



Community Noise Information Report Ascot

24th September 2014 – 17th February 2015

December 2017

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Introduction

This report presents an analysis of operational and noise data for the noise monitor located in Ascot. At the request of local residents, Heathrow Airport Ltd installed a temporary noise monitor on the grounds of Ascot Racecourse between 24th September 2014 and 17th February 2015.

The report is structured using a template developed by Anderson Acoustics and Helios working with members of the Heathrow Community Noise Forum (HCNF) Working Group for Monitoring & Verification. It is set out as:

- **Section 2 – Key Findings** are presented.
- **Section 3 – Background & Methodology** provides an overview of how the airport operates, noise and how the data (both operations and noise) have been analysed.
- **Section 4 – Flight track data** presents analysis of the flight tracks and operations around the Ascot area including routes, proximity, spatial distribution, height and aircraft types. As flight track data has been collected for many years in the airport's noise and track-keeping (NTK) system, analysis has compared the noise monitoring period with an equivalent period in 2010/11.
- **Section 5 – Noise Monitor Data** presents an analysis of aircraft noise event and overall community noise levels as measured at the noise monitor. Noise data is analysed only for the monitoring period. Comparison with a historic period is not possible as monitoring has not taken place at the same location previously.

- **Section 6 – Noise Modelling** presents noise levels derived from the verified Heathrow Airport noise model. Average noise levels and noise event statistics have been generated across the wider geographic area for an average day of operations that affect this community across the summer of 2011 and 2015 to provide a broader understanding of whether there are any differences in noise exposure between the two years. The baseline year of 2011 was agreed as no trials took place in this period and is prior to changes perceived by some members of the community.
- **Section 7 – Appendices** presents large scale versions of all of noise modelling results and provides greater detail on noise terminology around how sound is described, how aircraft noise is measured and how differences of sound level relate to human perception.

It should be noted that this report is intended to describe noise exposure rather than the impact of that exposure - we cannot judge how each individual will respond. The report describes exposure and differences therein (as applicable) of aircraft using a variety of both operations and noise related metrics.

Whilst this report is a comprehensive analysis, it is not intended to be exhaustive. Should there be any questions or comments arising from the data presented herein, these should be addressed to the HCNF for additional analysis.

Note: Wherever this report refers to "2014/15 monitoring period", it should be noted that this is specifically the period from 24th September 2014 to 17th February 2015. Similarly, "2011 equivalent period" specifically refers to the period from 24th September 2010 to 17th February 2011.



Key Findings

Operations and the community

Ascot is overflowed by both westerly and easterly departures. On westerly operations, the aircraft tend to be those on the Midhurst (MID) route while those on easterly operations tend to be departing on the Compton (CPT) route.

The proportion of aircraft using the MID route on westerly days has been fairly constant over the period 2010/11 to 2014/15. Over the same period, there was a small increase in the proportion using CPT on easterly operations.

There was, overall, a 5% increase in operations passing through the westerly gate on westerly operations in the 2014/15 period compared to 2010/11 and an increase of about 20% movements passing through the easterly gate on easterly operations.

Traffic was highly concentrated on westerly departures coinciding with the westerly departure trials that were underway during the 2014/15 monitoring period.

The average height of westerly departing aircraft were about 250ft lower in 2015 compared to 2011 while the height of easterly arrivals were, on average, 400ft higher.

Compared to the airport as a whole, a smaller proportion of the traffic passing through the westerly gate are small twin-engine aircraft although compared to 2010/11, there has been a small shift towards medium sized aircraft.

The busiest period of the day, in terms of movements through the gate, on both easterly and westerly operations is around midday.

Noise levels in the community based on measurement at Windlesham monitor

It is not possible to draw conclusions about aircraft noise based on measured noise at Ascot Racecourse for the following reasons;

Less than 10% of noise events are correlated to aircraft suggesting there are other dominant noise sources in the vicinity.

There was no relationship between distance to aircraft and noise level for the most dominant aircraft types suggesting that those events that were correlated to aircraft were contaminated by other noise sources.

Many of the noise event durations were greater than would be expected from an aircraft passing overhead, in some cases up to an hour.

There is little difference in the hourly $L_{Aeq,1hr}$ values, particularly during the morning and evening period, suggesting aircraft noise is not dominant at this location.

Difference in community noise levels between 2011 and 2015 based on noise modelling

On westerly operations, Ascot falls outside the daytime $L_{Aeq,16hr}$ 50dB and $N_{65}=10$ contours for both 2011 and 2015. However the $L_{Aeq,16hr}$ and N_{65} increased by 2-3dB and up to 25 respectively over the same time period.

On westerly operations, Ascot falls outside the night-time $L_{Aeq,8hr}$ 45dB for both 2011 and 2015. In 2015, the N_{60} at Ascot was 2 after being less than 1 in 2011. Both the $L_{Aeq,8hr}$ and N_{60} increased over the five year period however the number of noise events was initially very low.

On easterly operations, Ascot falls outside the daytime $L_{Aeq,16hr}$ 50dB for both 2011 and 2015. In 2015, Ascot fell within the $N_{60}=10$ contour after being outside in 2011. Both the $L_{Aeq,16hr}$ and N_{65} increased over the five year period.

On easterly operations, Ascot falls outside the night-time $L_{Aeq,8hr}$ 45dB and $N_{60}=1$ contours for both 2011 and 2015.



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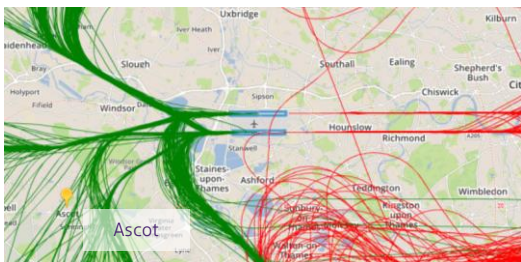
Appendices



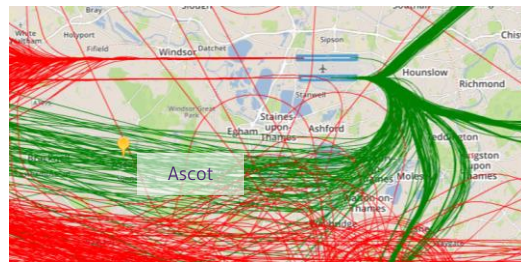
Understanding how wind direction affects aircraft operations.

Wind direction and operating direction

- The direction aircraft land and take-off from Heathrow depends on the direction of the wind. For safety reasons, aircraft take-off and land into the wind.
- When the wind blows from the west, aircraft arrive from the east, over central London, and take off to the west. This is called westerly operations. Conversely, when the wind blows from the east, aircraft arrive from the west over Berkshire and take off to the east. This is called easterly operations.
- The figures below show flight tracks for a typical day of easterly and westerly operations. Arrivals are shown red, departures green.



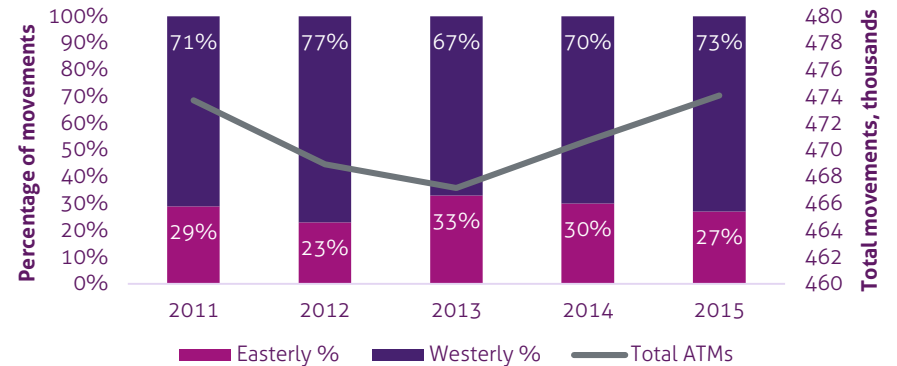
Flight tracks on a westerly day (8th March 2016)



Flight tracks on an easterly day (18th March 2016)

The proportion of easterly/westerly operations

- Around Heathrow, the prevailing wind direction is from the west.
- Heathrow also operates what is known as the 'westerly preference'. Aircraft will continue to operate in a westerly direction until there are tail winds consistently of 5kts or more. This was implemented to protect more densely populated areas to the east of the airport.
- As a result, the airport is typically on westerly operations for about 70-75% of the year.
- The figure below presents the **annual** proportion of easterly and westerly operations for the last 5 full years.



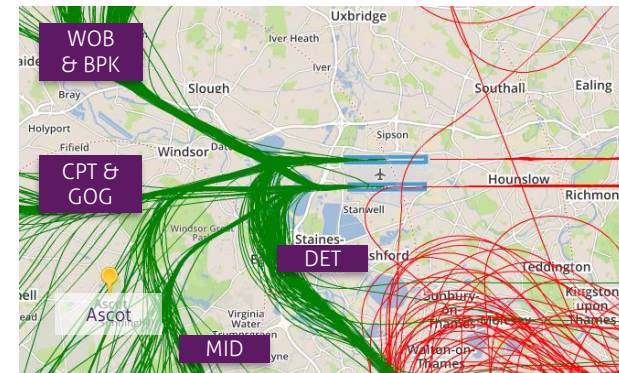
Note: Further information about operations at Heathrow can be found at <http://www.heathrow.com/noise/heathrow-operations>



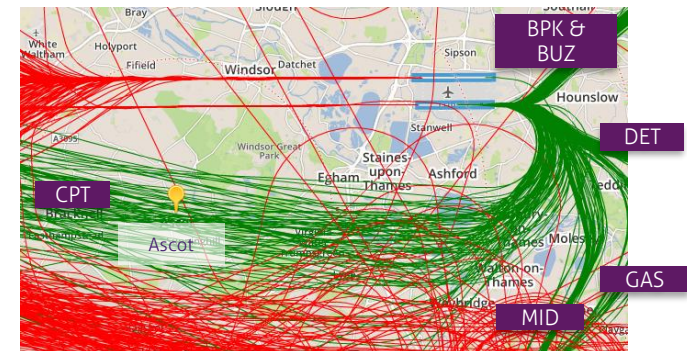
Understanding where aircraft fly near to Ascot.

- The images to the right presents a typical day of westerly operations (top) and easterly operations (bottom) with arrival tracks shown in red and departures in green.
- Aircraft departing the airport follow one of six pre-defined routes (Noise Preferential Routes – or NPRs), typically based upon their destination. These are represented by the purple and grey corridors.
- Ascot is overflown by both westerly departures predominantly on the MID route and easterly departures on CPT route. On westerly departures the aircraft are on average at 5,700ft whereas on easterly departures the aircraft are at 7,800ft.
- This report will primarily focus on westerly and easterly departures.

Arrival and departure tracks on westerly operations



Arrival and departure tracks on easterly operations



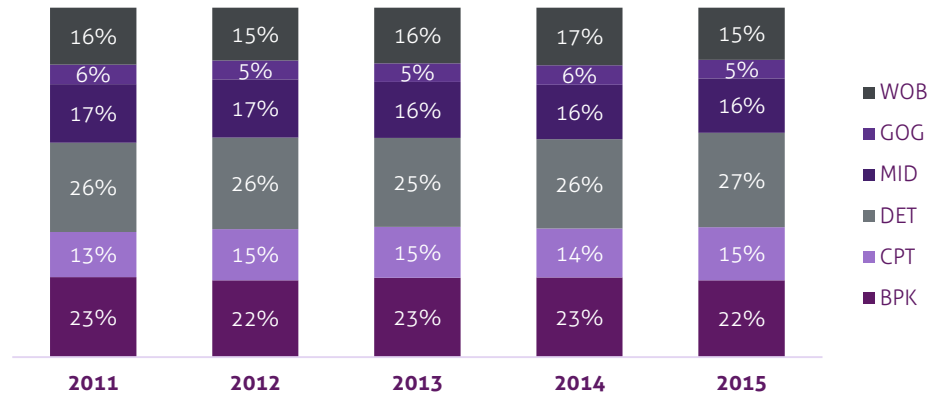
DET and GOG are the new names for the DVR and SAM routes respectively. Throughout this document they are referred to as DET and GOG



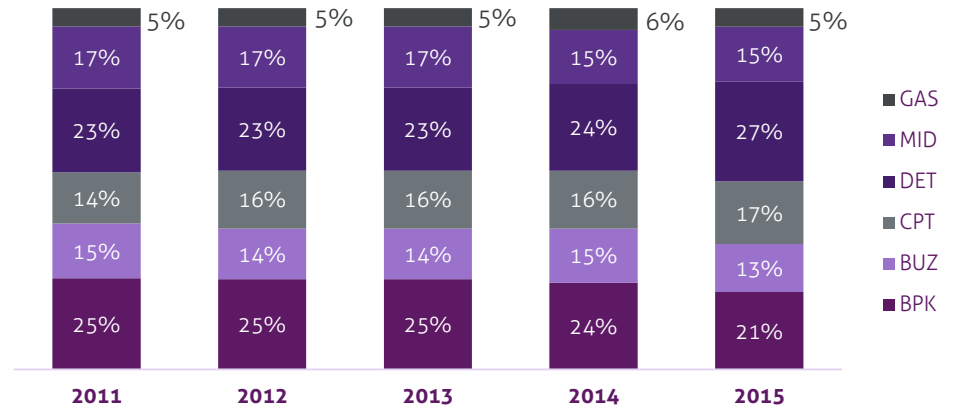
Understanding where aircraft fly on departures.

- Ascot is overflowed by both westerly and easterly departures. While there is no set route aircraft should take between holding stack and final approach on arrivals, departures must follow one of six NPRs.
- The figures to the right show the proportions of **annual** departure route usage on westerly and easterly operations for each year from 2011-2015.
- On westerly operations, there are small fluctuations from year to year, but route usage has remained broadly consistent over the five year period with 16-17% of departures following the MID route.
- On easterly operations, there has been some change in route usage in particular a shift from route which leave the airport to the north to those which leave to the south. This has resulted in the proportion of aircraft on the CPT route increasing from 14% to 17% of easterly departures.

Annual departure route use during westerly operations



Annual departure route use during easterly departures



Understanding operational and gate data. ✈️

Operational data.

- The following operational data were provided for the period 24th September 2014 – 17th February 2015 and the same period for 2010/11:
 - Easterly/westerly movements - % of movements in easterly/westerly direction.
 - Daily logs - Number of flights operating from Heathrow per day by runway used
 - Heathrow flight-by-flight data - Aircraft type, departure route, runway.

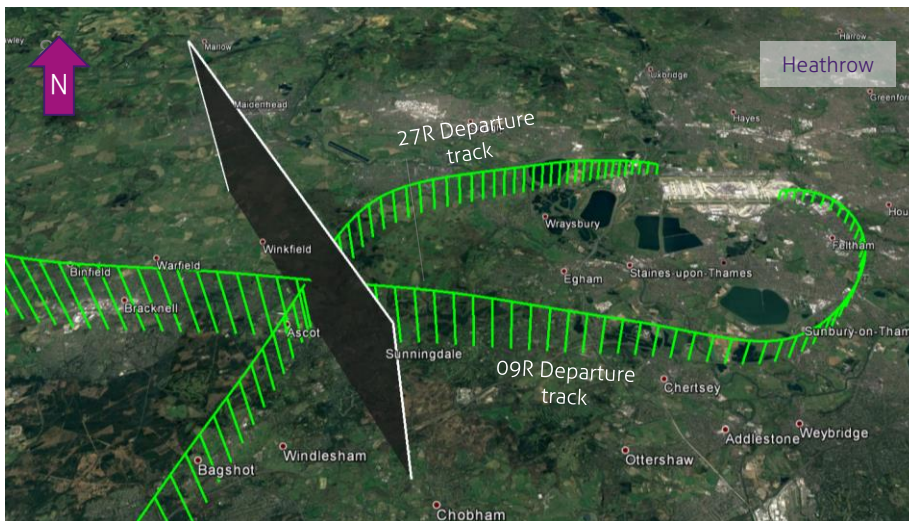
Gate analysis.

- To investigate the heights, distribution and concentration of aircraft, the Noise and Track Keeping (NTK) system's "gate analysis" function was used to provide data on where aircraft have flown relative to the noise monitor.
- A 'gate' was drawn over Ascot centred on the temporary noise monitor; the position of which is shown below

- The gate was designed to capture both westerly and easterly departures passing through them and extends to a height of 20,000ft.
- The heights and positions of each aircraft passing through the gate were extracted from ANOMS, Heathrow's NTK system. Heathrow departures to both the west and the east were investigated in this report.
- The following data were extracted:
 - Aircraft deviation from the centre of the gate
 - Aircraft height at gate
 - Time that the aircraft penetrated the gate
 - Departure route flown – 'standard instrument departure route' (SID)
 - Aircraft type
 - Runway used

Can the data be trusted?

- Through the Heathrow Community Noise Forum (HCNF), an independent study was carried out, investigating the accuracy of flight track data of Heathrow systems.
- The results confirming the integrity of the data and models are presented in the following report:
http://www.heathrow.com/file_source/HeathrowNoise/Static/NLR_HCNF_20160125.pdf



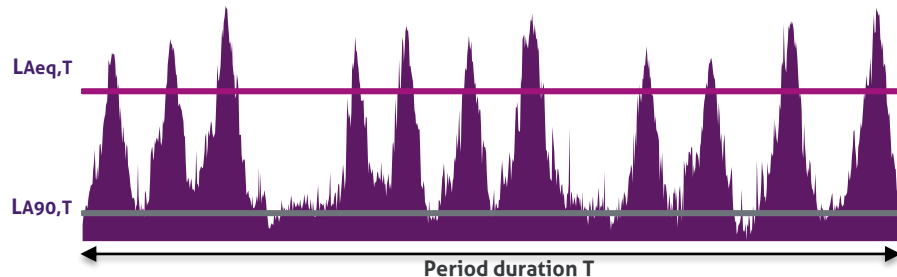
Understanding measured noise data.

Measured noise data:

- A Larson Davis 870, Type 1 integrating sound level meter was set to measure total ambient and background noise levels over hour periods in addition to individual noise events which, where possible, are linked to aircraft operations.
- Measured data is passed into Heathrow's NTK System without modification – no data has been excluded due to adverse weather conditions.
- For this report, noise data has been provided by Heathrow for the period 24th September 2014 – 17th February 2015. Note that a historical comparison is not available since the noise monitor was not installed at this location in previous years.

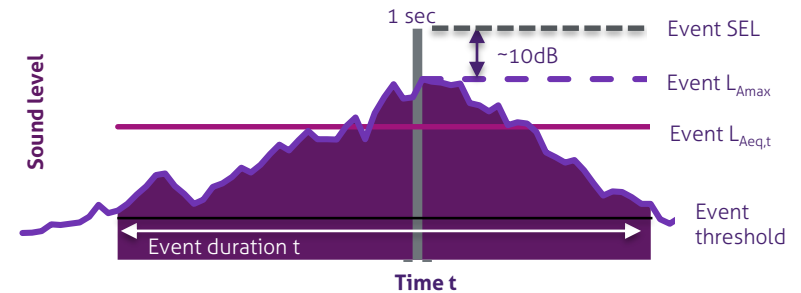
Ambient and background noise levels:

- The figure below illustrates how sound levels can vary over a time period T where aircraft events are experienced. The following metrics are typically used to describe the overall noise environment – $L_{Aeq,T}$ and $L_{A90,T}$. These are described as follows:
 - $L_{Aeq,T}$ – the total sound level across period T from all sources;
 - $L_{A90,T}$ – the sound level exceeded for 90% of the time across period T from all sources, this is often regarded as a measure of the background noise;
 - The NTK system provides these metrics in 1hr periods ie $T=1hr$.



Noise events:

- For ALL noise events, three descriptors are provided:
 - L_{Amax} - the maximum A-weighted sound pressure level during the event
 - SEL (sound exposure level or single event level) - the sound level of a one second burst of steady sound level that contains the same A-weighted sound energy as the whole event; and
 - Duration – the length of time (t) in seconds that the event exceeds the event detection threshold set on the sound level meter. The threshold is set dependent on local background noise conditions and can vary between monitor locations.
- For noise events linked to an aircraft operation the following data is also provided :
 - Aircraft type
 - Runway
 - Route
 - Position at time of L_{Amax}
 - Position at point of closest approach.
- The figure below illustrates the sound metrics associated with an aircraft noise event. The difference between L_{Amax} and SEL is typically around 10dB.

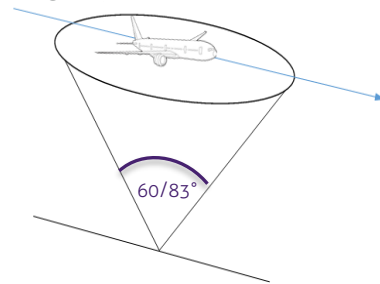


Analysing noise levels from aircraft in this area.

To undertake analysis of measured aircraft noise events, two perspectives are considered.

