Community Noise Information Report
Eton Wick

30th May – 29th November 2019

March 2020

Introduction

At the request of local residents, Heathrow Airport Ltd installed a temporary noise monitor on the grounds of the Eton Wick Scout Hut between 30th May and 29th November 2019. This report presents analysis of the airport's operations and the noise data during the first six months of the monitor's deployment.

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

- **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 above Eton Wick, including routes, proximity, spatial distribution, height and aircraft types. As flight track data have been collected for many years in the airport's noise and track-keeping (NTK) system, analysis has compared the noise monitoring period with the equivalent six-month period in 2015.
- **Section 5 – Noise Monitor Data** presents an analysis of aircraft noise events and overall community noise levels as measured by the noise monitor. In the absence of previous monitoring at this location, the noise data are analysed for the monitoring period only.
- **Section 6 – Noise in the Wider Area** presents noise levels derived from noise modelling. Aircraft noise models have been generated for easterly and westerly days for the summer periods of both 2013 and 2017 using the AEDT modelling software. Previous reports have been based on Heathrow's verified noise model using INM. This software has been superseded by AEDT.
- **Section 7 – Appendices** presents large-scale versions of the noise modelling results, and provides information on how sound is described, how aircraft noise is measured, and how different sound levels relate to human perception.

It should be noted that this report is intended to describe noise exposure rather than the impact of that exposure, which is subject to individual circumstances. 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 considered to present a comprehensive set of analyses, it is not intended to be exhaustive. Should this report prompt any questions or comments, these should be addressed to the HCNF for consideration.

Key Findings

Operations and the community

The noise monitor in Eton Wick is predominantly overflown by westerly departures from both runways. It is about 1km south of the UMLAT and BPK routes that head north from the airport. The monitor is also about 2km north of arrivals to the northern runway on easterly operations, but very few events are recorded from these flights.

Between 2015 and 2019, there has been a 10% increase in the number of movements passing near to Eton Wick on a typical day of westerly operations. There was a similar increase in the number that were deemed to pass overhead.

On westerly operations, there has been a slight change to the concentration of flights following the UMLAT and BPK routes at Eton Wick with the swathe widening slightly towards the south.

The average height of aircraft above Eton Wick on westerly operations has decreased by approximately 200ft. The A380 was, on average, the lowest aircraft type above Eton Wick; however, it is one of two types that increased altitude compared to 2015.

Small twin engine aircraft are responsible for the majority of the movements near Eton Wick; however, the proportion reduced between 2015 and 2019 due to a growth in the use of large twin engine aircraft, particularly the B787.

The busiest periods of the day occur in the periods 10:00-11:00 and 19:00-20:00 during which up to 21 movements pass near Eton Wick each hour. The 10% increase in movements per full days of westerly operations were, in general, spread across the day.

Noise levels in the community based on measurement at the Eton Wick monitor

Almost all noise events recorded at Eton Wick are from aircraft on westerly departures. These are split equally between aircraft on the UMLAT and BPK departure routes that head north from the airport.

On days of full westerly and easterly operations, there are, on average, 58 and 1 aircraft noise events recorded per day respectively.

The average L_{Amax} for all aircraft noise events measured at Eton Wick was 71dB and would typically last for 28 seconds. The average level and duration of quad engine aircraft were approximately 6dB greater and 20 seconds longer than smaller aircraft respectively.

The B777 was responsible for the largest number of noise events (42%). The A320 family of aircraft accounted for only 5% of noise events, despite making up 60% of movements, suggesting the background noise is too high to capture all quieter noise events.

The B747 was the loudest aircraft passing overhead at Eton Wick followed by the A380 and B767. The B737 was the quietest.

The first noise events were typically captured from 08:00 onwards with two peaks occurring at 12:00-13:00 and 22:00-23:00, during which there were six noise events per hour.

The daytime $L_{Aeq,16hr}$ (from all noise sources) was 55 and 53dB on westerly and easterly operations respectively, while the night $L_{Aeq,8hr}$ levels were 45 and 49dB.

Difference in community noise levels between 2013 and 2017 based on noise modelling

On westerly operations, there was a decrease in average daytime noise levels of 1-2dB, whilst the number of events exceeding 65dB decreased by up to 25 per day.

The average level during the night period on westerly operations decreased in 2017 compared to 2013 by up to 1dB, while the number of events exceeding 60dB increased by an average of up to 2 per night.

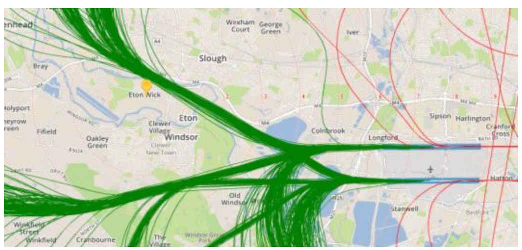
On easterly operations, there was up to a 1dB decrease in average modelled daytime $L_{Aeq,16hr}$ noise level between 2013 and 2017. Eton Wick sits outside the N65 contours and therefore a change in N65 cannot be expressed.

There was an increase in average night-time aircraft noise on easterly operations of less than 1dB. Eton Wick also falls outside the N60=1 contour so no change in N60 can be provided.

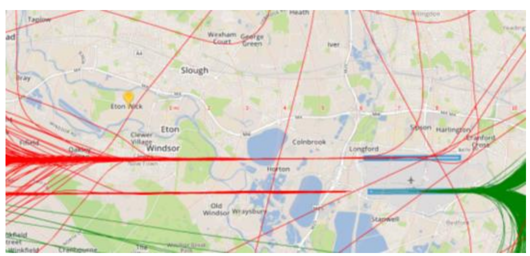
Understanding how wind direction affects aircraft operations

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 in red, departures green. The position of the noise monitor is indicated by the yellow pin drop.



Flight tracks on a westerly day (29th January 2020)



Flight tracks on an easterly day (23rd January 2020)

The proportion of easterly/westerly operations

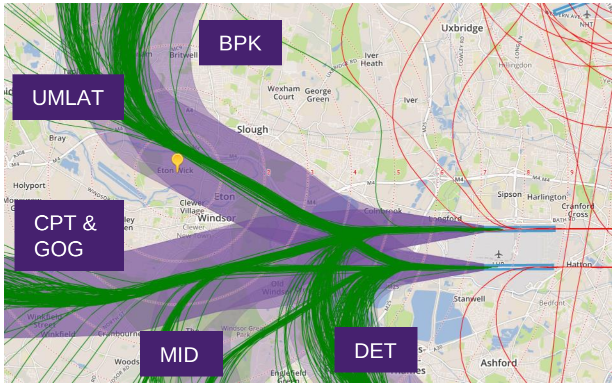
- Around Heathrow, the prevailing wind direction is from the west.
- Heathrow also operates what is known as the 'westerly preference'. Aircraft will continue to operate in a westerly direction until there are tail winds consistently of 5 knots or more. This was implemented to protect more densely populated 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 9 full years.

Note: Further information about operations at Heathrow can be found at https://www.heathrow.com/company/local-community/noise/operations

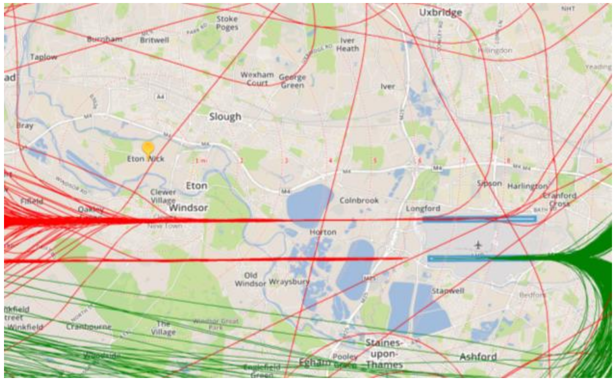
Understanding where aircraft fly near to Eton Wick

- The images to the right present a typical day of westerly operations and easterly operations with arrival tracks shown in red and departures in green.
- Aircraft departing the airport follow one of six pre-defined Noise Preferential Routes (NPRs) on both easterly and westerly operations. The choice of route is typically based upon the destination of the flight and is not selected by Heathrow. These are shown by the shaded purple areas in the upper image.
- Eton Wick is predominantly overflown by westerly departures following the UMLAT or BPK route (as indicated in the map to the right). At it's closest point, the noise monitor is positioned approximately 1km to the south-west of the centreline of these routes, and falls within the NPRs.
- On easterly operations, the noise monitor is positioned almost 2km north of the arrival track to the northern runway.

Arrival and departure tracks on westerly operations (NPRs shaded in purple)



Arrival and departure tracks on easterly operations



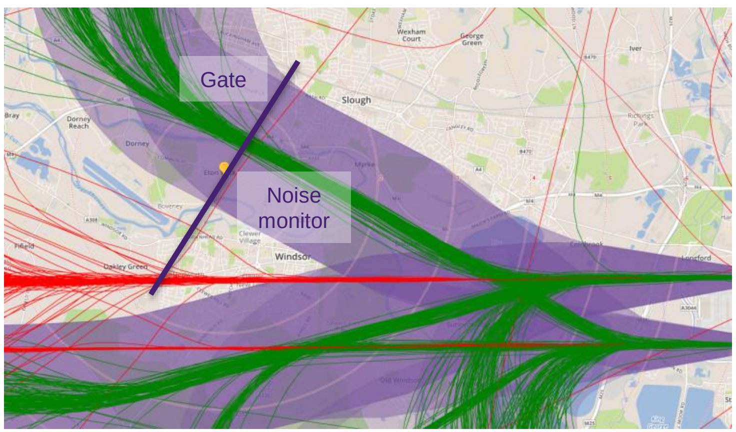
Understanding operational and gate data.

Operational data

- The following operational data were provided for the period between 30th May and 29th November 2019, and also for the same period for the four previous years:
  - 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 single gate 3km wide to capture the full width of the UMLAT and BPK NPRs was drawn over Eton Wick centred on the temporary noise monitor.



This figure shows the position of the gate relative to both westerly arrivals (red) and easterly departures (green)

- The gate is 12,000ft high to cover all movements through the gate and perpendicular to the UMLAT and BPK departure routes.
- The height and position of each aircraft passing through the gate were extracted from ANOMS, Heathrow's NTK system. The following data were extracted:
  - Aircraft deviation from the centre of the gate
  - Aircraft height at gate
  - Time that the aircraft entered the gate
  - Departure route flown – 'standard instrument departure' (SID) route
  - 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 NTK systems.

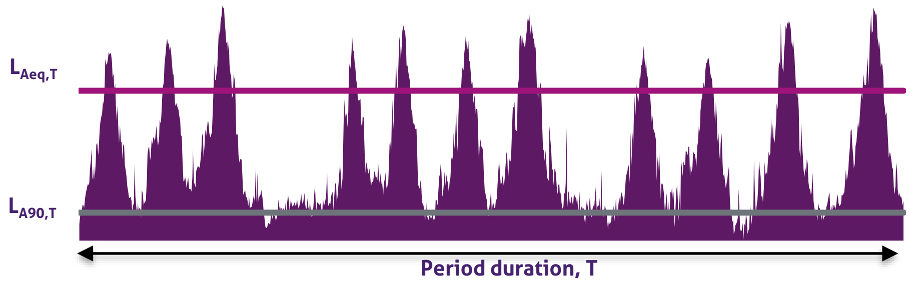
Understanding measured noise data

Measured noise data:

- A Bruel & Kjaer 3639-A, 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 have been excluded due to adverse weather conditions.
- For this report, noise data have been provided by Heathrow for the period 28th March – 27th September 2019. Note that a historical comparison is not available since the noise monitor was not installed at this location in previous years.

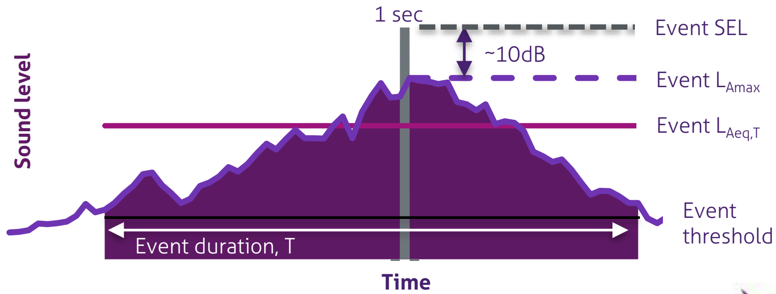
Ambient and background noise levels:

- 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 'ambient' sound level across period T from all sources
  - $L_{A90,T}$ – the 'background' sound level exceeded for 90% of the time across period T from all sources
- The NTK system provides these metrics in 1hr periods, i.e. T=1hr.



Noise events:

- When the measured noise level exceeds a pre-determined threshold, a noise event is recorded.
- 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 singe 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
  - 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.



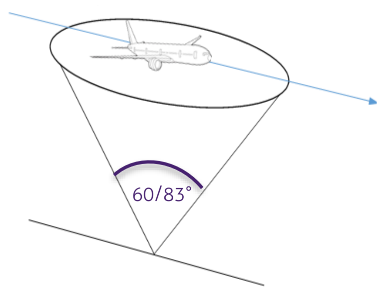
Analysing noise levels from aircraft in this area

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 average noise levels from that aircraft type.

There is no consensus as to what constitutes an overhead flight. In February 2017 the CAA published guidance (CAP 1498) recommending the use of an imaginary cone over the receiver with an apex of 60 or 83 degrees. This is illustrated in the figure below.

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

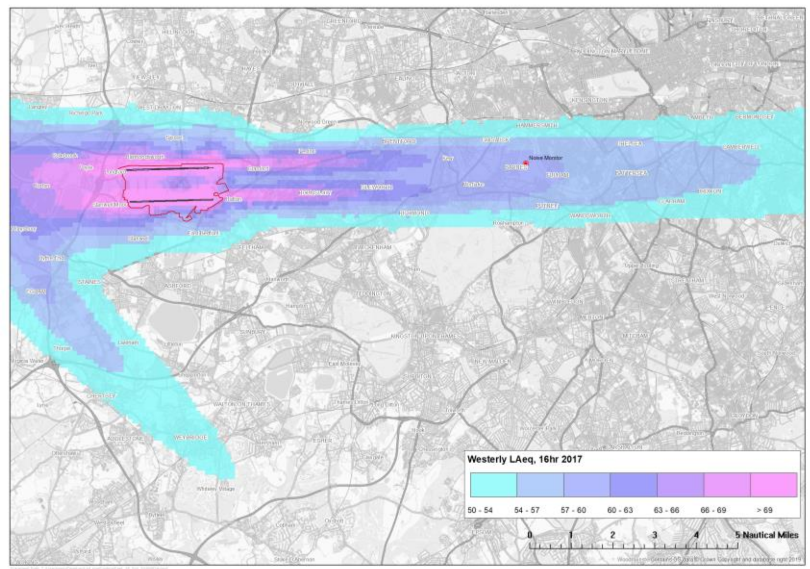


This community information report will, where applicable, present results for overhead flights determined by CAA guidance (based on the 83 degree cone), as well as all registered aircraft noise events.

Noise Modelling

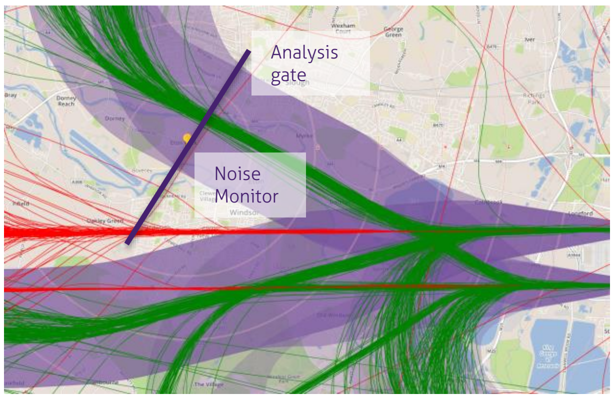
- Aircraft noise modelling has been used to provide an understanding of differences in the noise environment between 2013 and 2017 over the wider geographic area.
- Differences in daytime and night-time levels for an **average day and night of easterly and westerly operations** across the summer periods of 2013 and 2017 have been derived using the Heathrow AEDT model.

Example contours generated by aircraft noise modelling



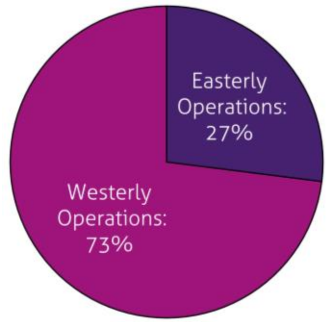
Overview of flight track data

30th May – 29th November 2019

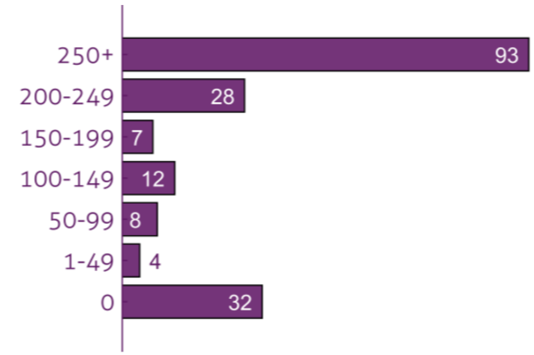


Example day of departing aircraft tracks in the vicinity of Eton Wick during westerly operations & the gate position (width 3km)

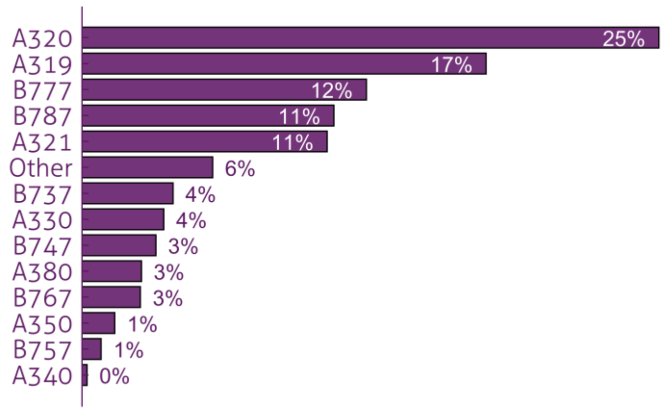
Total 244,623 operations into Heathrow



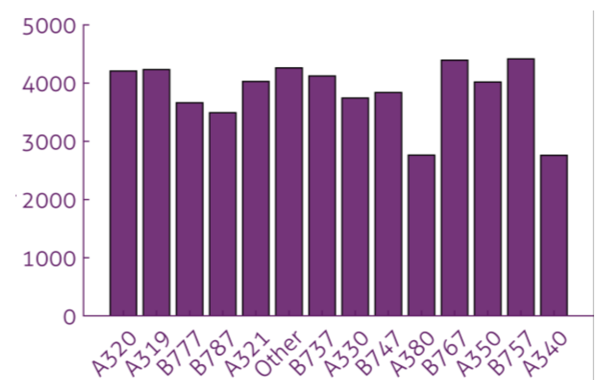
Number of westerly departures per day passing through the analysis gate (184 days in total)



Proportion of departing aircraft types passing through the analysis gate



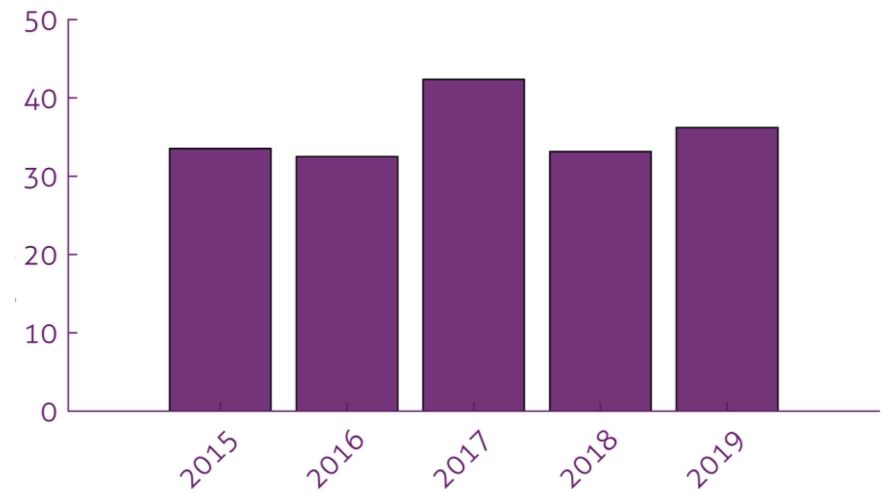
Average height of departing aircraft as they pass through the analysis gate (ft)



Is the number of flights over the area different in 2019 to 2015?

