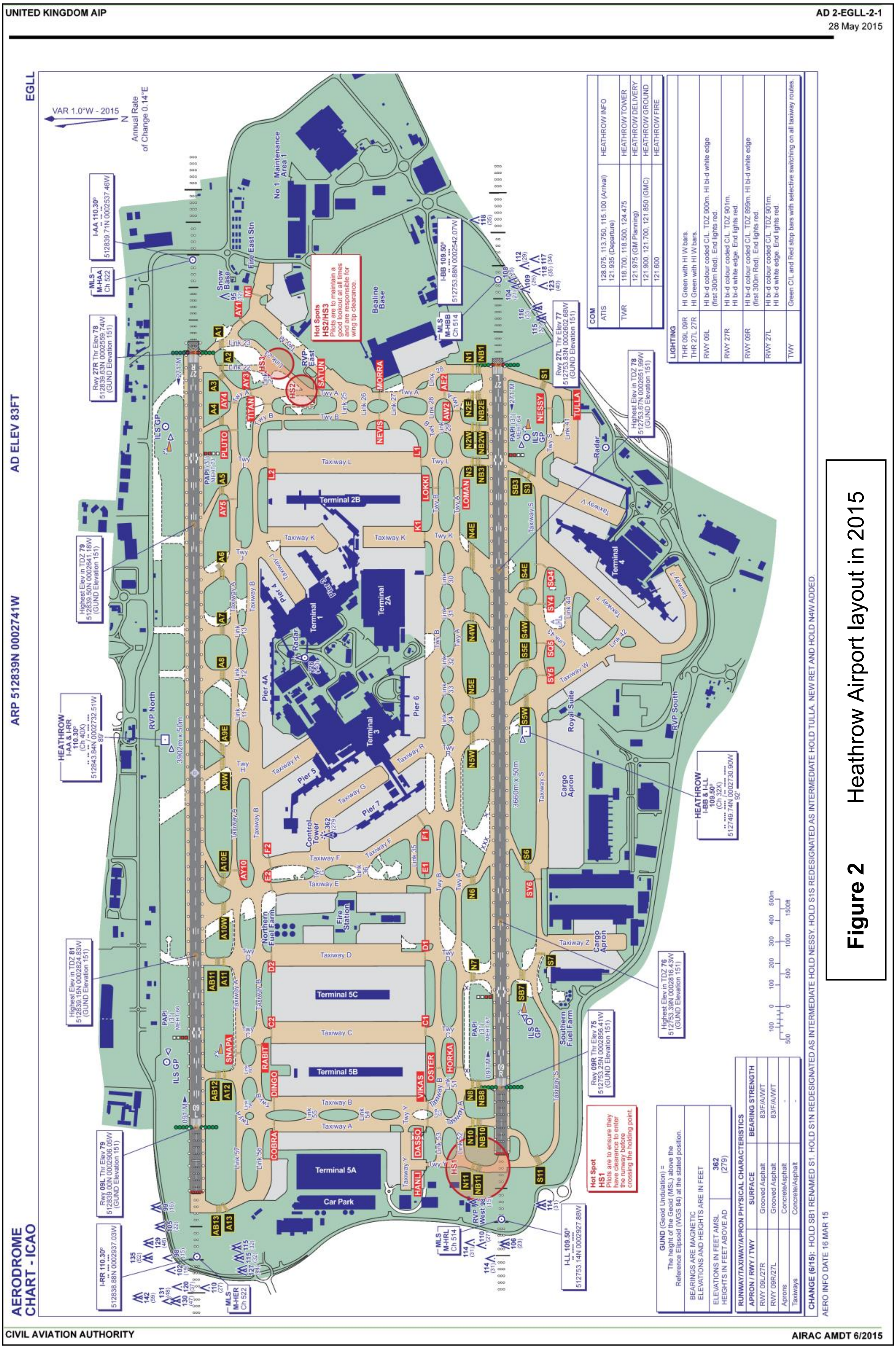
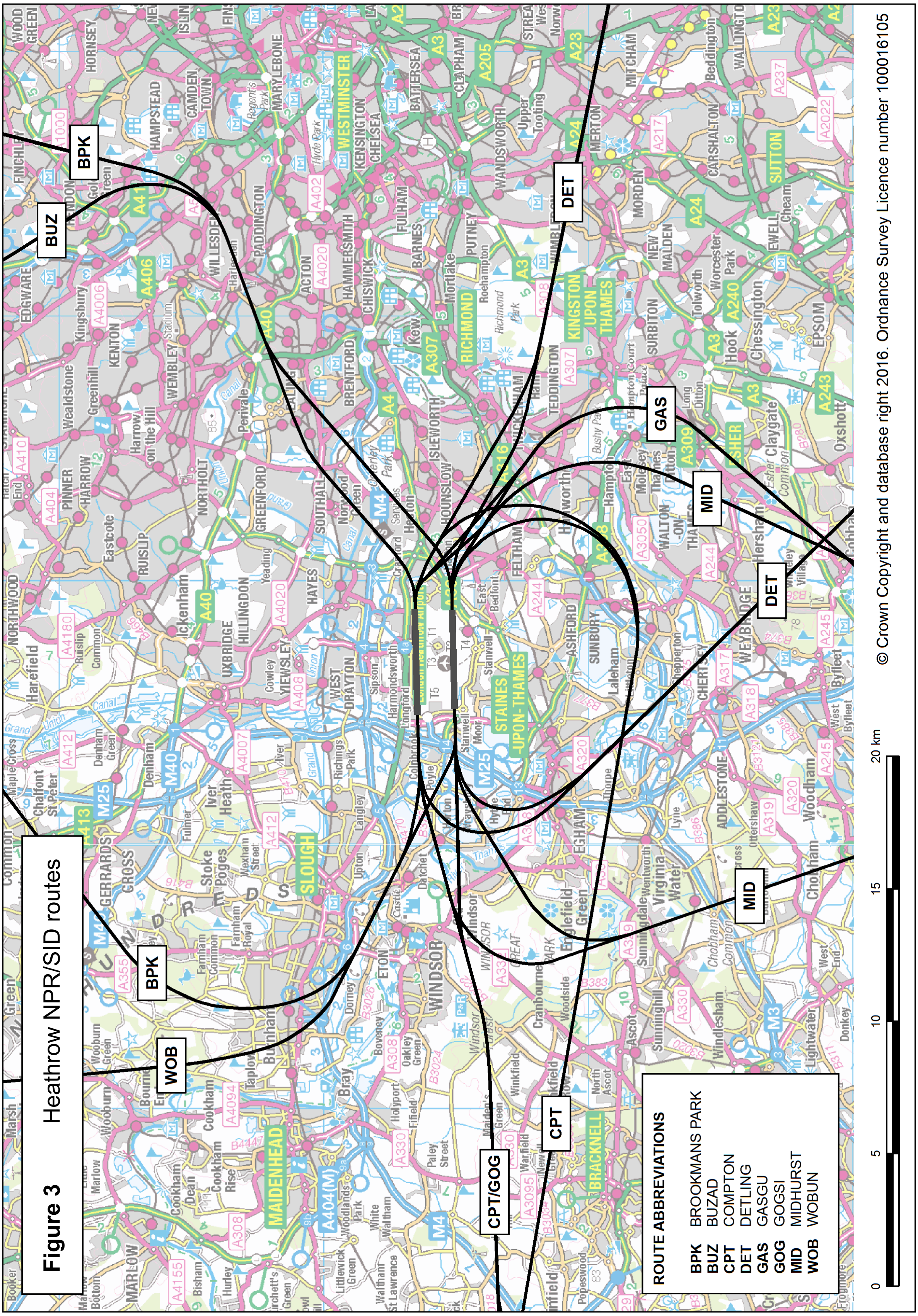