- Firstly, noise in the community. Aircraft overhead will generally have a higher noise level than those further away. However, noise from aircraft further away still contributes to the noise environment. So when describing noise from aircraft in an area all aircraft noise events should be considered.
- Secondly, if considering relative noise levels of aircraft it is best practice to restrict analysis to aircraft deemed 'overhead' to enable like for like comparison. This ensures that flights that are quieter purely as a result of being further away do not artificially reduce the analysed noise levels from that aircraft type.
- There is no consensus as to what constitutes an overhead flight but one definition involves drawing an imaginary cone above the noise monitor reaching an altitude of 7000ft. A recent ERCD report (CAP 1498) suggests this apex of this cone could be 60 or 83 degrees. This is illustrated in the figure below.

Flights are considered overhead if the aircraft pass within cone above the noise monitor

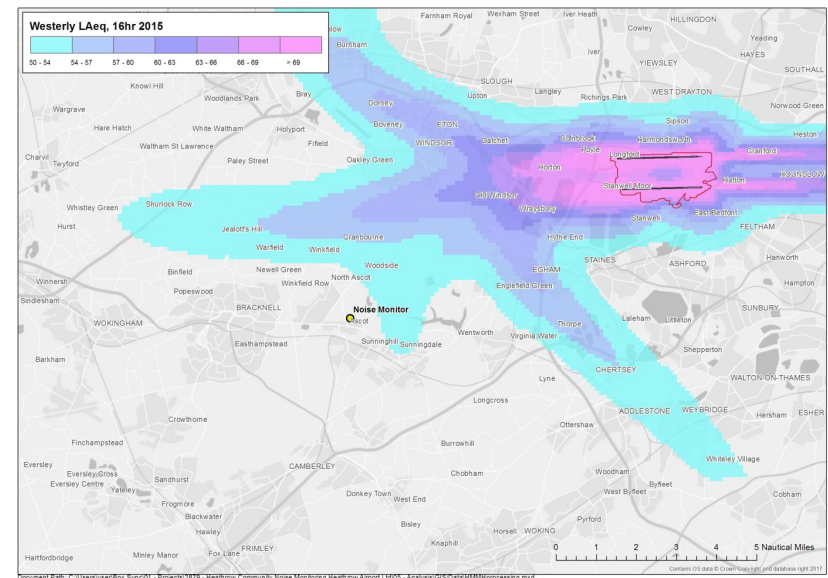


- Although this method has its limitations, this community information report will, where applicable, present results for overhead flights in the 60 degree cone.

Noise Modelling

- Aircraft noise modelling has been used to provide an understanding of differences in the noise environment between 2011 and 2015 over the wider geographic area.
- Differences in daytime and night time levels for an **average day and night of easterly and westerly operations** across the summer of 2011 and 2015 have been derived using the Heathrow INM model developed for the 2014/15 departure trials and verified recently by NLR.

Example contours generated by aircraft noise modelling



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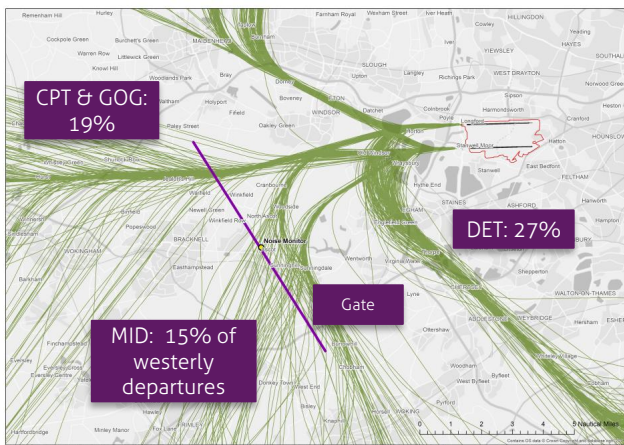
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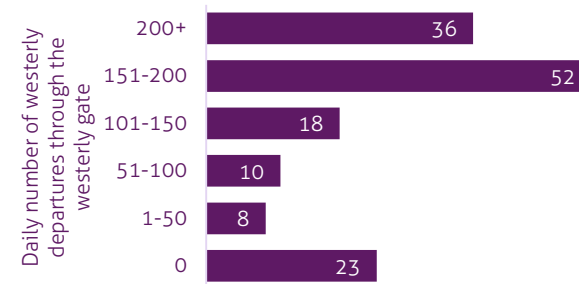
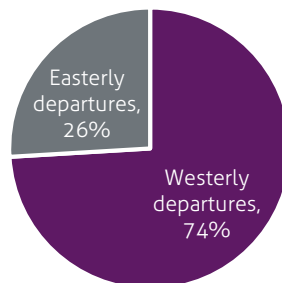
Overview of flight track data

24th September 2014 - 17th February 2015



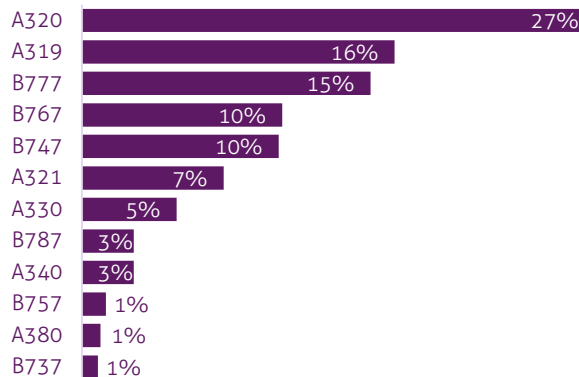
Example day of aircraft tracks in the vicinity of Ascot during westerly operations

Total 92,030 departures from Heathrow

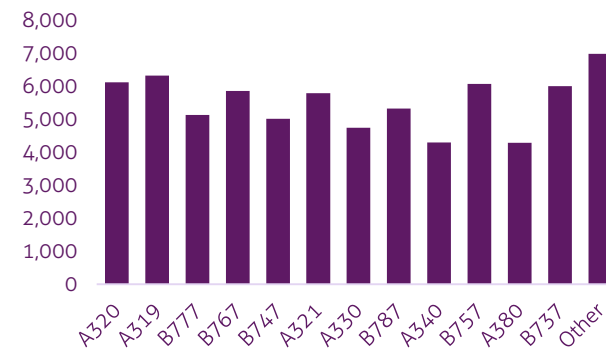


Number of westerly departures per day passing through the gate (147 days in total)

Proportion of departing aircraft types passing through the gate

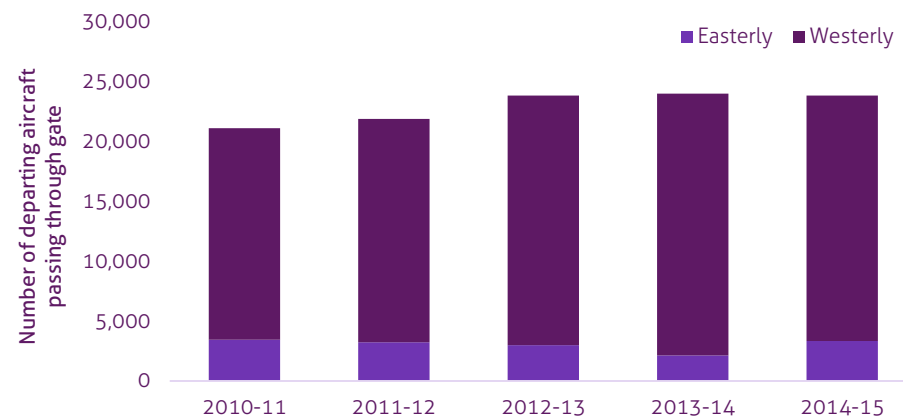


Average height of departing aircraft as they pass through the gate



Is the number of flights over the area different in 2014/15 to 2010/11?

- The figure to the right shows the total number of departures that passed through the gate (on westerly and easterly operations respectively) in the periods 2010-11 to 2014-15.
- Over the five year period, between 17,000 and 22,000 aircraft penetrated the gate on westerly departures and between 2,000 and 3,500 movements passed through the gate on easterly departures.
- Year to year changes can be attributed to changes in the wind directions and the proportion of aircraft flying each departure route.
- The proportion of westerly operations changed from 69% in the 2010/11 period to 74% of all movements for the 2014/15 monitoring period.**
- On full days of westerly operations, there was a slight increase in departures passing through the gate while the number of those passing through the overhead cone (indicated by the figures in parentheses) also increased from 12 to 24.
- On full days of easterly operations, the number of departures through the gate increased from 72 to 87 while those in the 60° overhead cone remained constant.



	2010/11	2014/15	Change	Change (%)
Proportion of westerly operations (all Heathrow flights)	69%	74%	+5%	N/A
Average number of westerly departures passing through the gate during days of 100% westerly operations (overhead in parentheses).	178 (12)*	187 (24)	+9 (+12)	+5% (+100%)
Average number of easterly departures passing through the gate during days of 100% easterly operations (overhead in parentheses).	72 (8)	87 (8)	+15 (-)	+21% (-)

Note: Wherever this section of the report refers to 2014-15, it should be noted that this is specifically the measurement period from 24th Sept 2014 to 17th Feb 2015. Similarly, 2010-11 specifically refers to the period from 24th Sept 2010 to 17th Feb 2011.

* Figures in parentheses indicate number of flights passing through the 60 degree overhead cone



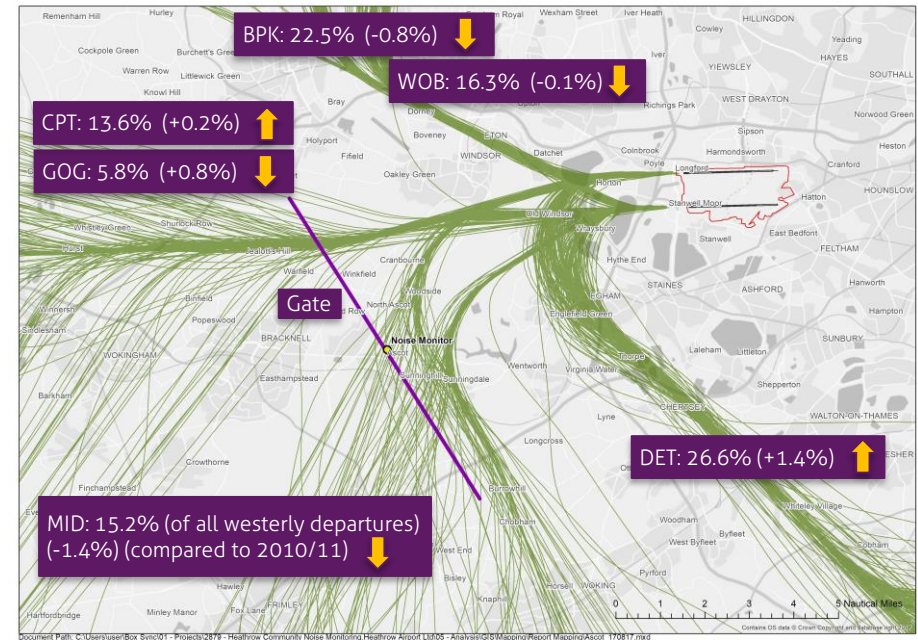
Is westerly departure route usage different between 2010/11 and 2014/15?

- The figure to the right presents the proportion of flights using each route during a typical full westerly day in the 2014/15 period compared to 2010/11. Some aircraft on the MID route are regarded as 'overhead' in the Ascot area (it is noted that aircraft that are not overhead may still be audible in this area).
- In the 2014/15 period, the proportion of westerly departures on a westerly day using the MID route decreased from 16.6% to 15.2% over the same period in 2010/11.** DET was the most commonly used westerly departure route in the 2014/15 period.

Actual numbers of aircraft and percentages of total movements in each time period

Westerly departure route	2011	2015	Number difference	% difference
BPK	14,720	15,310	590	+4%
CPT	8,494	9,274	780	+9%
DET	15,951	18,132	2,181	+14%
GOG	3,151	3,931	780	+25%
MID	10,500	10,350	-150	-1%
WOB	10,376	11,140	764	+7%
Total	63,192	68,137	4,945	+8%

- The figures presented in the table reflect a change in the proportion of aircraft using each departure route, and an increase in westerly operations during 2014/15 period compared to 2010/11.

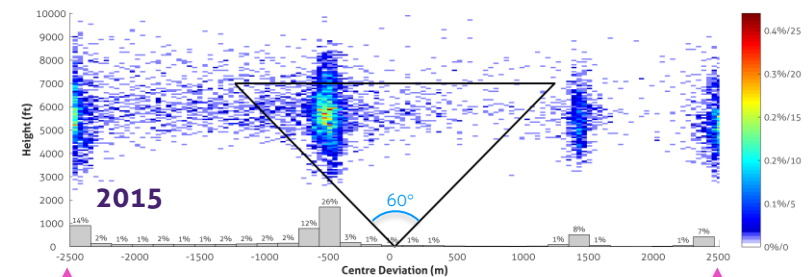
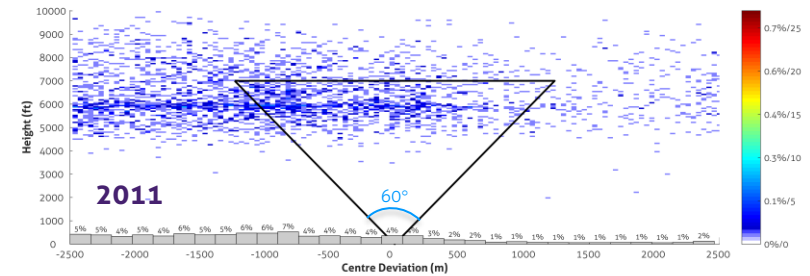


Note: More details of movements trends can be found in Heathrow's Annual Flight Performance Reports and the CAA reports at <http://www.heathrow.com/noise/facts-stats-and-reports/reports> and on the ERCD website.



Is the concentration of westerly operations different between 2010/11 and 2014/15?

- The figures to the right are 'heat maps' showing the 2D concentrations of westerly departing aircraft as they pass through the gate during the 2010/11 (the upper figure) and 2014/15 (the lower figure) monitoring period in addition to the concentration at different distances from the centre along the length of the gate shows by the grey bars.
- The scale presents the number of aircraft in the grid square (pixel). For example a "red" indicates 25 movements passing through a grid square in the gate in both figures.
- The original gate was 14km wide but for this analysis has been truncated to 5km, 2.5km either side of the noise monitor to focus on the 'overhead' flights.
- In 2010/11, aircraft were dispersed over a wide swath with more aircraft to the east of the Ascot. A concentration of flights can be seen at an altitude of 6,000ft as aircraft reach a period of level flight during their departure profiles.
- There is a distinct change in 2014/15, where the aircraft flew more concentrated routes. It should be noted that the westerly departure trial took place over this monitoring period which is responsible for the increased concentration. The main swathe of the DOKEN route from the northern runway was 500m laterally from the noise monitor.
- Noise events generated by the aircraft movements that fall within the 60° overhead cone (see page 9) shown in the lower heat map have been considered as "overhead" in the noise data analysis.

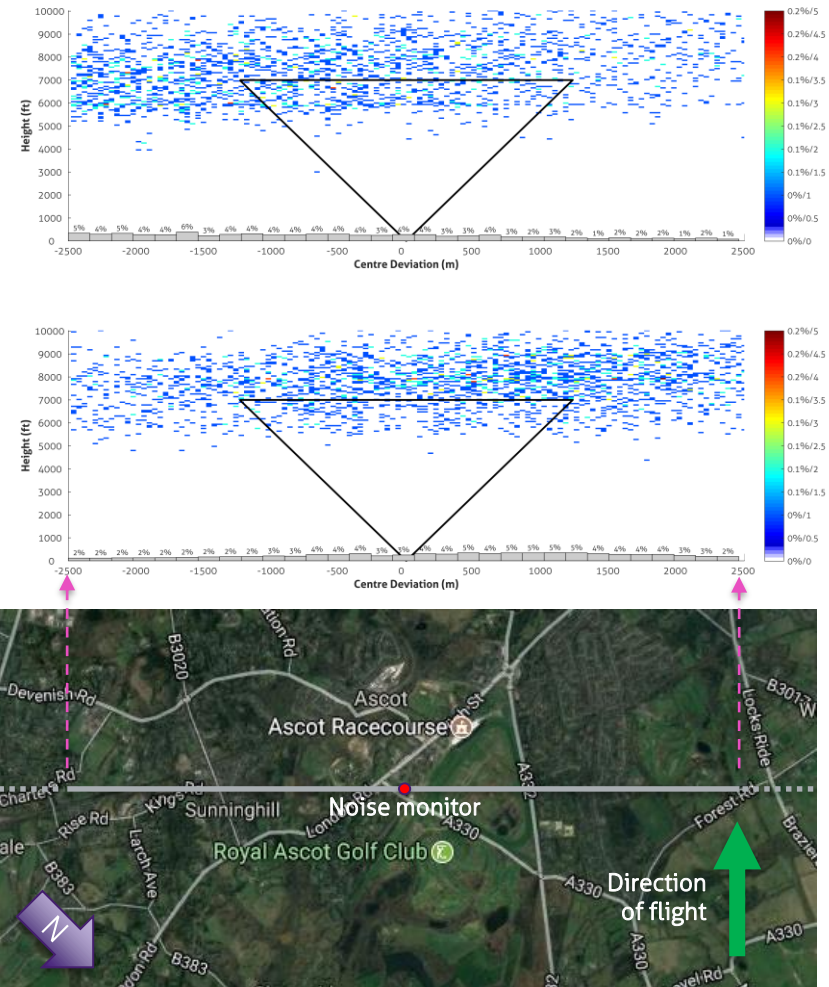


Note: The "heat maps" have been normalised to account for differences between the number of westerly departures in each of the monitoring periods. This allows the concentrations in each graph to be compared. This method does not account for any changes in daily number of movements passing through the gate - these changes are presented on Page 12. The maps are divided into grid squares, 40m horizontally by 60ft vertically.



Is the concentration of easterly operations different between 2010/11 and 2014/15?

- These figures have been designed to illustrate the degree of concentration of departing aircraft passing through the gate on easterly operations.
- The scale presents the number of aircraft in the grid square (pixel). For example a "red" indicates 5 movements passing through a grid square in the gate in both figures.
- The grey bars under the 'heat map' show the actual concentration at different distances from the centre of the gate.
- In general, in both 2010/11 and 2014/15, the aircraft are spread over a wide swathe either side of the noise monitor.
- In 2010/11, there was a slightly greater concentration of flights south of the noise monitor while in 2014/15, the greater concentration had moved north of the monitor.

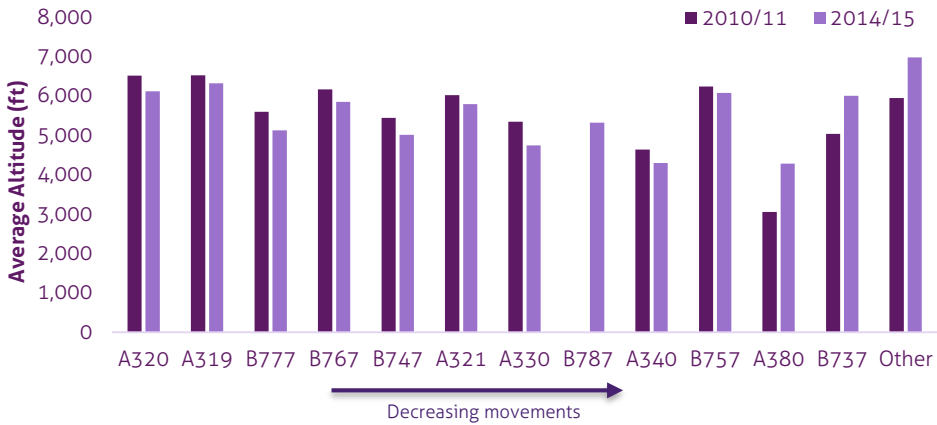
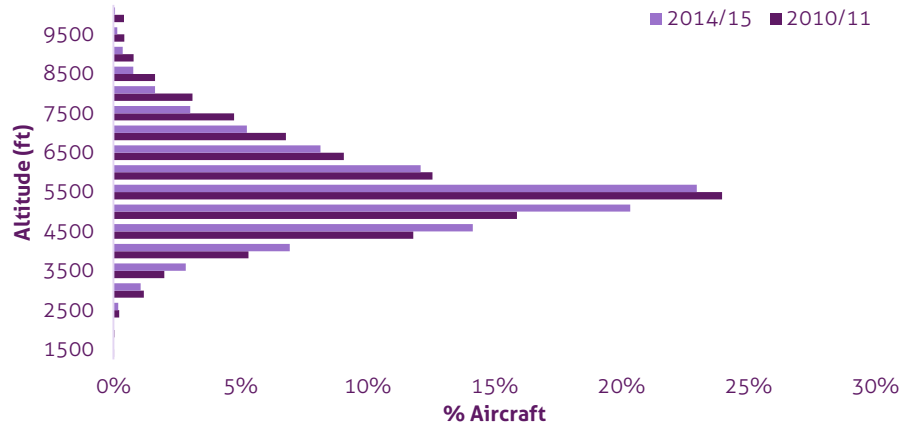


Note: The "heat maps" have been normalised to account for differences between the number of easterly departures in each of the monitoring periods. This allows the concentrations in each graph to be compared. This method does not account for any changes in daily number of movements passing through the gate - these changes are presented on Page 12. The maps are divided into grid squares, 40m horizontally by 60ft vertically.