- The figure to the right shows the total number of departures that passed through the westerly gate in the period from 30th May to 29th November from 2015 to 2019.
- Annually, between 32,000 and 43,000 departures pass through the gate on westerly operations, of which the majority are departures on the UMLAT and BPK routes.
- Year to year changes can be attributed to fluctuations in the proportion of westerly operations (determined by wind direction), total number of movements and the proportion of aircraft flying each departure route.
- The table indicates that the proportion of westerly operations in 2015 was 71%, in 2019 73%.
- On a full day of westerly operations:
  - There was a 10% increase in the number of movements passing through the gate from 248 in 2015 to 273 in 2019.
  - There was an 11% increase in the number of movements passing overhead from 167 in 2015 to 185 in 2019 (as indicated by the numbers in parentheses).

Number of aircraft passing through the gate on westerly operations ('000s)



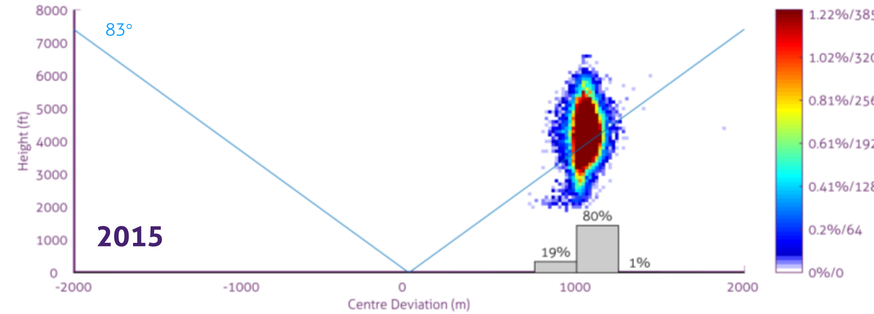
	2015	2019	Difference	Change (%)
Proportion of westerly operations (all Heathrow flights)	71%	73%	+2%	N/A
Average number of westerly departures passing through the gate during full days of westerly operations.	248 (167)*	273 (185) *	+25 (+19)*	+10% (+11%)*

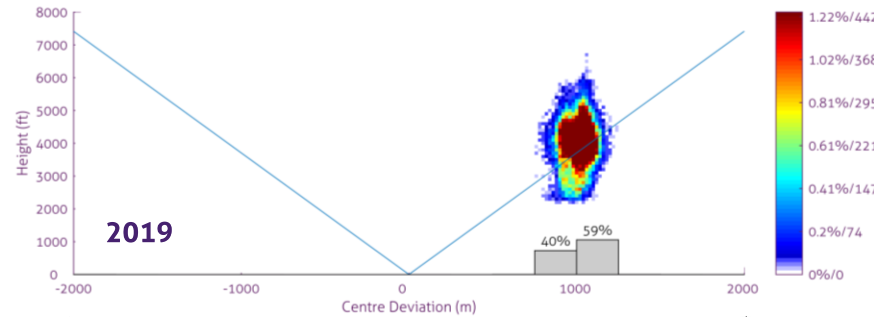
* Figures in parentheses indicate the number of flights passing through the 83 degree overhead cone.

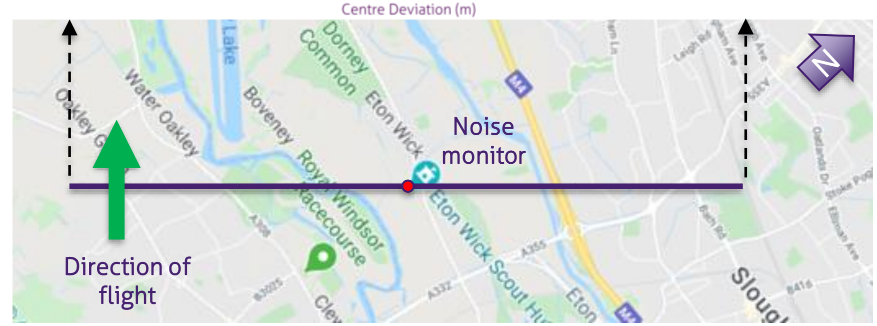
Note: Wherever this section of the report refers to *2019*, it should be noted that this is specifically the measurement period from 30th May to 29th November 2019. Similarly, 2015 specifically refers to the period from 30th May to 29th November 2015.

Is the concentration of flights different between 2015 and 2019?

- The figures to the right are "heat maps" showing the 2D concentrations of departing aircraft as they pass through the gate on westerly operations during the 2015 (the upper figure) and 2019 (the lower figure) monitoring period. Also shown by the grey bars is the concentration at different distances from the centre along the length of the gate.
- The scale has been normalised according to the proportion of movements. In other words, the same colour represents the same proportion of movements in each plot yet may represent a different number of movements.
- The gate has been designed to be perpendicular to the routes closest to the noise monitor (i.e. BPK and UMLAT).
- The figures show the width of the swathe is slightly wider in 2019 compared to 2015 with a proportion of the flights in the swathe moving south. This indicates flights above Eton Wick are slightly less concentrated in 2019.



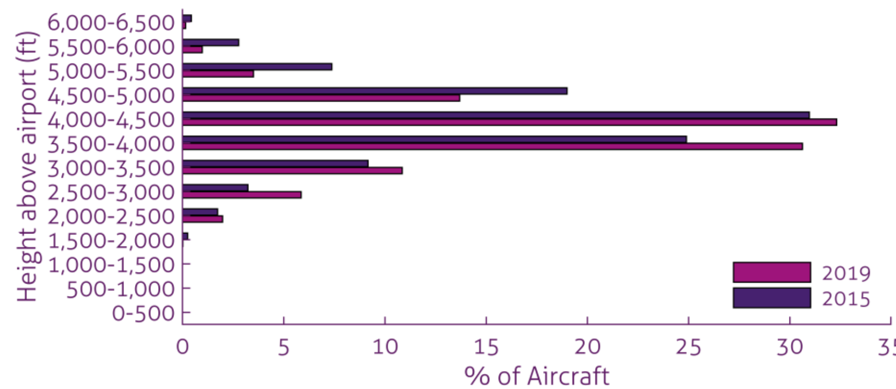


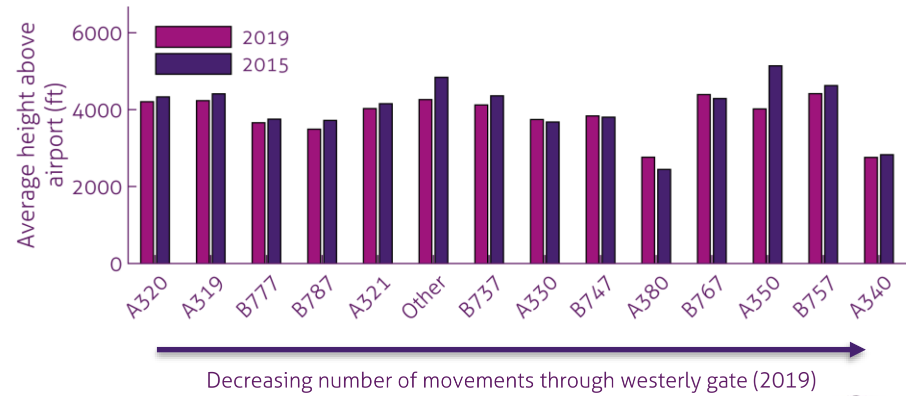


Are aircraft heights different between 2015 and 2019?

- The table to the right presents the average height of departing aircraft passing through the gate on westerly operations in the 2015 and 2019 periods.
- This indicates that aircraft above Eton Wick were, on average, approximately 190ft lower in the 2019 period compared to 2015 however it should be noted that in 2019 99.8% of all departures met the minimum climb gradient of 4% to an altitude of not less than 4,000ft.
- The figures present the distribution of these aircraft heights through the westerly gate comparing 2015 with 2019 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows that although in both years the greatest proportion of aircraft passed through the gate between 4,000ft and 4,500ft, in 2019 a greater proportion of aircraft passed through the gate at each altitude band under 4,500ft compared to 2015.
- The lower figure shows that the height of aircraft varies with type. The B757 and B767 were the highest aircraft types in 2019 (although, in this case, the sample size is small), while the A380 and A340 (both quad engine aircraft) are the lowest.
- Most aircraft types flew slightly lower in 2019 compared to 2015, with the exception of the A330, B747, A380 and B767.

	2015	2019	Difference
Average height of departures through the gate	4,170ft	3,890ft	-190ft

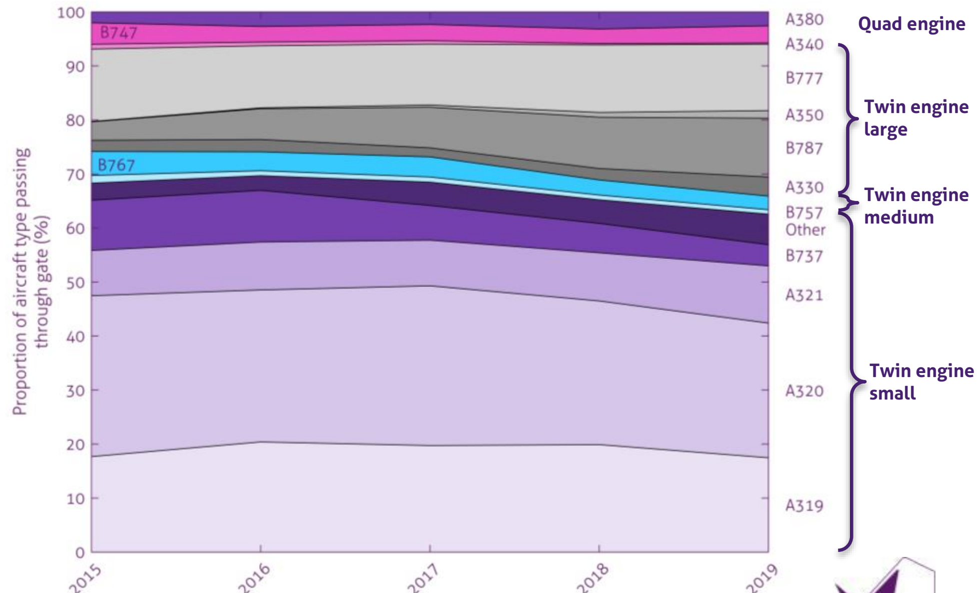




Is the fleet mix different between 2015 and 2019?

- The table to the right presents the mix of departing aircraft that passed through the analysis gate and overall at Heathrow in the 2015 and 2019 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, B787)
  - twin engine medium aircraft (B767)
  - twin engine small aircraft (B737, A320 family)
- The analysis on Page 12 indicates that, on average, the number of departing aircraft flying through the gate has increased by approximately 10% on days of full westerly operations between 2015 and 2019.
- The analysis on this page indicates although the overall proportion of A380s has fallen at Heathrow a greater proportion are flying over Eton Wick. There has been a significant increase in the use of large twin engine aircraft at the expense of all other aircraft size categories with the exception of the A380.
- 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.
- The figures indicate the largest change in the fleet mix flying over Eton Wick over the previous five years has been the increased use of B787, predominantly in favour of small twin engine aircraft.

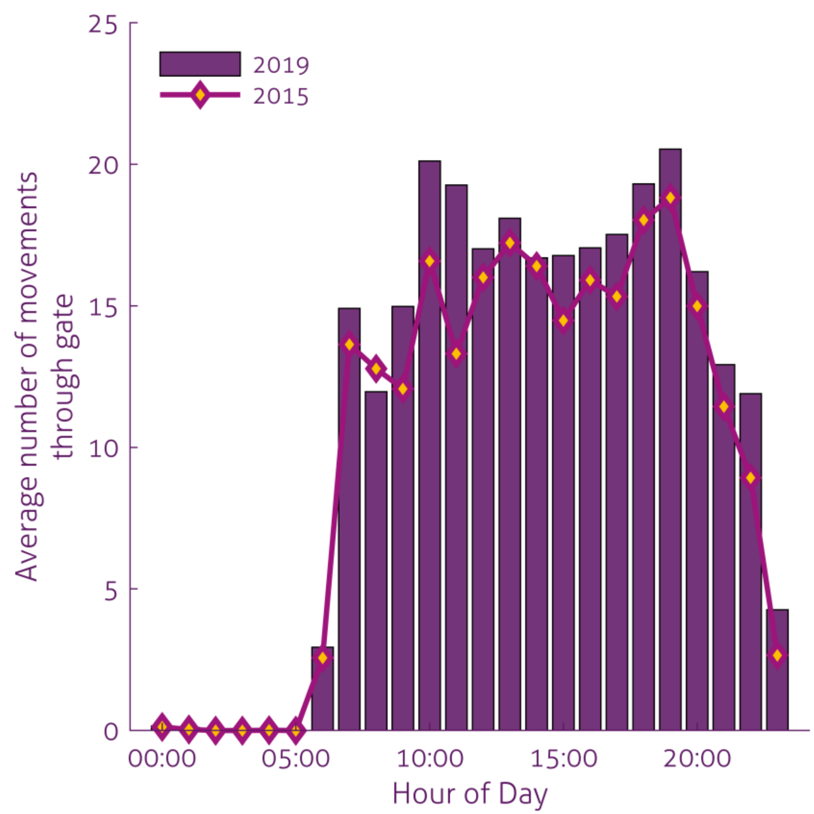
Fleet mix				
Category	Analysis gate		All LHR	
	2015	2019	2015	2019
A380	5.5%	7.6%	3.8%	3.5%
Quad engine	5.3%	1.3%	9.8%	5.2%
Twin engine large	17.4%	31.1%	17.4%	26.8%
Twin engine medium	4.1%	2.6%	2.9%	3.9%
Twin engine small	67.6%	57.5%	66.1%	60.6%



* Days of 100% westerly operations only

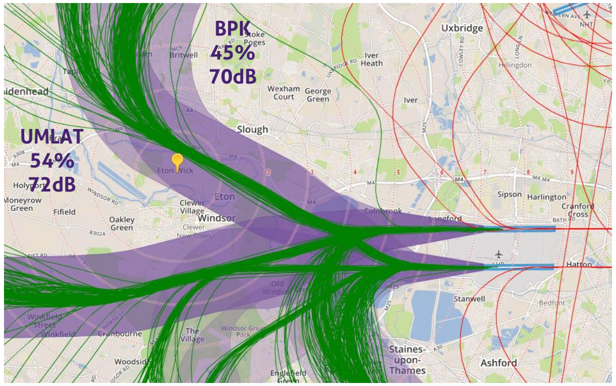
Does the number of flights over the area vary across the day? Is there a difference between 2015 and 2019?

- The figures to the right present the average number of departures through the analysis gate per hour in 2015 and 2019 during days of 100% westerly operations.
- The figures show that the first movements occur at 06:00 and during daytime hours (07:00-23:00) between 12 and 21 aircraft pass through the gate per hour.
- Throughout the day, there are two distinct peaks to the traffic through the gate: 10:00-11:00 and 19:00-20:00.
- In terms of average movements through the gate, Eton Wick is not affected by the runway alternation on westerly operations.
- Previous analysis on Page 12 has shown that there were, on average, 10% more flights through the gate per day on westerly operations in 2019 compared to 2015.
- In general, this increase was spread across the day with the biggest increases occurring between 09:00 and 12:00. The hour between 08:00 and 09:00 was the only period that saw a reduction in movements.
- Of the total 184 days in the 2019 monitoring period, 89 days (48%) were 100% westerly operations and 18 days (10%) were on 100% easterly operations.



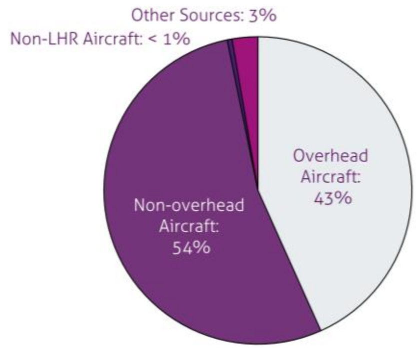
Overview of noise monitor data recorded at Eton Wick

30th May – 29th November 2019

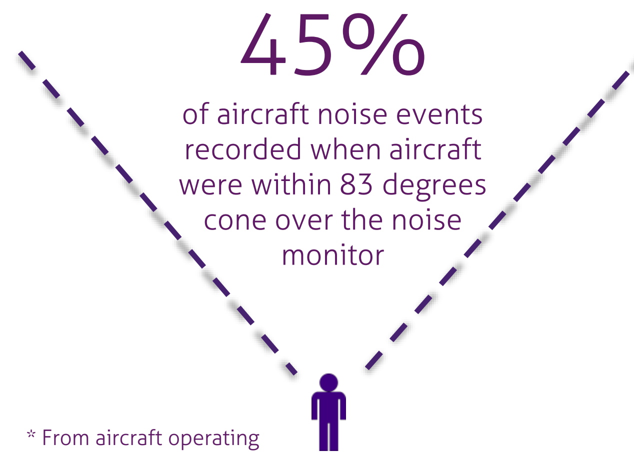


Monitor location, % noise events by route & average L_{Amax}

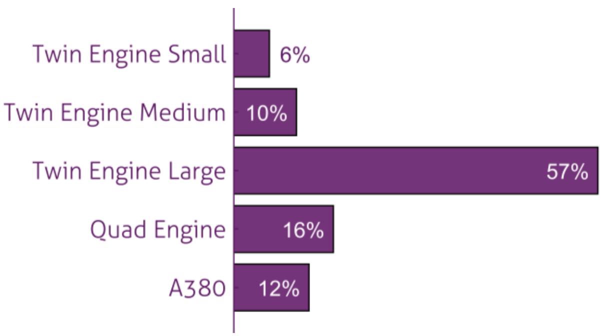
7,753 Measured Noise Events*



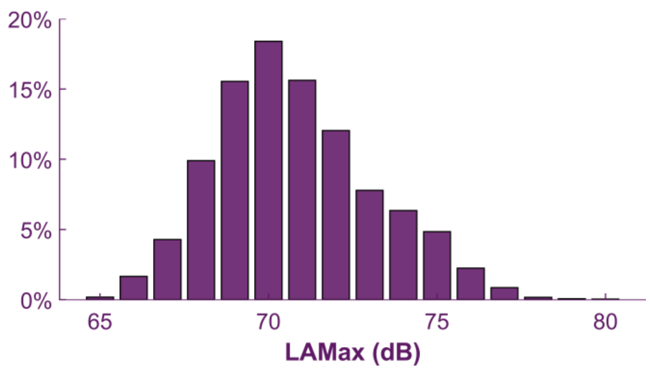
* From all noise sources



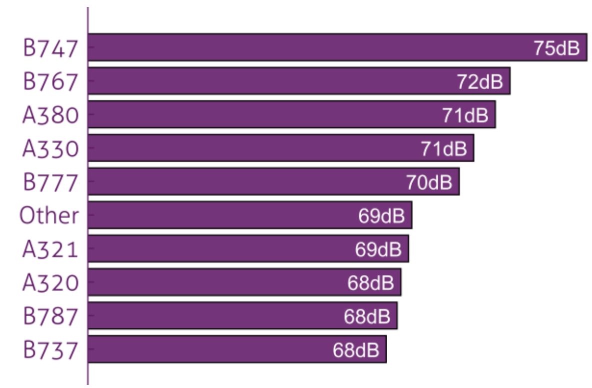
* From aircraft operating into Heathrow



Noise events by aircraft size



Overall distribution of maximum event noise level



Average L_{Amax} by aircraft type*

*Overhead aircraft on westerly departures only

Noise monitoring overview

Monitoring location, duration and setup

- A temporary noise monitor was installed in the grounds of the Eton Wick Scout Hut on the 30th May 2019.
- The monitor was set up to record noise events based on a threshold sound pressure level of 65.6 dB being exceeded for more than six seconds.
- The location of the noise monitor is shown in the figure to the right. It is just south of the centrelines of the BPK and UMLAT routes.

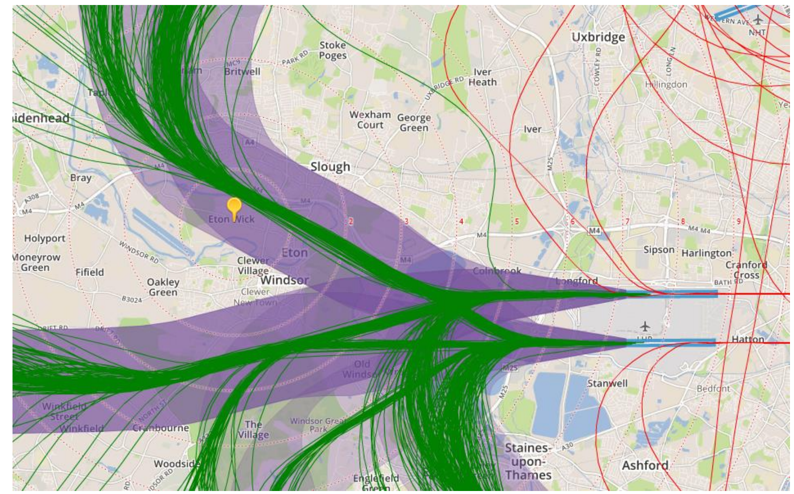
Noise event summary

- A total of 7,753 noise events were measured during the monitoring period. Of these around 96% were from aircraft using Heathrow and 3% were from non-aircraft sources.
- More than 99% of the aircraft registering noise events at the noise monitor were using the UMLAT and BPK westerly routes. A small number were easterly arrivals.
- Overall, 45% of aircraft registering noise events were overhead (based on the 83 degree cone) - 62% of these were on the westerly UMLAT route, the remainder on westerly BPK route.