Figure 2 Heathrow Airport layout in 2015

Figure 3 Heathrow NPR/SID routes



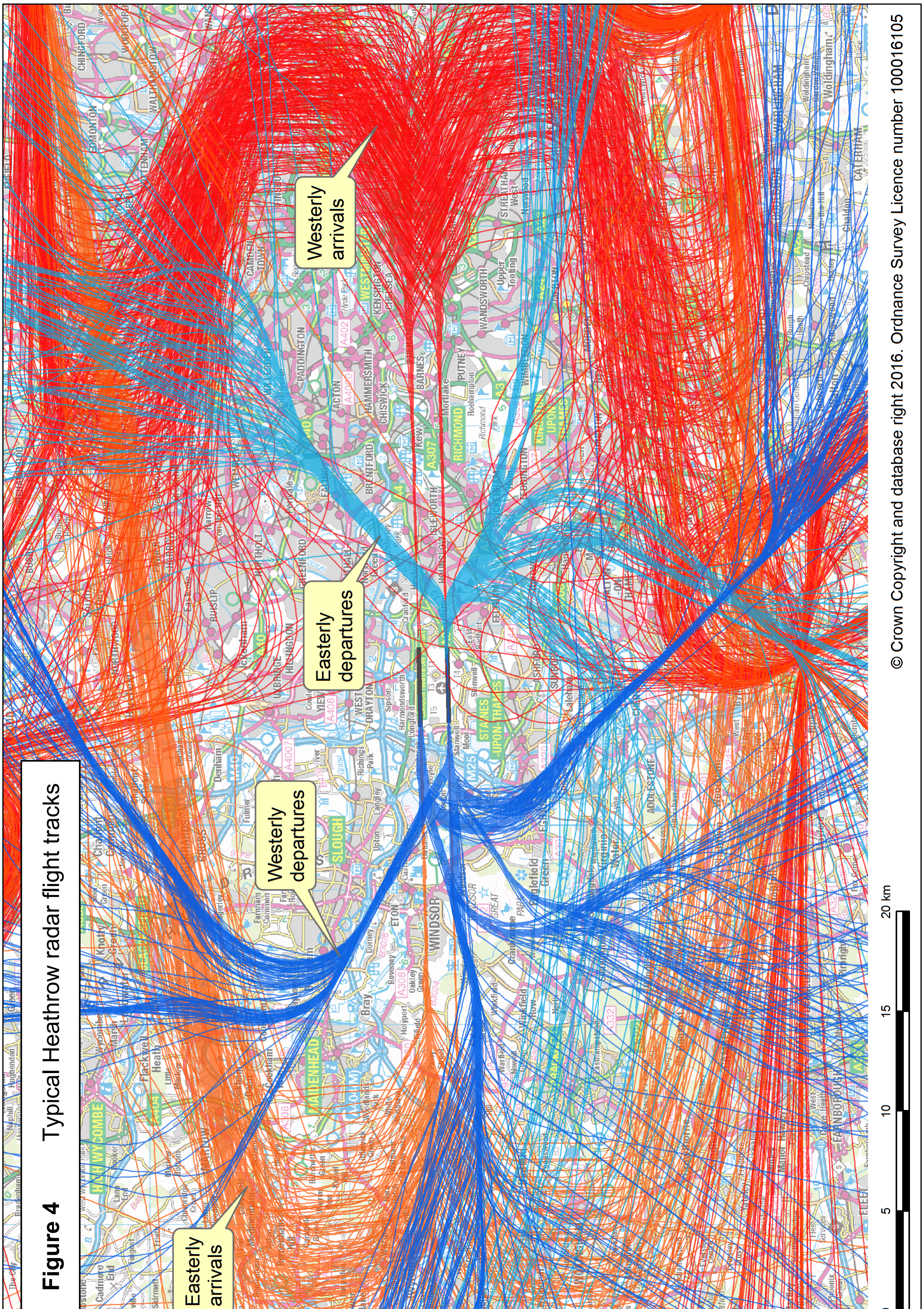
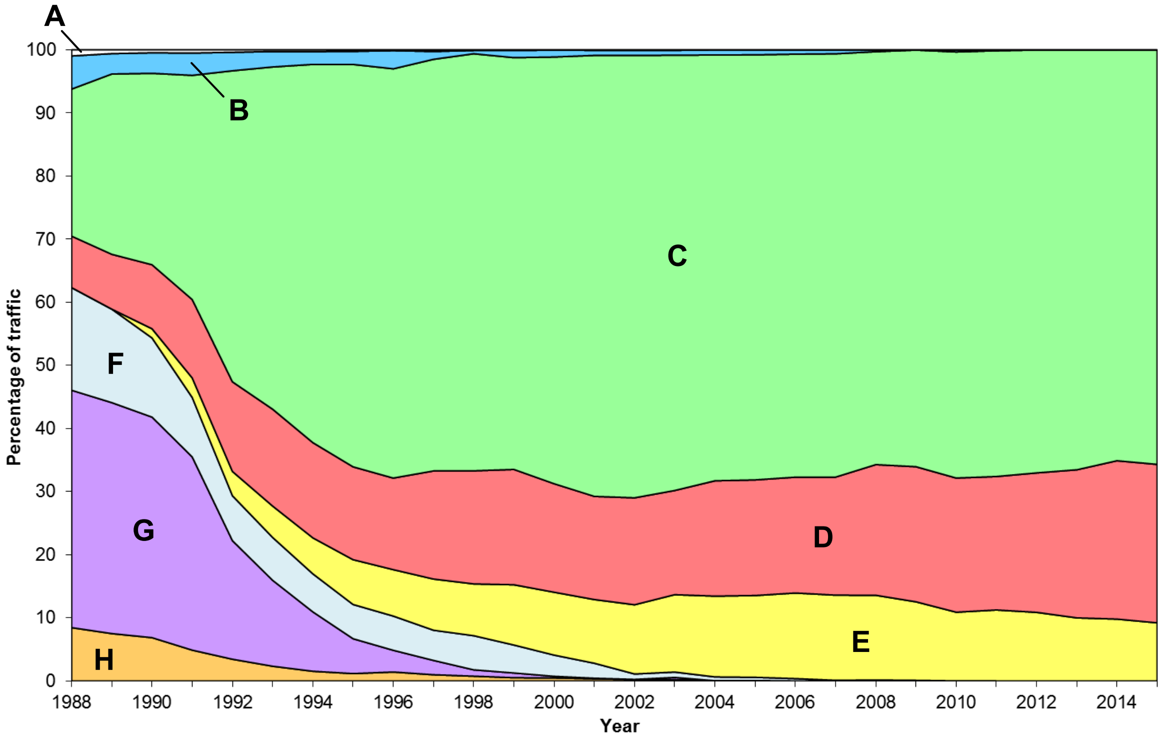