Are aircraft heights on westerly operations different between 2010/11 and 2014/15?

- The table to the right presents the average height of departing aircraft on westerly operations as they passed through the gate in the 2010/11 and 2014/15 periods.
- This indicates that aircraft above Ascot were on average about 260ft (4%) lower in 2014/15 compared to 2010/11.**
- The figures present the distribution of these aircraft height through the gate comparing 2010/11 with 2014/15 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows that in 2010/11, there was a greater proportion of aircraft in each interval above 5,500ft, and a smaller proportion of aircraft in each interval below 5,500ft. The only exception being that in 2010/11, there were more aircraft in the 3,000-3,500ft interval.
- The lower figure shows that the average height of aircraft varies with type.
- The A380, B737 and 'other' aircraft flew higher in 2014/15 compared to 2010/11 while all others flew lower

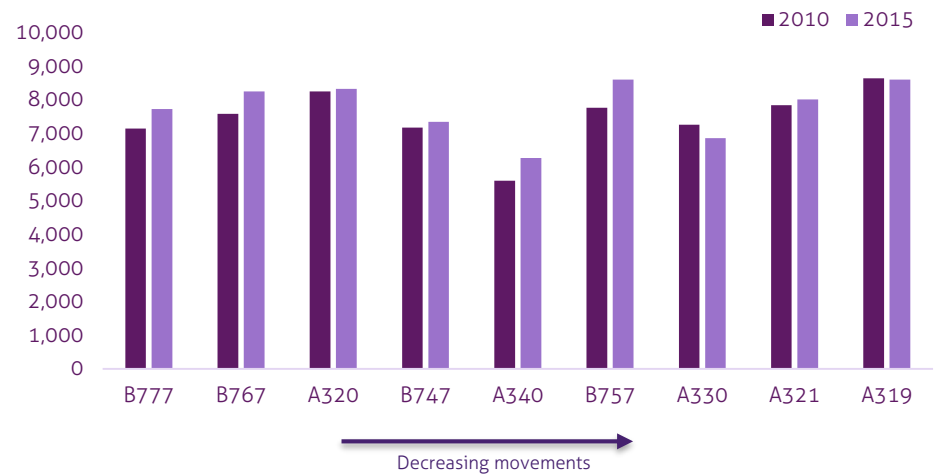
	2011	2015	Difference
Average height of departures through gate	5,944ft	5,683ft	-261ft



Are aircraft heights on easterly operations different between 2010/11 and 2014/15?

- The table to the right presents the average height of departing aircraft on easterly operations as they passed through the gate in the 2010/11 and 2014/15 periods.
- **This indicates that aircraft above Ascot were on average about 420ft (6%) higher in 2014/15 compared to 2010/11.**
- The figures present the distribution of these aircraft height through the gate comparing 2010/11 with 2014/15 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows that the main concentration of flights was between 5,500 and 6,000ft in 2010/11, this increased to between 7,500ft and 8,000ft in 2014/15. There were also fewer aircraft at the lowest altitudes (<5,000ft) in the 2014/15 compared to 2010/11.
- The lower figure shows that the average height of aircraft varies with type.
- All aircraft types flew higher in 2014/15 compared to 2010/11 with the exception of the A330 and A319.

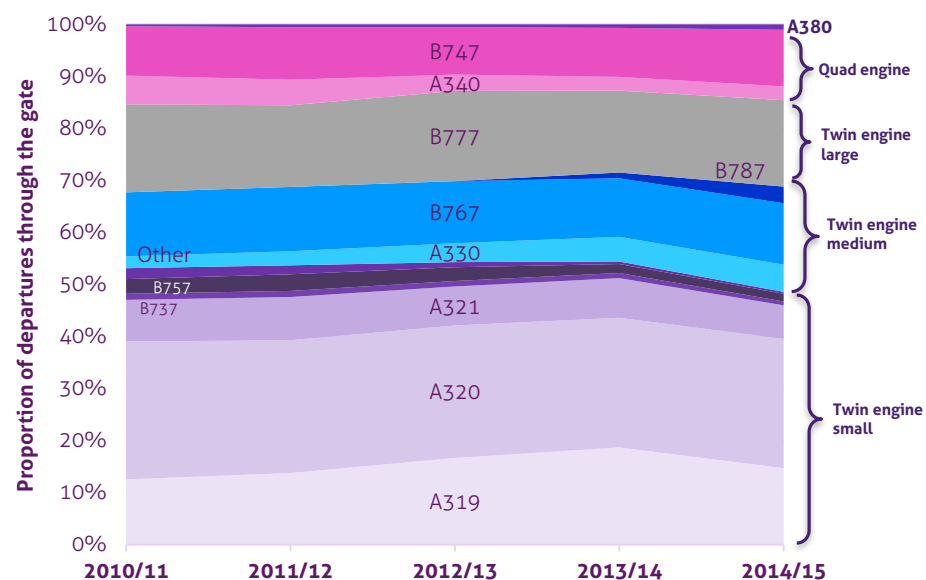
	2011	2015	Difference
Average height of departures through westerly gate	7,419ft	7,838ft	+419ft



Is the fleet mix different between 2010/11 and 2014/15?

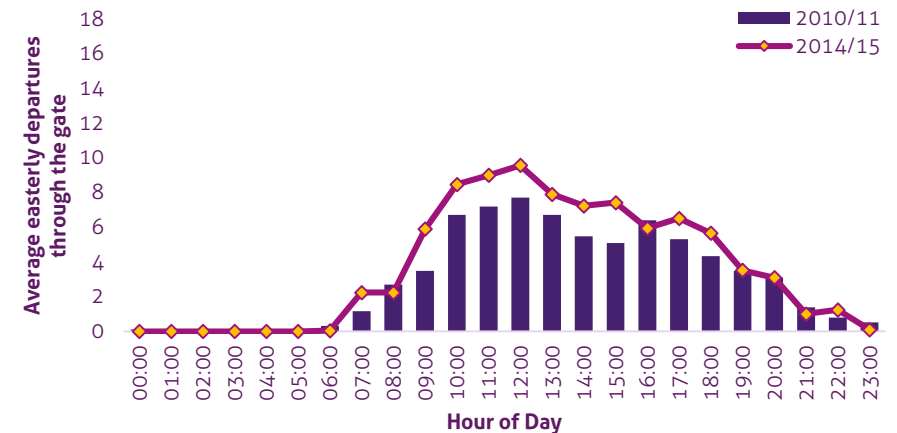
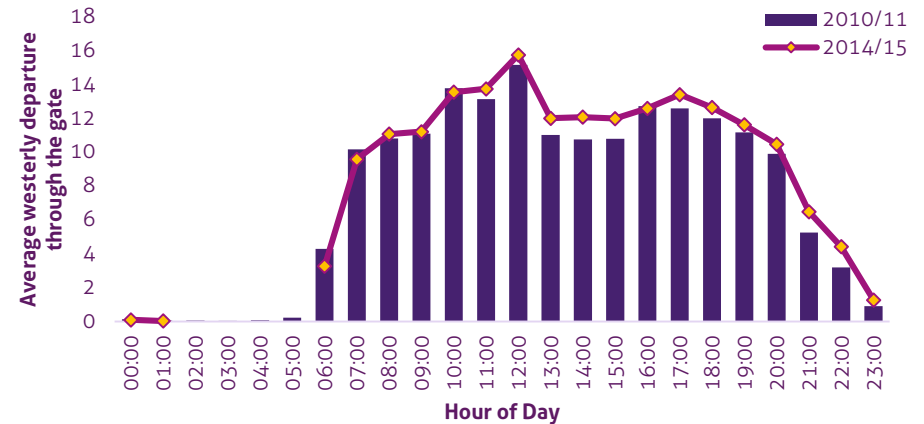
- The table to the right presents the mix of departing aircraft that passed through the gate and overall at Heathrow in the 2010/11 and 2014/15 periods.
- For simplicity the fleet mix has been split in to 5 groups:
 - the A380
 - quad (four) engine aircraft (including B747, A340),
 - twin engine large aircraft (B777, A350 (not in regular service in 2014/15))
 - twin engine medium aircraft (B767, B787, A330) and
 - twin engine small aircraft (B737, A320 family).
- Previous slides indicated that the number of departing aircraft flying through the gate on an average day of full westerly operations by 5% from 2010/11 to 2014/15
- The analysis on this page indicates that there is a smaller proportion of the smaller aircraft passing through the gate compared to Heathrow traffic as a whole with the small twin engine aircraft accounted for around 50% of departures through the gate.
- The main change in fleet mix has been a shift from small to medium sized twin aircraft.
- The figure provides a more detailed picture of how the fleet mix has changed across the period. The aircraft categories used in this report are distinguished by the different colour schemes.
- Although there are year to year fluctuations, there have not been large changes to the fleet mix although the A380 and B787 have entered service over this period.

Fleet mix				
Category	Passing through gate		All LHR	
	2011	2015	2011	2015
A380	0.3%	1.0%	0.9%	3.1%
Quad engine	15.0%	13.5%	11.8%	7.2%
Twin engine large	16.9%	16.6%	12.1%	13.3%
Twin engine medium	14.5%	20.3%	9.3%	12.9%
Twin engine small	53.2%	48.6%	65.9%	63.4%



Does the number of flights over the area vary across the day? Is there a difference between 2010/11 and 2014/15?

- The figures to the right present the average number of departures through the gate per hour in 2010/11 and 2014/15 during days of 100% westerly and easterly operations.
- The figure shows that the distribution of departing aircraft passing through the westerly gate peaks at around midday with up to about 16 flights per hour.
- The distribution of the flights across the day did not change significantly between 2010/11 and 2014/15, although the 5% increase in traffic through the gate on westerly operations generally occurred after 13:00.
- The analysis indicates that on average, on a day of full westerly operations, there were around on average around one delayed departures between 23:00 and 00:00 that pass through the gate.
- On easterly operations, the traffic through the gate also peaks at around midday. The increase in traffic highlighted on page 13 is generally spread across the hours 07:00-19:00.
- In both years, out of a total of 147 days, 84 (57%) were on 100% westerly operations.



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Noise monitoring overview.

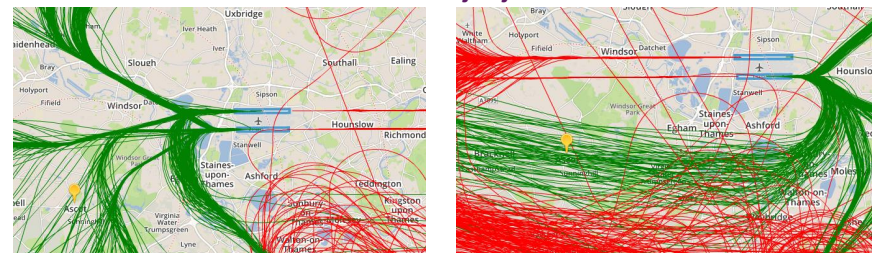
Monitoring location, duration and setup

- A temporary noise monitor was installed on the grounds of Ascot Racecourse between 24/09/2014 and 17/02/2015.
- The monitor was set up to record noise events based on a threshold sound pressure level of 62 dBA being exceeded for more than 20 seconds.
- The location of the noise monitor is shown in the figures to the right. The position is under a number of westerly departures on the MID route and on CPT for easterly departures from 09R.
- The close up map shows the position of the noise monitor. The noise monitor is approximately 35m from an A-road and 100m from the edge of a residential area, both of which could be sources of noise.

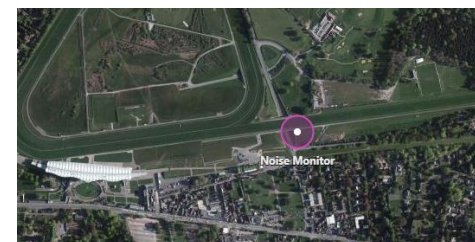
Noise event summary

- A total of 37,460 noise events were measured during the monitoring period. Of these, less than 10% were correlated to aircraft using Heathrow and 90% were from non-aircraft sources. Around 700 events were registered from aircraft not using Heathrow.
- As the following pages will demonstrate, many of these noise events that were correlated to aircraft movements were contaminated due to other noise sources in the proximity of the noise monitor and therefore, it has not been possible to fully analyse the noise event data in the same manner as the Community Noise Information reports for other areas.

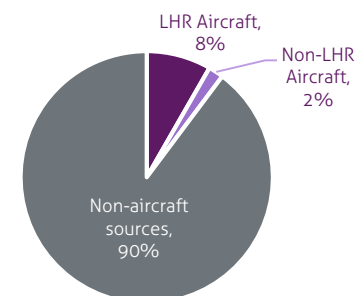
Noise preferential routes, monitor position and flight tracks on typical westerly and easterly day



Close-up of monitor position

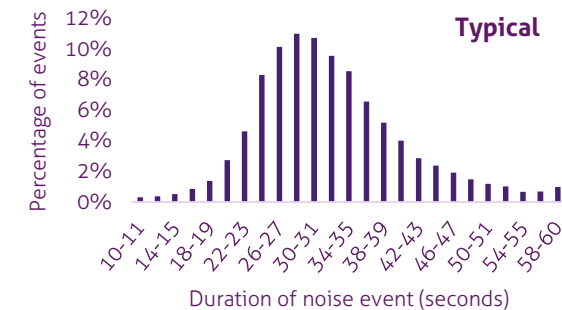
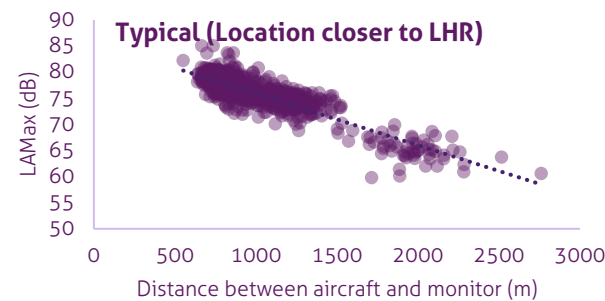
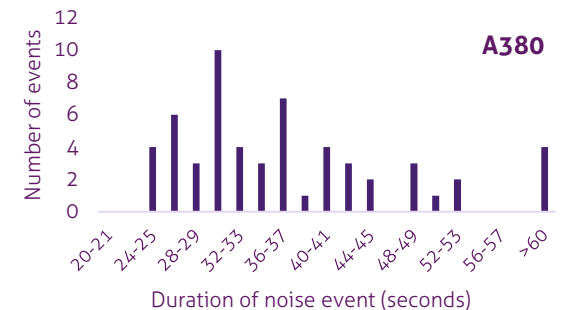
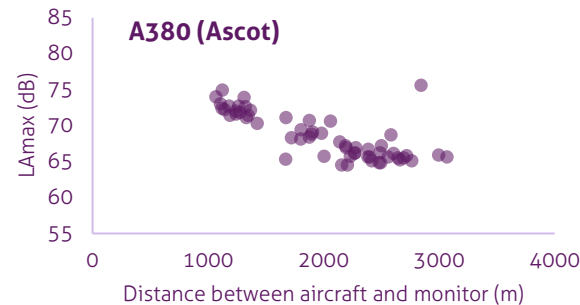
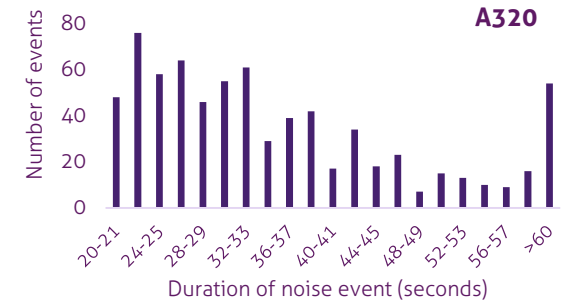
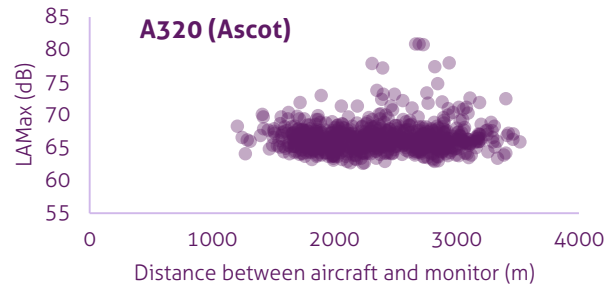


Measured Noise Events



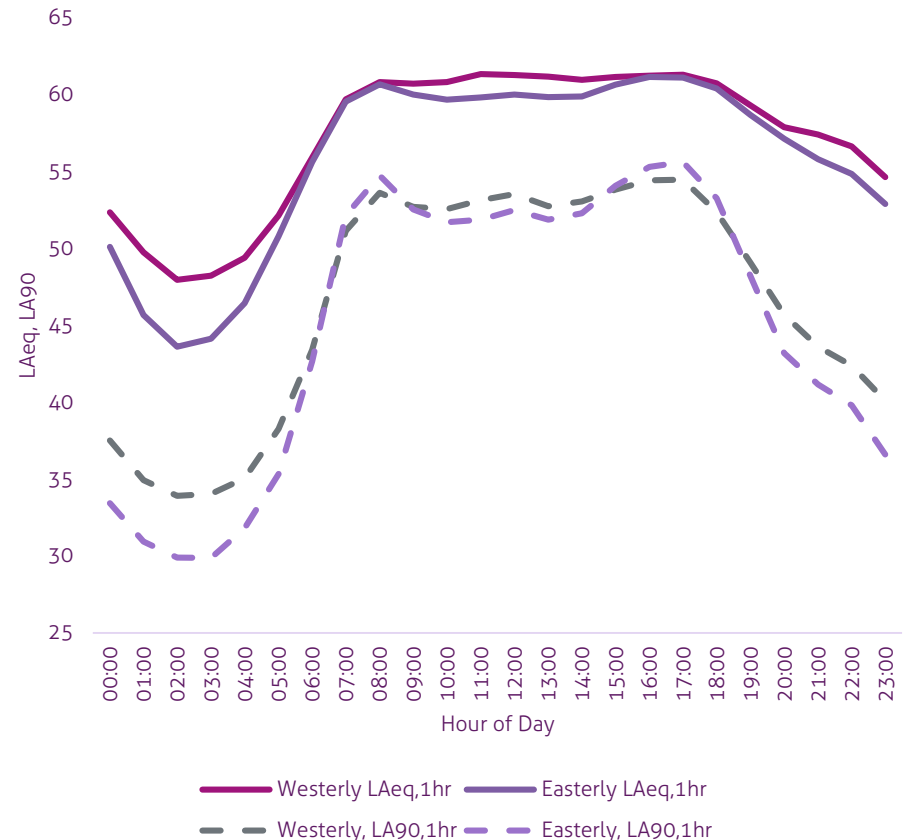
Analysis of aircraft noise events

- An analysis of noise events for following two aircraft types are shown on this page;
 - A320 - highest proportion of traffic at Heathrow
 - A380 – largest aircraft operating at Heathrow
- The left hand figures shows the relationship between the maximum level of an aircraft noise event and the distance from the noise monitor to aircraft. The top two figures show the relationship for the two aircraft types at Ascot whilst the bottom figure shows the relationship at a position closer to the airport where aircraft noise is dominant. Given the noise levels do not decrease with distance for the most common aircraft at Ascot this suggests the correlated noise events are contaminated by other noise sources.
- Further evidence that the aircraft noise events are contaminated by other noise sources is shown by the distribution of noise event durations in the right hand column. since aircraft travel at roughly similar speeds, the duration of an aircraft noise event is quite predictable usually lasting between 20 and 50 seconds. The top two figures show , a significant number of noise events exceeded 60 seconds in duration suggesting aircraft noise is corrupted by other noise sources since the level continues to exceed the monitor threshold once the aircraft has passed the monitor (assuming aircraft noise triggered the event initially).



What are overall ambient noise levels across the day on easterly and westerly operations?

- The figure to the right shows the average (arithmetic mean) hourly $L_{Aeq,1hr}$ and $L_{A90,1hr}$ on days where 100% of operations were either westerly or easterly. It should be noted that these metrics describe the overall noise environment including all noise sources, not just aircraft noise.
- During days of full westerly operations daytime $L_{Aeq,1hr}$ values between 07:00 and 20:00 are generally 60-61dB then decreases into the evening.
- In the morning and evening periods, the easterly and westerly average $L_{Aeq,1hr}$ values are similar. At around midday, the westerly days are up to 1.5dB louder corresponding with a peak in traffic shown on page 20.
- Given the measured $L_{Aeq,16hr}$ is almost 15dB greater than the modelled value (Page 27) which only takes into account aircraft noise, it would further confirm that other sources dominate the noise environment at the monitor location.
- On westerly operations, the background noise ($L_{A90,1hr}$) is up to 5dB higher than during easterly operations.