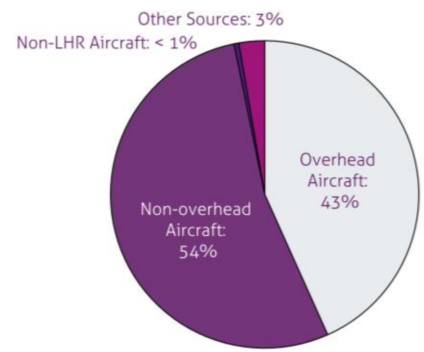
Percentage of aircraft noise events by route

Westerly				Easterly arrivals	Overhead
UMLAT		BPK			
27L	27R	27L	27R	09L	
25%	29%	22%	24%	<1%	45%

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

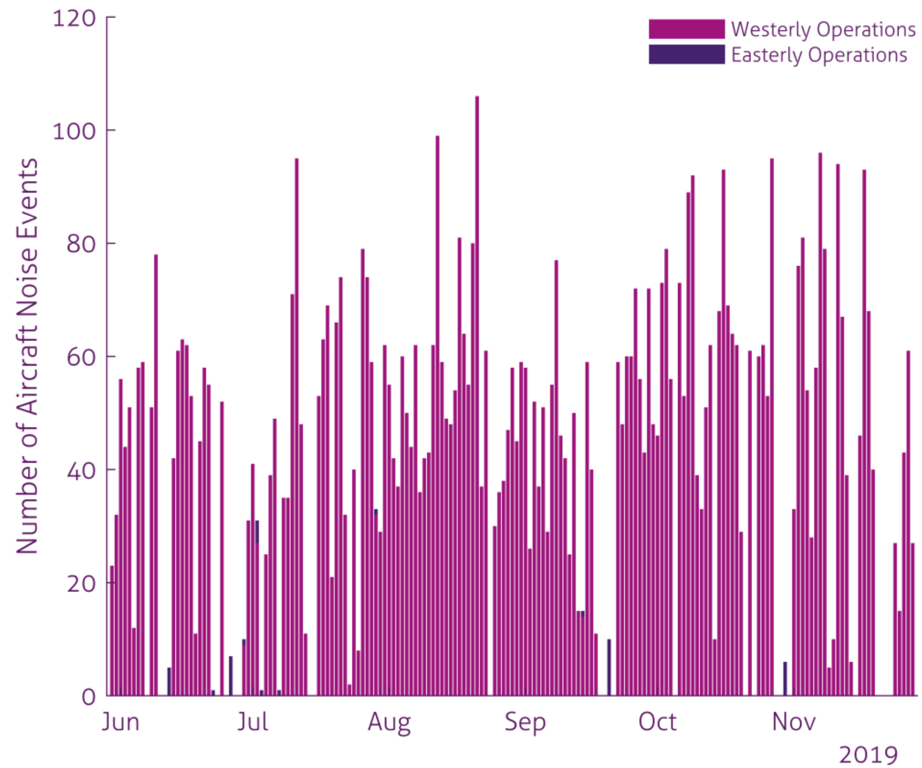


Measured noise event summary



Does the direction of operation affect the number of measured aircraft noise events?

- Noise events are almost exclusively captured at Eton Wick during periods of westerly operations by aircraft using both the UMLAT and BPK routes.
- During the monitoring period, 89 out of 184 days (48%) were 100% westerly operations and 77 days (42%) were 100% easterly operations. On the remaining days, the airport switched direction of operation during the day.
- During full days of westerly operations, there were, on average, 58 aircraft noise events triggered per day.
- During full days of easterly operations, there was an average of just one aircraft noise events per day – all of which are arrivals to the northern runway (09L).
- On average, 43% of measured aircraft noise events were recorded by aircraft passing within the 83 degree overhead cone.
- Over the 184 days for which monitoring was taking place, 45% of days experienced 50 or more aircraft events, whilst 16% had less than 5 aircraft noise events.
- It is noted that an absence of aircraft noise events does not necessarily mean that aircraft would be inaudible. There may be aircraft further away that are audible but have not triggered the noise event detection threshold.



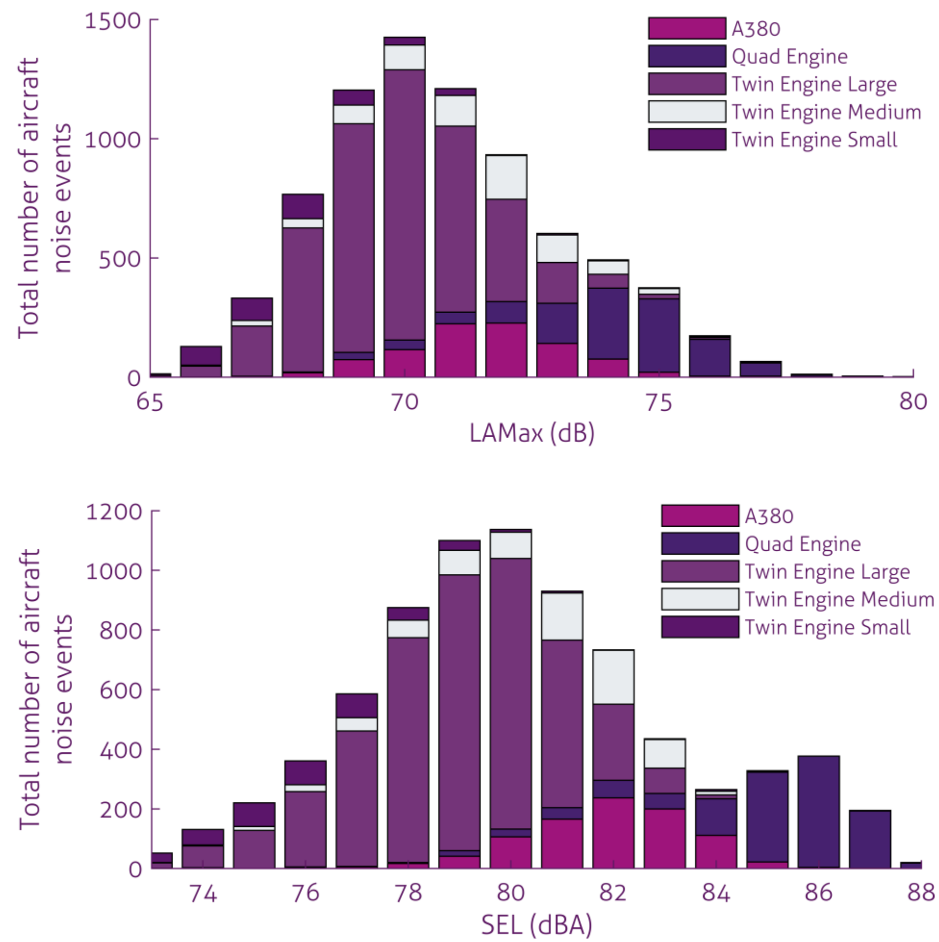
What was the range of L_{Amax} and SEL noise levels from aircraft events?

- The figures to the right present the range of L_{Amax} (top) and SEL (bottom) noise levels for all aircraft noise events measured at the Eton Wick monitor during the monitoring period. An explanation of metrics is given on Page 10.
- The table below presents the average L_{Amax} and SEL for each aircraft type group.
- The average L_{Amax} of all aircraft events is 71.3dB. The loudest aircraft group are quad engines (including B747s and A340s), while the quietest group are the small twin engine aircraft.

Aircraft group	Average L_{Amax}, dB	Average SEL, dB
A380	72.1	82.3
Quad engine	74.5	85.4
Twin engine large	70.4	79.4
Twin engine medium	71.8	81.0
Twin engine small	68.8	77.0

- As this analysis considers ALL events measured at this monitor regardless of distance or route these results cannot be used to compare the relative noise levels of aircraft types. An analysis of aircraft type noise levels is presented on Page 24.
- For non-aircraft related events, the mean L_{Amax} is 74.6dB reaching a maximum of 97.6dB.

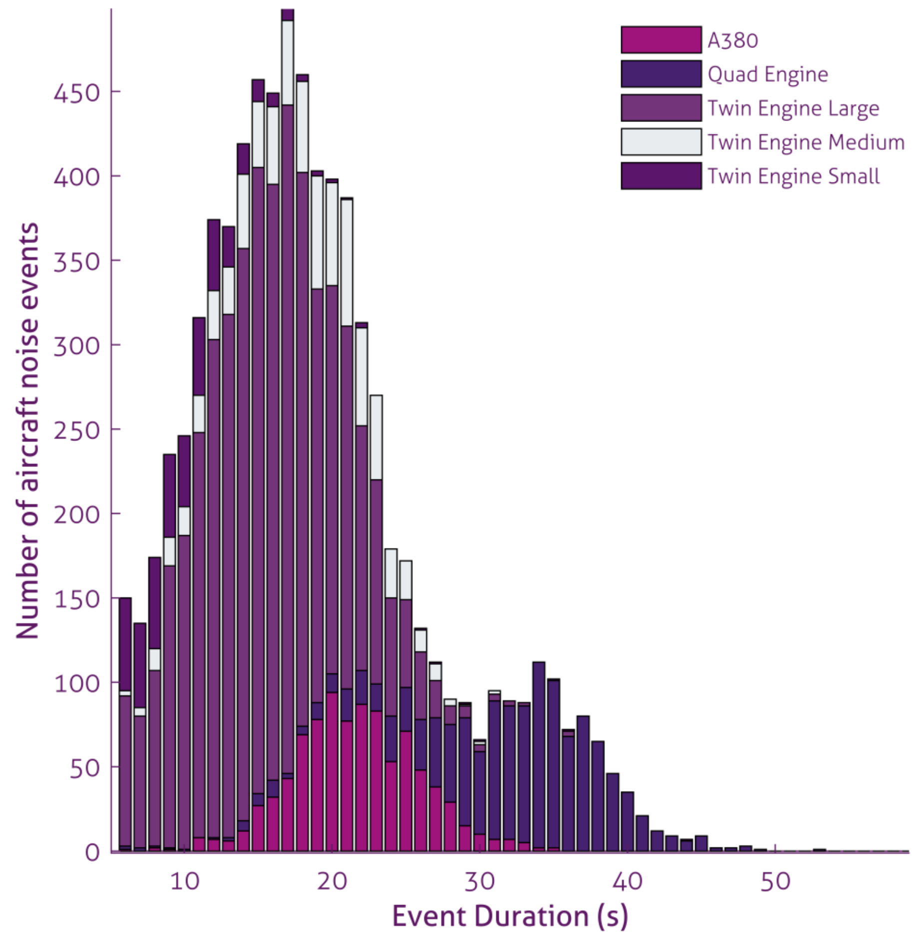
Note: throughout this report, unless otherwise stated, the arithmetic mean is calculated.



How does the duration of an aircraft event vary?

- The duration of an event (as defined for the purposes of this comparison only) is the time for which the noise level exceeds the event threshold level, which, in this case is 65.6dB.
- In addition, events are only recorded if the duration is longer than 6s to prevent impulsive sounds that are not characteristic of aircraft noise being recorded or to prevent shorter duration transient events such as cars or lorries being captured.
- The average duration of **all measured aircraft events** was 28 seconds. The quad engine group, which predominantly comprises B747s and smaller number of A340s, is notably larger than all aircraft groups. This is responsible for the peak at 86dB in the SEL plot on the previous page.
- A small number of events with durations greater than 60 seconds were excluded from this analysis as they were assumed to be contaminated by other noise sources.

Aircraft group	Average noise event duration (seconds)
A380	21.6
Quad engine aircraft	32.2
Twin engine - large	15.7
Twin engine - medium	18.3
Twin engine - small	11.1



Which aircraft types account for the measured noise events?

- The table to the right shows the proportion of aircraft noise events recorded for each aircraft type overall, by route, and whether the analysis shows it to be overhead at the noise monitor.
- The aircraft types listed are limited to the most common aircraft types operating at Heathrow. The remaining aircraft types are listed under 'Other'.
- The B777 was responsible for the largest share of aircraft noise events, at 42% this was almost three times the next aircraft, the B747. The B777 movements were fairly evenly split between the westerly UMLAT and BPK routes, while the vast majority of B747 routes were from aircraft on UMLAT.
- The aircraft noise events at Eton Wick are generally dominated by larger aircraft types. The A320 family, which was responsible for about 60% of movements through the gate, only accounted for 5% of noise measured at Eton Wick during the monitoring period. This suggests that the background noise may be too high at this location to capture all aircraft noise events.

Aircraft Type	Total*	Route			Overhead**
		Westerly UMLAT	Westerly BPK	Other	
B777	42%	19%	22%	<1%	17%
B747	15%	14%	1%	<1%	11%
A330	13%	5%	8%	<1%	4%
A380	12%	4%	7%	<1%	1%
B767	9%	9%	0%	<1%	8%
A321	4%	0%	3%	<1%	1%
B787	2%	1%	1%	<1%	0%
A320	1%	0%	1%	<1%	1%
A340	1%	0%	0%	<1%	0%
B737	1%	1%	0%	0%	0%
A319	0%	0%	1%	0%	0%
A350	0%	0%	0%	<1%	0%
B757	0%	0%	0%	0%	0%
Other	1%	0%	0%	0%	1%
Total* **	**100%**	**54%**	**45%**	**1%**	**45%**

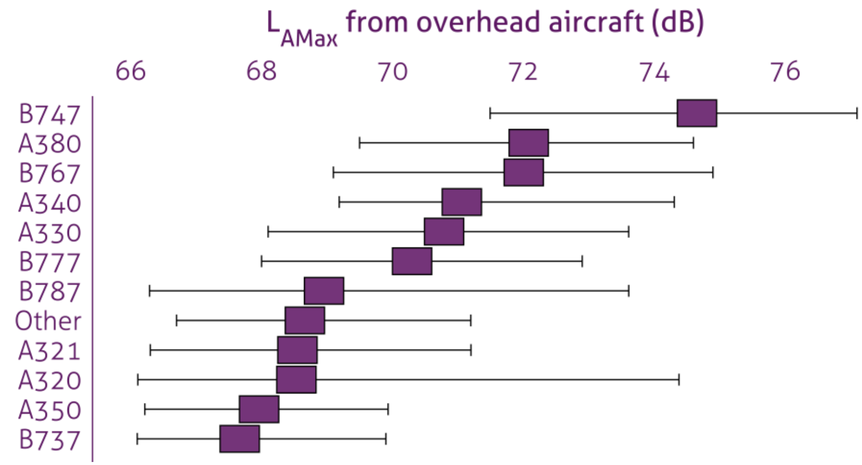
* Percentage based on 7,753 aircraft noise events recorded between 30th May and 29th November 2019.
** Defined as being with the 83 degree cone described on Page 9.
*** Totals may differ to sum of aircraft types due to rounding.

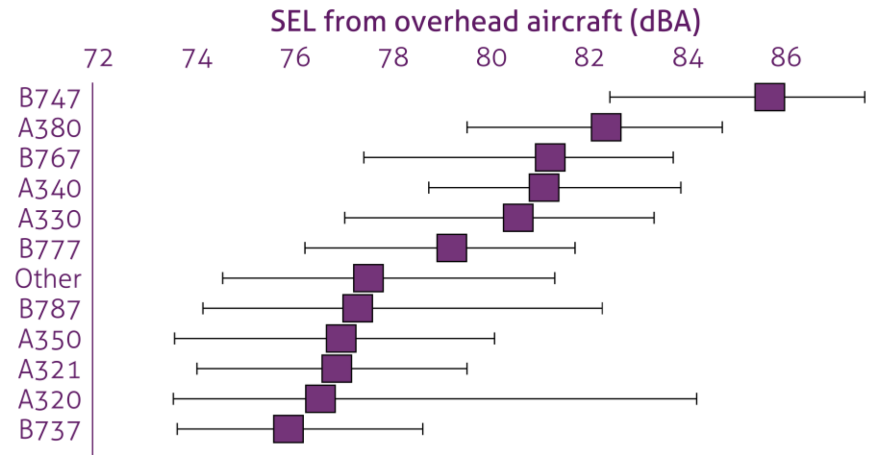
Comparison of average noise levels for different aircraft types

The plot in the top right show the average L_{Amax} of each aircraft type in addition to the 5th and 95th percentile within the 83 degree overhead cone. These were exclusively departures on westerly operations.

- At Eton Wick, the highest average measured noise level was from the B747, which at 74.5dB L_{Amax} was more than 2dB louder than the next loudest aircraft types; the A380 and B767.
- The B737 is the quietest aircraft type at just under 68dB L_{Amax}.
- The average L_{Amax} of the newest aircraft types in service at Heathrow, the B787 and A350 (both large twin engine aircraft), are 68dB; comparable to the small twin engine aircraft.

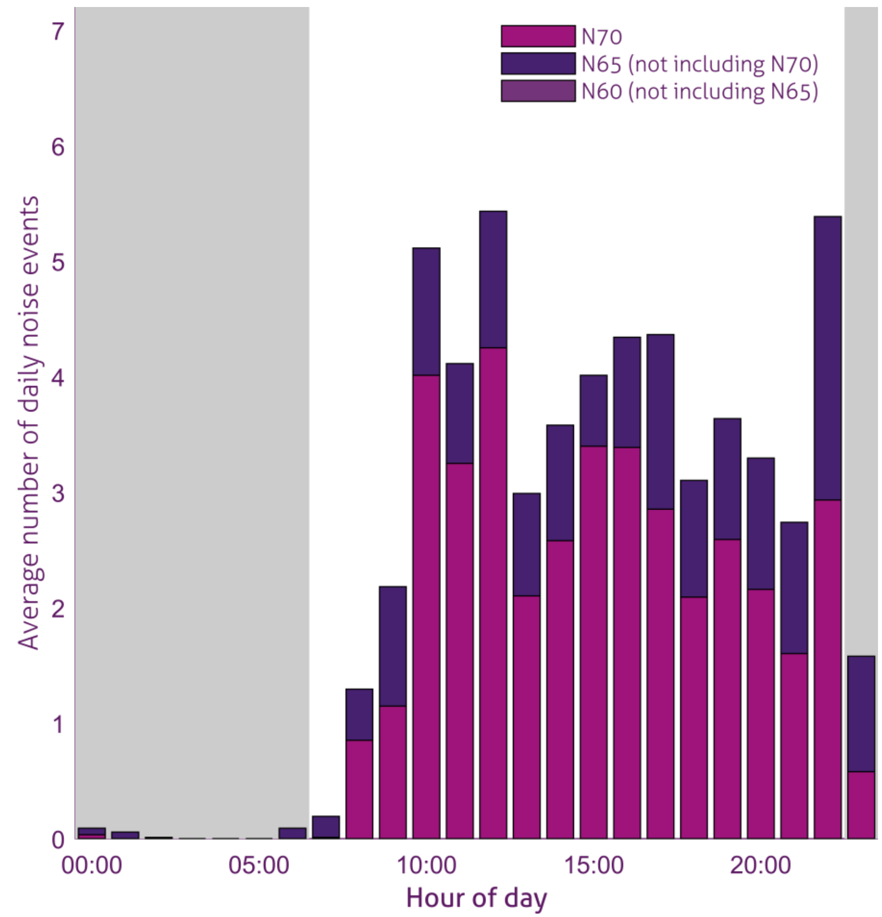
The plot in the bottom right corner shows the average SEL of each aircraft type. The SEL takes into account all energy within a noise event. The relationship of aircraft types is similar to that seen in the L_{Amax} plot; however, the small twin engine aircraft are relatively quieter than larger aircraft types, presumably due to the shorter average duration of noise events.





How does the number of noise events vary across a day?

- It is recognised that the response to aircraft noise is related to more than average noise levels alone. The number of events and their individual levels are becoming increasingly recognised as a useful indicator of community response to aircraft noise.
- The N_{above} metrics describe the number of events in a period where the L_{Amax} exceeds a given value. For example, an $N65_{1hr}$ of 10 means that ten aircraft generated a maximum noise level greater than 65dB L_{Amax} in a single hour.
- The figure to the right shows the average hourly N60, N65 and N70 values across an average 24hr period on full days of westerly operations.
- During the daytime hours (07:00 and 23:00), there were typically up to six aircraft noise events being registered per hour. The busiest hours, in terms of number of noise events, are 12:00-13:00 and 22:00-23:00.
- On an average westerly day, the N65 during the 16h day period (07:00-23:00) was 56; the N60 during the 8h night (23:00-07:00) was two.
- The N60 during the night period on westerly days was predominantly made up of late runners between 23:00 and 00:00.