Figure 4 Typical Heathrow radar flight tracks

Figure 5 Heathrow Noise Class trend 1988-2015



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

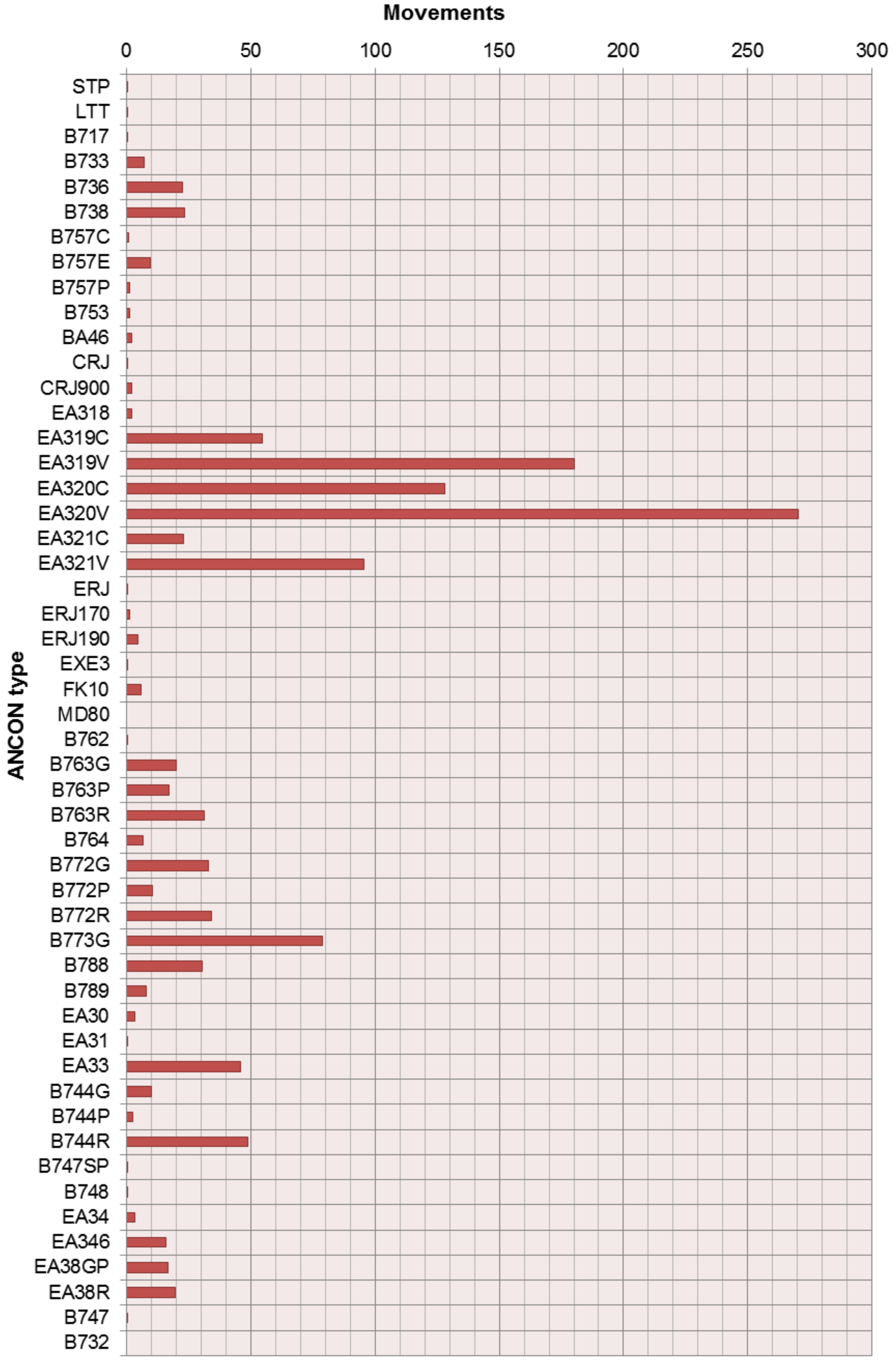
Chapter 3/4 jets
C Narrow-body aircraft, e.g. Airbus A320, Boeing 737-700
D Wide-body twins, e.g. Boeing 767-300, Boeing 777-300
E Wide-body 3 or 4-engine aircraft, e.g. Airbus A380, Boeing 747-400

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

2nd generation twin jets
G Narrow-body twins (including Ch.2 and hush-kitted versions), e.g. Boeing 737-200

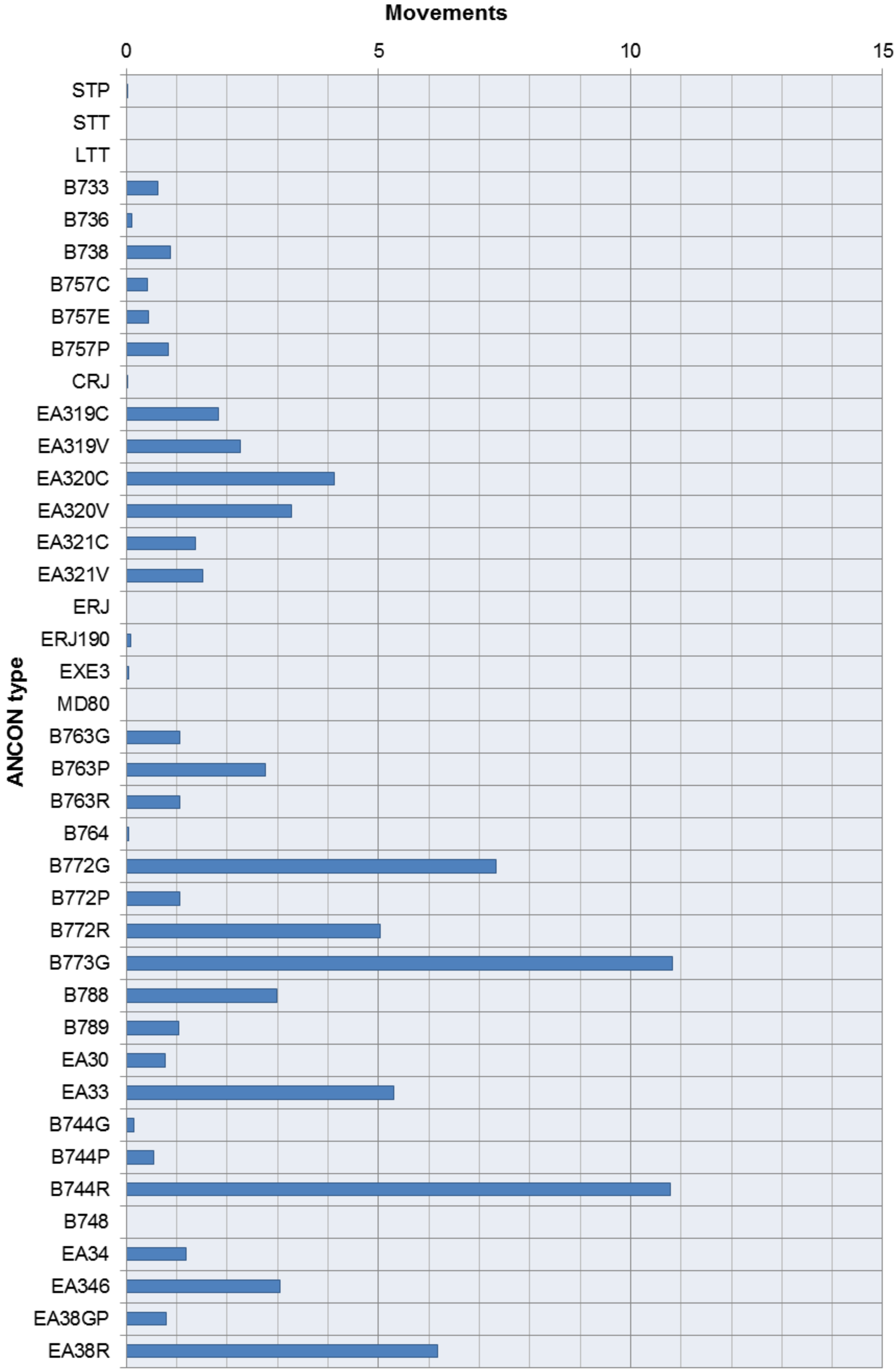
1st generation jets
H Narrow-body 3 or 4-engine aircraft (including hush-kitted versions), e.g. Boeing 727

Figure 6a Heathrow 2015 average summer day movements by ANCON aircraft type



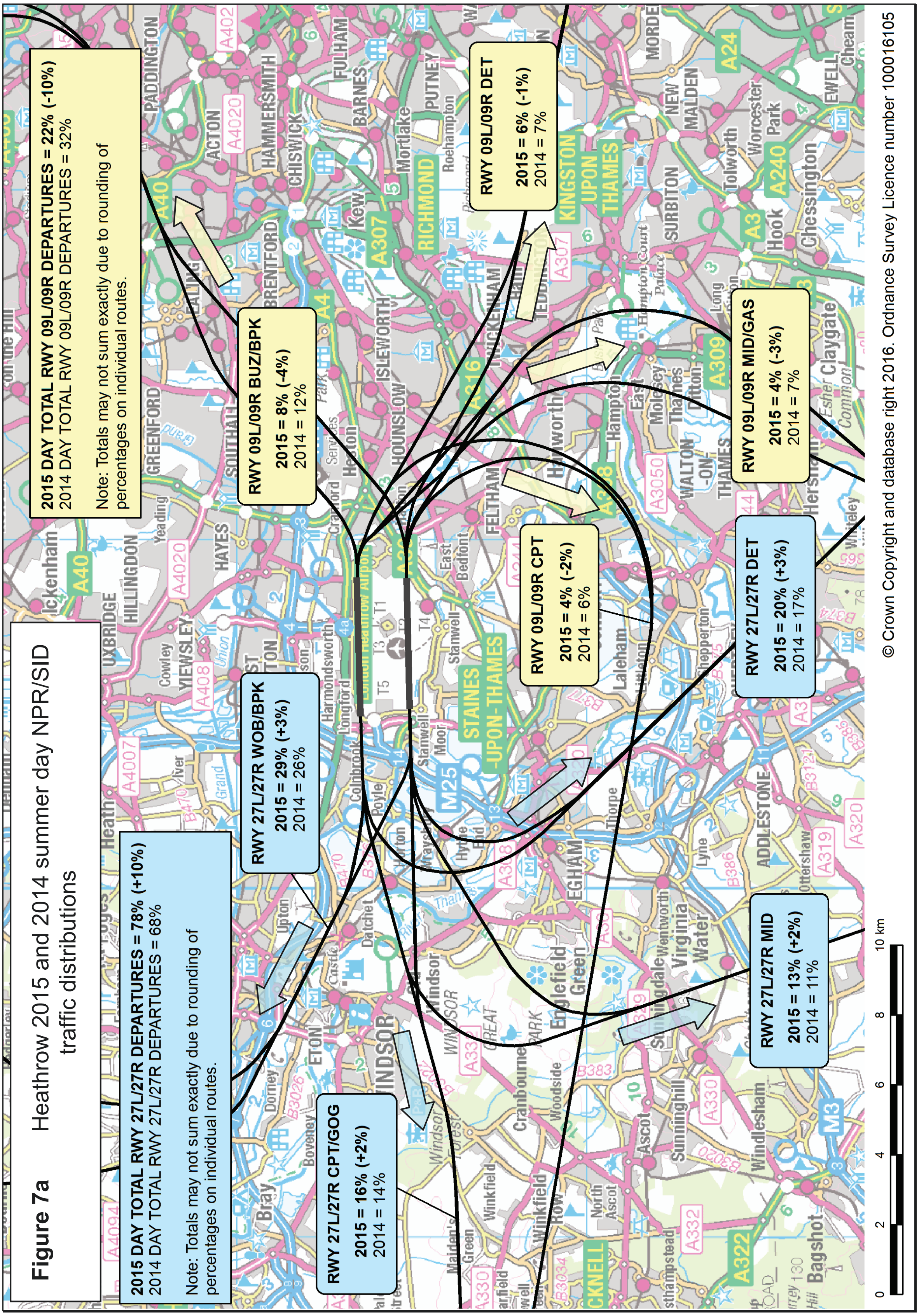
Note: ANCON types are shown in the same order as **Table 2a**.