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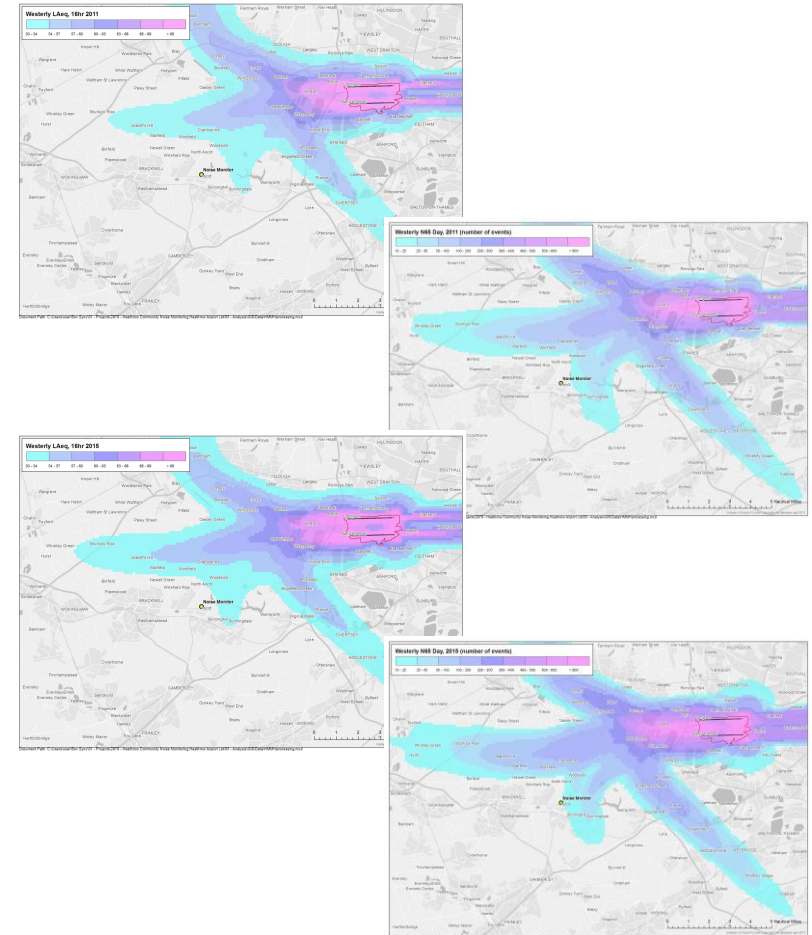
7

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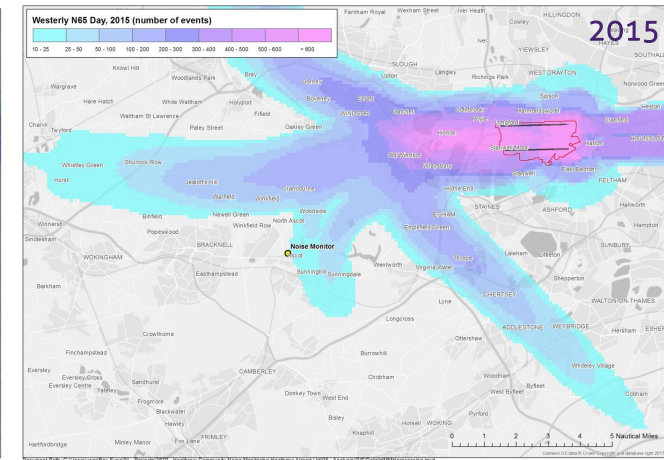
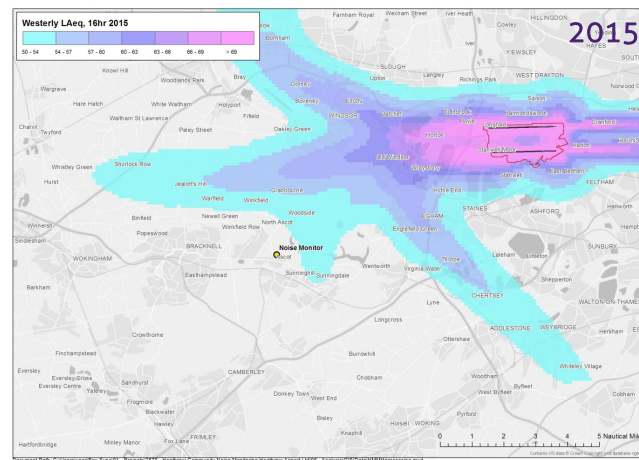
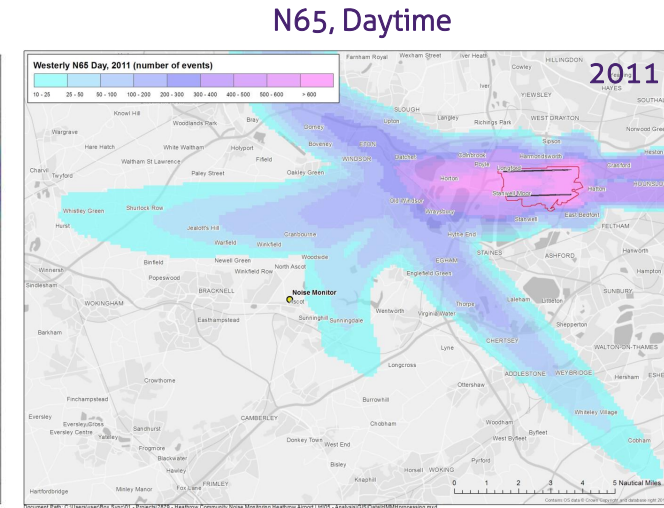
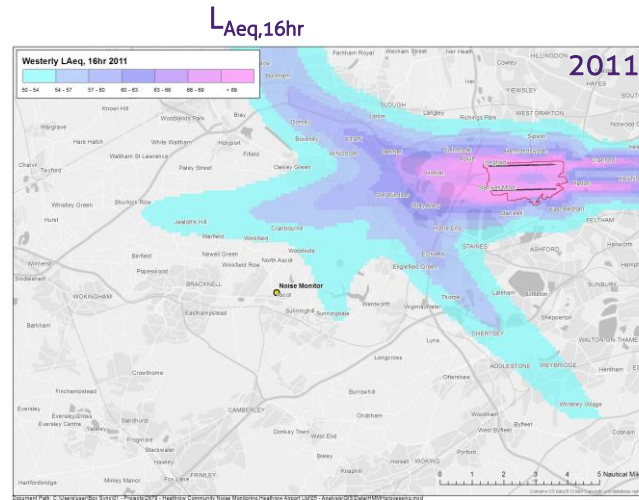
Comparing longer term average daytime ($L_{Aeq, 16hr}/N65$) and night-time ($L_{Aeq, 8hr}/N60$) aircraft noise levels around the airport using modelling.

- While a noise monitor can provide an in-depth picture of the noise environment at a specific location, the data cannot be used to provide an understanding of the noise environment over a wider geographical area.
- The Heathrow INM model has been run using flight track data for **2011 and 2015** to investigate whether there are any differences in daytime ($L_{Aeq, 16hr}/N65$) and night-time ($L_{Aeq, 8hr}/N60$) for an **average day and night of westerly and easterly operations** across the summer in each of these years.
- Note that these contours are specific to westerly and easterly operations respectively and are not the same as the traditional annual contours which derive an overall average for the summer that combines westerly and easterly operations. They only use days when there were full westerly or easterly operations across that day.
- Daytime $L_{Aeq, 16hr}$ values are presented in bands >50 dB, > 54dB and then in 3 dB increments to 69 dB.
- Night-time $L_{Aeq, 8hr}$ values are presented in 5dB bands starting at >40 dB to 65 dB.
- These are longer terms metrics averaged over 16 and 8hrs and do not directly reflect the shorter term fluctuations between individual events.
- It should be noted that aircraft noise modelling to levels around 50 dB carries increasing uncertainty in the result. In areas where aircraft noise levels are in this range it should be noted that many non aircraft noise sources may be of similar (or even higher) levels. Interpretation of the modelled results at this noise level should bear this mind.



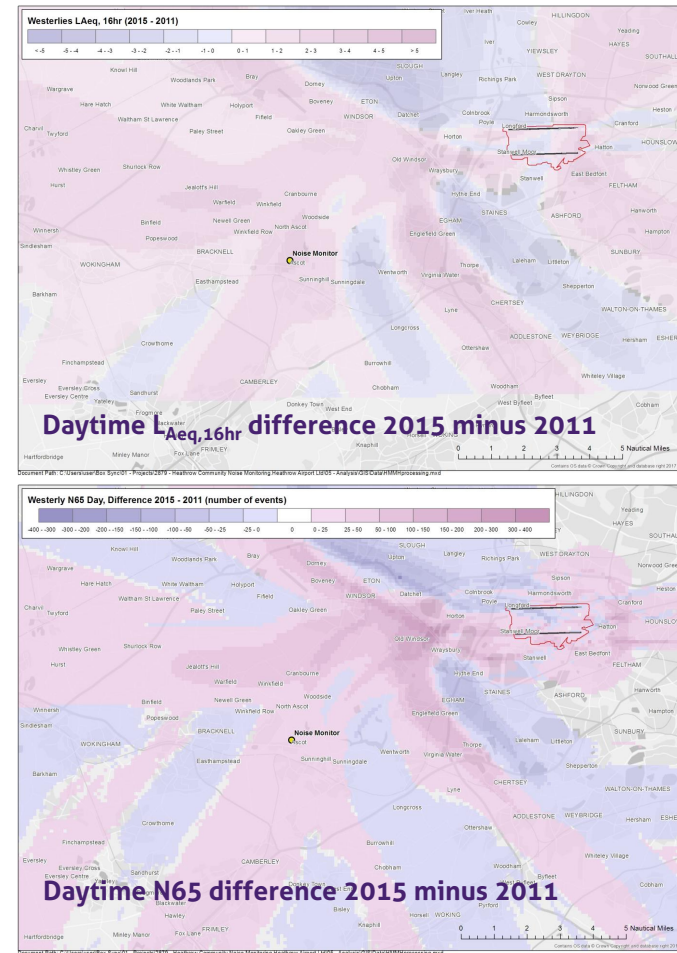
Modelled average westerly daytime $L_{Aeq,16\text{hr}}$ and N65 aircraft noise levels

- The figures to the right show the 2011 and 2015 daytime $L_{Aeq,16\text{hr}}$ bands in the left column and N65 bands in the right column for **an average westerly summer day when the airport is on 100% westerly operations**.
- The position of the noise monitor is marked by the yellow dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dBa over the 16 hour day period between 7am and 11pm.
- Larger figures are shown in Appendix A.



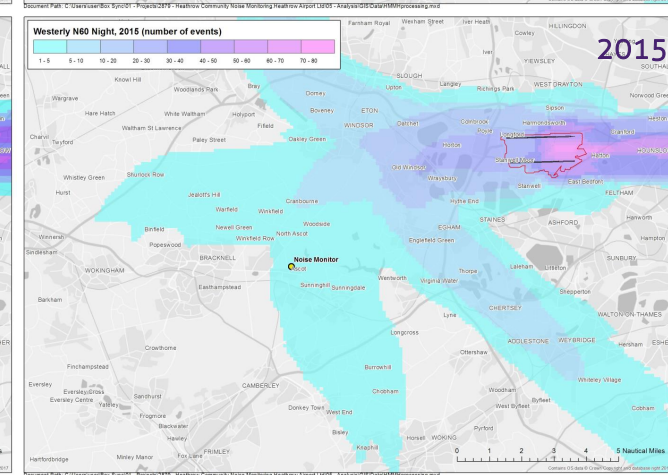
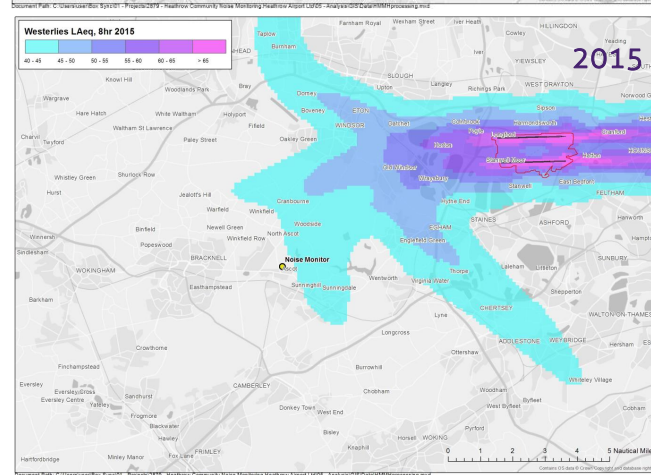
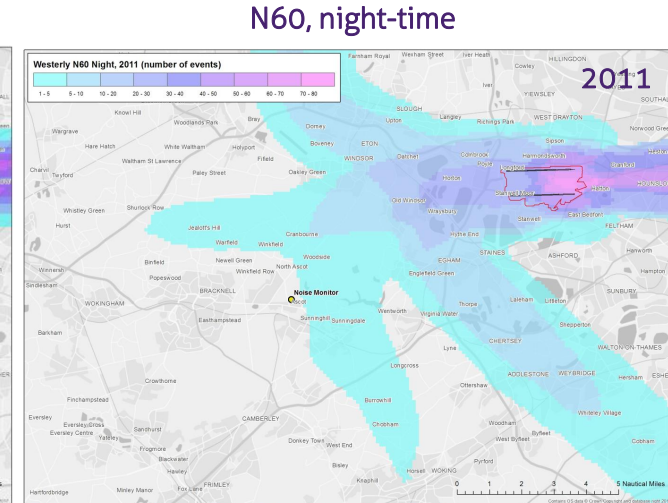
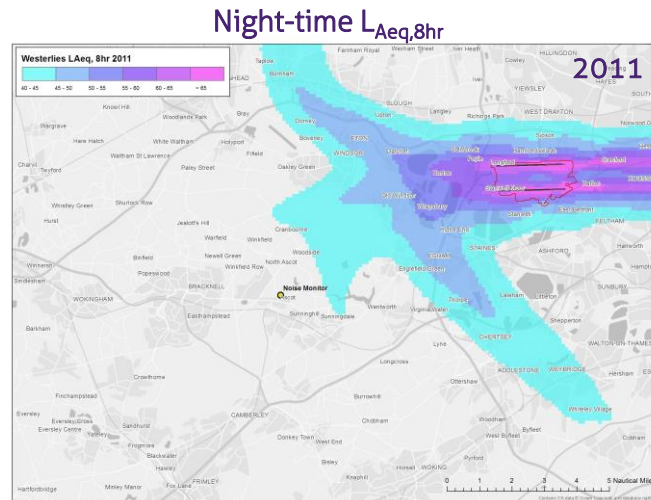
Modelled westerly daytime $L_{Aeq,16hr}$ and $N65_{(16hr)}$ differences

- The difference in the modelled average $L_{Aeq,16hr}$ and $N65_{16hr}$ contours around Heathrow between 2011 and 2015 are shown in the figures to the right. This is for **an average westerly summer day when the airport is on 100% westerly operations**
- The upper image shows the change in daytime $L_{Aeq,16hr}$ and the bottom image shows the change in daytime $N65_{16hr}$. Areas with a decrease in average exposure are shown in blue and those areas with an increase in average exposure shown in pink.
- At Ascot there was between around a 2-3dB increase in average modelled daytime noise level $L_{Aeq,16hr}$ between 2011 and 2015.
- The modelling indicates an increase of up to 25 daytime $N65$ events.
- It should be noted that, all other variables remaining constant, a difference in 15% of noise events, would correspond to about a 1dB increase/decrease in $L_{Aeq,16hr}$ and a doubling of noise events would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.
- Larger figures are shown in Appendix A.



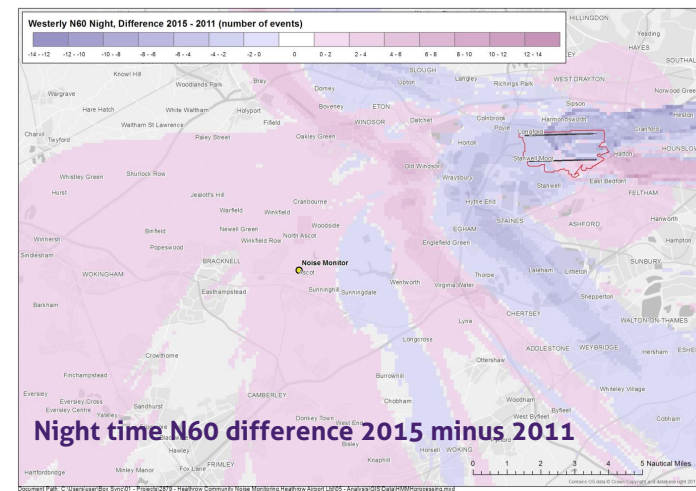
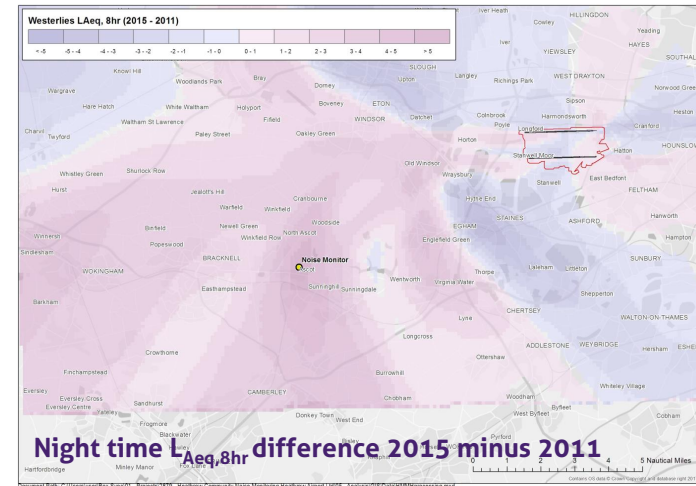
Modelled average westerly night time $L_{Aeq,8hr}$ and N60 aircraft noise levels.

- The figures to the right show the 2011 and 2015 night-time $L_{Aeq,8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on an average westerly summer night between 11pm and 7am when there are 100% westerly operations. Generated from **an average westerly summer day when the airport is on 100% westerly operations**
- The $L_{Aeq,8hr}$ contours are presented in 5dB intervals from >40 to > 65dB.
- The N60 is defined here as the number of aircraft noise events that exceed 60dB(A) over the 8 hour night period between 11pm and 7am.
- The figures to the right shows the average $N60_{8hr}$ values for 2011 and 2015 from 1 up to greater than 80 when the airport is on westerly operations.
- Larger figures are shown in Appendix A.



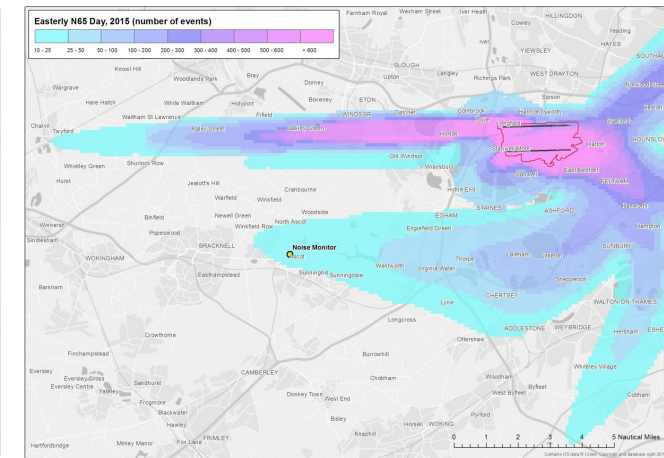
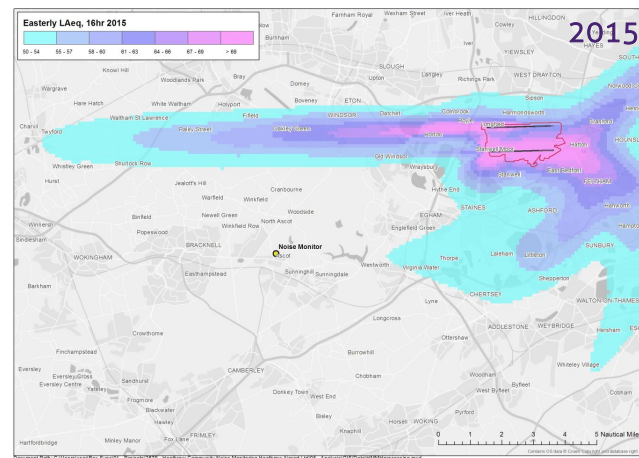
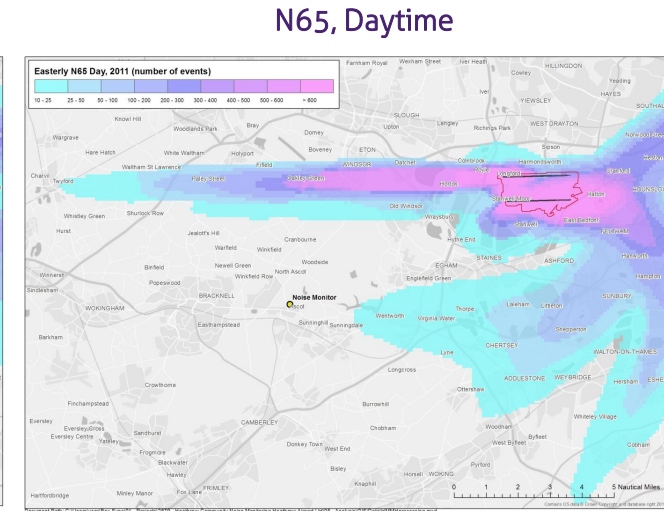
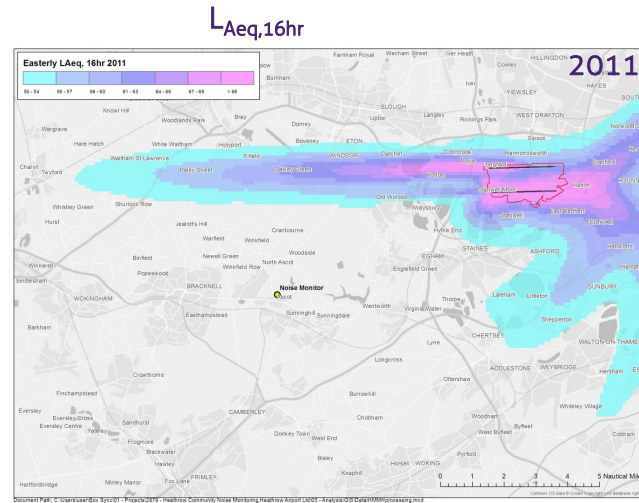
Modelled westerly night-time $L_{Aeq,8hr}$ and N60 differences - 2011 to 2015

- The difference in the modelled average $L_{Aeq,8hr}$ (upper figure) and $N60_{(8hr)}$ (lower figure) values **on 100% westerly operations** around Heathrow between 2011 and 2015 are shown in the figures to the right.
- Areas with an average decrease are shown in blue and those areas with an average increase in pink.
- At Ascot, there was about a 4dB increase in the $L_{Aeq,8hr}$ from 34 to 38dB but it should be noted the number of events above 60dBA was very low initially increasing from less than 1 to 2.
- Larger figures are shown in Appendix A.