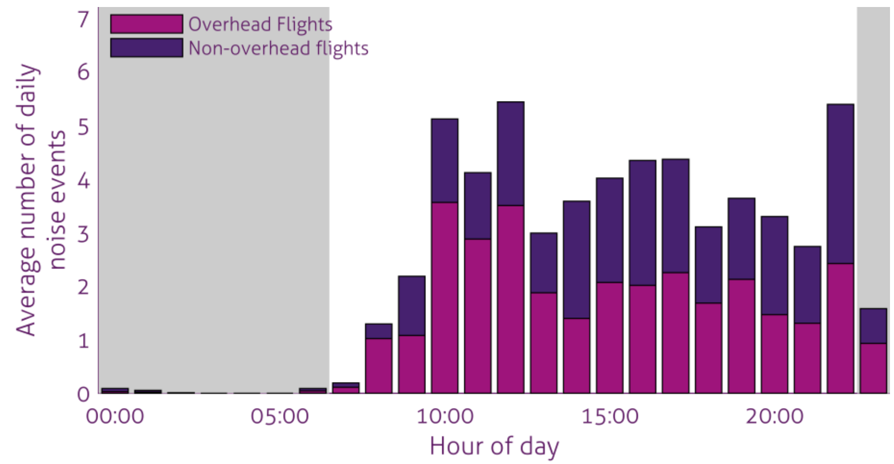
How does the number of aircraft noise events vary across a day?

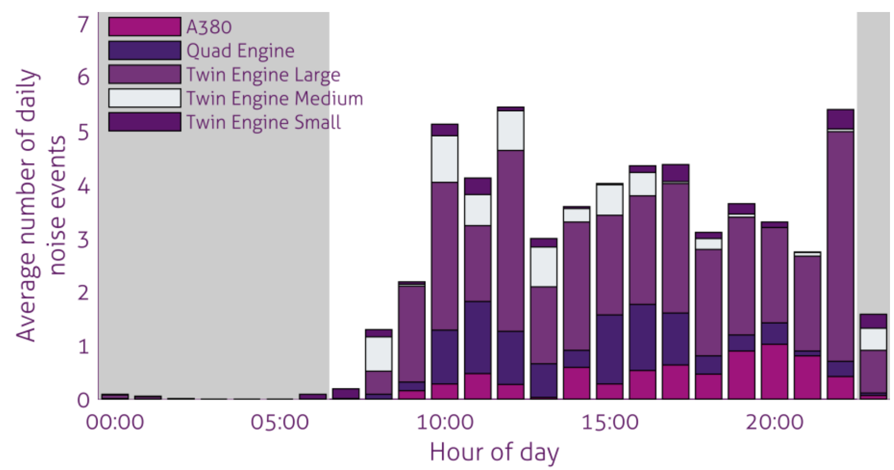
The top right figure shows the average number of noise events during each hour of the day for days of full westerly operations.

- During daytime hours, there were typically up to six aircraft noise events per hour of which the majority were overhead (passing within the 83 degree cone above the monitor).
- The proportion of overhead aircraft fluctuated throughout the day, but in general the proportion overhead was higher before 14:00 compared to the rest of the day.

The bottom right figure shows the same data broken down by aircraft size.

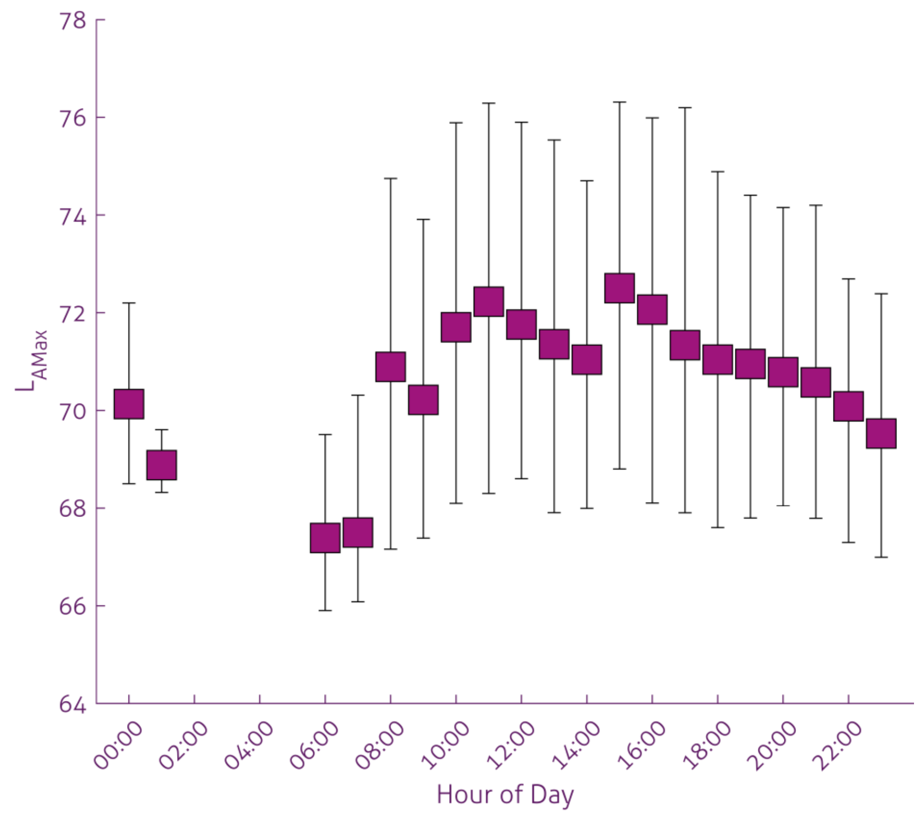
- Overall, a small proportion of noise events were from small twin engine aircraft. This was the case across all hours.
- Although forming a relatively small proportion of all events, the majority of noise events from medium-sized, twin engine aircraft occurred between 08:00 and 17:00.
- There are three peaks of quad engine aircraft (including A380s) through the day; 11:00-12:00, 16:00-17:00 and 20:00 to 21:00.
- During the busiest hour between 22:00 and 23:00, large twin engine aircraft are responsible for the vast majority of events.





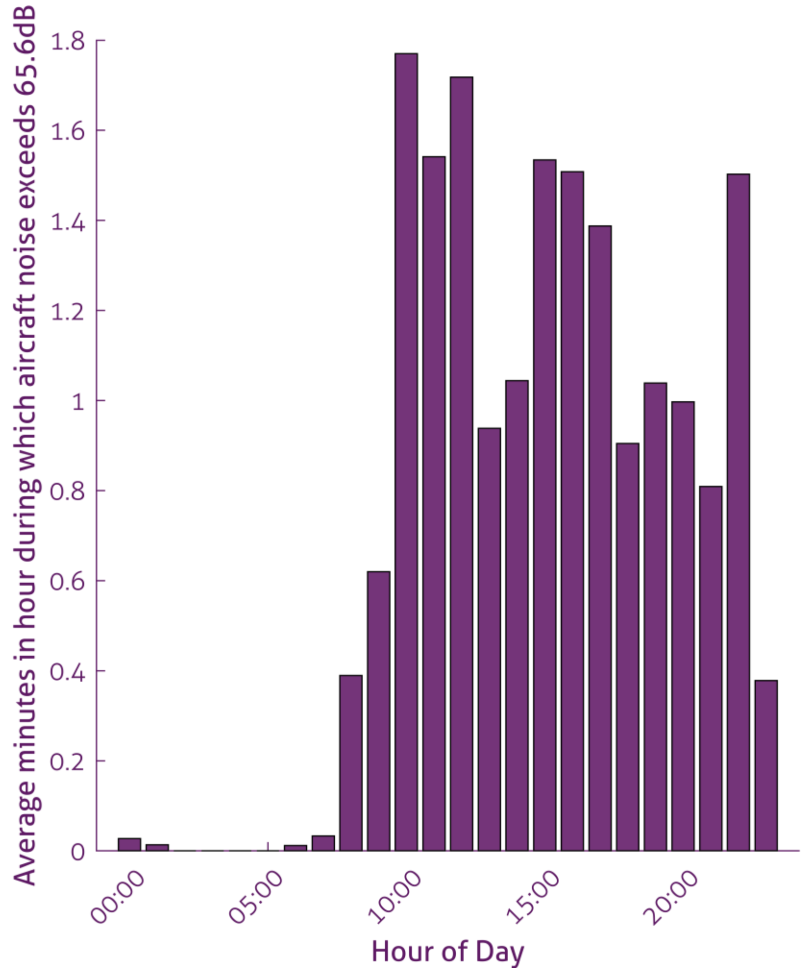
How does the L_{Amax} vary across a day?

- The figure to the right shows the average and range of L_{Amax} values of aircraft noise events for each hour of the day. The range represents the 5th and 95th percentile in each hour.
- In the morning period from 06:00 to 08:00, the average L_{Amax} is approximately 67dB. This occurs during a period when very few events are recorded at Eton Wick.
- Between 08:00 and 24:00, the average L_{Amax} falls between 70 and 72dB with a peak occurring 15:00-16:00. After 16:00, the average level gradually decreases towards midnight.
- In any given hour, the range of L_{Amax} is generally between 4 and 8dB.
- The early morning (00:00-02:00) data is an average of only around 15 aircraft events over the monitoring period (six months).



Average minutes in an hour during which aircraft noise exceeded monitor threshold

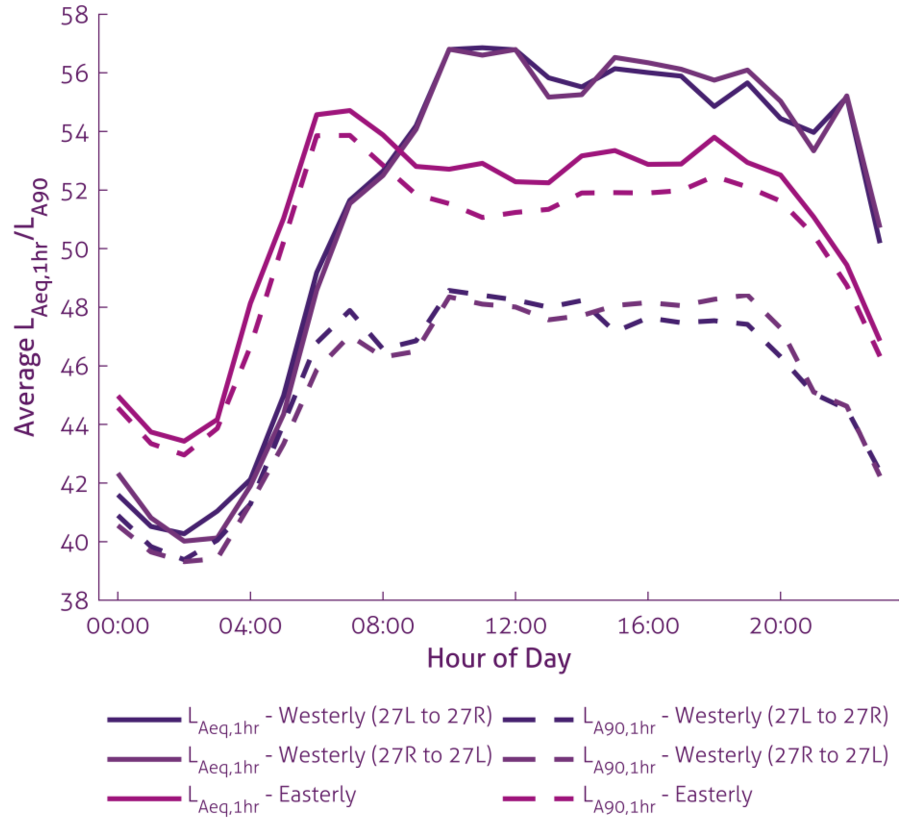
- The figure to the right shows the average number of minutes in each hour when the level of aircraft noise exceeds the noise event threshold – in this case 65.6dB – on a day of full westerly operations. At this location, this could be described as the amount of time (in minutes) that the aircraft noise level exceeds 65.6dB.
- It should be noted that individual aircraft events may be audible when the level is below that of the monitor threshold, and, therefore, the total time the events are audible may be greater than given in the figure. This would be particularly the case during the night when background noise is lowest.
- The figure shows that on full days of westerly operations, aircraft noise exceeded the monitor threshold for a total of up to 1.8 minutes per hour.
- The period during which the monitor threshold was exceeded for the greatest proportion occurred between 10:00 and 13:00.



Note: It is important not to compare the results on this page with other sites since the individual threshold can vary from monitor to monitor. The same noise event would register a longer duration if a lower threshold were to be used.

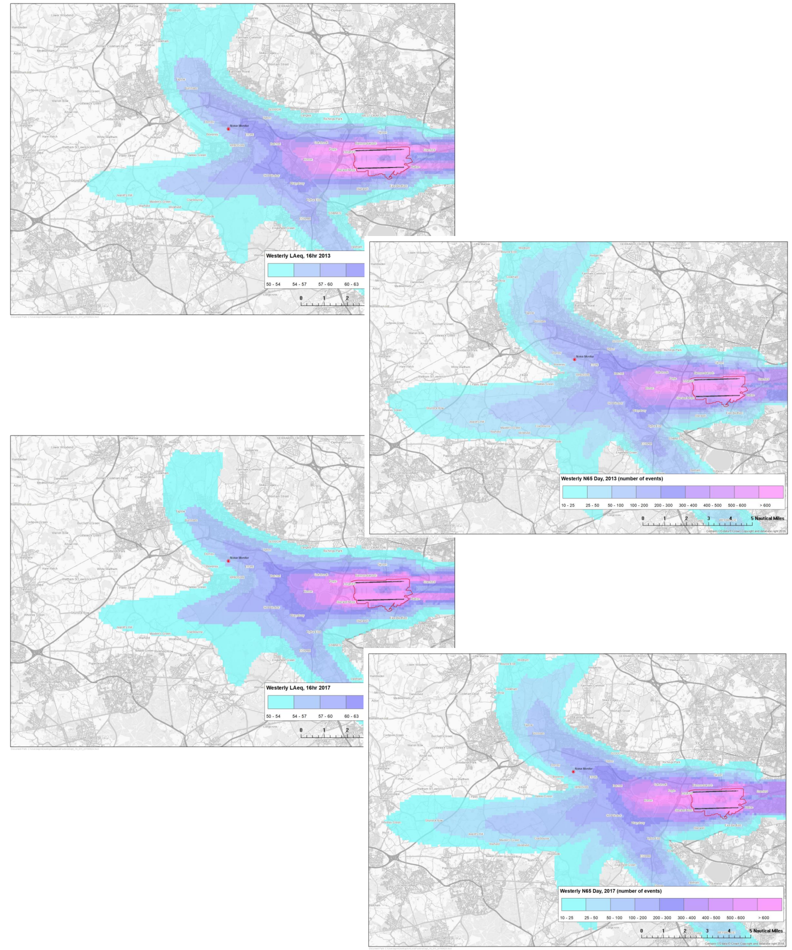
Do aircraft contribute to overall ambient noise levels?

- The figure to the right shows the average hourly $L_{Aeq,1hr}$ (ambient) and $L_{A90,1hr}$ (background) noise levels on days where 100% of operations were either westerly or easterly. It also shows the effect of runway alternation on overall noise levels.
- It should be noted that these metrics describe the overall noise environment comprising all noise sources, not just aircraft noise.
- During daytime hours (07:00-23:00), the hourly average noise levels fall between 52 and 57dB, with the loudest hours occurring between 10:00 and 13:00 and generally decreasing throughout the day. Runway alternation has little effect on the average noise levels.
- During full days of easterly operations, average noise levels peak between 06:00 and 08:00 reaching 55dB. From 09:00-22:00, the noise levels are approximately 53dB; 2-4dB quieter than the equivalent hour on westerly operations.
- During the period the monitor was in place, the average daytime $L_{Aeq,16hr}$ (07:00 - 23:00) was 55dB on westerly operations and 53dB on easterly operations from all noise sources.
- During the night, the average $L_{Aeq,8hr}$ (23:00 - 07:00) was 45dB on westerly operations and 49dB on easterly operations.



Modelled long term average aircraft noise levels around the airport

- 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 AEDT model has been run using flight track data for **2013 and 2017** 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 operations** across the summer in each of these years.
- Note that these contours are specific to easterly and westerly operations, and are not the same as the ERCD published annual contours, which derive an overall average for the summer that combines westerly and easterly operations. The following maps only use days when there were either full easterly or westerly operations across that day.
- Daytime $L_{Aeq,16hr}$ values are presented in bands >50dB, >54dB and then in 3dB increments to 69dB.
- Night-time $L_{Aeq,8hr}$ values are presented in 5dB bands starting at >40dB up to 65dB.
- These are longer terms metrics averaged over 16 and 8 hours and do not directly reflect the shorter term fluctuations between individual events.
- It should be noted that aircraft noise modelling to average levels around 50dB carries increasing degrees of uncertainty. 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 in mind.

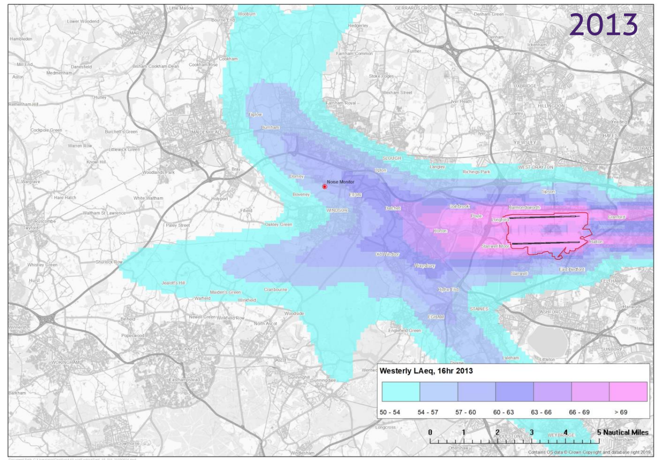


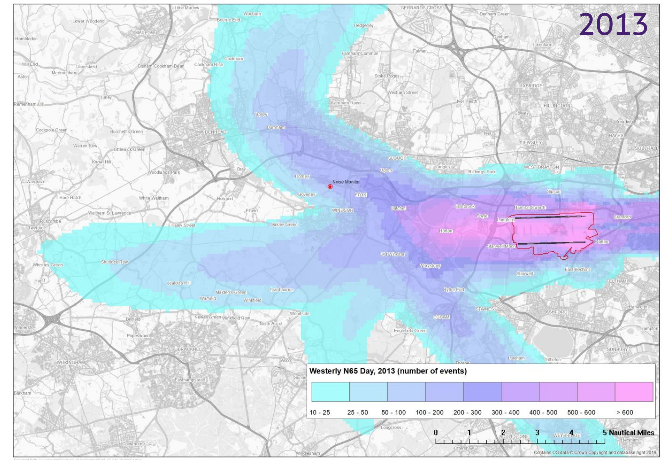
Average **daytime** aircraft noise levels – westerly operations

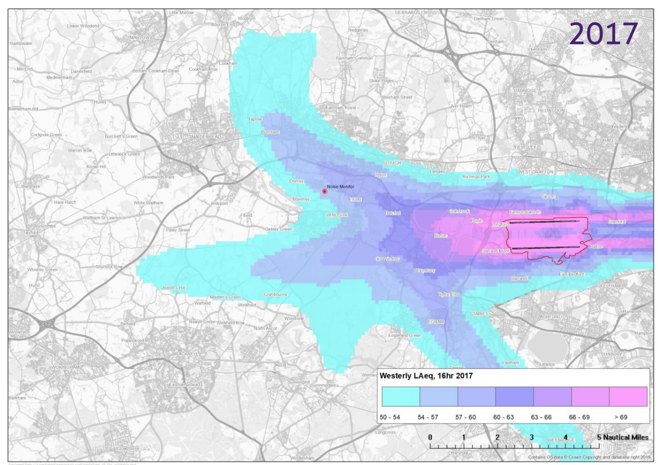
- The figures to the right show the 2013 and 2017 daytime $L_{Aeq,16hr}$ bands in the left column and N65 bands in the right column for **an average summer day when the airport is on 100% westerly operations**.
- The position of the noise monitor is marked by the red dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dB over the 16 hour day period 07:00-23:00.
- Larger figures are shown in Appendix A.