Figure 6b Heathrow 2015 average summer night movements by ANCON aircraft type



Note: ANCON types are shown in the same order as **Table 2b**.

Figure 7a Heathrow 2015 and 2014 summer day NPR/SID traffic distributions



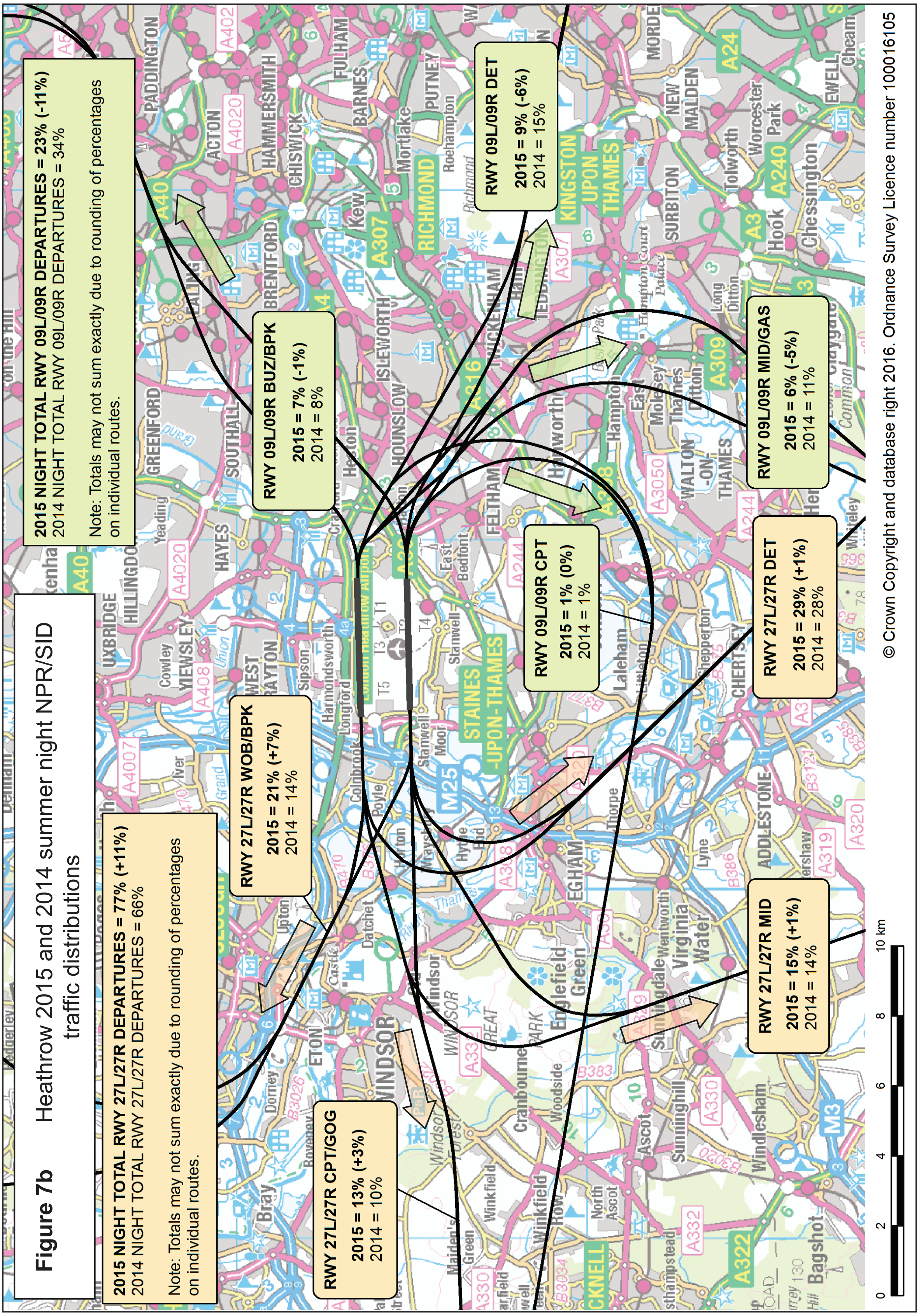
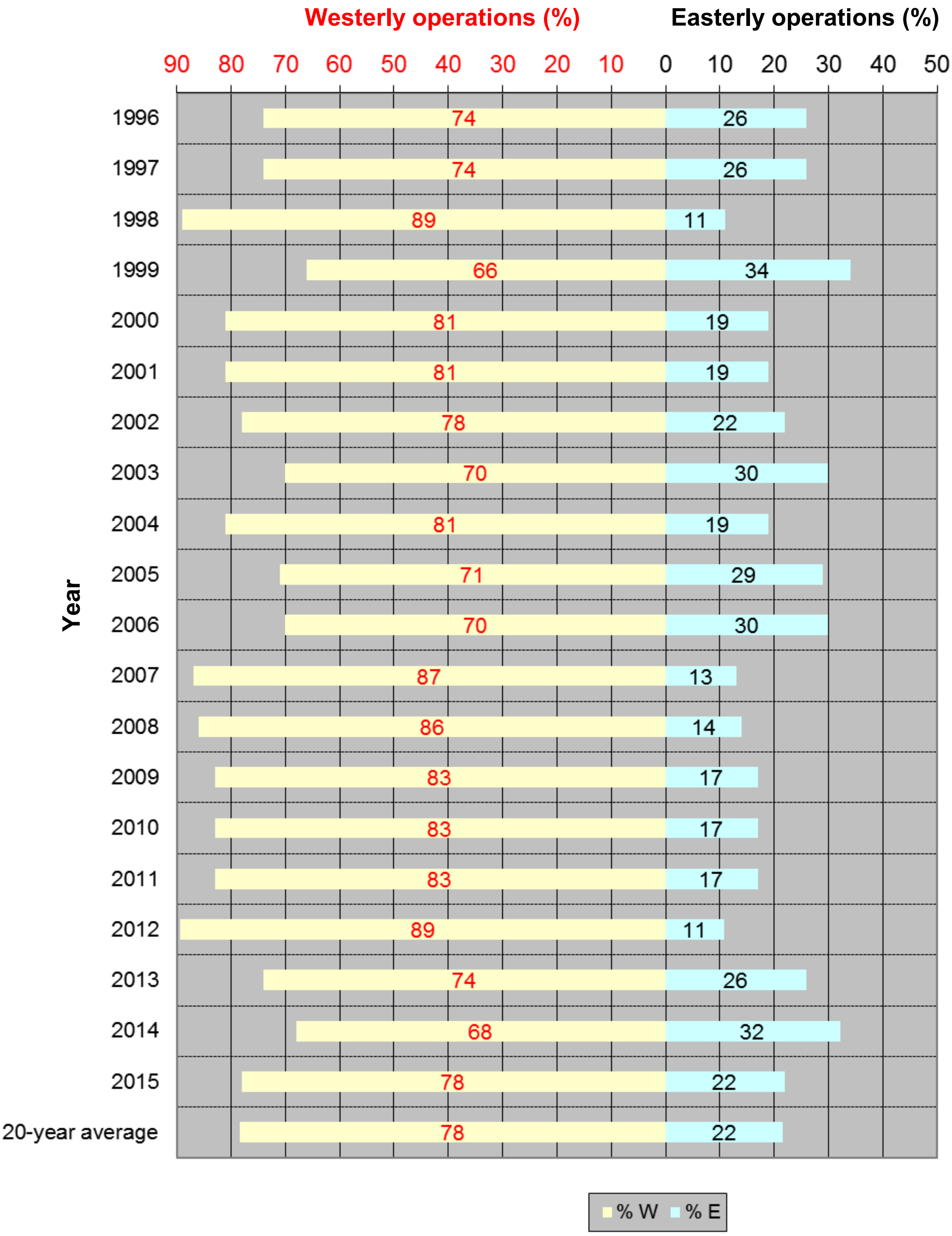