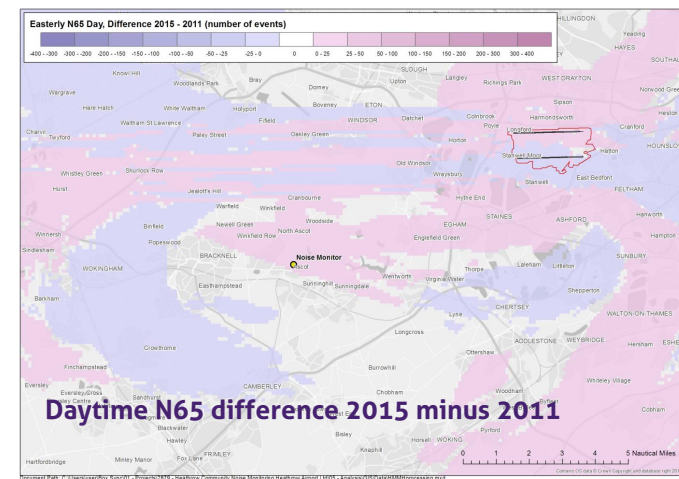
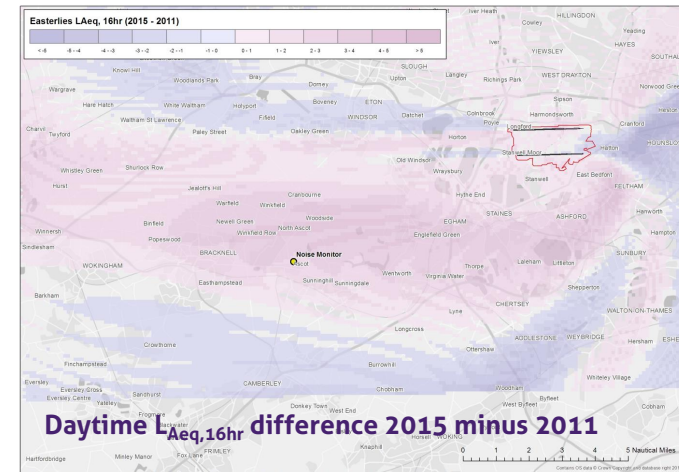
Modelled average easterly daytime $L_{Aeq,16\text{ hour}}$ and N65 aircraft noise levels

- The figures to the right show the 2011 and 2015 daytime $L_{Aeq,16\text{ hr}}$ bands in the left column and N65 bands in the right column for **an average easterly summer day when the airport is on 100% easterly operations**.
- The position of the noise monitor is marked by the yellow dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dBA over the 16 hour day period between 7am and 11pm.
- Larger figures are shown in Appendix A.



Modelled easterly daytime $L_{Aeq, 16\text{hr}}$ and $N_{65(16\text{hr})}$ differences

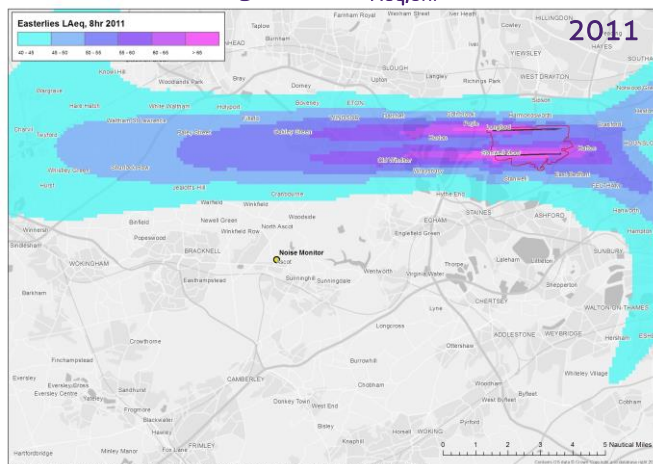
- The difference in the modelled average $L_{Aeq, 16\text{hr}}$ and $N_{65(16\text{hr})}$ contours around Heathrow between 2011 and 2015 are shown in the figures to the right. This is for **an average easterly summer day when the airport is on 100% easterly operations**
- The upper image shows the change in daytime $L_{Aeq, 16\text{hr}}$ and the bottom image shows the change in daytime $N_{65(16\text{hr})}$. Areas with a decrease in average exposure are shown in blue and those areas with an increase in average exposure shown in pink.
- At Ascot there was around a 1-2dB increase in average modelled daytime noise level $L_{Aeq, 16\text{hr}}$ between 2011 and 2015.
- The modelling also indicates a small increase of daytime N_{65} events.
- It should be noted that, all other variables remaining constant, a difference in 15% of noise events, would correspond to about a 1dB increase/decrease in $L_{Aeq, 16\text{hr}}$ and a doubling of noise events would correspond to about a 3dB increase/decrease in $L_{Aeq, 16\text{hr}}$
- Larger figures are shown in Appendix A.



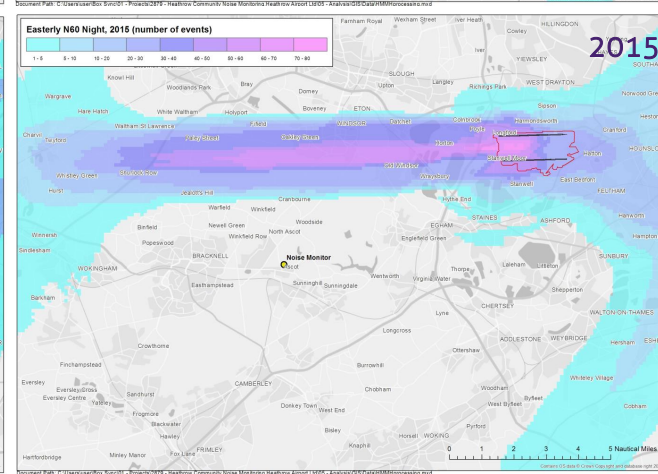
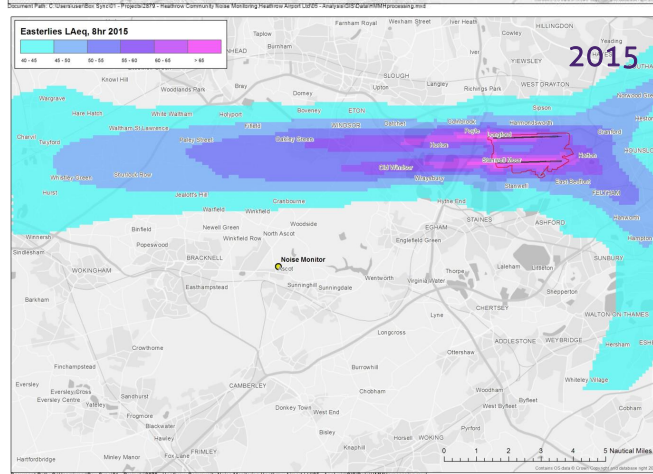
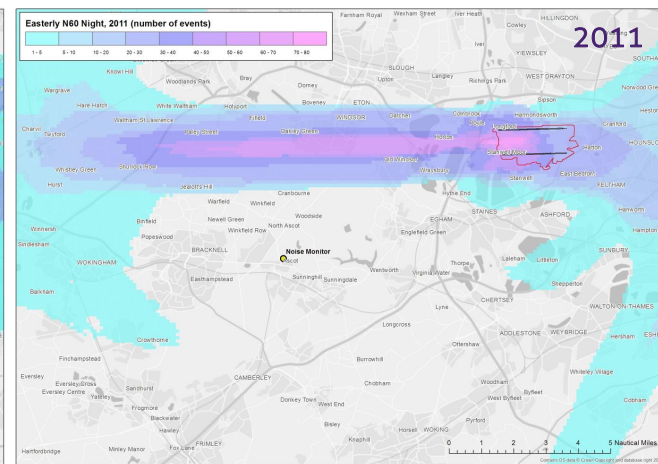
Modelled average easterly night time $L_{Aeq,8hr}$ and N60 aircraft noise levels.

- The figures to the right show the 2011 and 2015 night-time $L_{Aeq,8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on an average easterly summer night between 11pm and 7am when there are 100% easterly operations. Generated from **an average easterly summer day when the airport is on 100% easterly operations**
- The $L_{Aeq,8hr}$ contours are presented in 5dB intervals from >40 to > 65dB.
- The N60 is defined here as the number of aircraft noise events that exceed 60dBa over the 8 hour night period between 11pm and 7am.
- The figures to the right shows the average $N60_{8hr}$ values for 2011 and 2015 from 1 up to greater than 80 when the airport is on easterly operations.
- Larger figures are shown in Appendix A.

Night-time $L_{Aeq,8hr}$

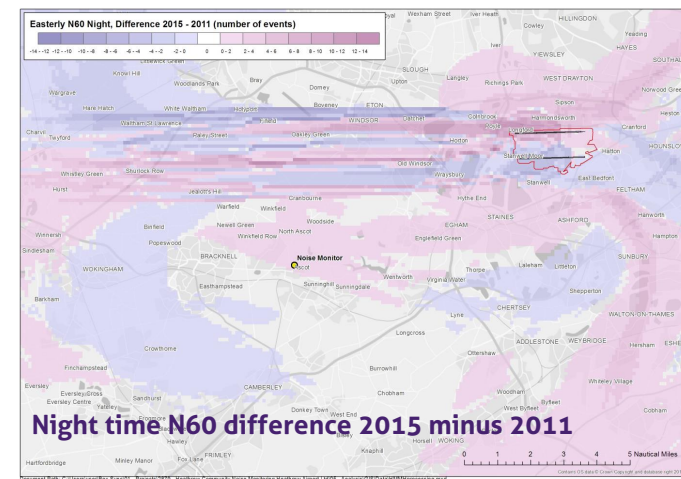
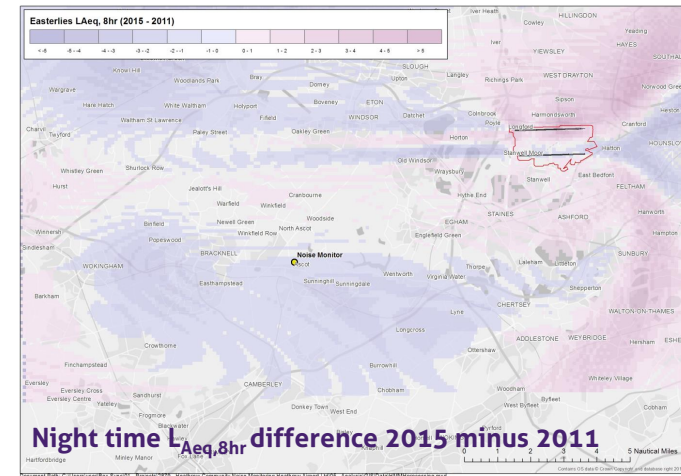


N60, night-time



Modelled average easterly night-time $L_{Aeq,8hr}$ and N60 differences

- The difference in the modelled average $L_{Aeq,8hr}$ (upper figure) and $N60_{(8hr)}$ (lower figure) values **on 100% easterly operations** around Heathrow between 2011 and 2015 are shown in the figures to the right.
- Areas with an average decrease are shown in blue and those areas with an average increase in pink.
- The results indicate a small decrease in the average night-time aircraft noise ($L_{Aeq,8hr}$) and a small increase in the number of events (N60) between 2011 and 2015.
- Larger figures are shown in Appendix A.



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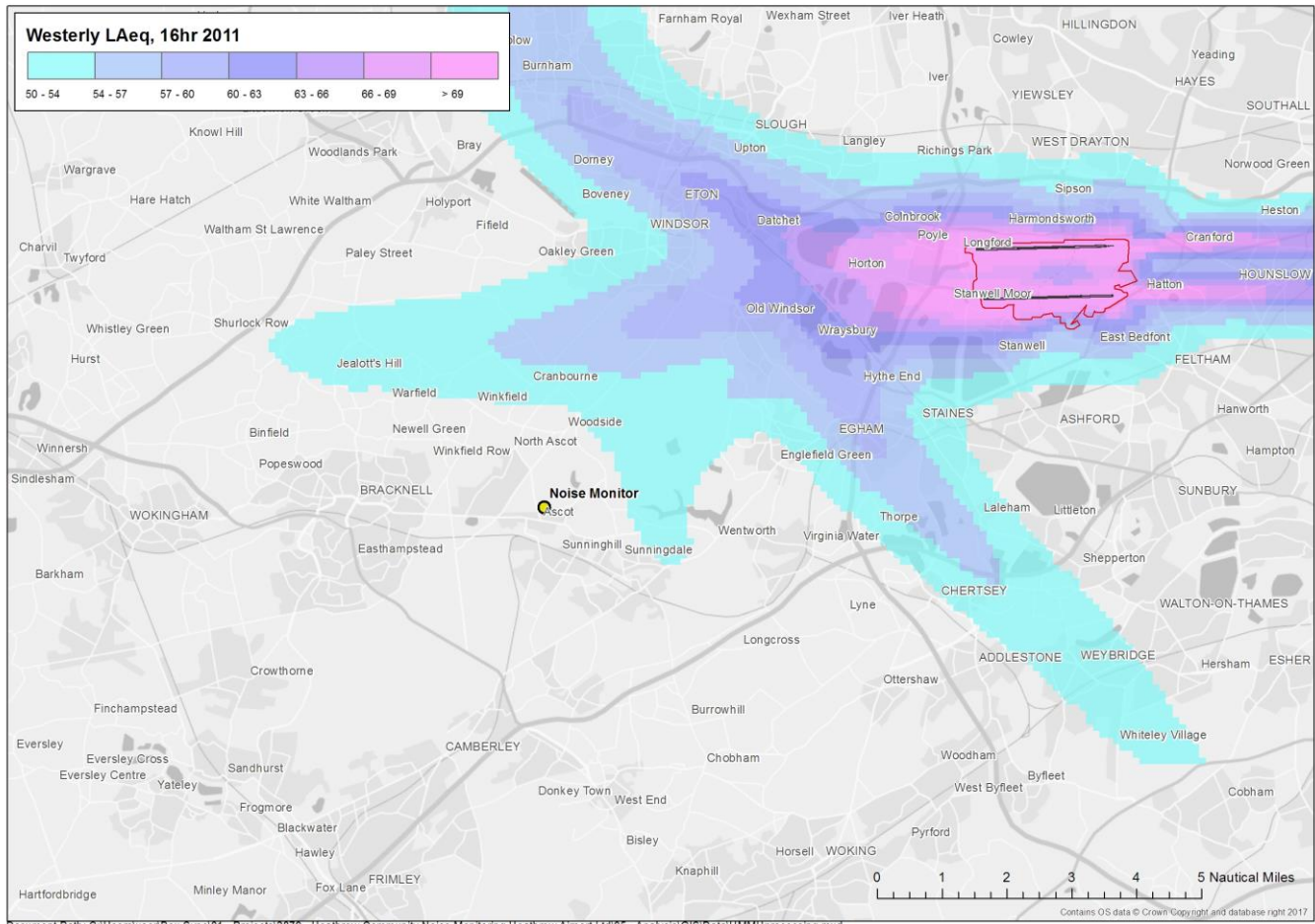
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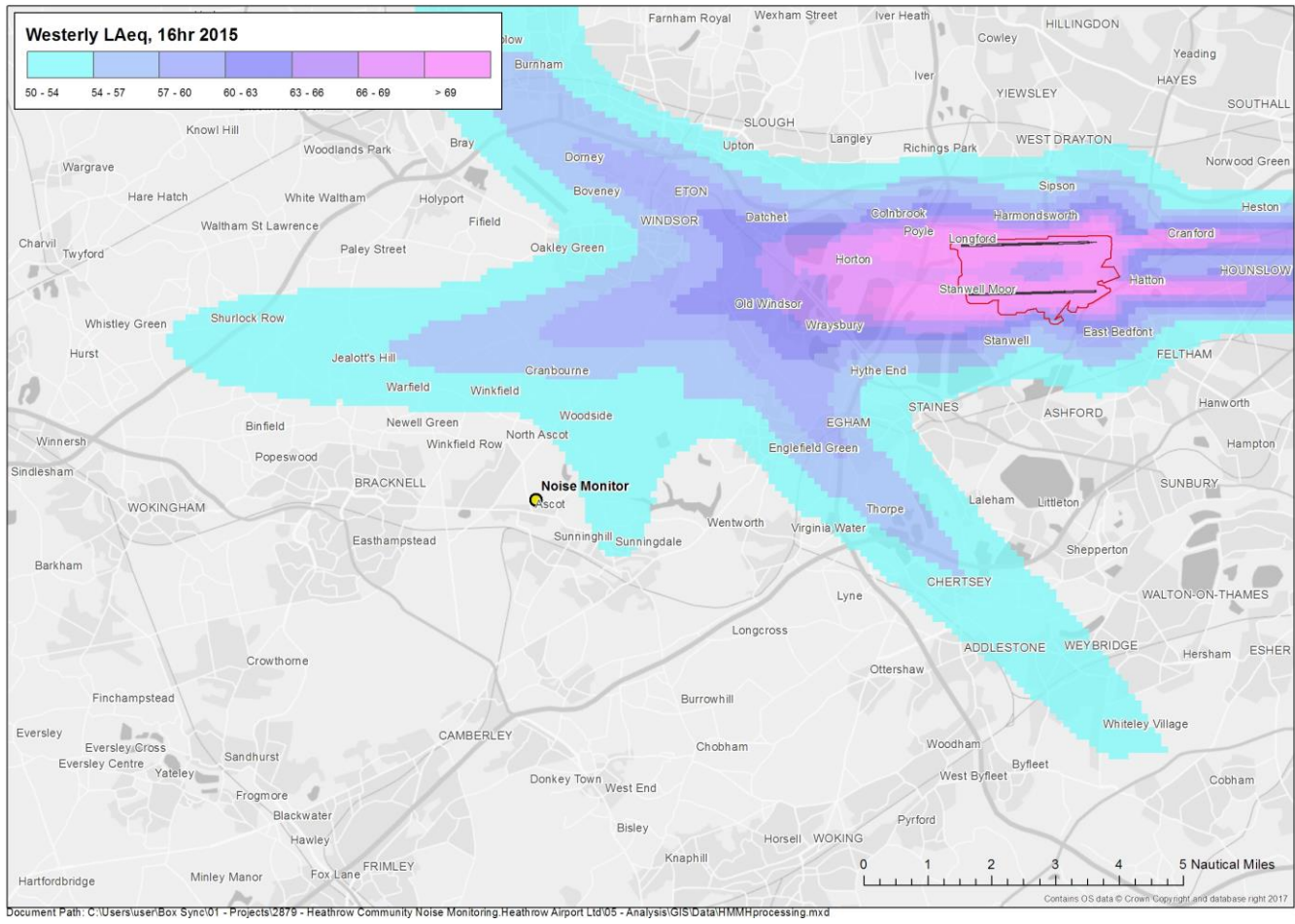
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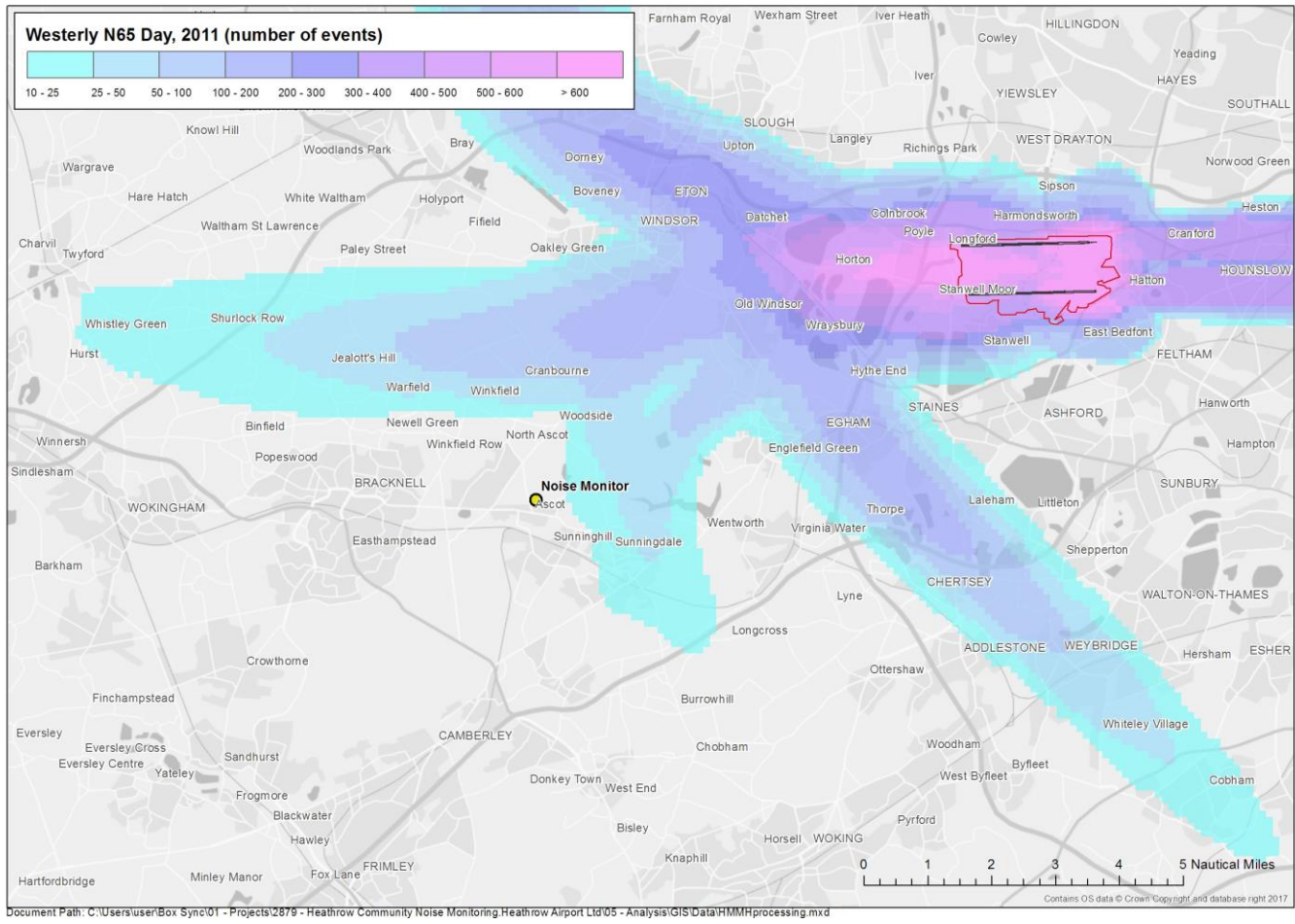
Appendix A: Average westerly day $L_{Aeq,16hr}$ contours (2011)