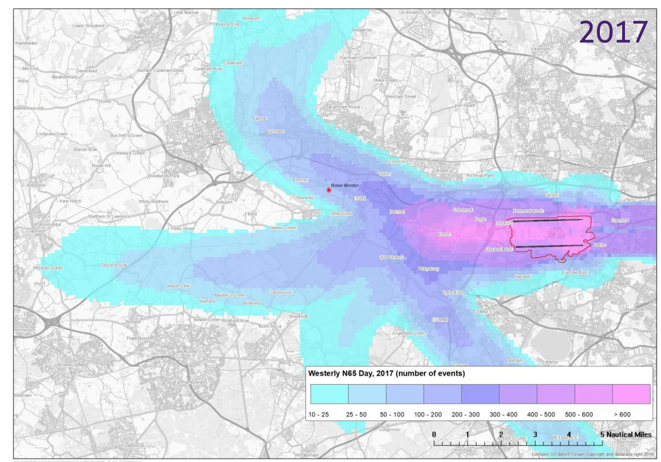
$L_{Aeq,16hr}$

N65



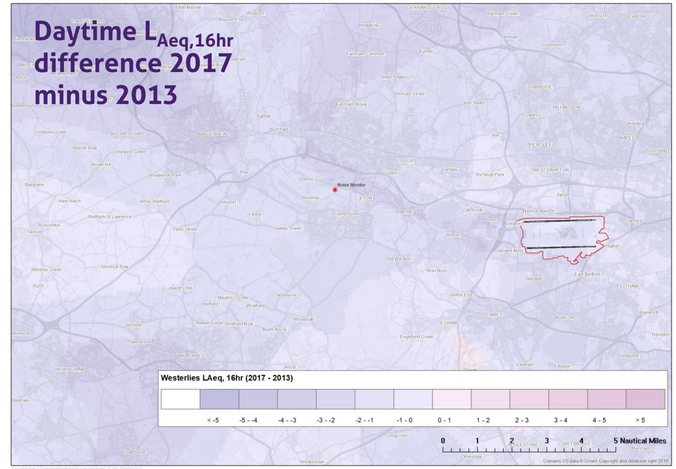


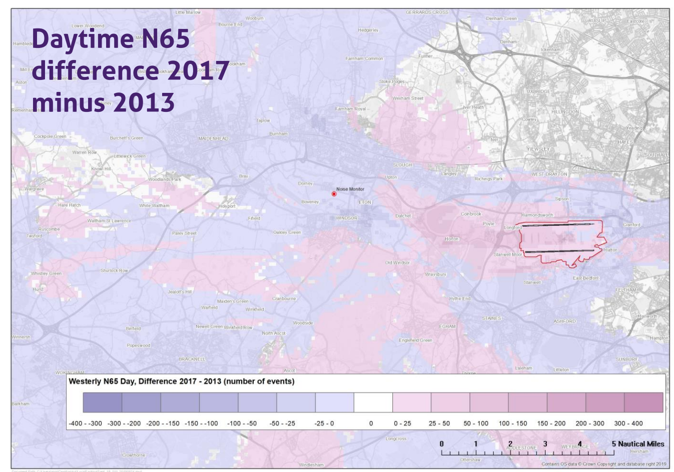




Differences in average **daytime** aircraft noise levels – westerly operations

- The difference in the modelled average $L_{Aeq,16hr}$ and $N65_{16hr}$ contours around Heathrow between 2013 and 2017 are shown in the figures to the right. This is for **an average 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 Eton Wick, there was between a 1 and 2dB decrease in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017, while the modelling also indicates a decrease of up to 25 daytime N65 events.
- It should be noted that, all other variables remaining constant, a difference of 15% in the noise levels would correspond to about a 1dB increase/decrease in $L_{Aeq,16hr}$ and a 100% difference would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.
- Larger figures are shown in Appendix A.

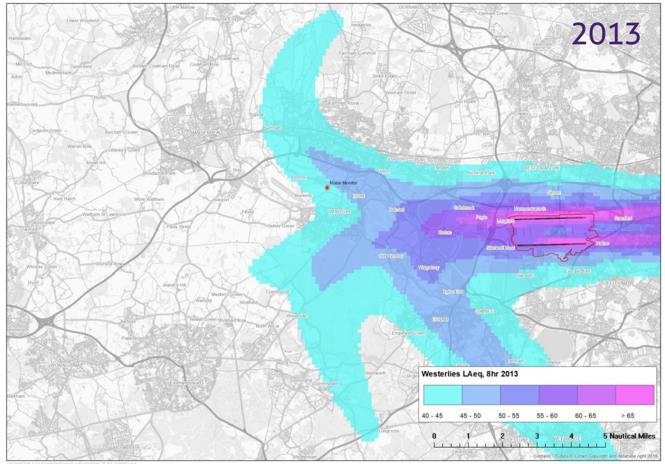


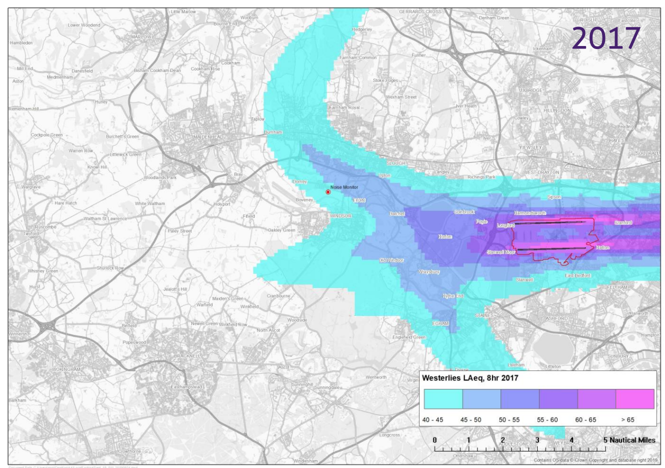


Average **night-time** aircraft noise levels – westerly operations

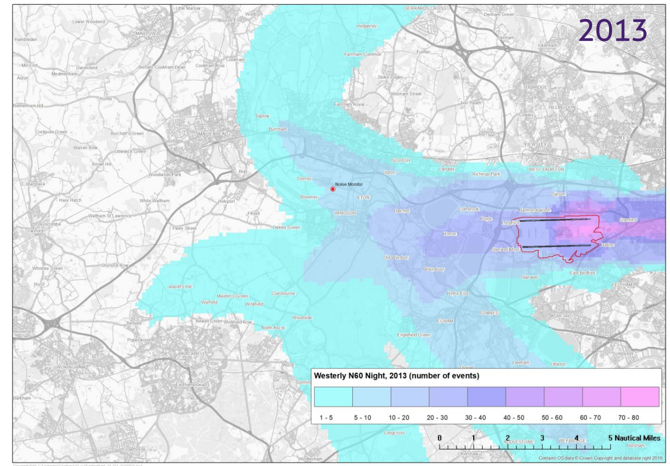
- The figures to the right show the 2013 and 2017 night-time $L_{Aeq,8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on an average summer night 23:00-07:00 when there are 100% westerly operations. Generated from **an average westerly summer day when the 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 over the 8 hour night period 23:00-07:00.
- Larger figures are shown in Appendix A.

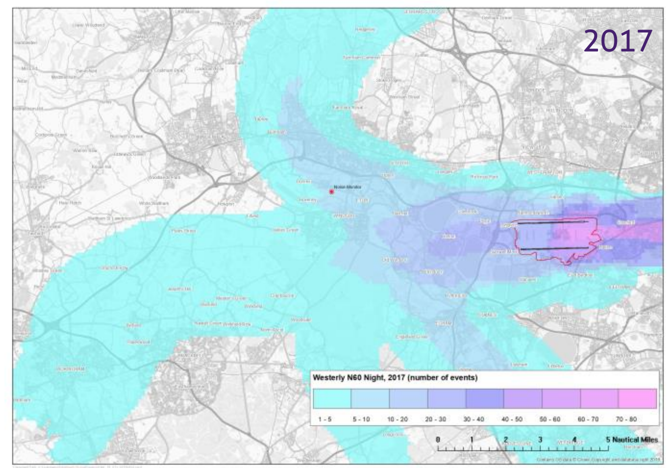
Night-time $L_{Aeq,8hr}$





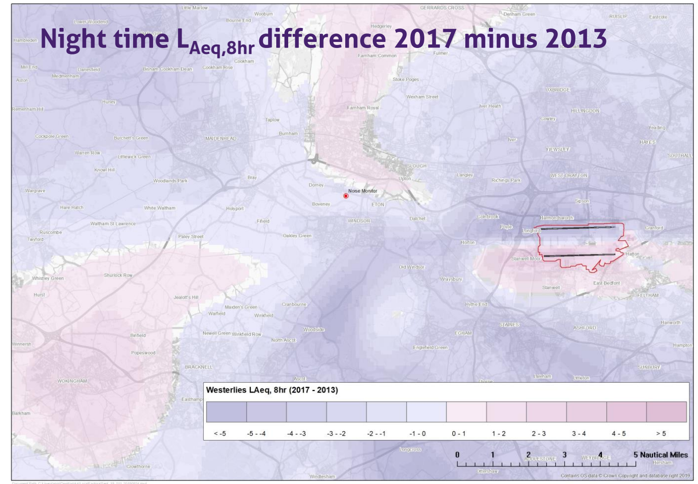
N60, night-time

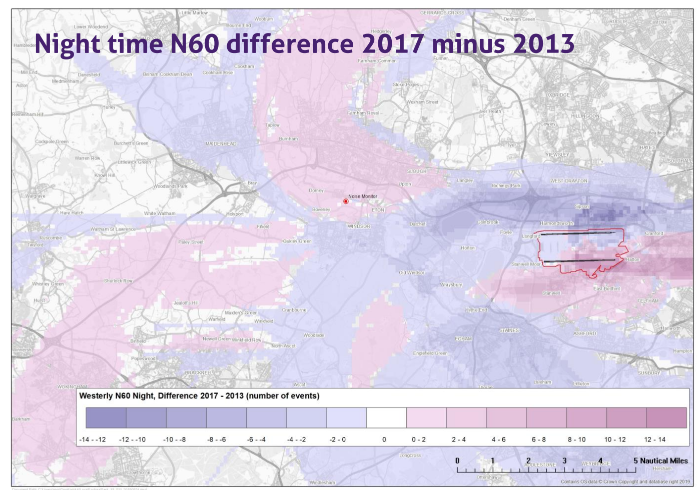




Differences in average **night-time** aircraft noise levels – westerly operations

- The difference in the modelled average $L_{Aeq,8hr}$ (upper figure) and $N60_{8hr}$ (lower figure) values **on 100% westerly operations** around Heathrow between 2013 and 2017 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 decrease in average night-time aircraft noise $L_{Aeq,8hr}$ of less than 1dB while the N60 increased by up to 2 at Eton Wick from 2013 to 2017.
- Larger figures are shown in Appendix A.

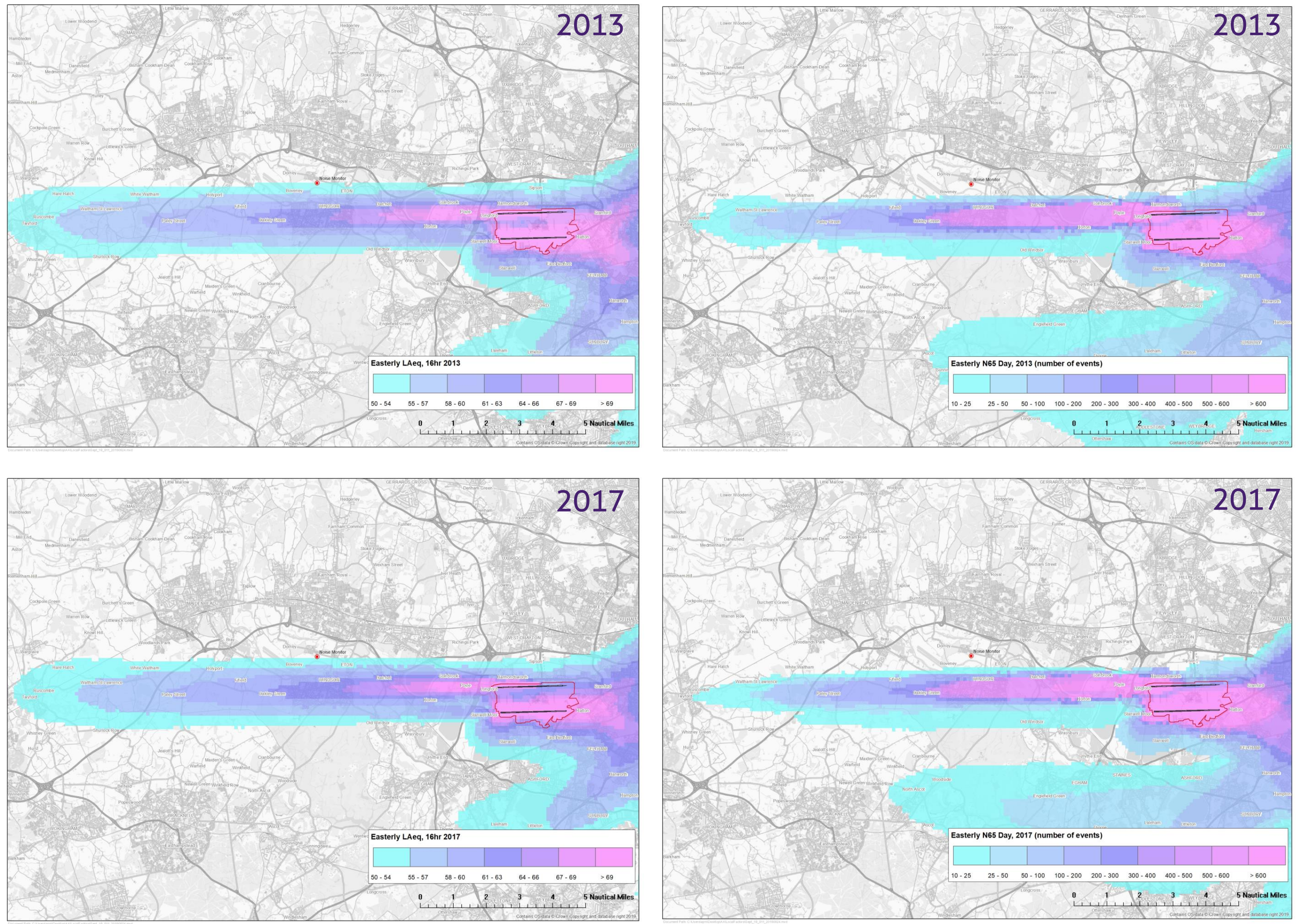




Average **daytime** aircraft noise levels – easterly operations

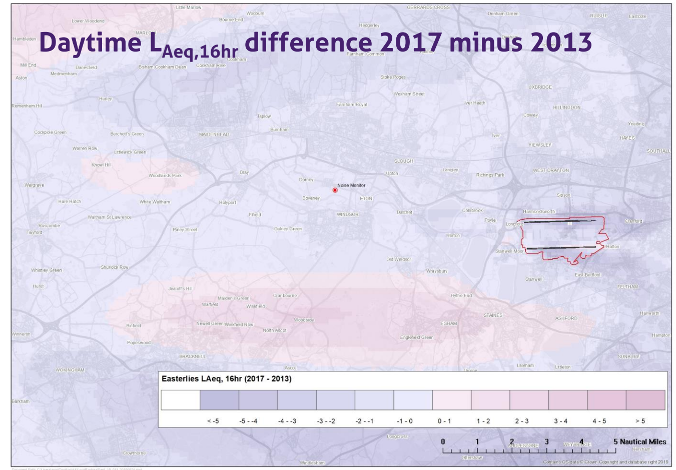
- The figures to the right show the 2013 and 2017 daytime $L_{Aeq,16hr}$ bands in the left column and N65 bands in the right column for **an average summer day when the airport is on 100% easterly operations**.
- The position of the noise monitor is marked by the red dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dB over the 16 hour day period 07:00-23:00.
- Larger figures are shown in Appendix A.

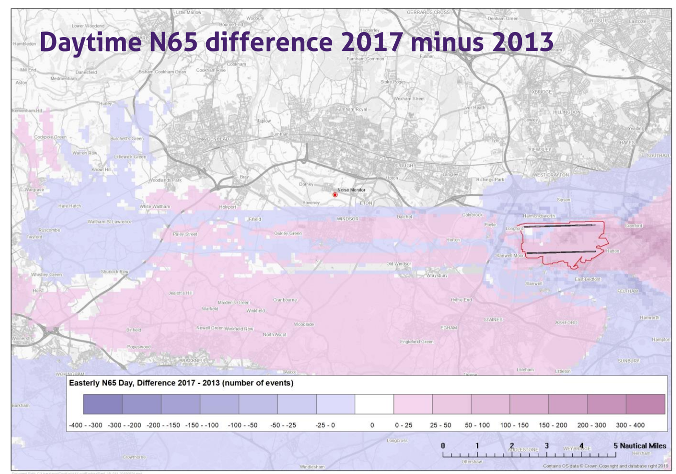
$L_{Aeq,16hr}$ | N65, Daytime



Differences in average **daytime** aircraft noise levels – easterly operations

- The difference in the modelled average $L_{Aeq,16hr}$ and $N65_{16hr}$ contours around Heathrow between 2013 and 2017 are shown in the figures to the right. This is for **an average summer day when the airport is on 100% easterly 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 Eton Wick there was up to a 1dB decrease in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017. However, since there were almost no noise events exceeding 65dB recorded at the noise monitor, the N65 is not a relevant metric on easterly operations at Eton Wick.
- It should be noted that, all other variables remaining constant, a difference of 15% in the noise levels would correspond to about a 1dB increase/decrease in $L_{Aeq,16hr}$ and a 100% difference would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.
- Larger figures are shown in Appendix A.

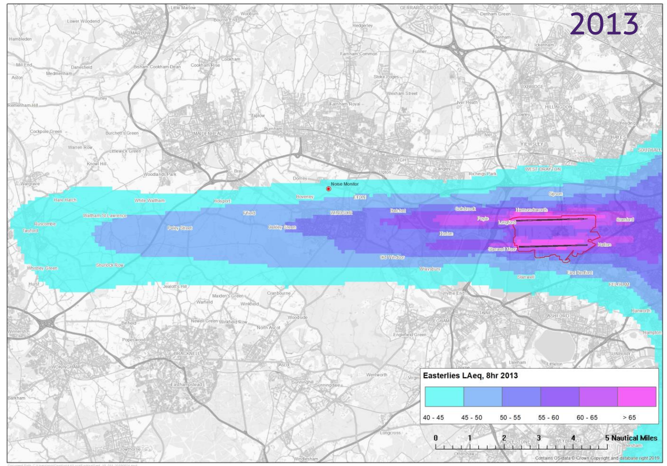


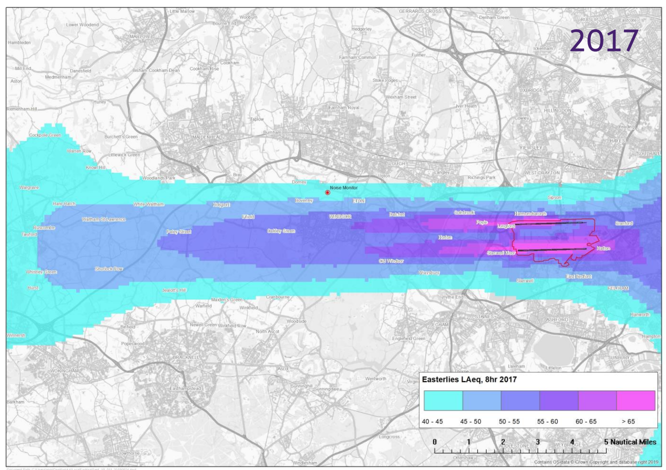


Average **night-time** aircraft noise levels – easterly operations

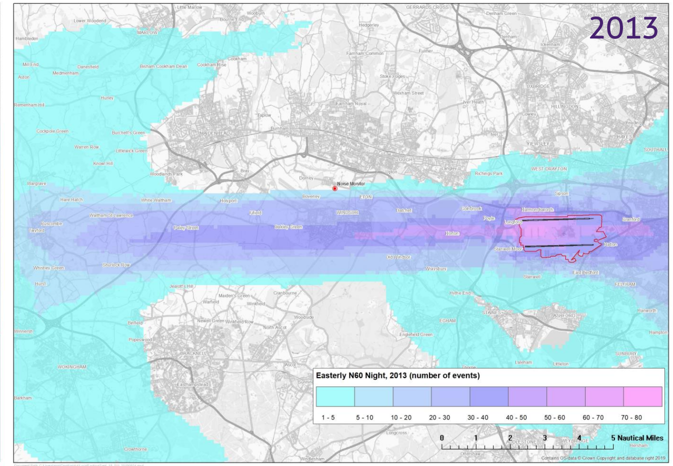
- The figures to the right show the 2013 and 2017 night-time $L_{Aeq,8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on **an average summer night 23:00-07:00 when there are 100% easterly operations.**
- The $L_{Aeq,8hr}$ contours are presented in 5dB intervals from >40 to >65dB.
- The N60 is defined here as the number of aircraft noise events that exceed 60dB over the 8 hour night period 23:00-07:00.
- Larger figures are shown in Appendix A.