Figure 7b Heathrow 2015 and 2014 summer night NPR/SID traffic distributions

Figure 8 Heathrow average summer day runway modal splits 1996-2015



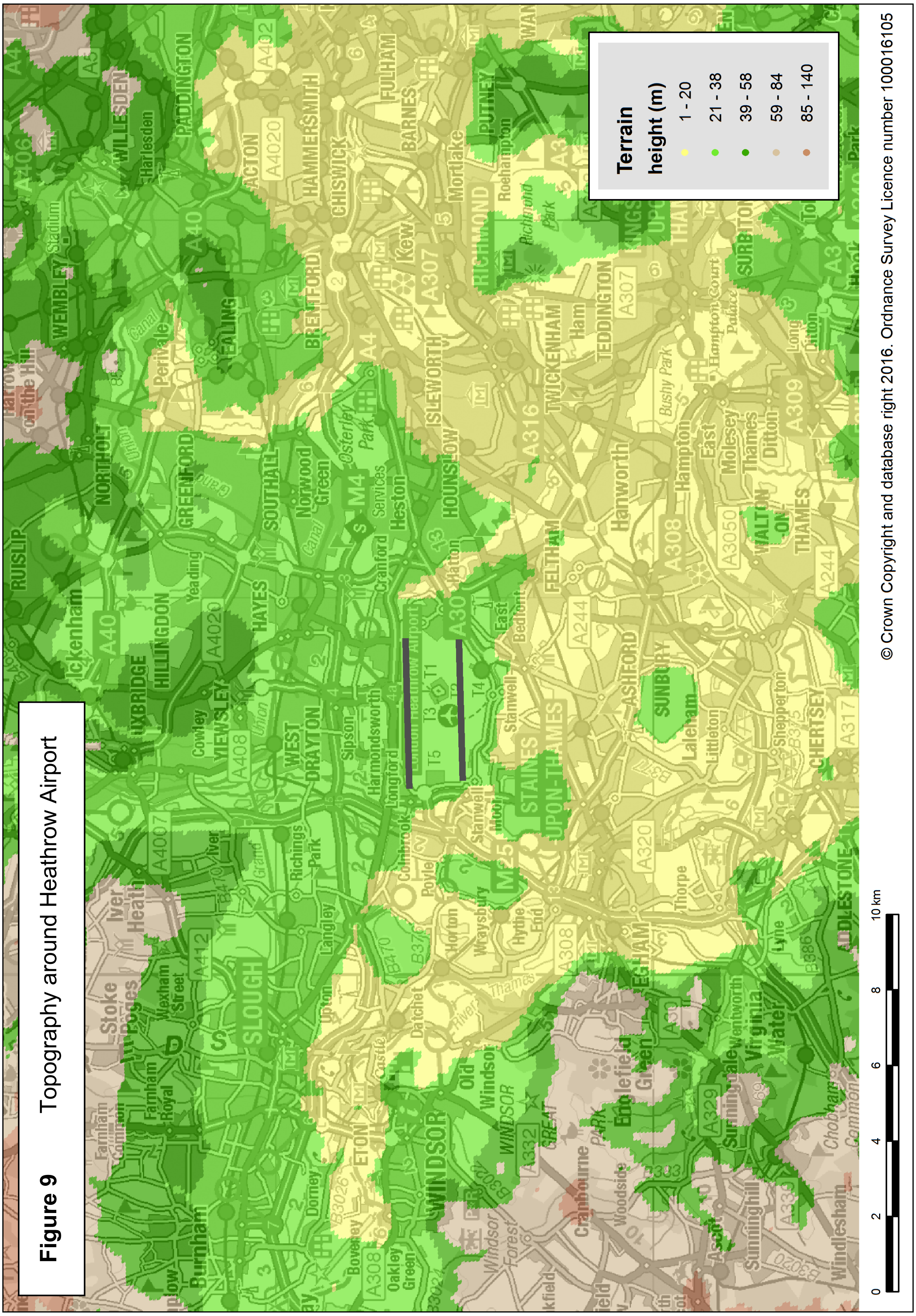
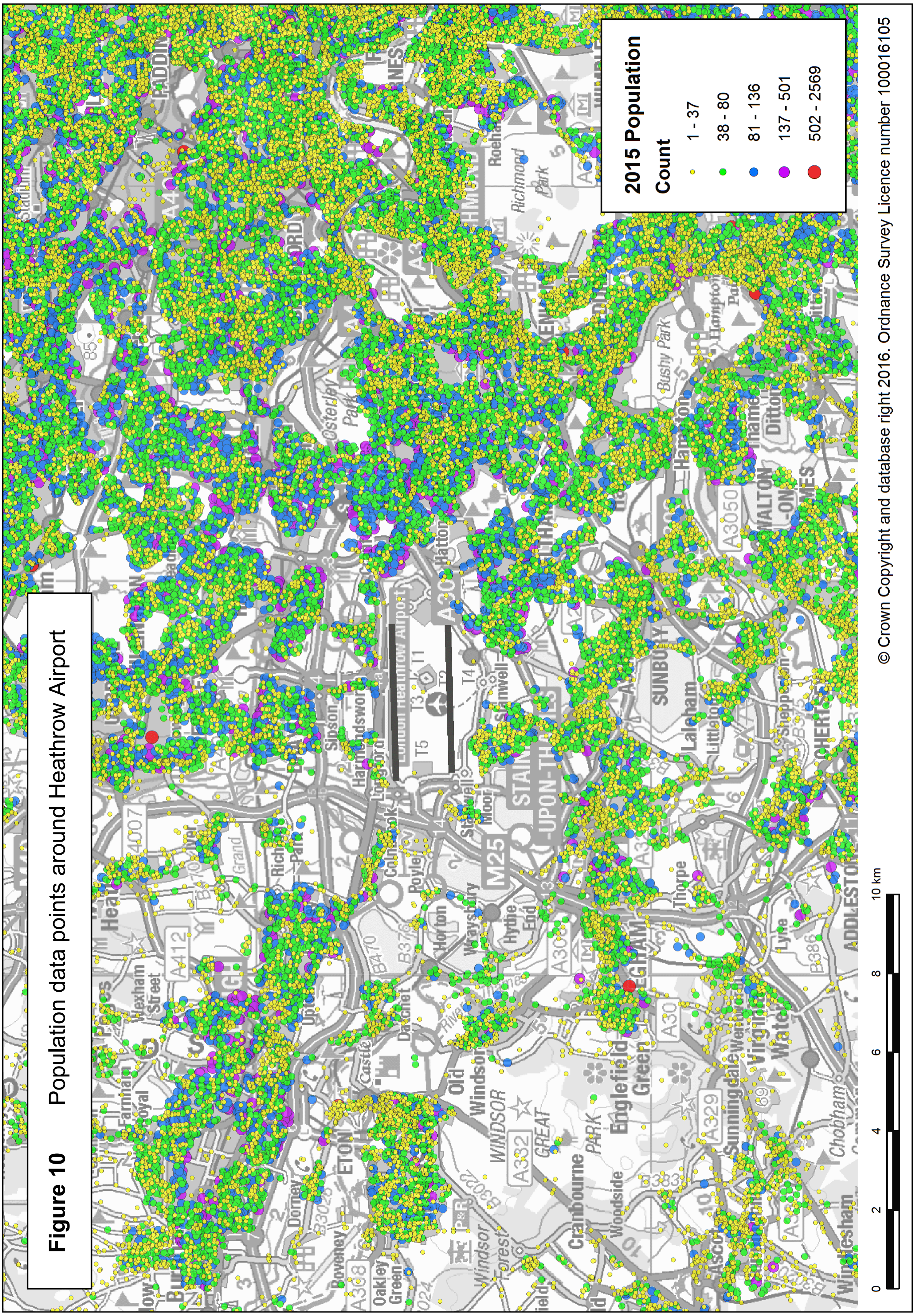