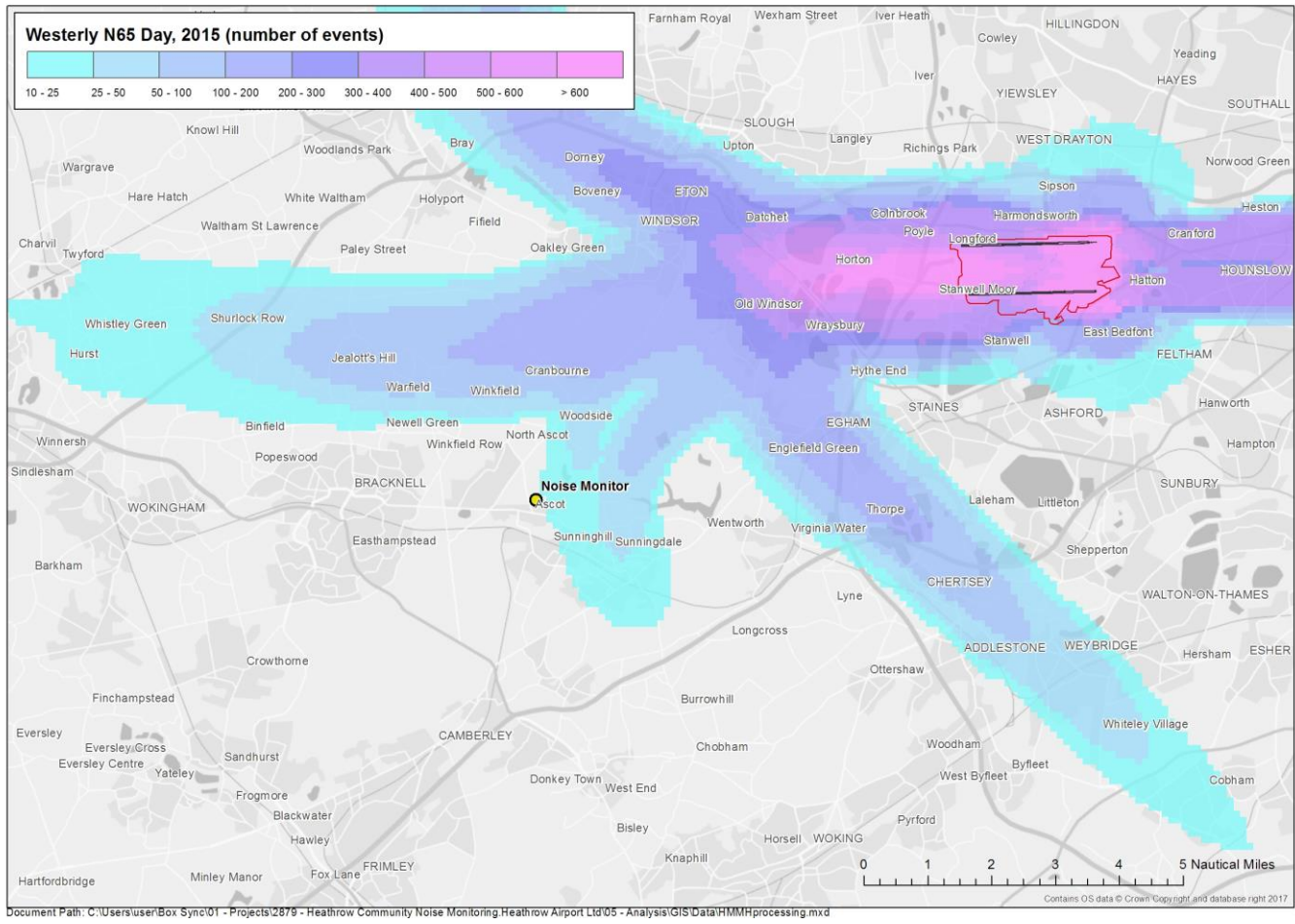
Appendix A: Average westerly day $L_{Aeq, 16hr}$ contours (2015)



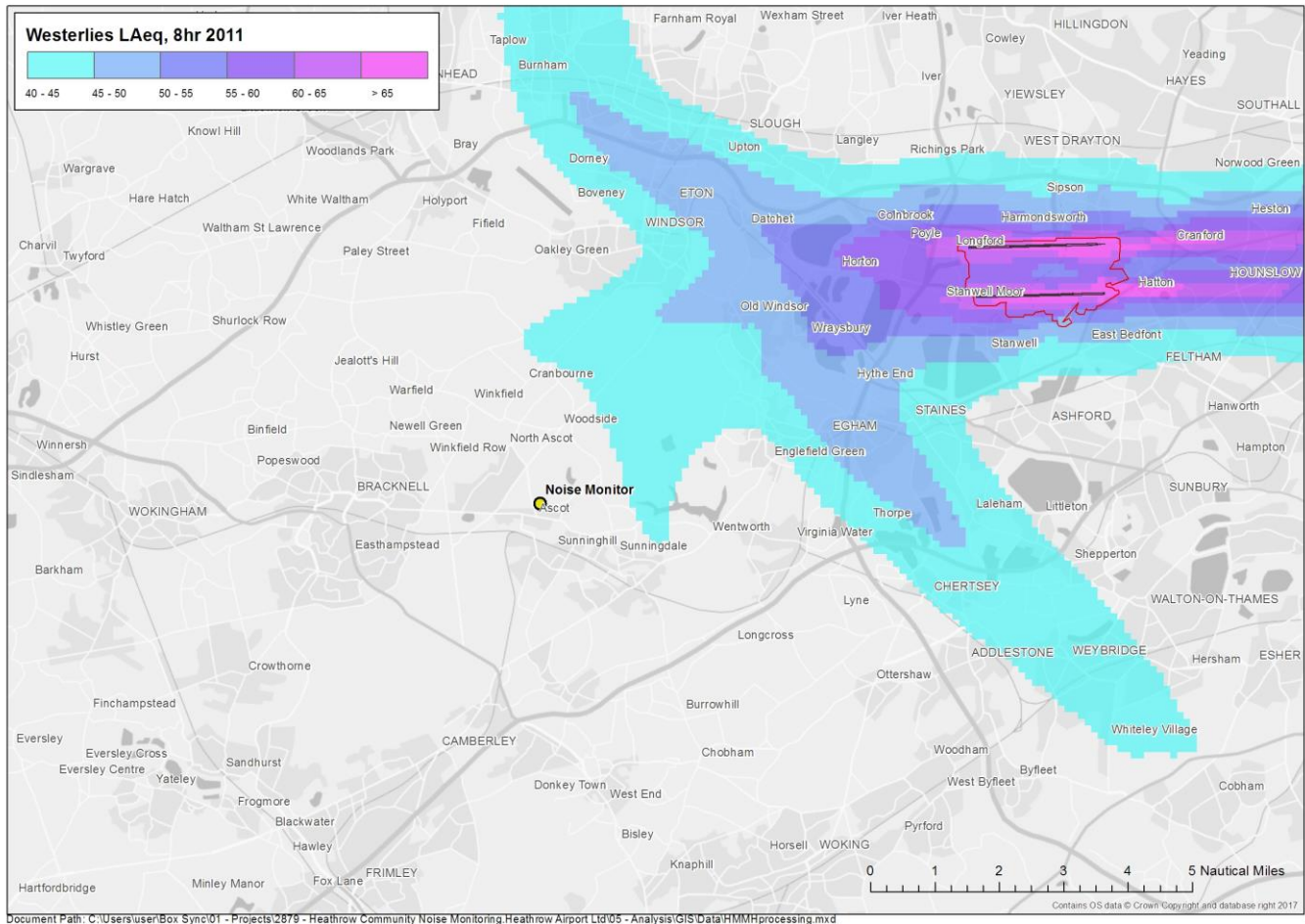
Appendix A: Average westerly day N65_{16hr} contours (2011)



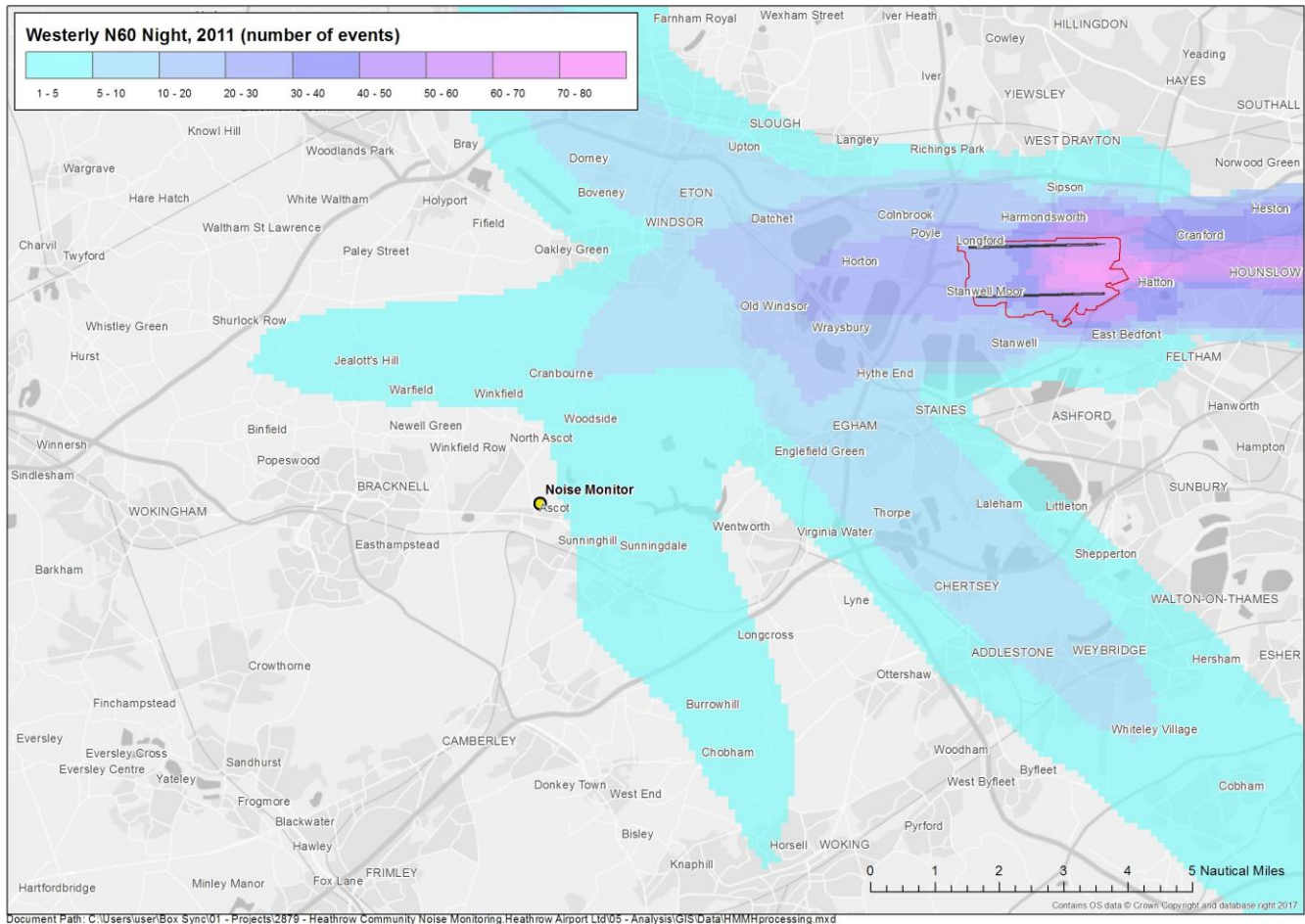
Appendix A: Average westerly day N65_{16hr} contours (2015)



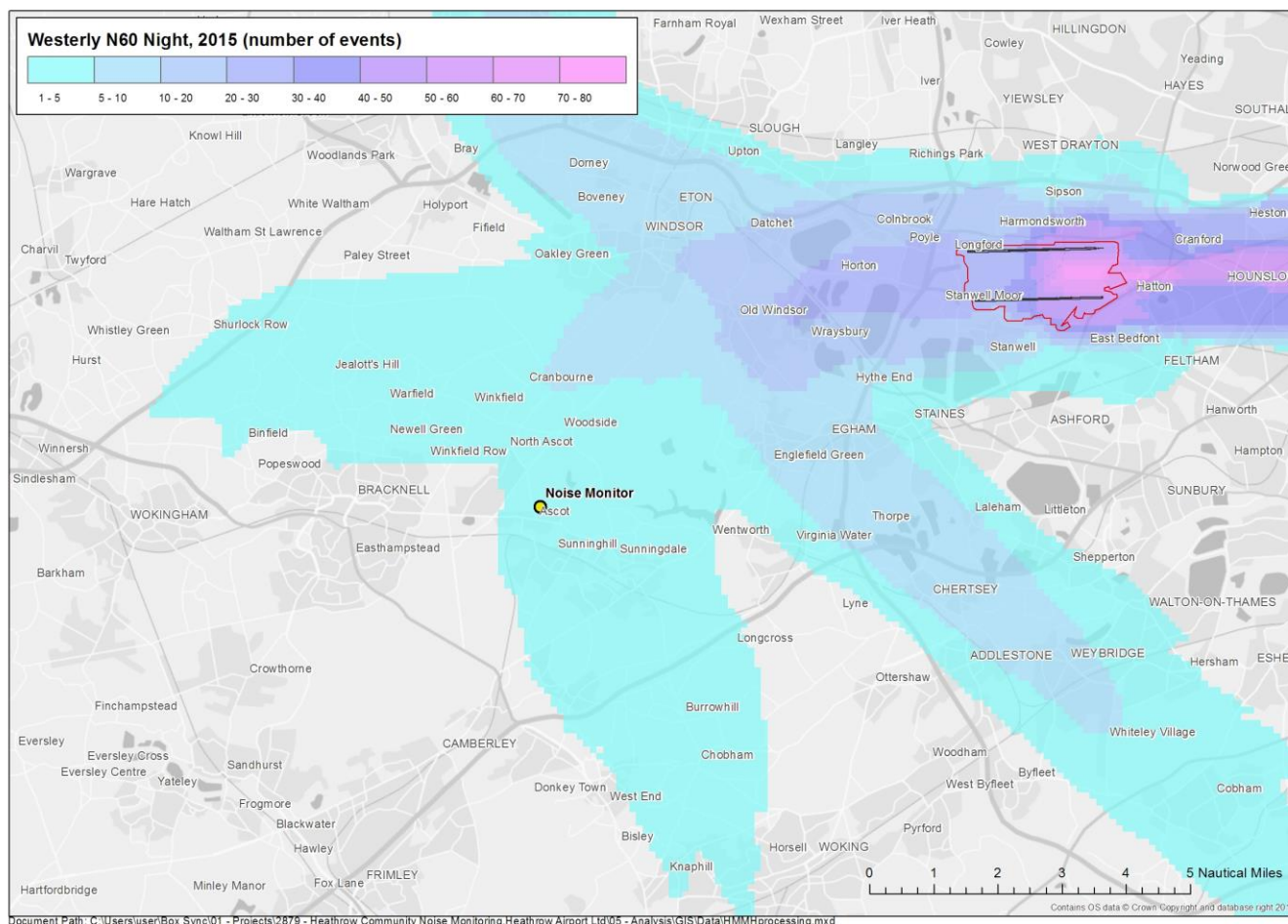
Appendix A: Average westerly night $L_{Aeq,8hr}$ contours (2011)



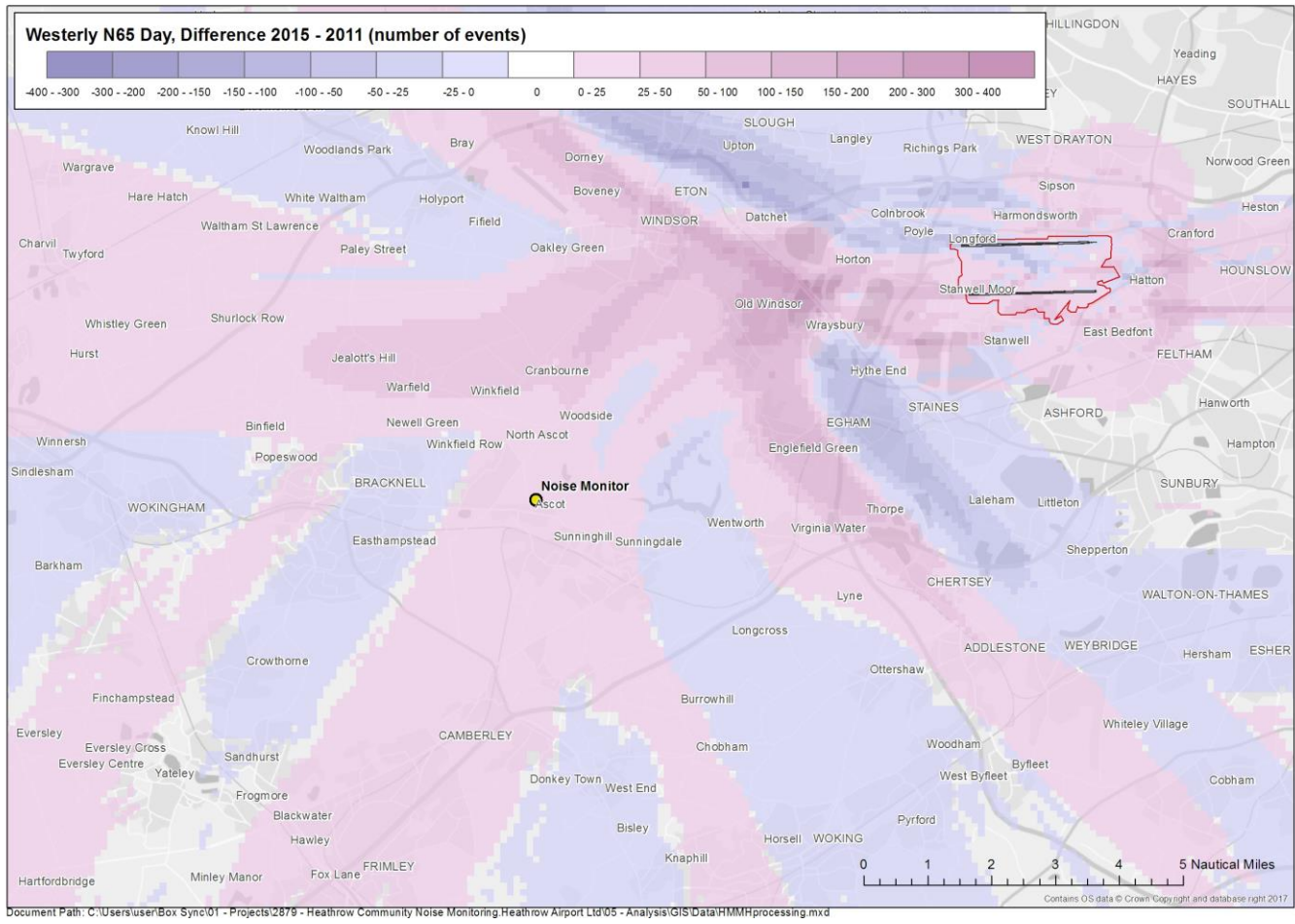
Appendix A: Average westerly night N60_{8hr} contours (2011)