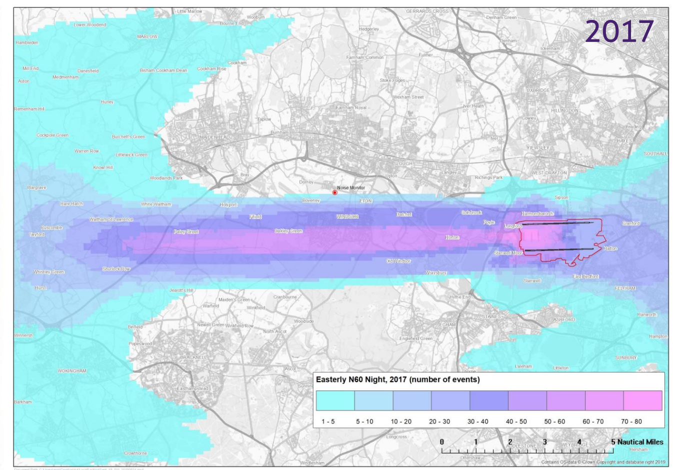
Night-time $L_{Aeq,8hr}$





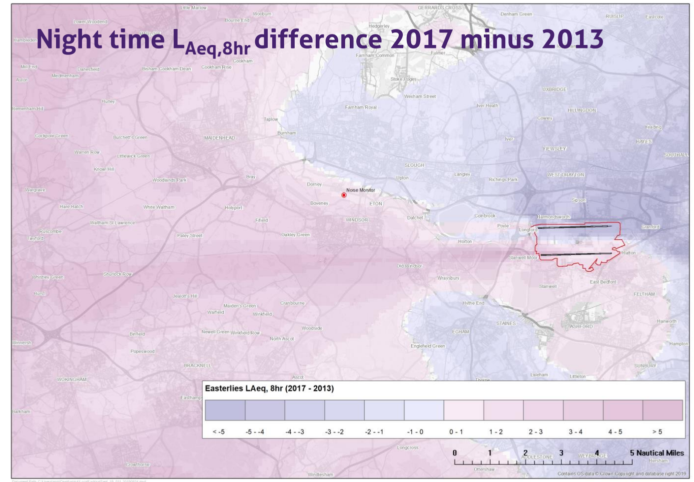
N60, night-time

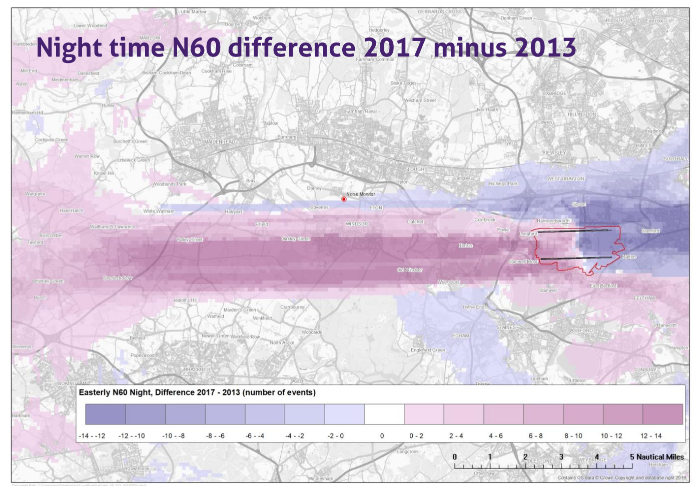




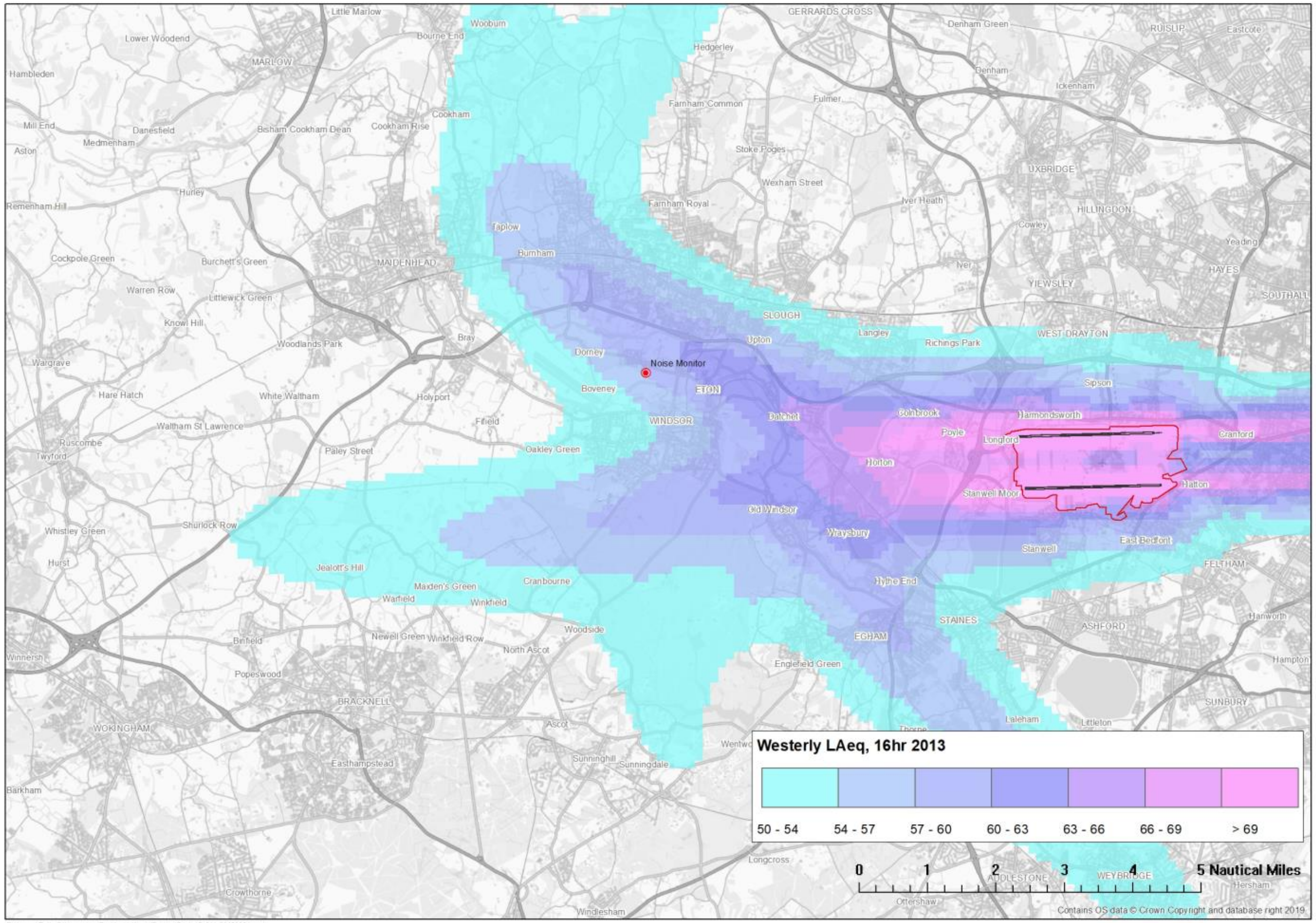
Differences in average **night-time** aircraft noise levels – easterly operations

- The difference in the modelled average $L_{Aeq,8hr}$ (upper figure) and $N60_{8hr}$ (lower figure) values **on 100% easterly operations** around Heathrow between 2013 and 2017 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 an increase in average night-time aircraft noise $L_{Aeq,8hr}$ of up to one decibel at Eton Wick from 2013 to 2017. In a similar manner to the difference in N65 on Page 37, Eton Wick falls just outside of the N60=1 contour in both 2013 and 2017.
- Larger figures are shown in Appendix A.

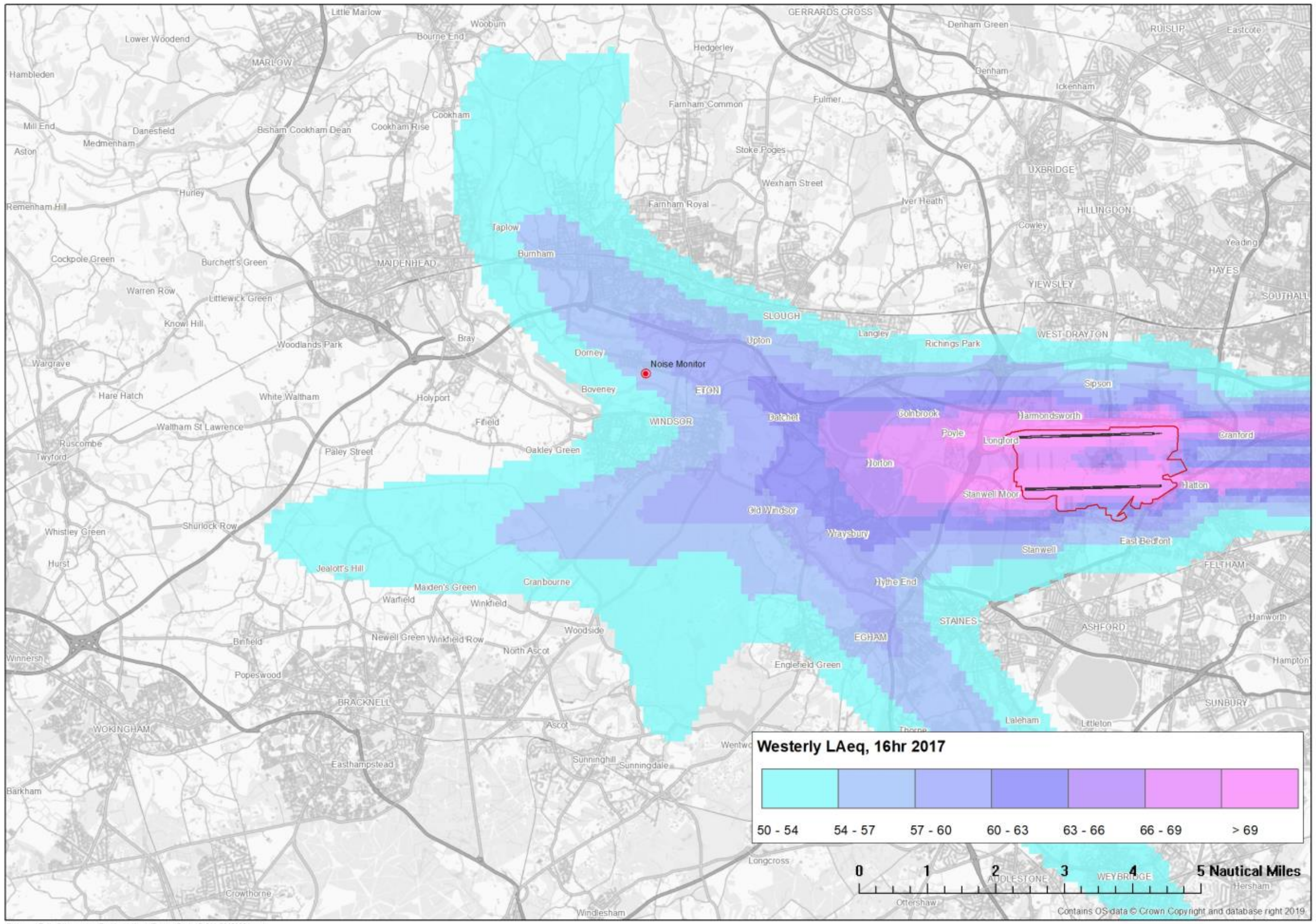




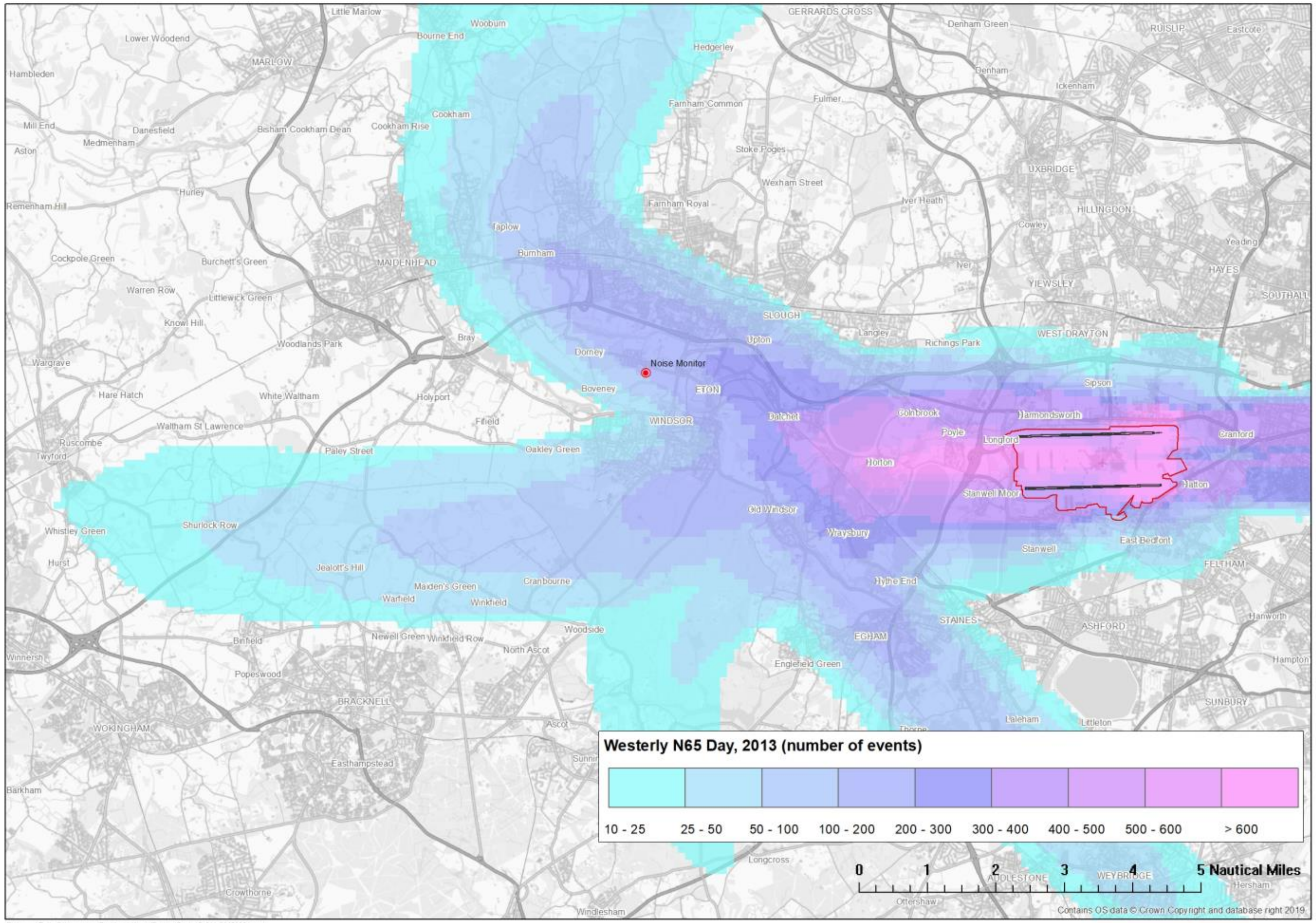
Appendix A: Average westerly day $L_{Aeq,16hr}$ contours (2013)



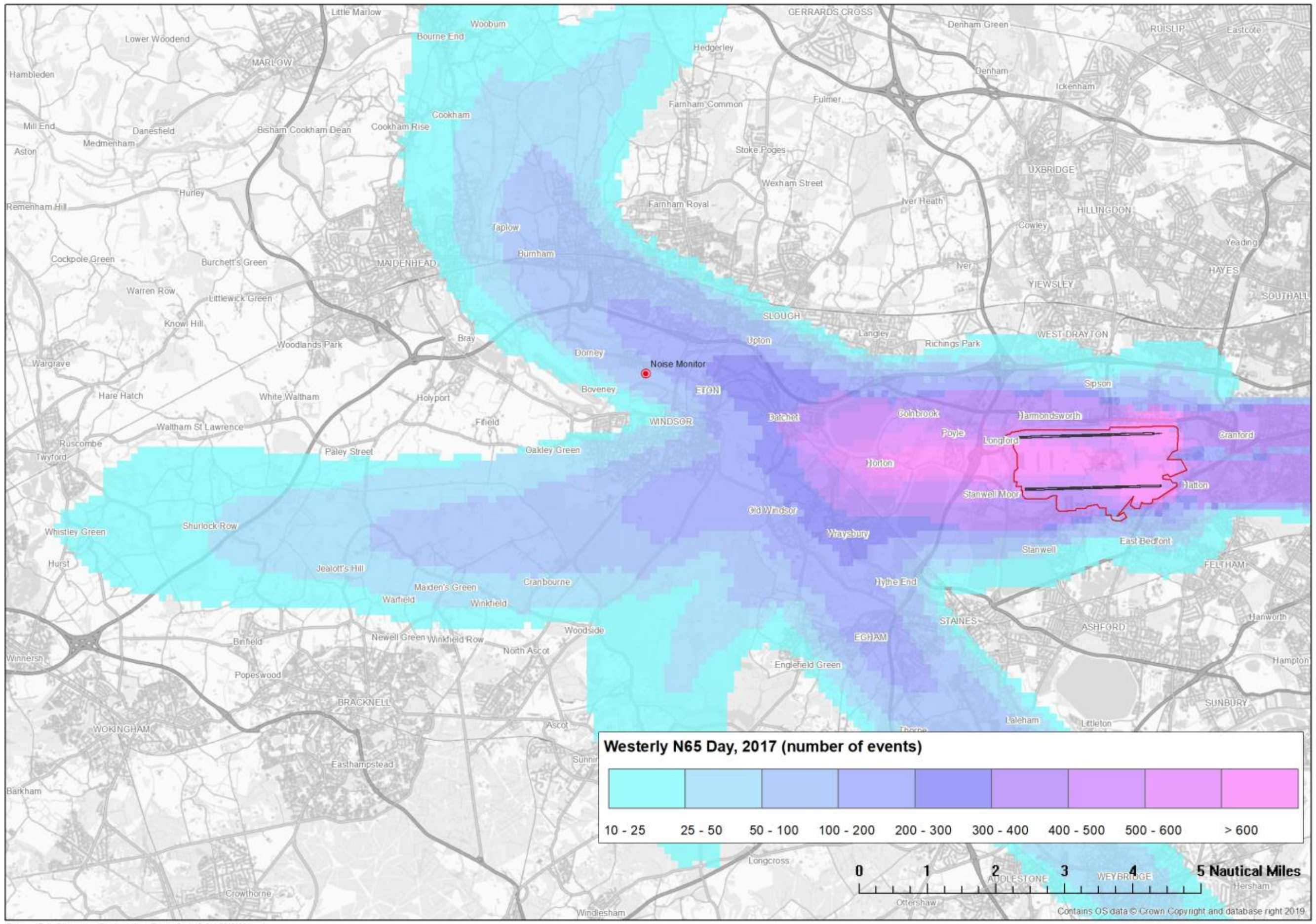
Appendix A: Average westerly day $L_{Aeq,16hr}$ contours (2017)