Figure 9 Topography around Heathrow Airport

Figure 10 Population data points around Heathrow Airport



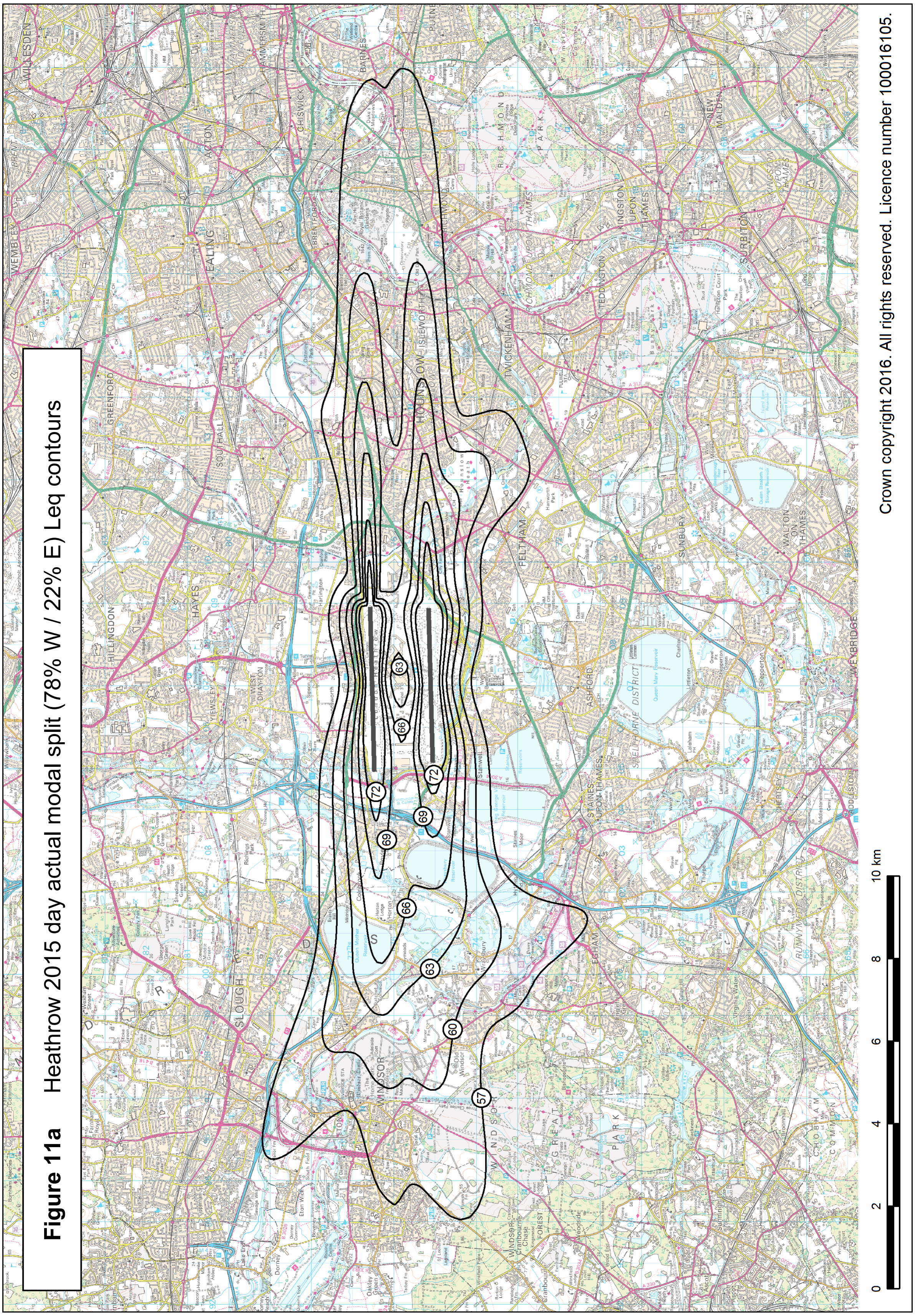


Figure 11a Heathrow 2015 day actual modal split (78% W / 22% E) Leq contours

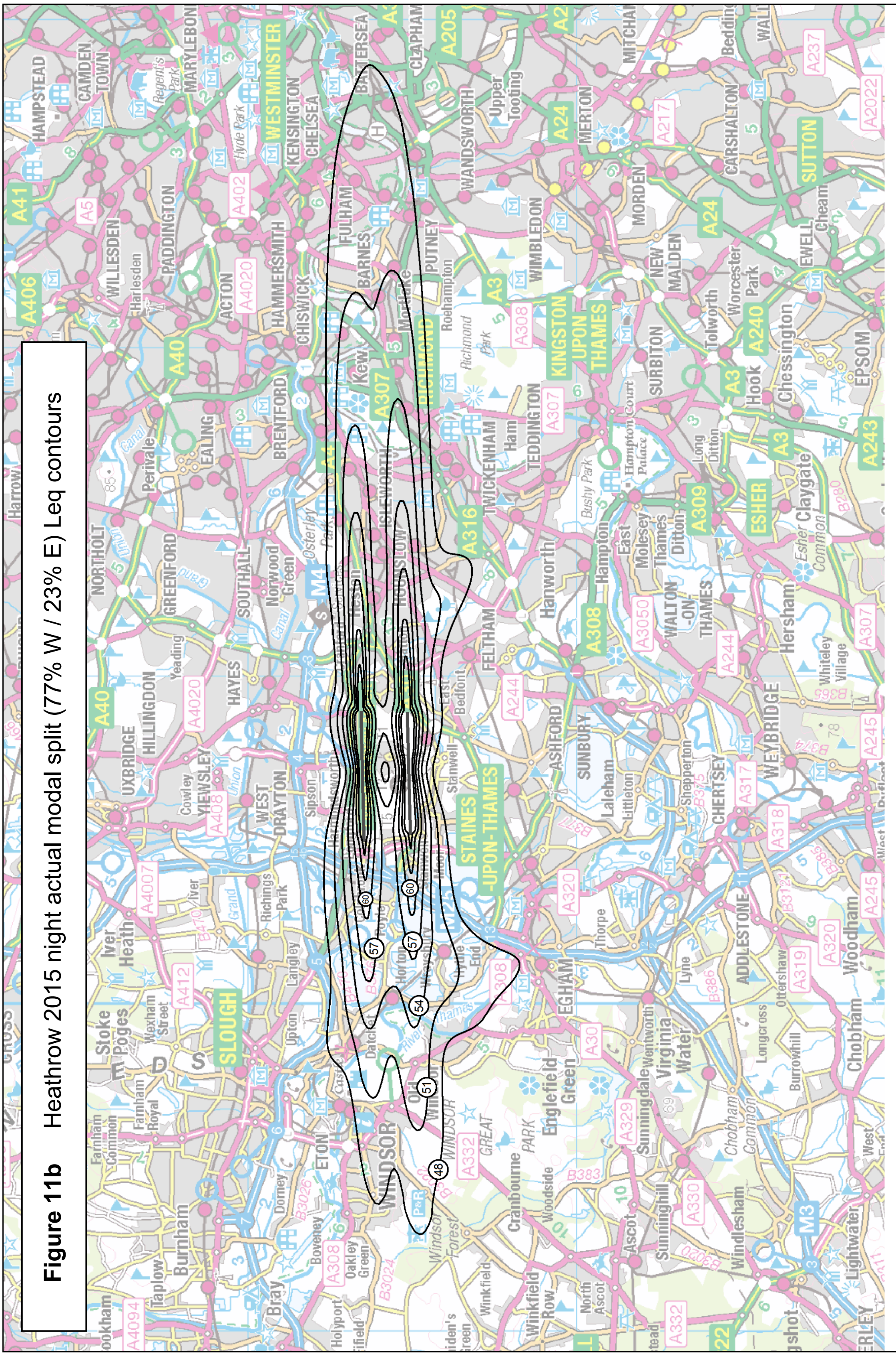