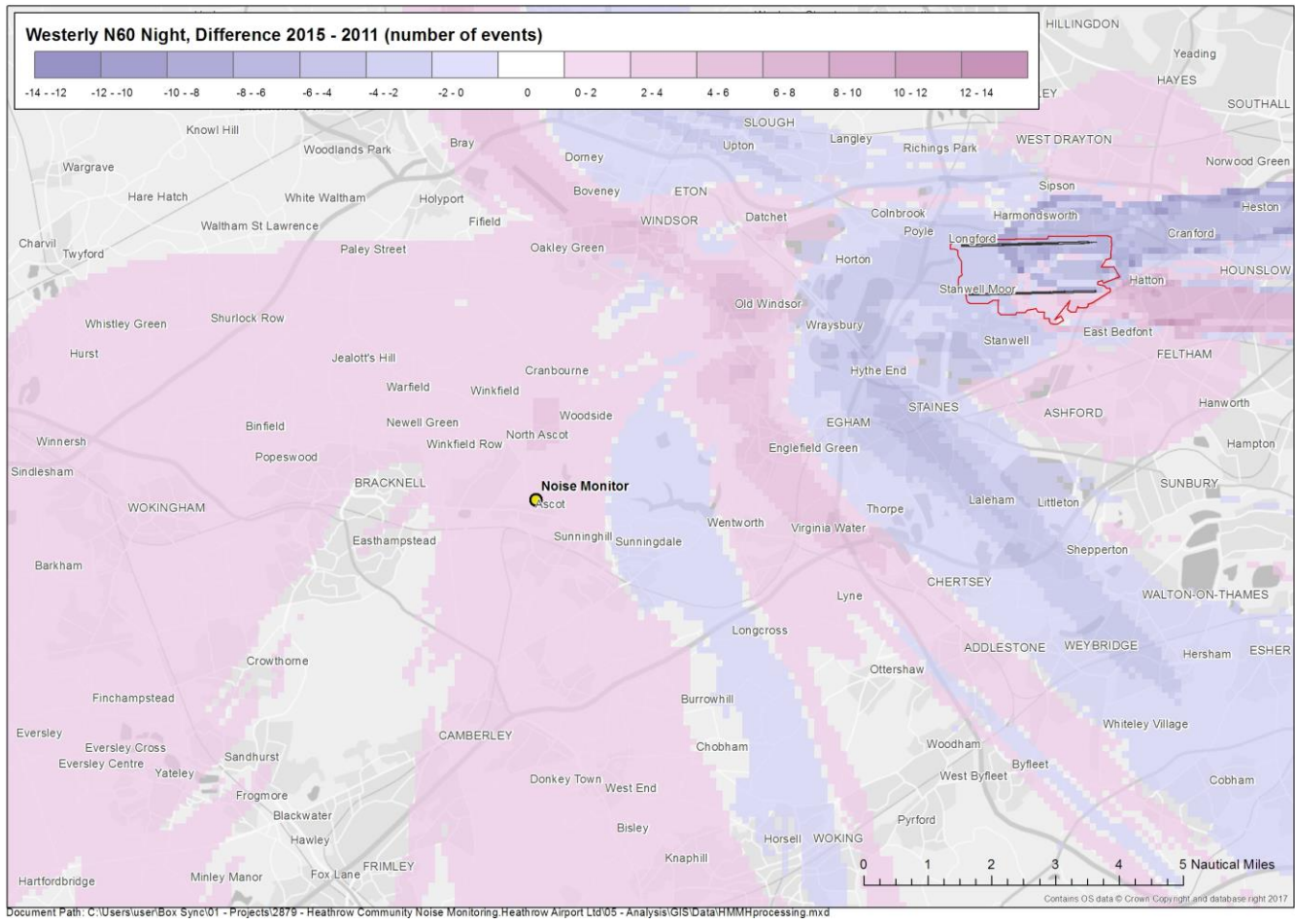
Appendix A: Average westerly night N60_{8hr} contours (2015)



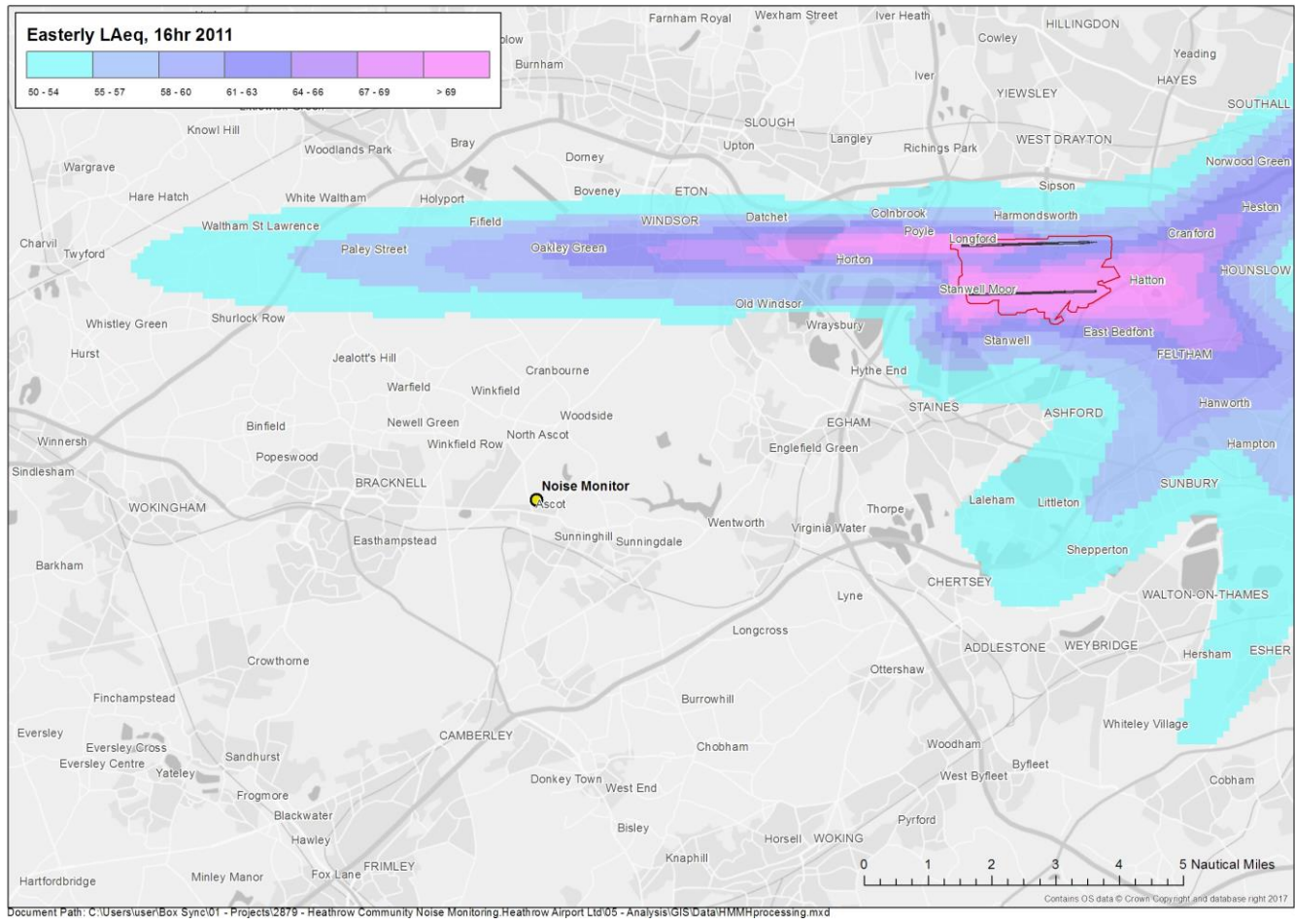
Appendix A: Average westerly day N65_{16hr} difference (2015 minus 2011)



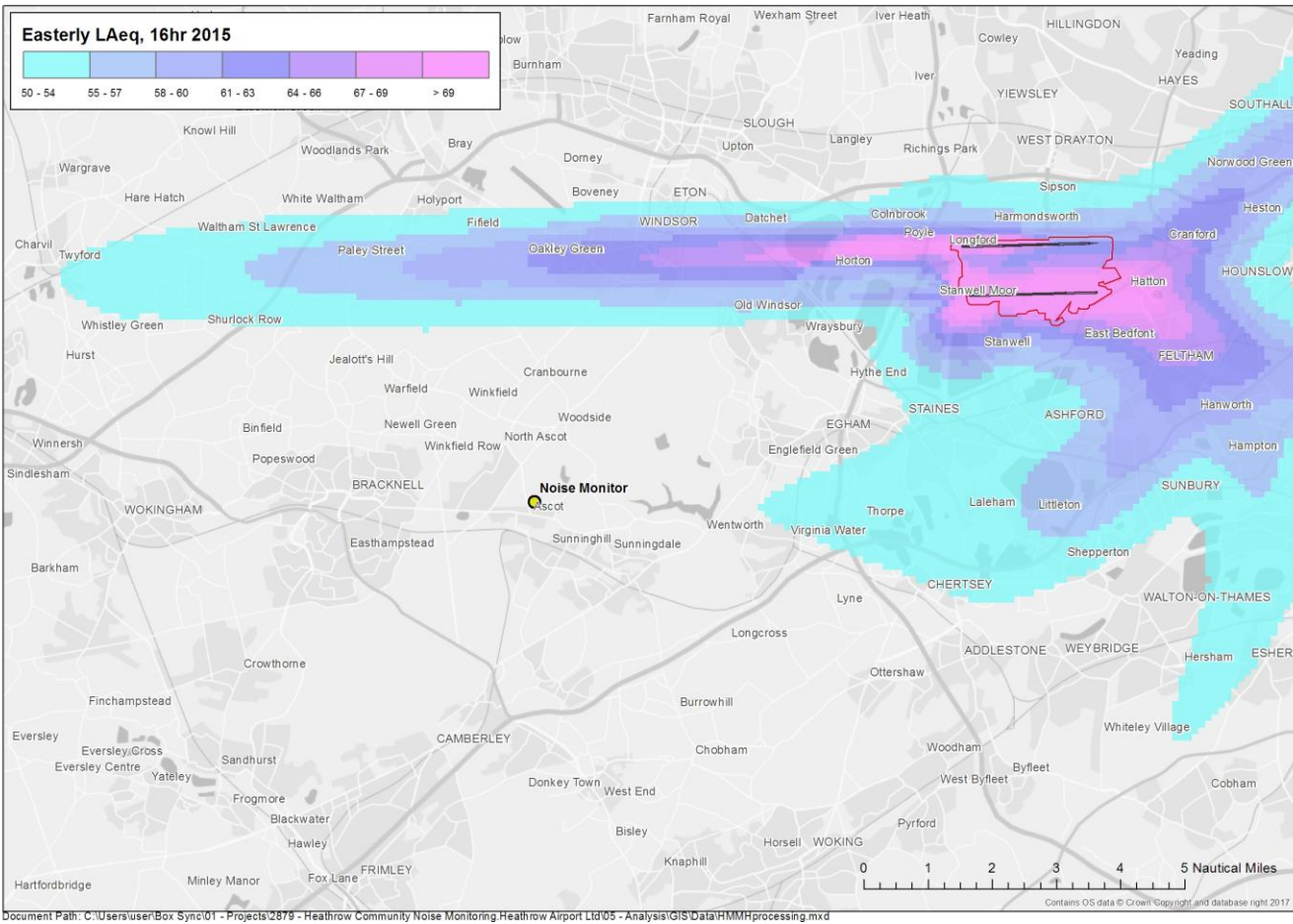
Appendix A: Average westerly night N60_{8hr} difference (2015 minus 2011)



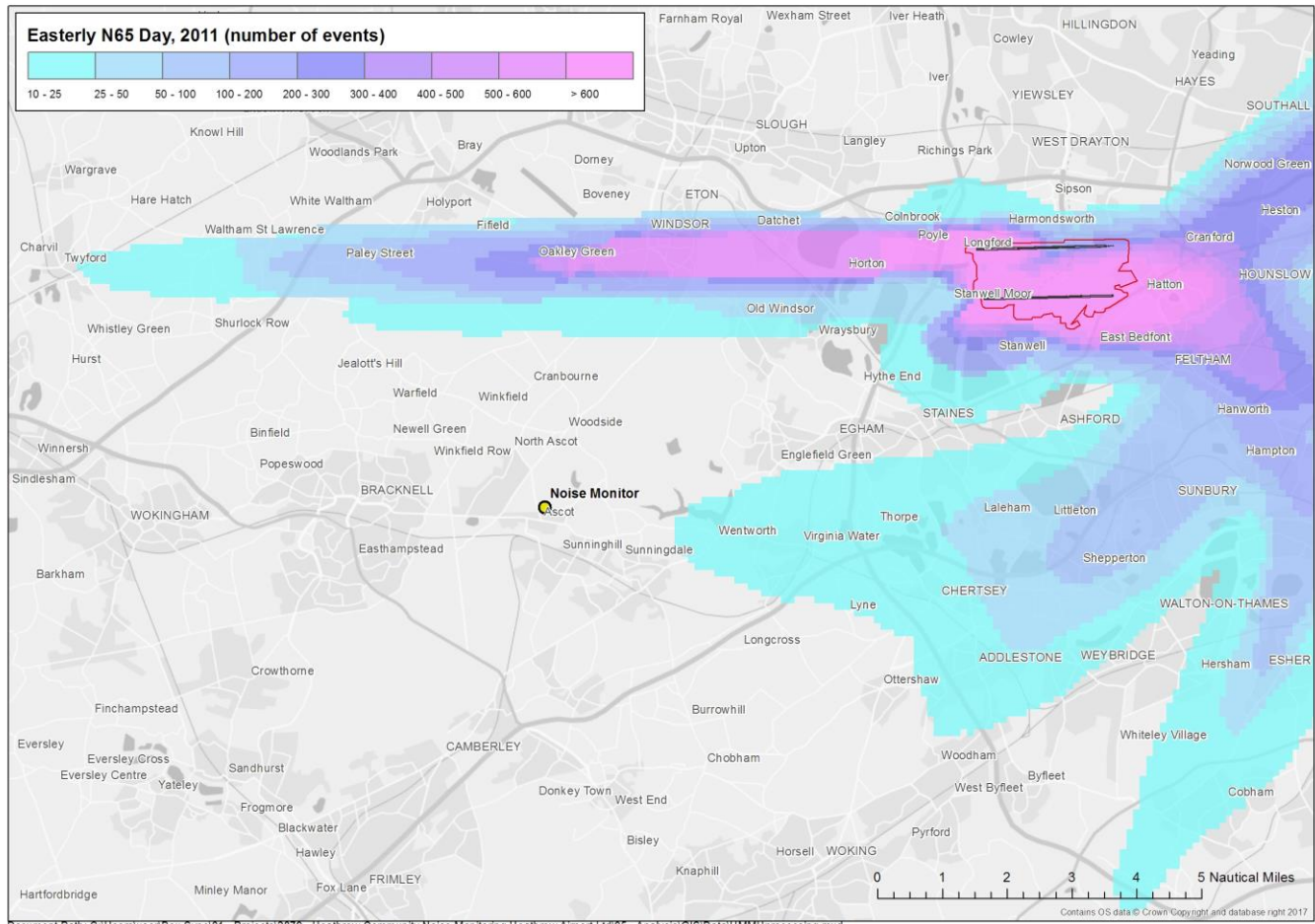
Appendix A: Average easterly day $L_{Aeq, 16hr}$ contours (2011)



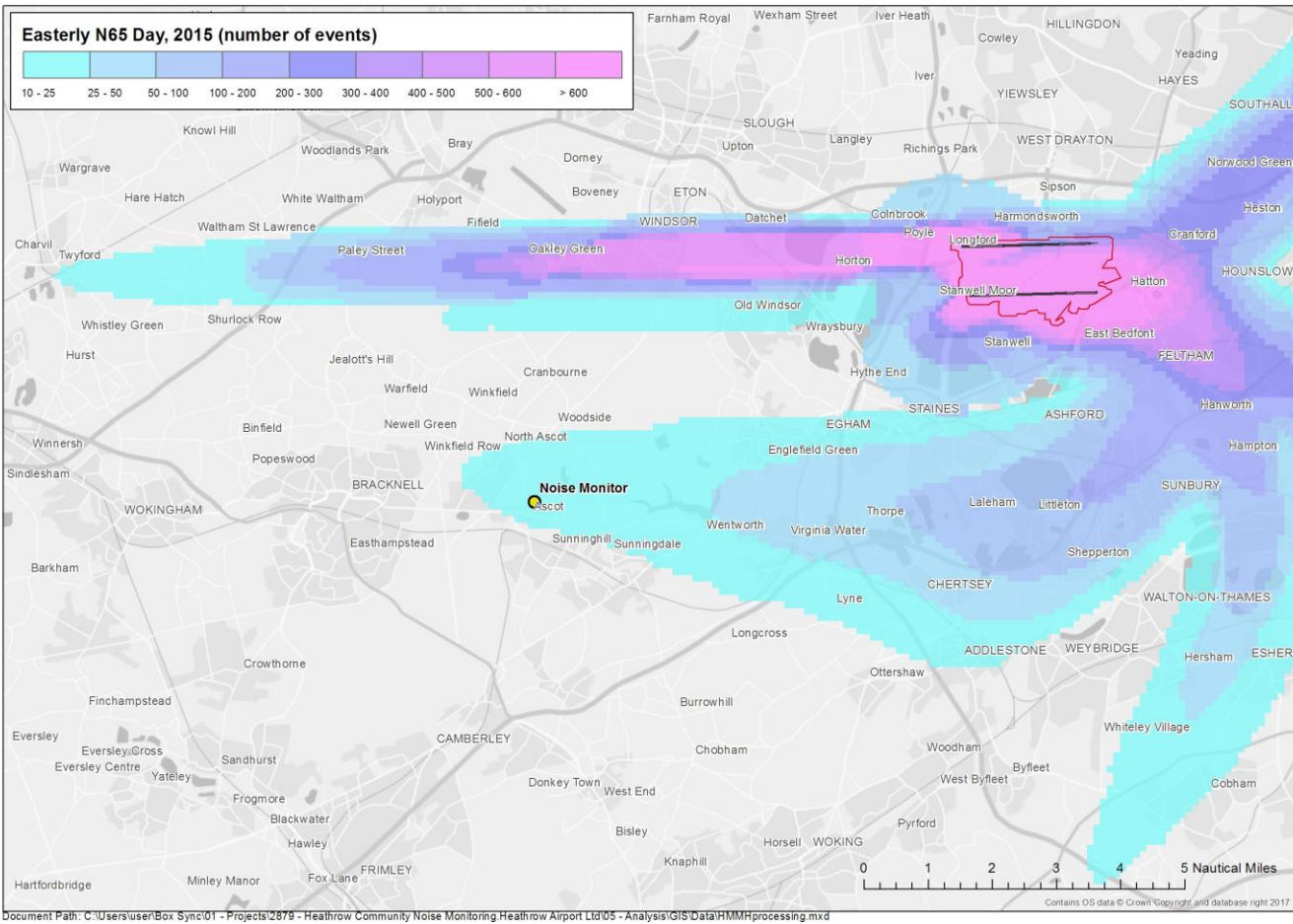
Appendix A: Average easterly day $L_{Aeq,16hr}$ contours (2015)