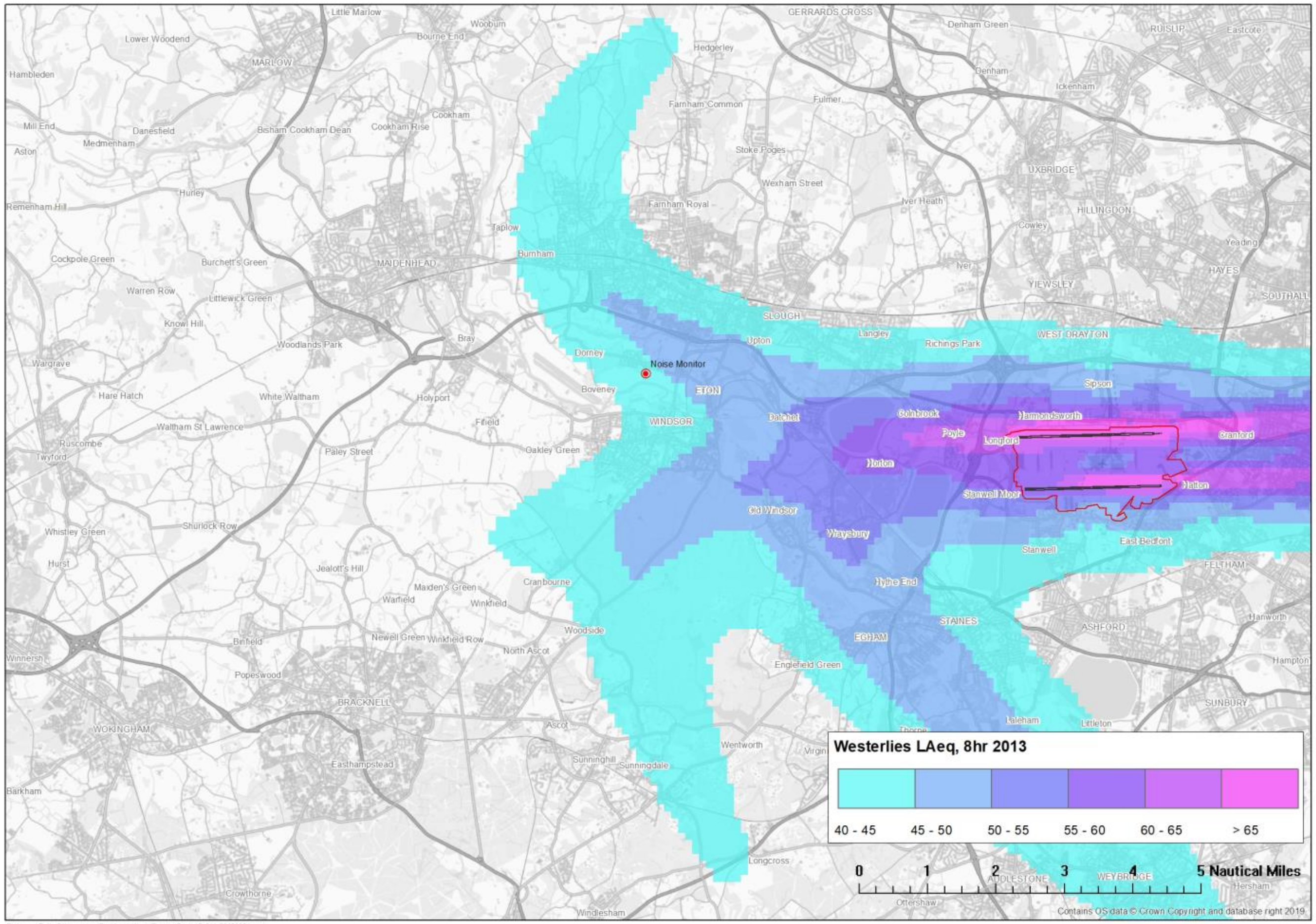
Appendix A: Average westerly day $N65_{16hr}$ contours (2013)



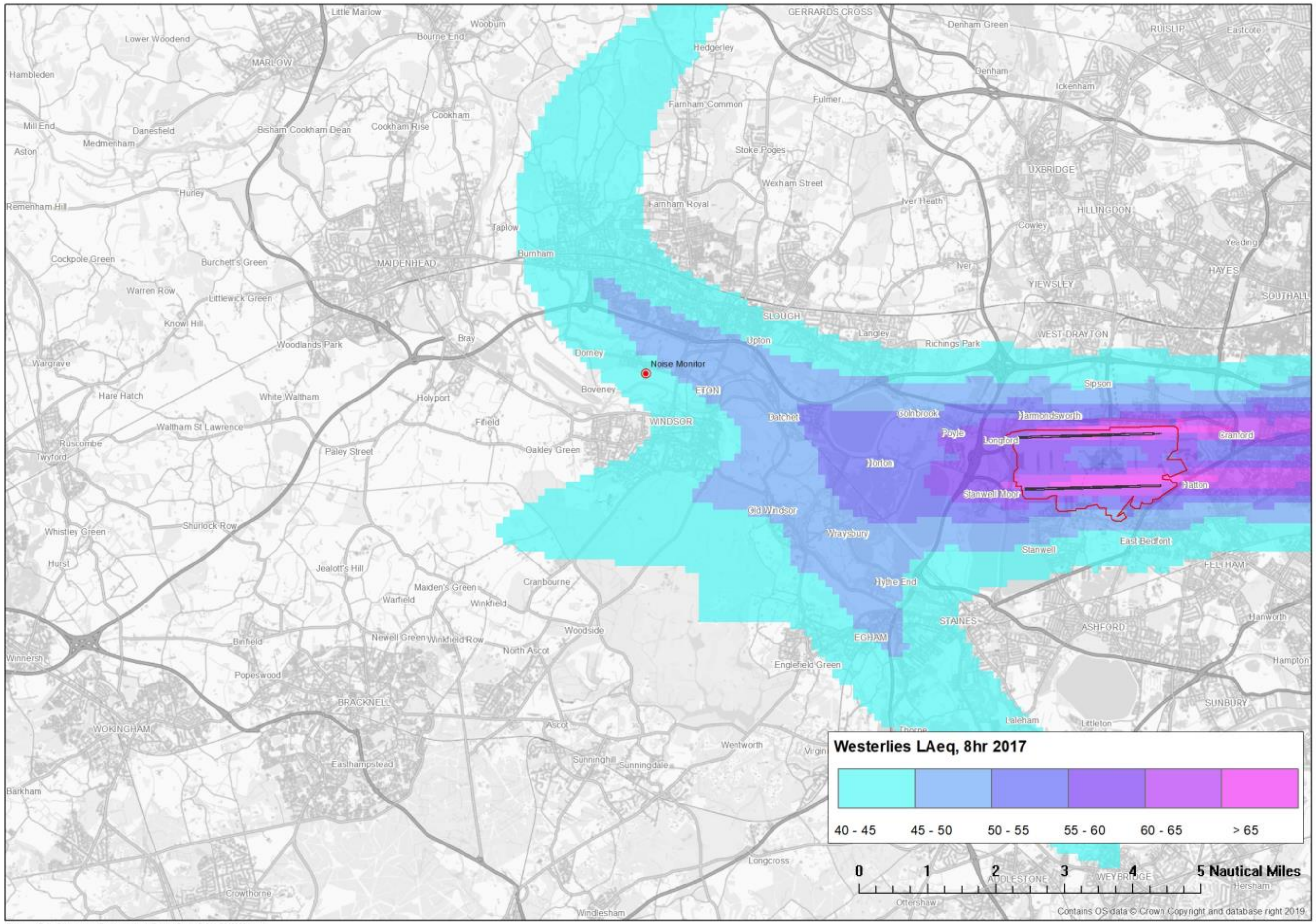
Appendix A: Average westerly day $N65_{16hr}$ contours (2017)



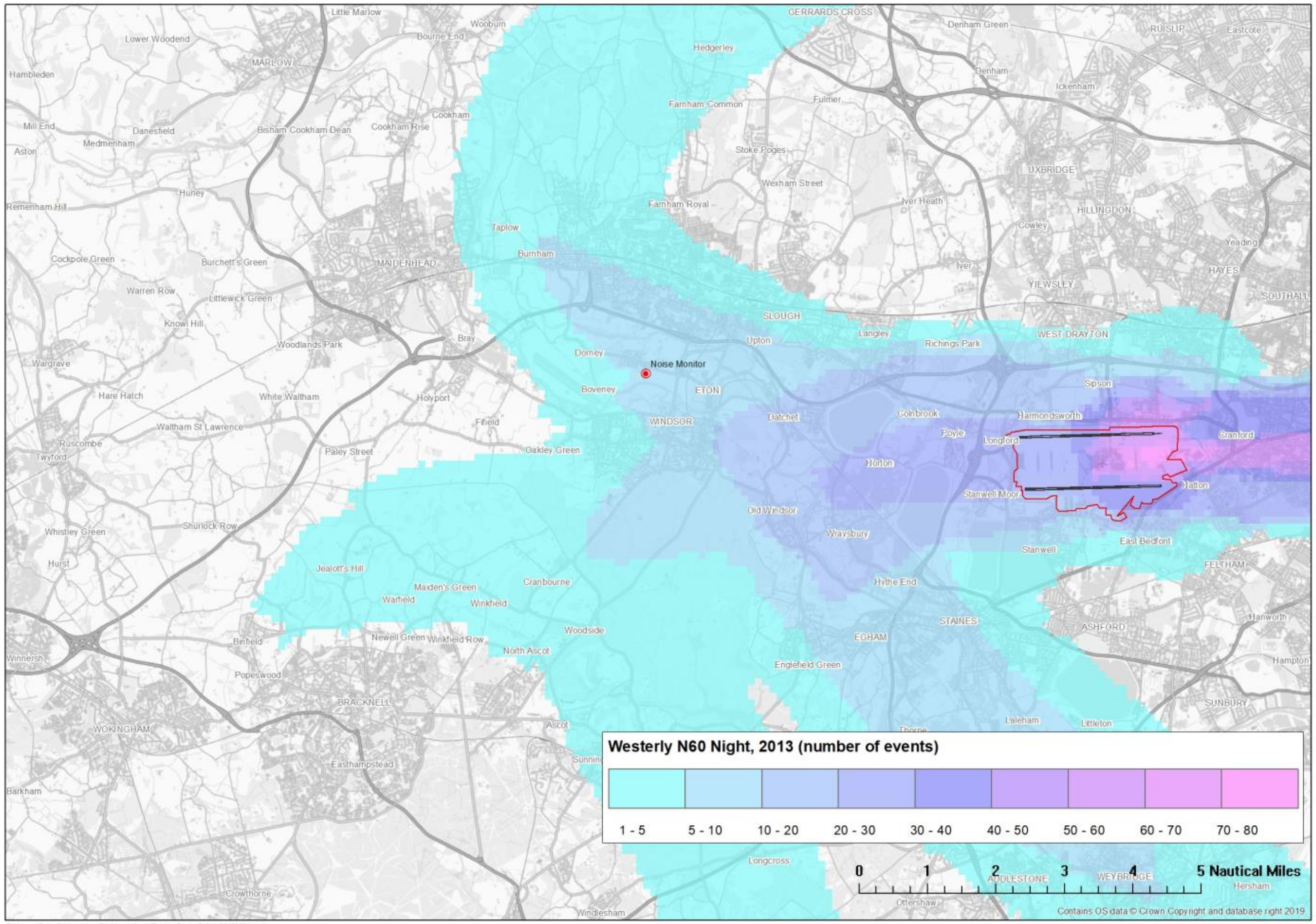
Appendix A: Average westerly night $L_{Aeq,8hr}$ contours (2013)



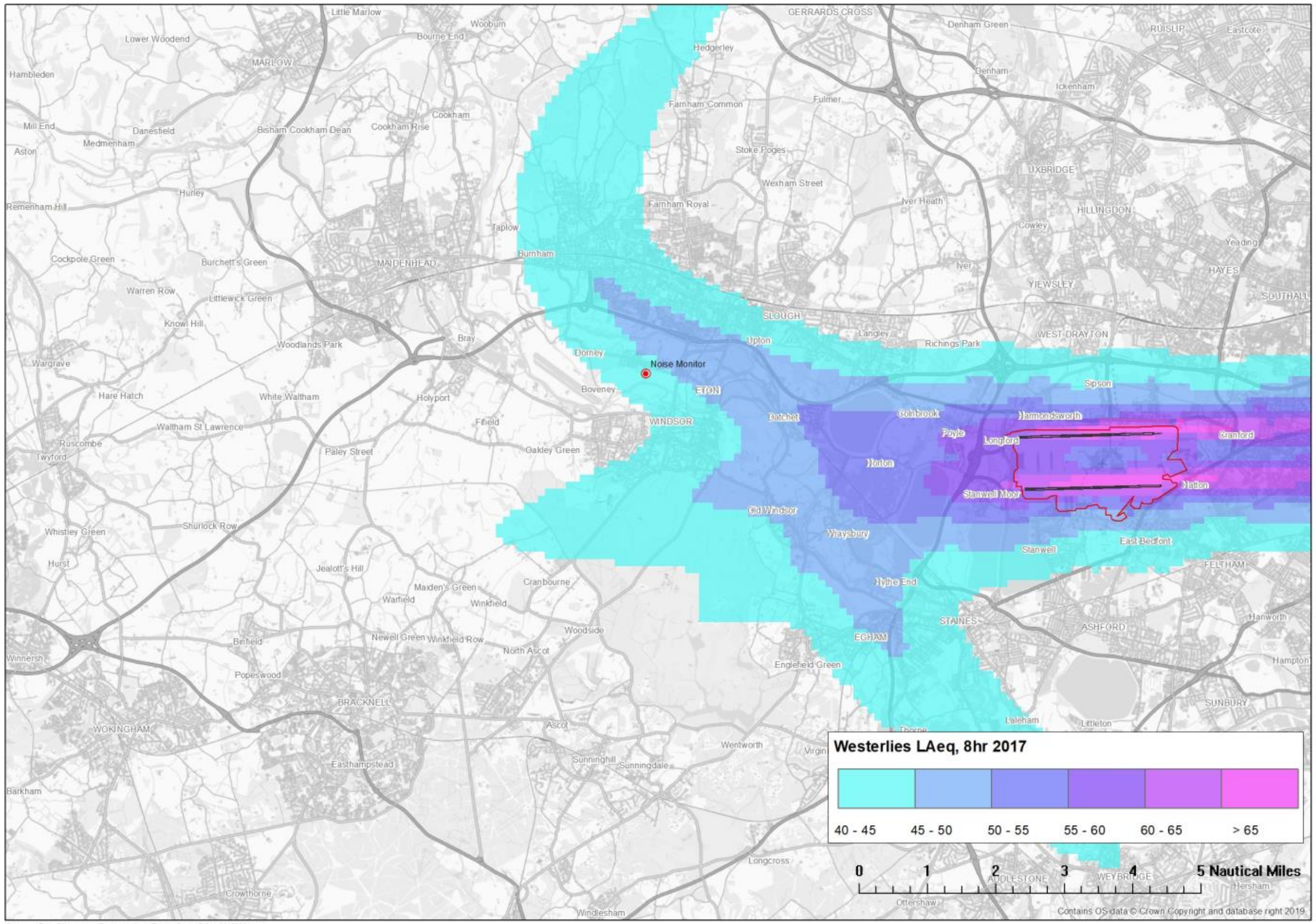
Appendix A: Average westerly night $L_{Aeq,8hr}$ contours (2017)



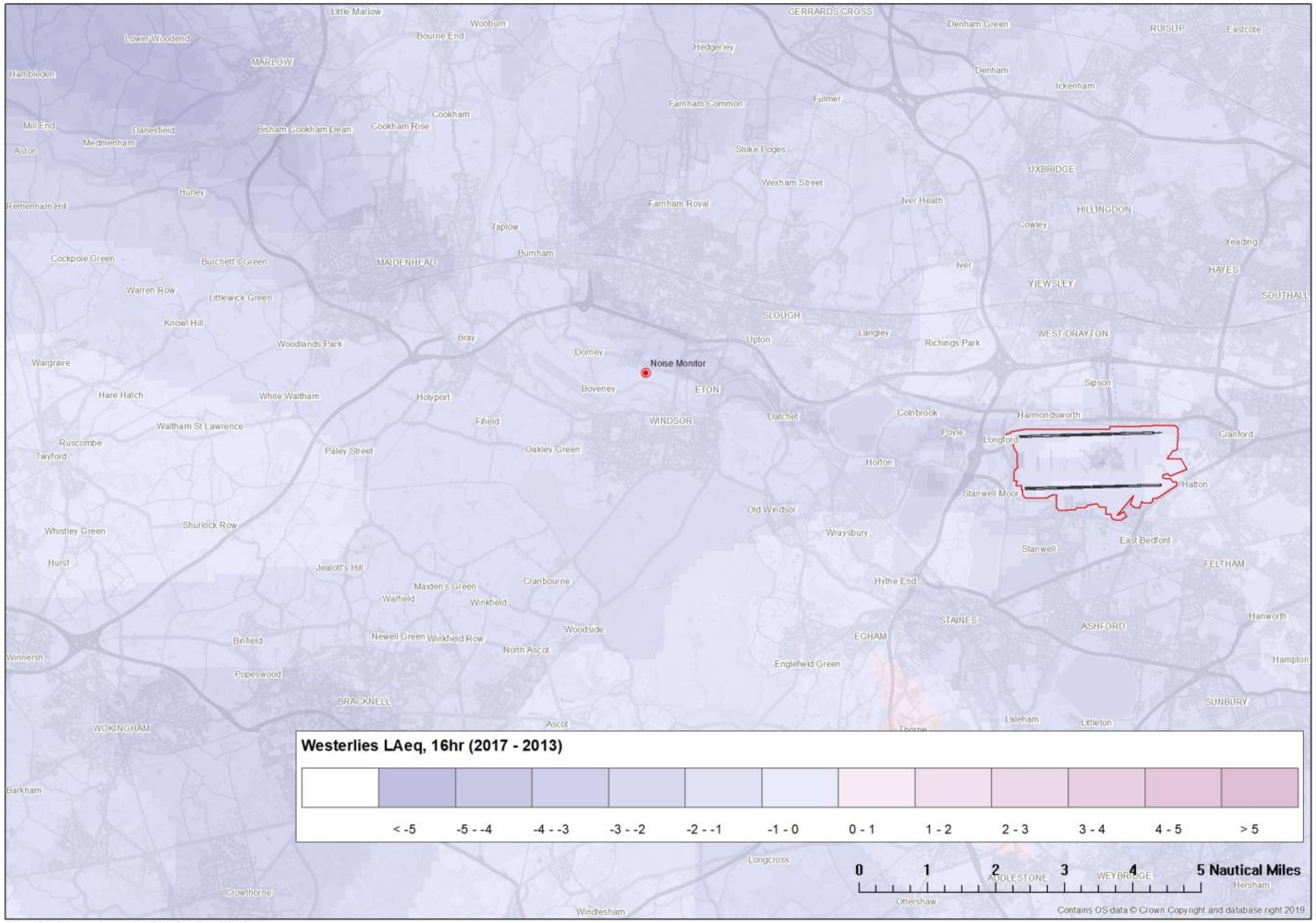
Appendix A: Average westerly night $N60_{8hr}$ contours (2013)



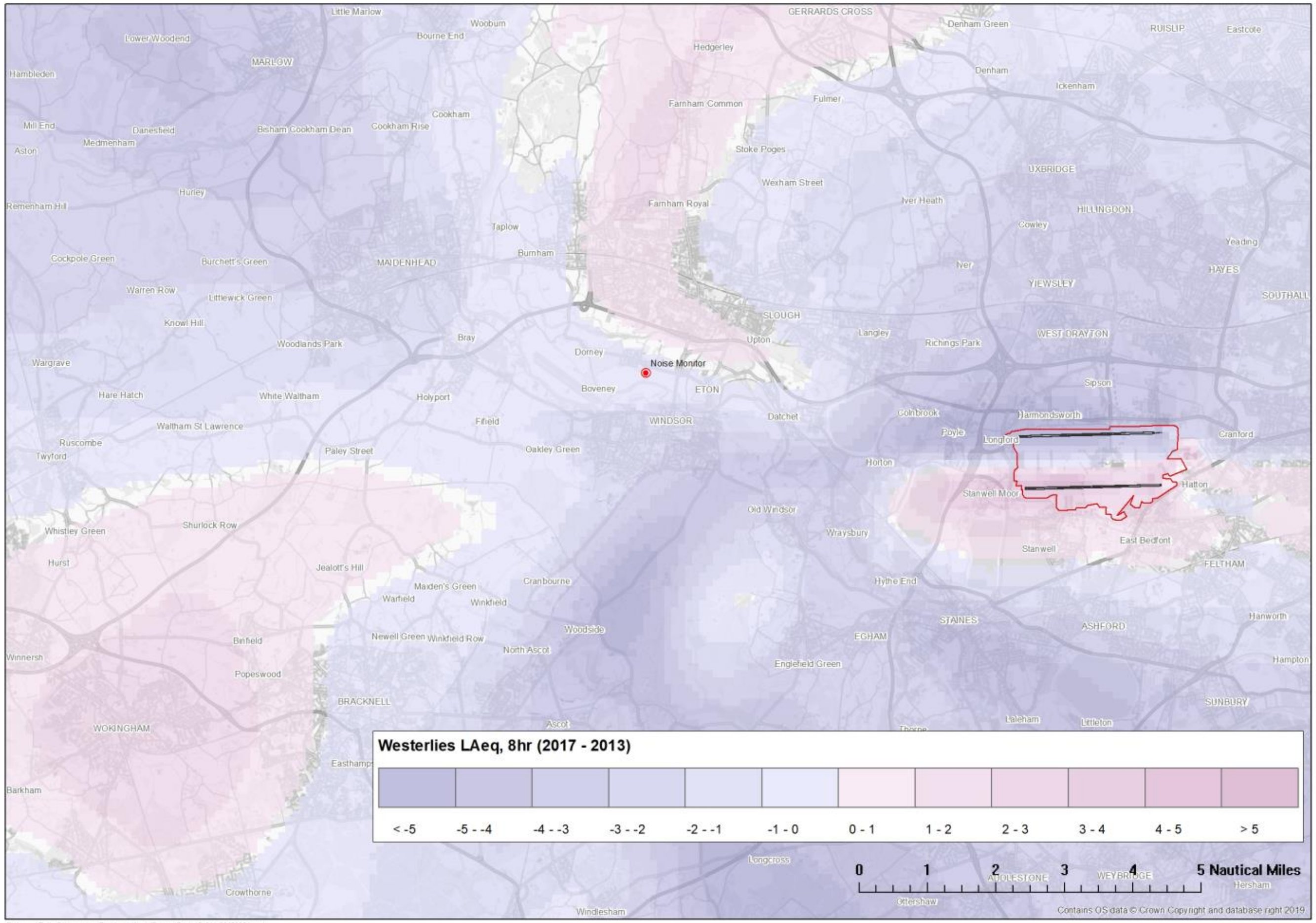
Appendix A: Average westerly night $N60_{8hr}$ contours (2017)