Figure 11b Heathrow 2015 night actual modal split (77% W / 23% E) Leq contours

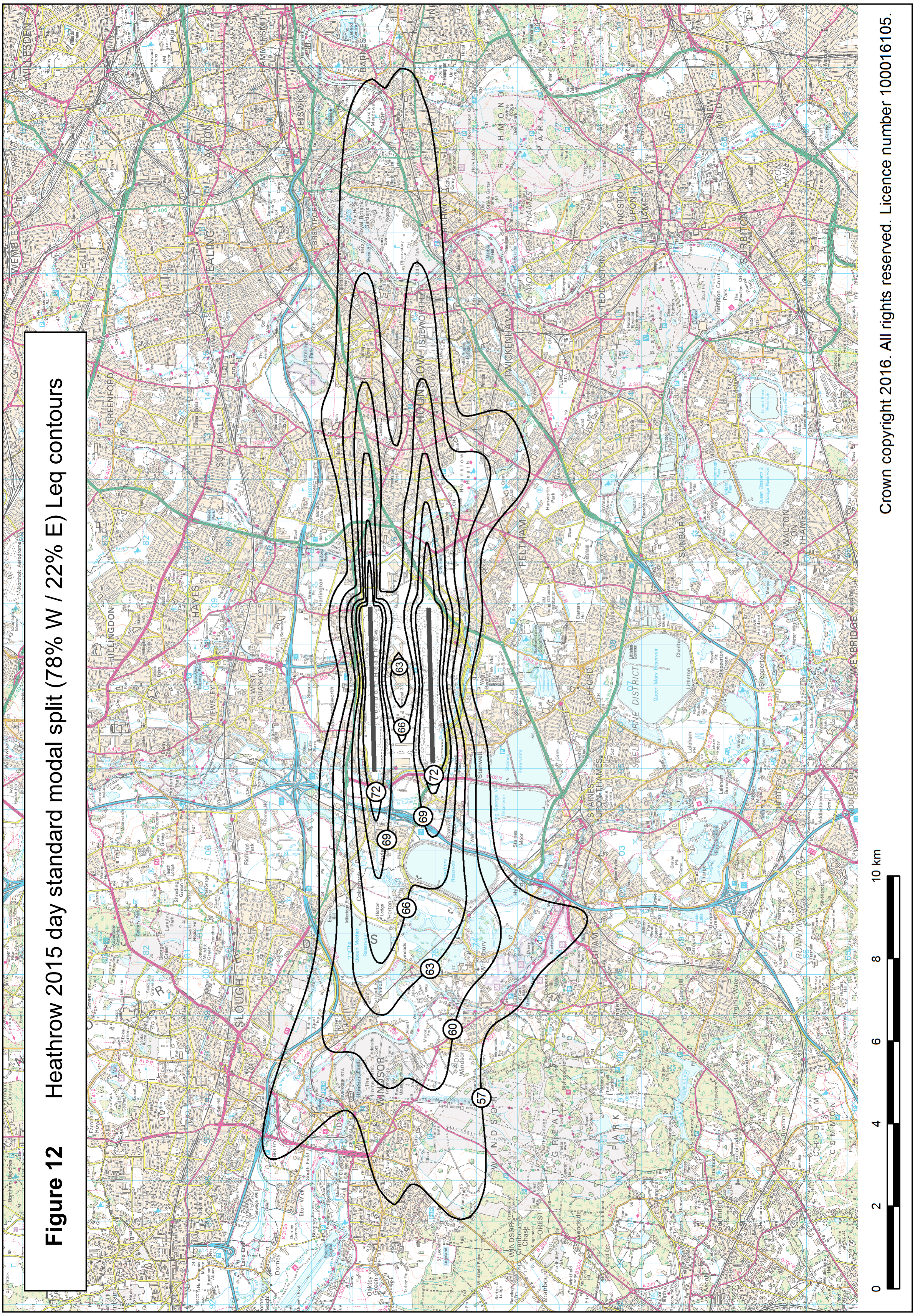


Figure 12 Heathrow 2015 day standard modal split (78% W / 22% E) Leq contours

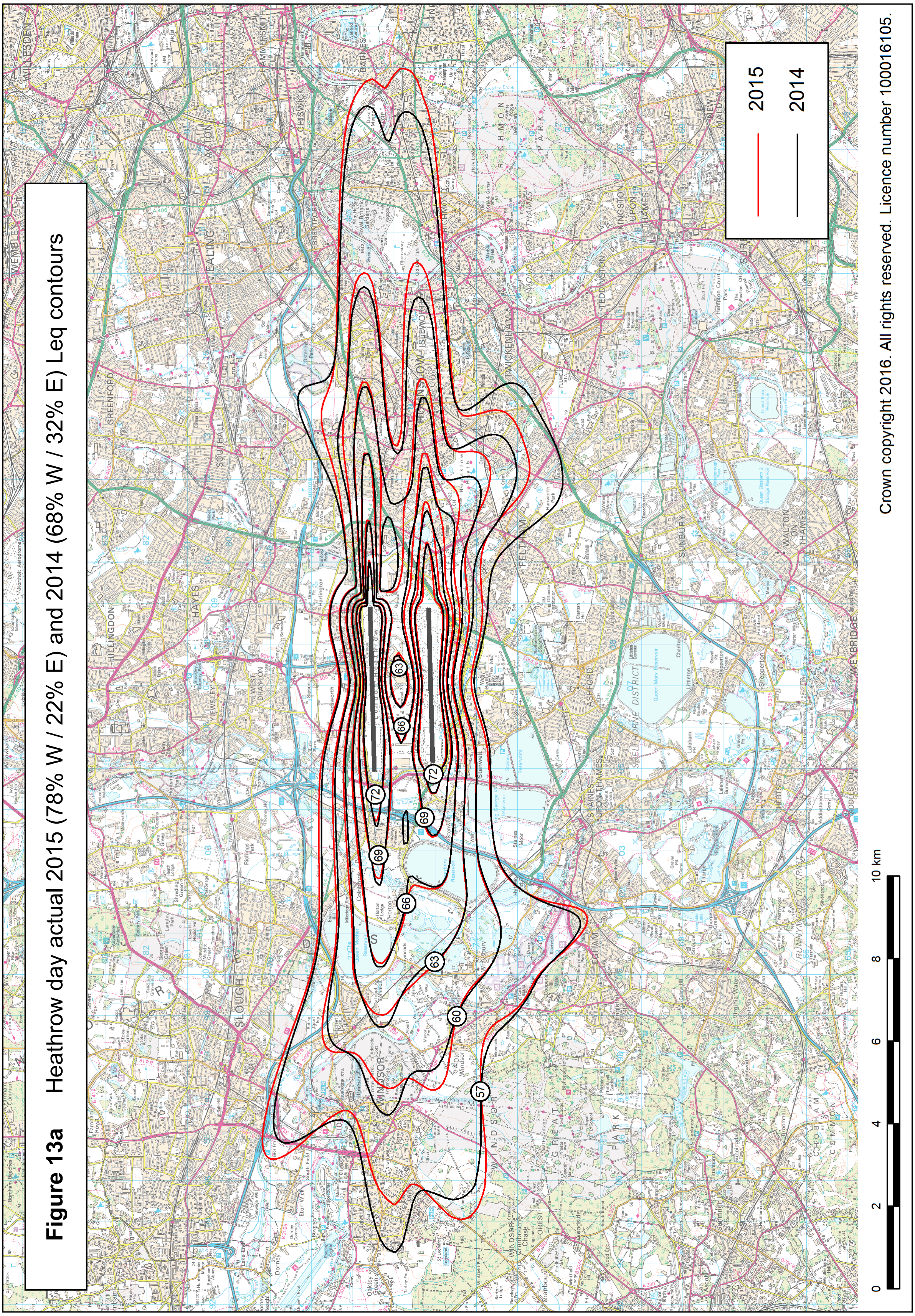


Figure 13a Heathrow day actual 2015 (78% W / 22% E) and 2014 (68% W / 32% E) Leq contours