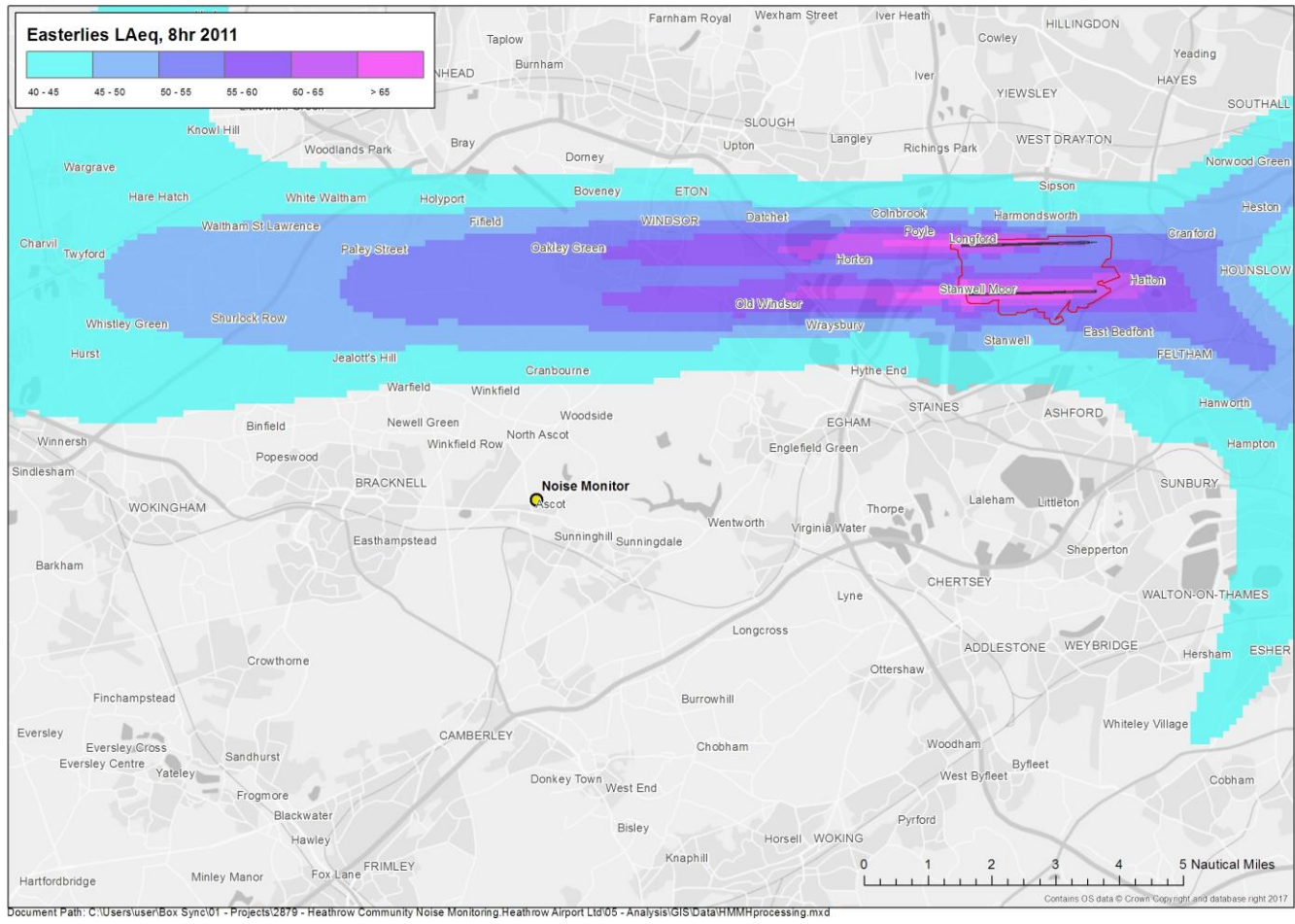
Appendix A: Average easterly day N65_{16hr} contours (2011)



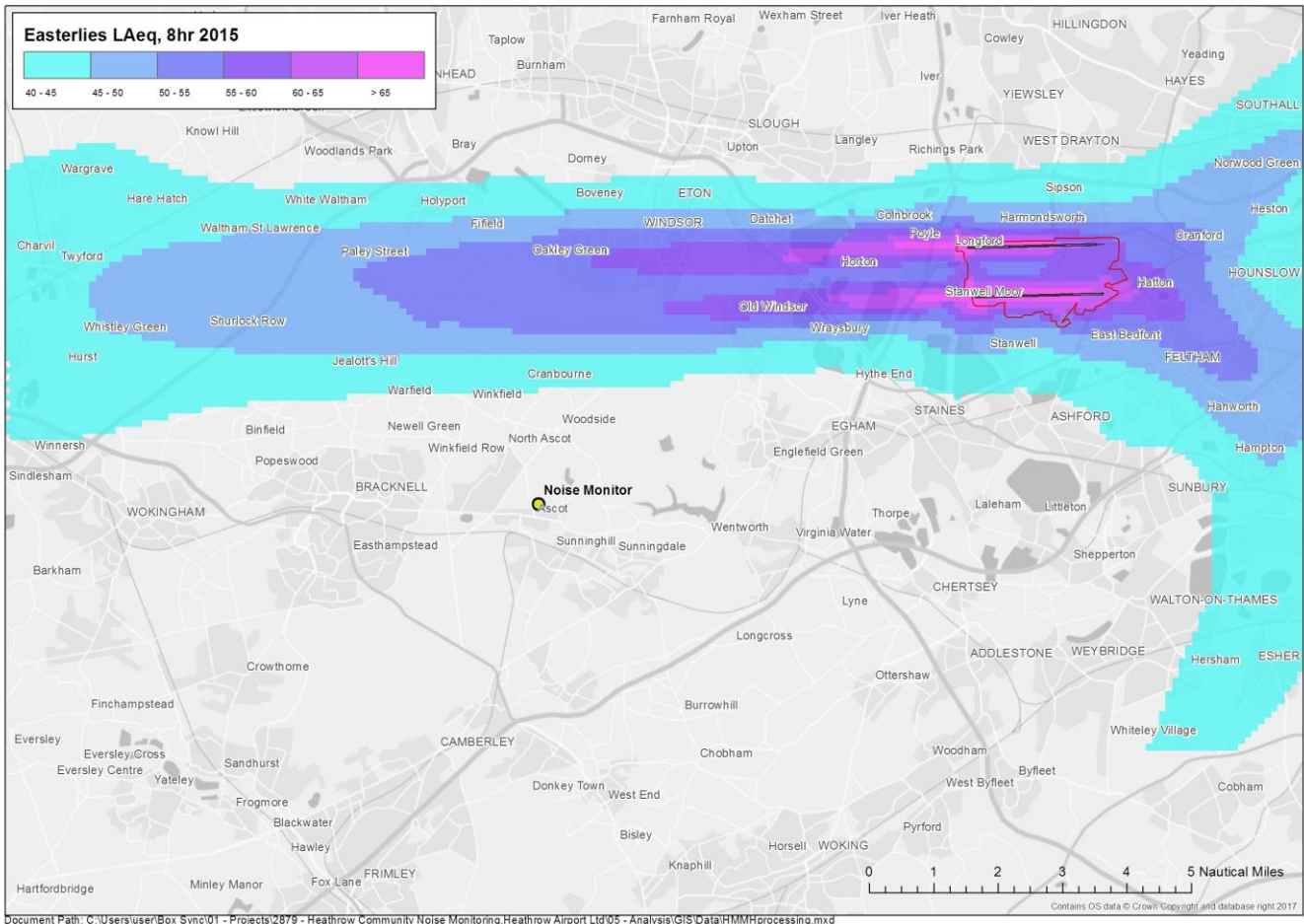
Appendix A: Average easterly day N65_{16hr} contours (2015)



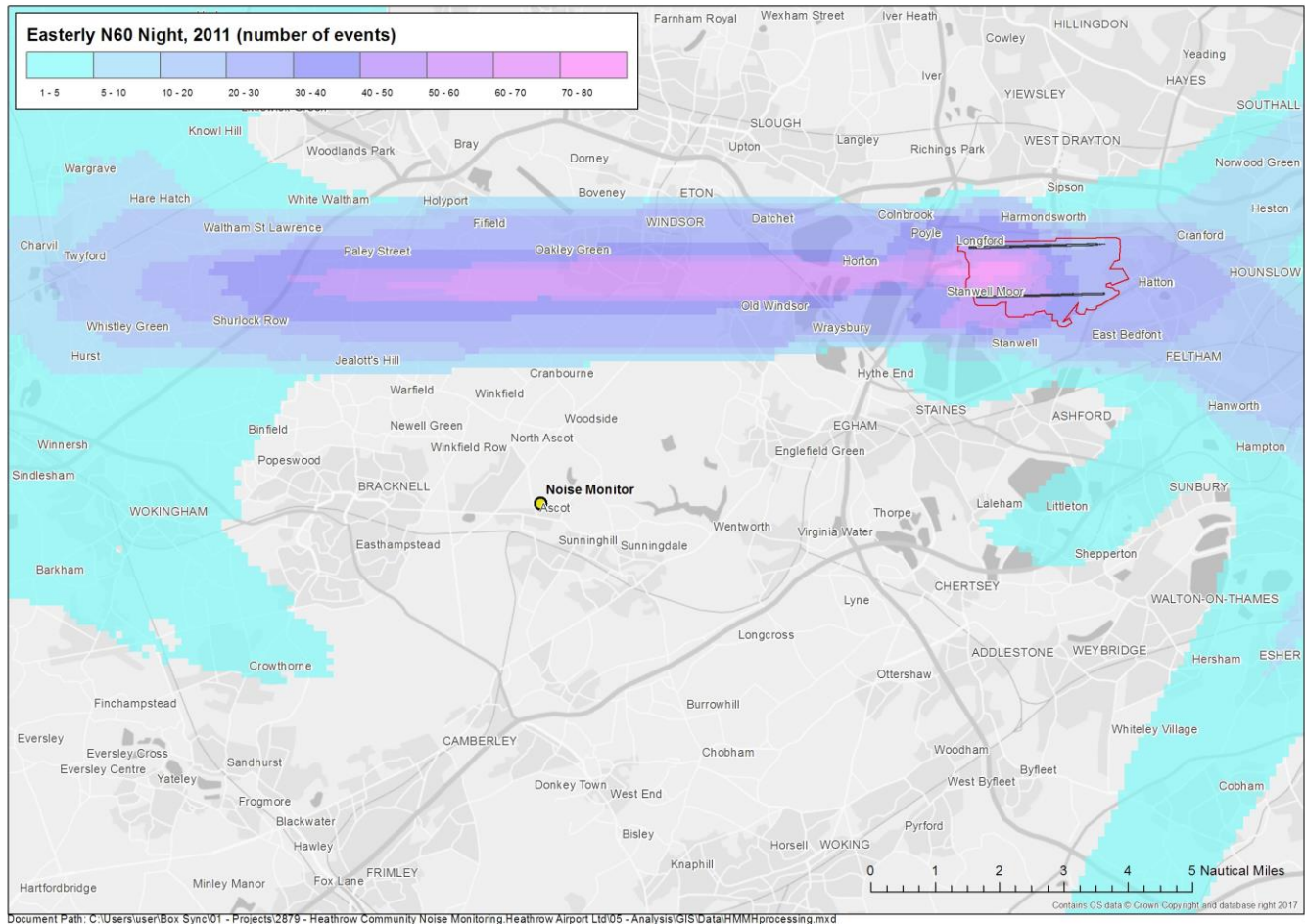
Appendix A: Average easterly night $L_{Aeq,8hr}$ contours (2011)



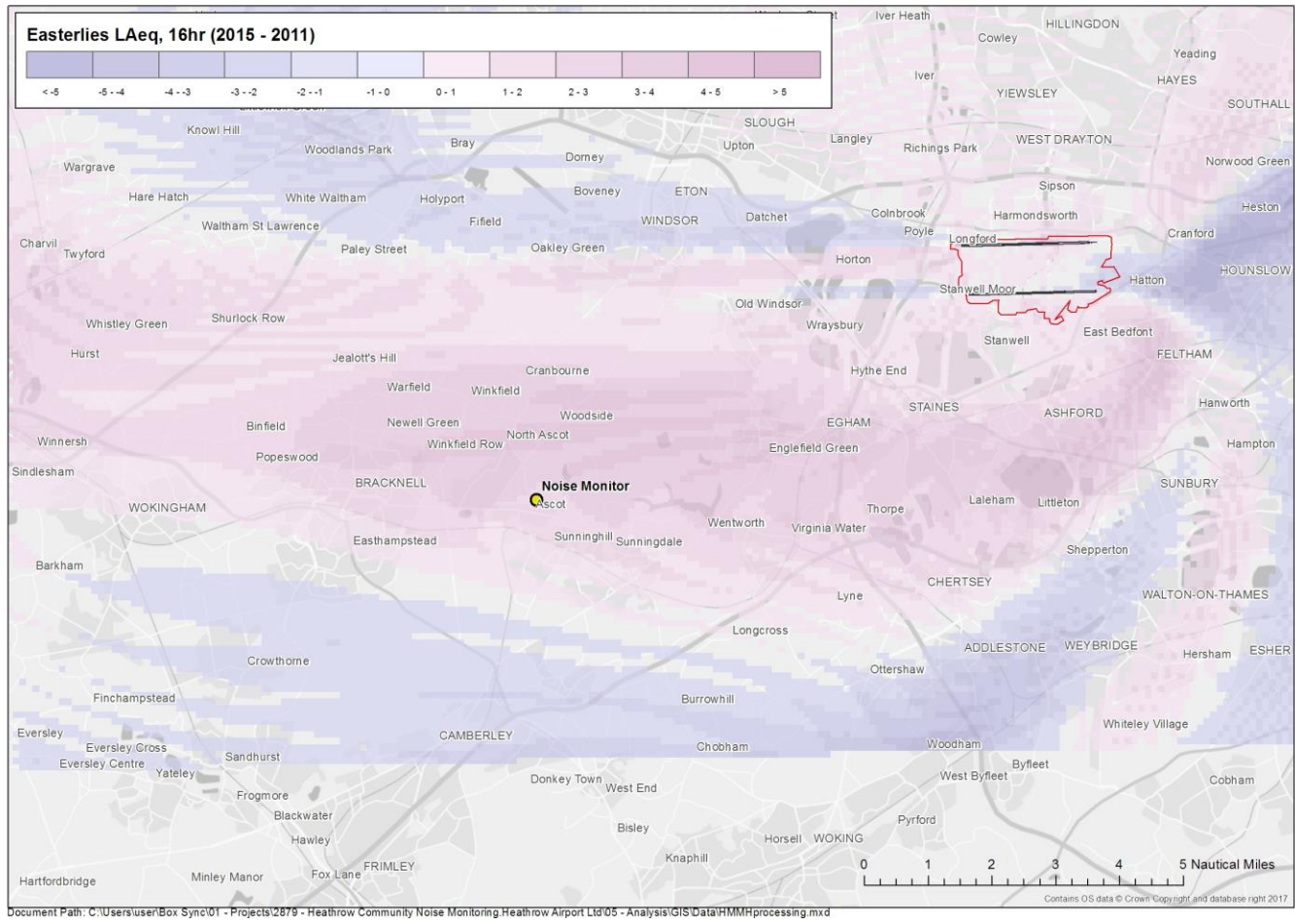
Appendix A: Average easterly night $L_{Aeq,8hr}$ contours (2015)



Appendix A: Average easterly night N60_{8hr} contours (2011)



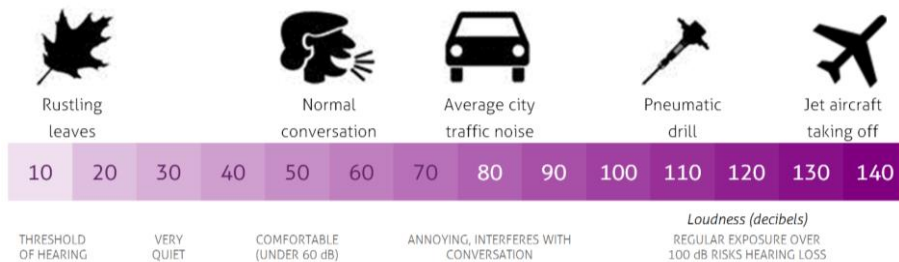
Appendix A: Average easterly day $L_{Aeq, 16hr}$ difference (2015 minus 2011)



Appendix B: Noise Terminology

How is noise measured?

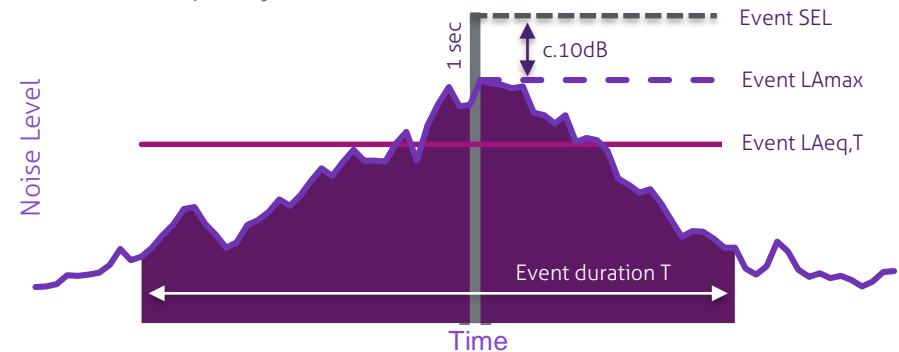
There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Noise is therefore measured using a logarithmic scale, to account for this wide range, called the decibel (dB). Typical noise levels of everyday sounds are shown in the figure below.



The human ear is capable of detecting sound over a range of frequencies from around 20 Hz to 20 kHz, however its response varies depending on the frequency and is most sensitive to sounds in the mid frequency range of 1 kHz to 5 kHz. Instrumentation used to measure noise is therefore weighted across the frequency bands to represent the sensitivity of the ear. This is called 'A weighting' and is represented as dB(A). All units in this report use this A-weighting.

How is aircraft noise measured?

As an aircraft passes over a location, noise levels slowly increase from ambient levels, reach a maximum and decrease back down to ambient levels. An example flyover is shown below.



There are a number of metrics that can then be used to characterise a noise event all of which can be derived from modelling:

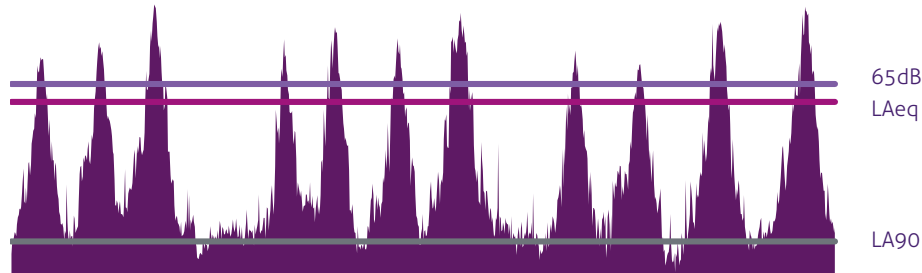
- The L_{Amax} is the highest sound pressure level during the event, it is an instant value, this is used typically with noise limits;
- The $L_{Aeq,t}$ is the continuous sound pressure level that would generate the same energy as that of the fluctuating noise level during the event of period T. It is in effect the average noise level over the time of the event;
- The SEL (sound exposure level or single event level), is the sound pressure that would arise for if all the energy of the event were to be delivered in 1 second.



Appendix B: Noise Terminology

How is long term noise exposure measured?

The L_{Amax} and SEL are useful at describing the noise level of individual events but how is aircraft noise exposure measured over time? The standard approach is based on long term averages such as the L_{Aeq} in the UK. The L_{Aeq} for a period of aircraft overflights is demonstrated in the figure below.



Although the L_{Aeq} plays a role in policy and planning assessment it does not adequately describe community experience. Supplementary noise metrics have been developed to better reflect community experience in simpler language. For example, the N65 describes the number of events which exceed 65dB which, in the above example, would be 11 over the period displayed.

The L_{A90} is a useful indicator of background noise in the absence of aircraft or other distinctive noise events. The L_{A90} is defined as the noise level which is exceeded for more 90% of monitored period and is demonstrated by the grey line in the figure above.

How does noise vary with distance?

As we move away from a sound source, the level we hear reduces since the sound energy is spread over a larger and larger area. If we assume a source emits sound equally in all directions, we can generate some rules regarding sound levels at different distances. For example, if the distance between a source and the receiver is doubled, the sound level will reduce by 6dB or if it is increase by a factor of 10 the level will reduce by 20dB.

Ratio of Distances	Level difference
1	0dB
1.25	2dB
1.5	3.5dB
2	6dB
5	14dB
10	20dB



Appendix B: Noise Terminology

How is noise level related to loudness?

Loudness is a subjective measure that describes the perceived strength of a sound. It is related to sound level but also related to other parameters such as frequency and duration. The table below provides an indication of the how the perceived loudness of a sound changes with an increase or decrease in sound level. For example, an increase of 10dB corresponds to a doubling of perceived loudness. It should be noted that the table below should only act as a guide to the relationship between level and perceived loudness – since loudness is a subjective measure, the same sound will not create the same loudness perception by all individuals

Level difference (dB)	Loudness Perception
+20dB	x 4
+10dB	x 2
+6dB	x 1.5
+3dB	x 1.2
±0dB	0
-3dB	÷ 1.2
-6dB	÷ 1.5
-10dB	÷ 2
-20dB	÷ 4

How does average noise level relate to number of events?

Average noise levels are determined by not only the level of individual aircraft events but also the frequency of which they occur. Due to the logarithmic nature in which noise is measured, a doubling of noise energy relates to a 3dB increase in average noise level. Therefore, if the number of events is doubled over a given time period (assuming the levels of the events are the same), the $L_{Aeq,T}$ will increase by 3dB. Further factors are shown in the table below.

Number of Events	Noise level difference
x4	+6dB
x2	+3dB
0	0
÷2	-3dB
÷4	-6dB