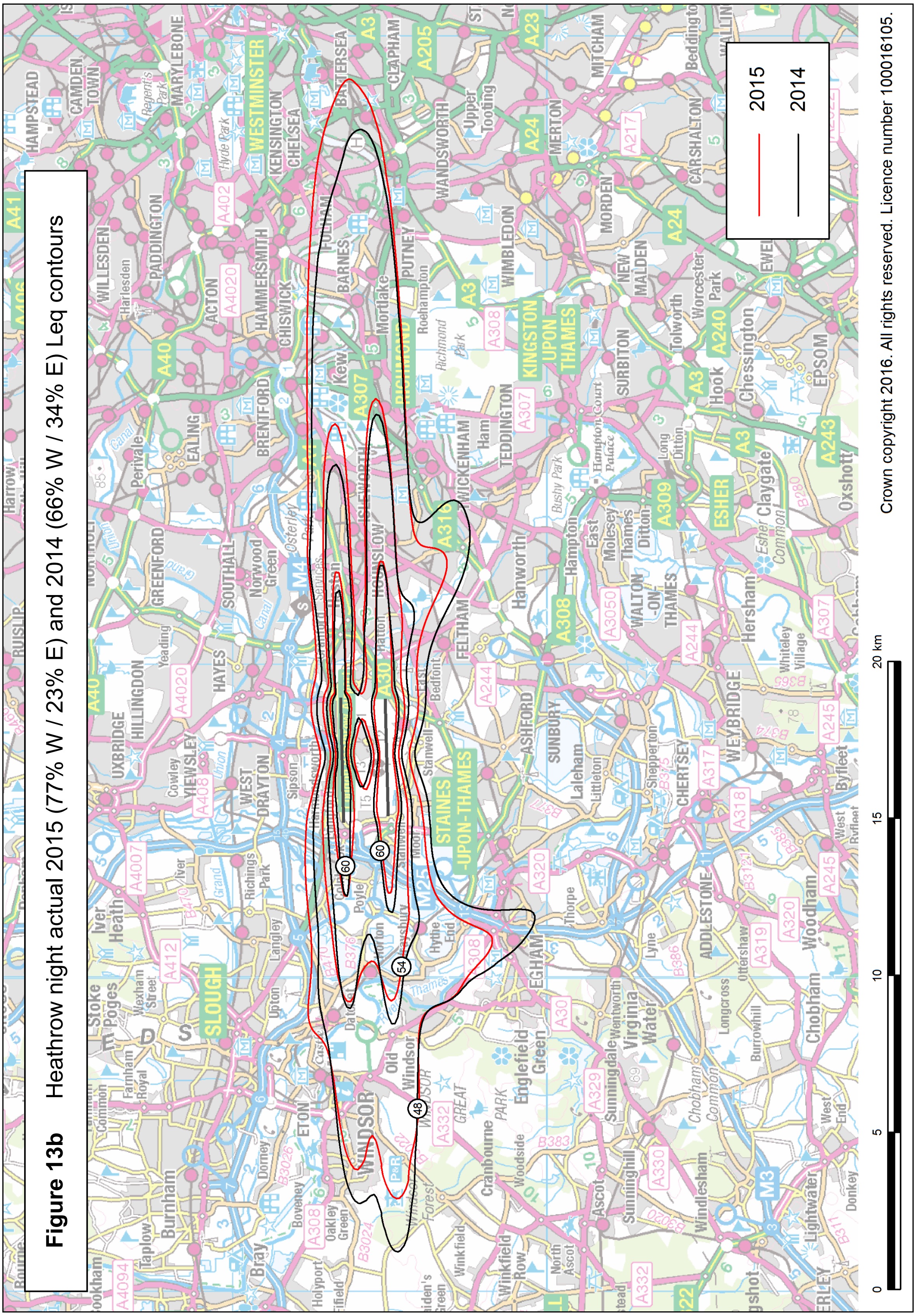


Figure 13b Heathrow night actual 2015 (77% W / 23% E) and 2014 (66% W / 34% E) Leq contours

Figure 14 Heathrow day standard 2015 (78% W / 22% E) and 2014 (77% W / 23% E) Leq contours

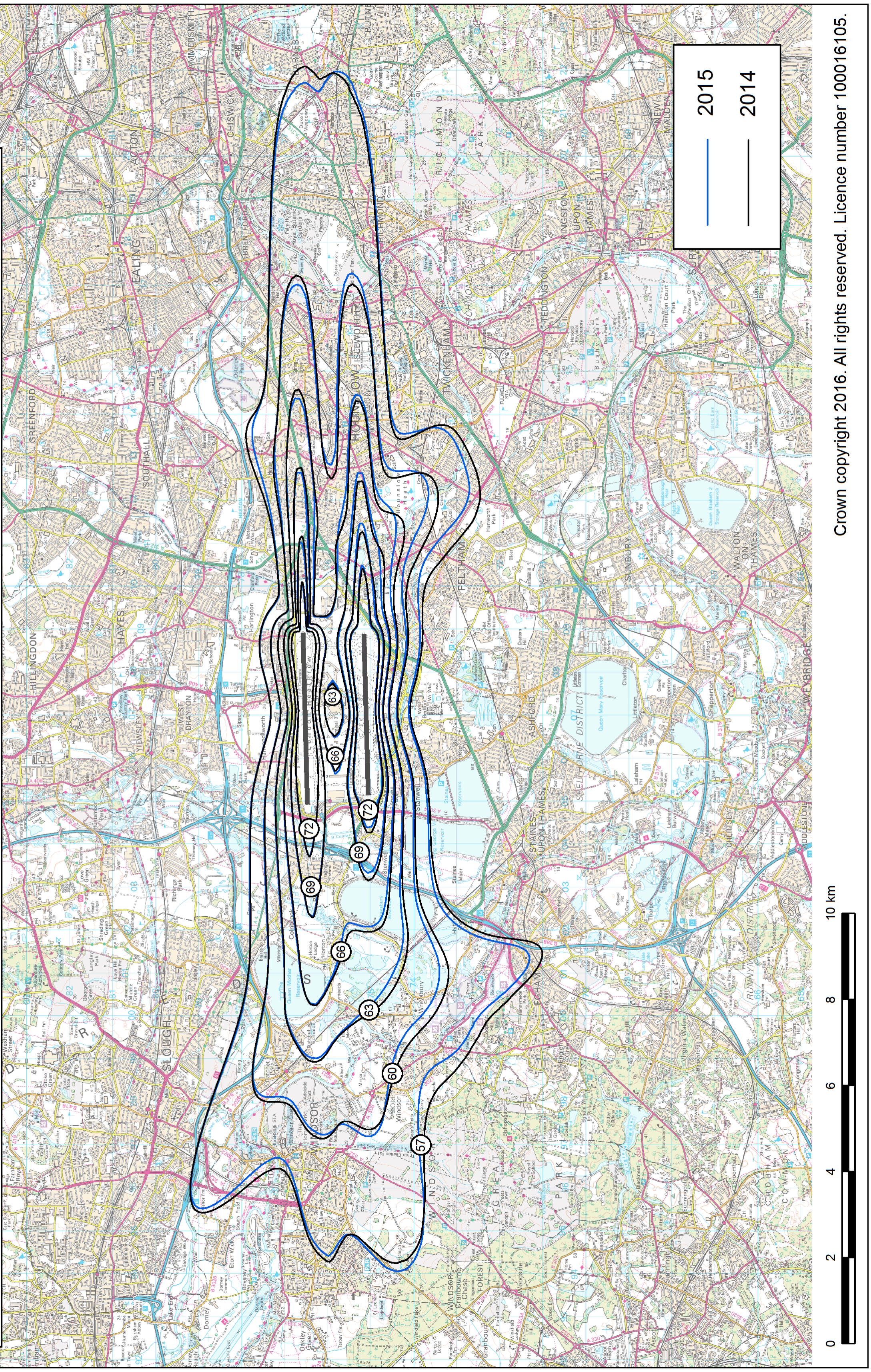


Figure 15 Heathrow annual traffic and summer day Leq noise contour area/population trend 1988-2015