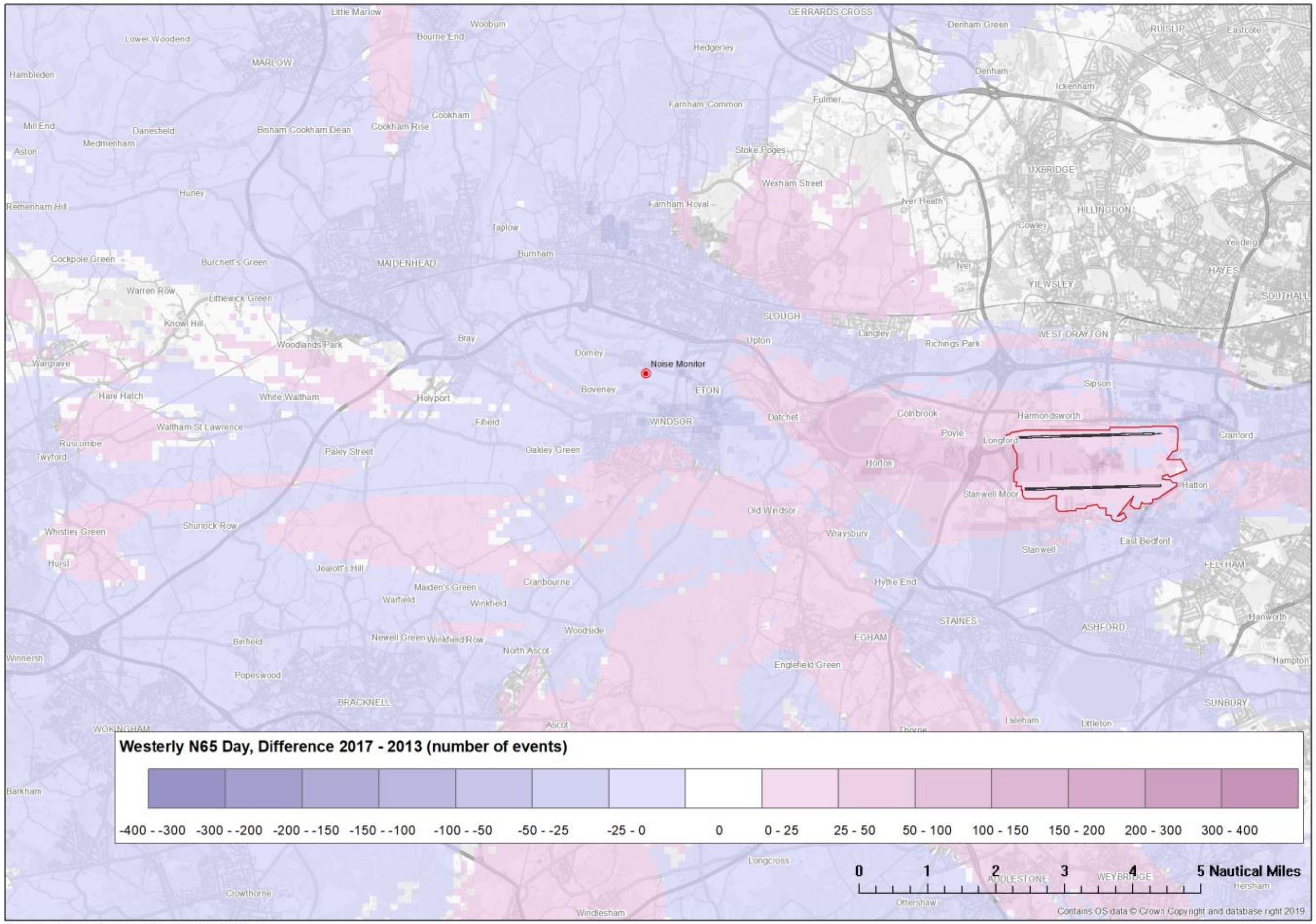
Appendix A: Average westerly day $L_{Aeq,16hr}$ difference (2017 minus 2013)



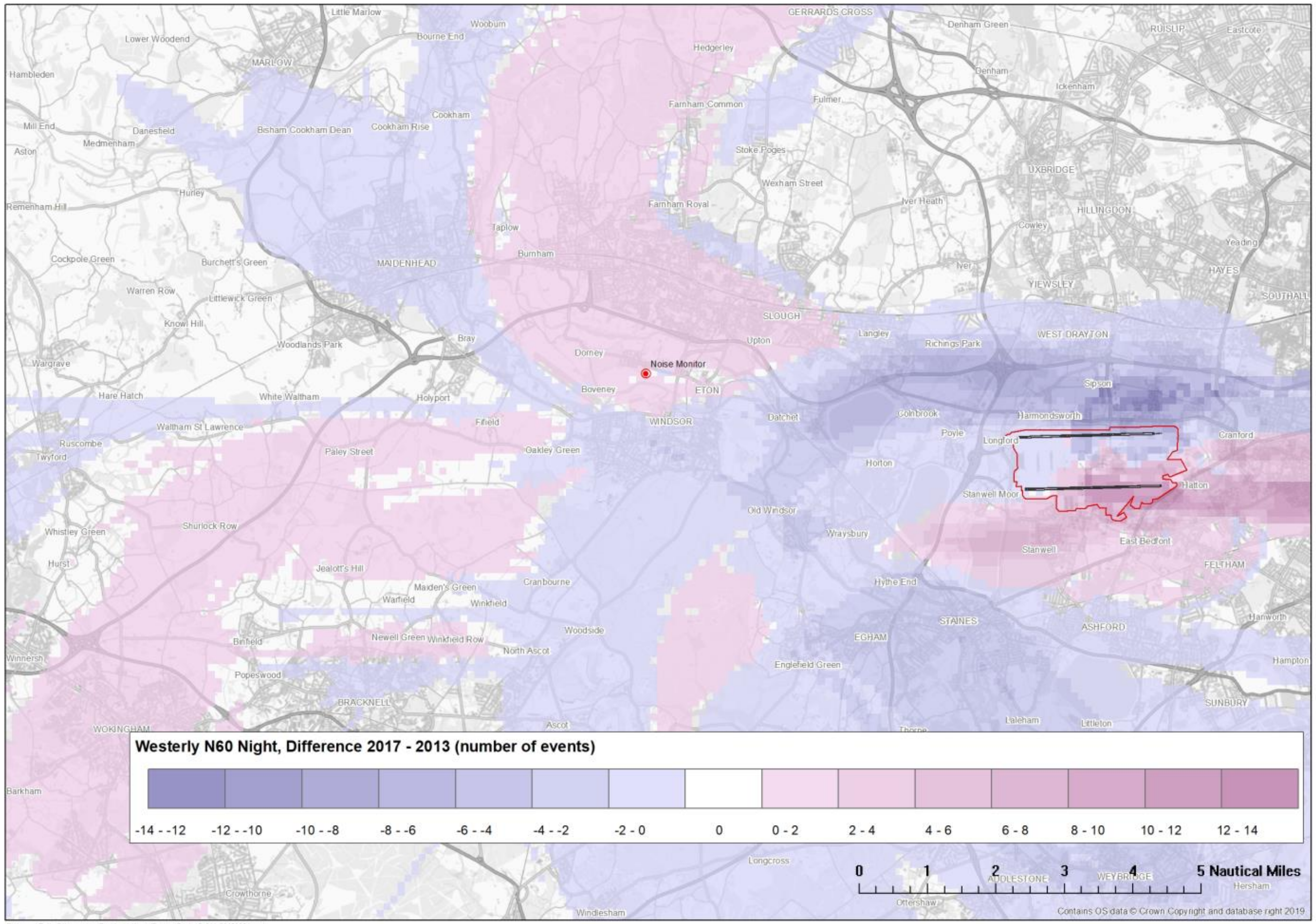
Appendix A: Average westerly night $L_{Aeq,8hr}$ difference (2017 minus 2013)



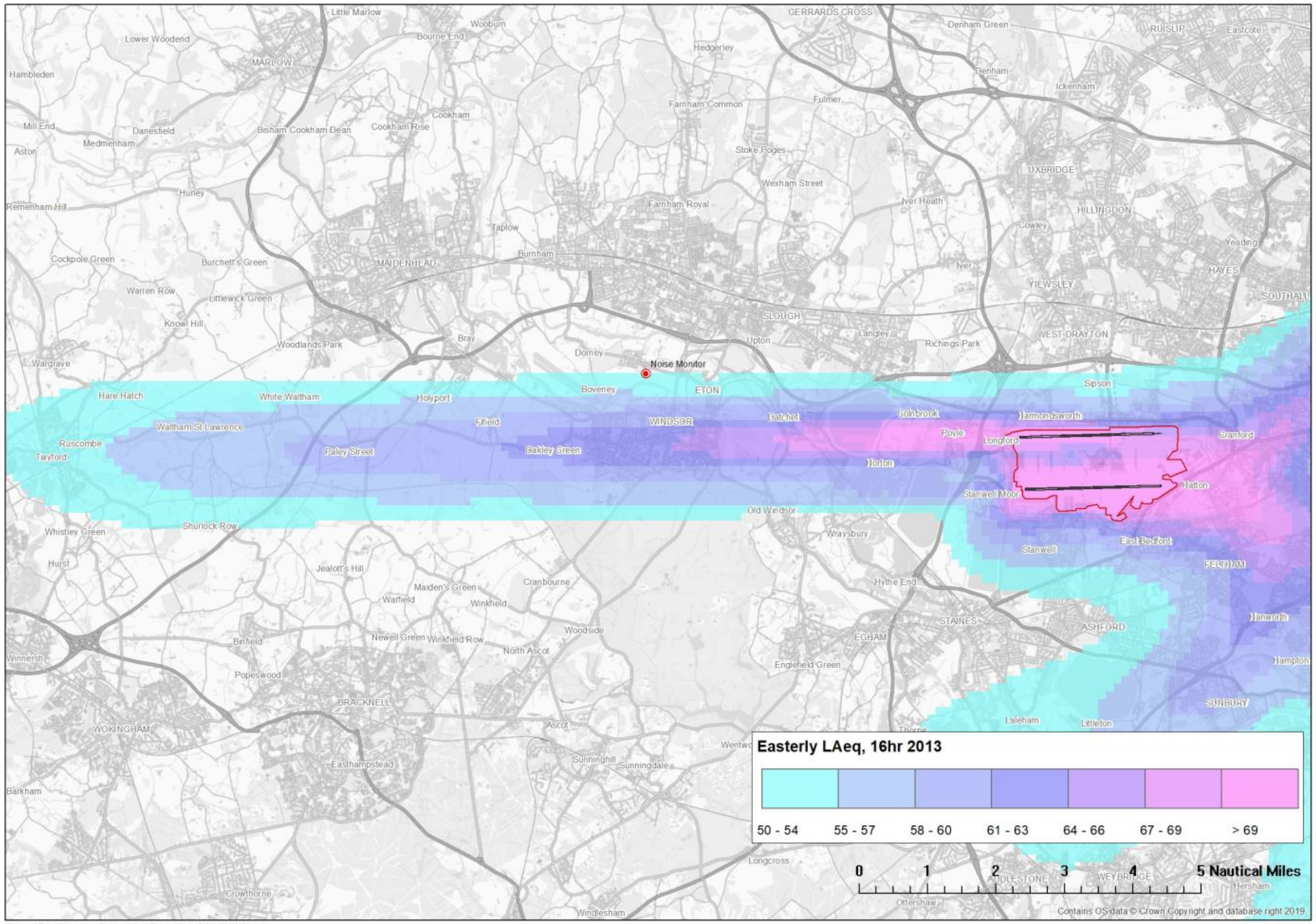
Appendix A: Average westerly day N65$_{16hr}$ difference (2017 minus 2013)



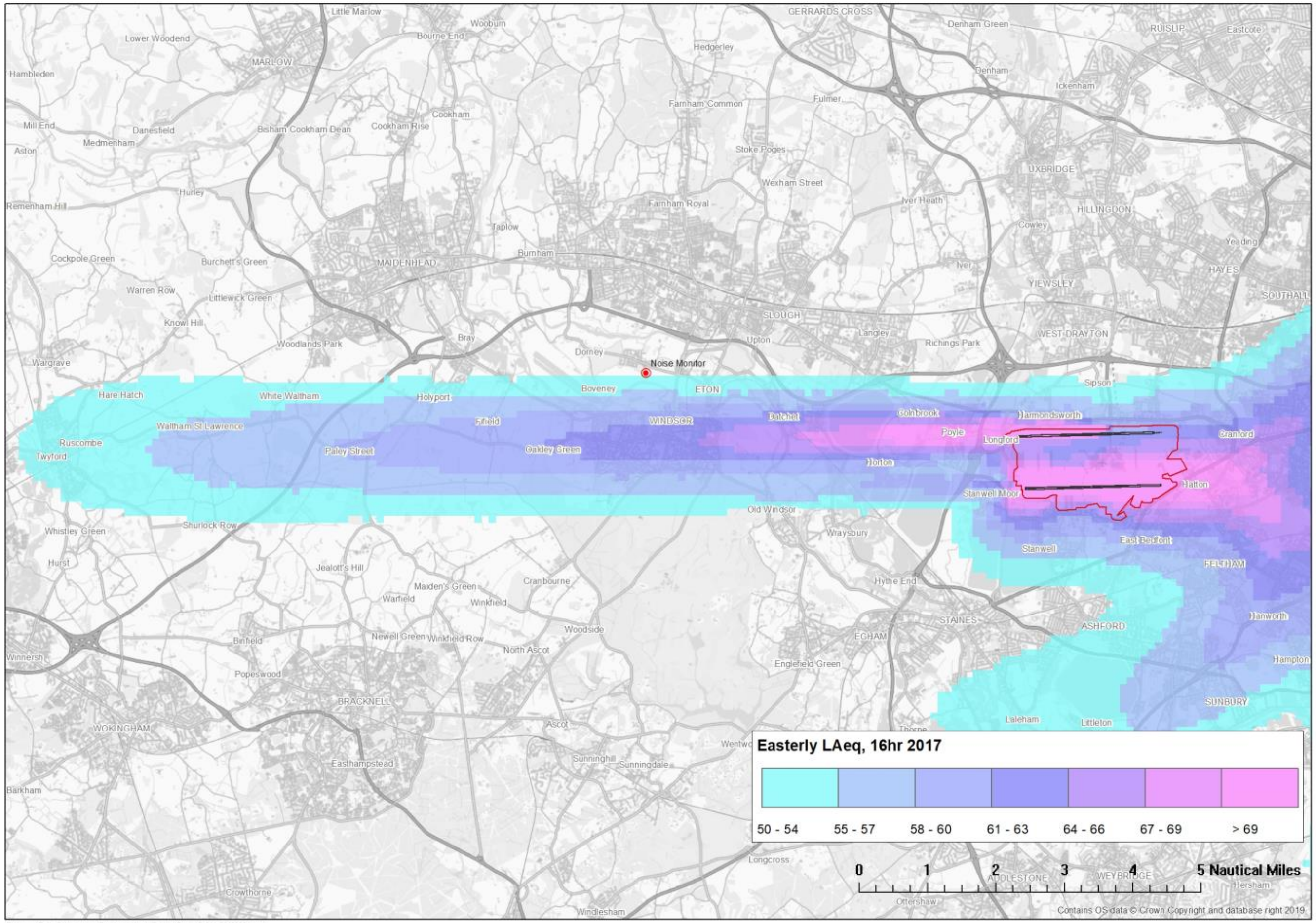
Appendix A: Average westerly night $N60_{8hr}$ difference (2017 minus 2013)



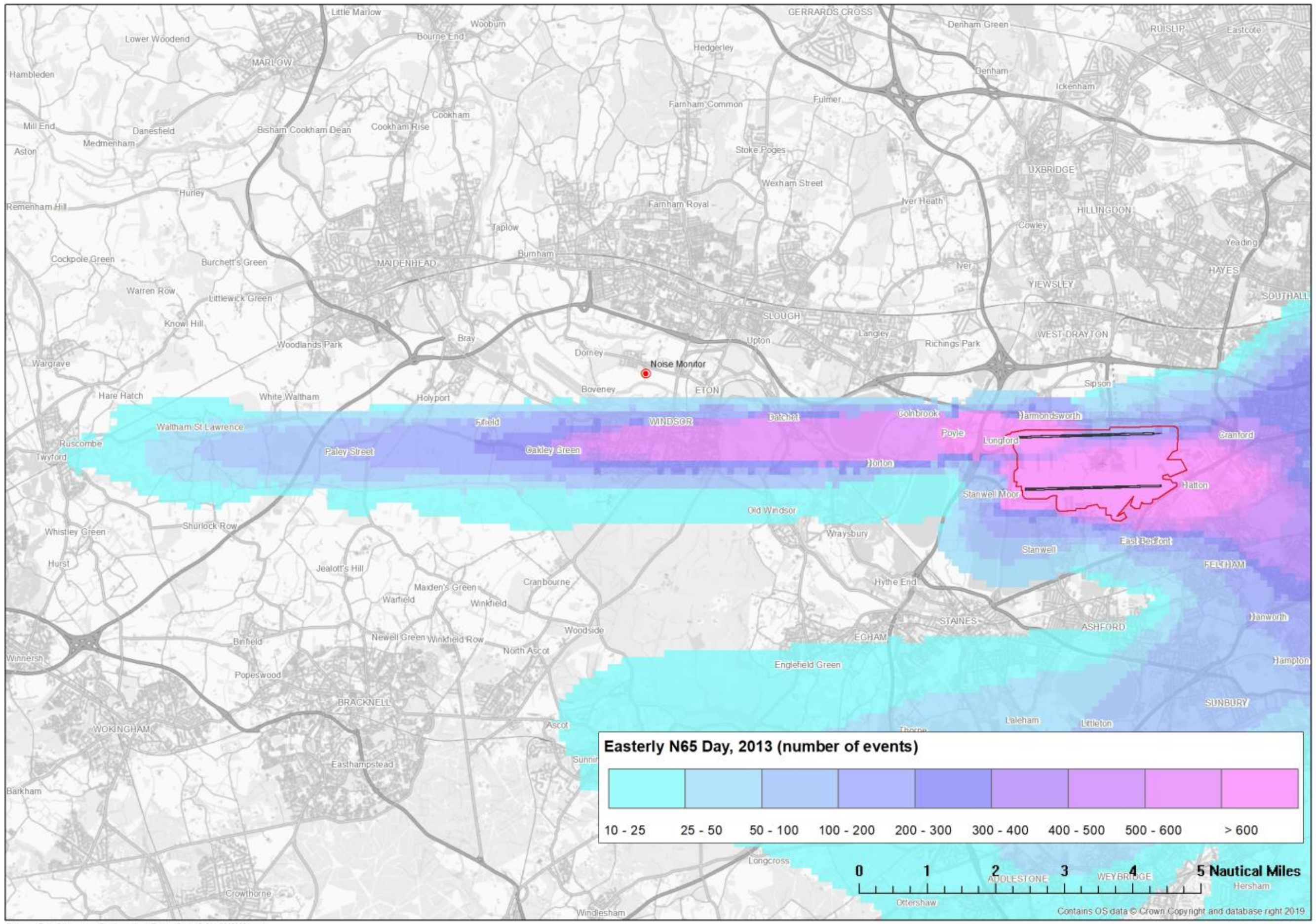
Appendix A: Average easterly day $L_{Aeq,16hr}$ contours (2013)



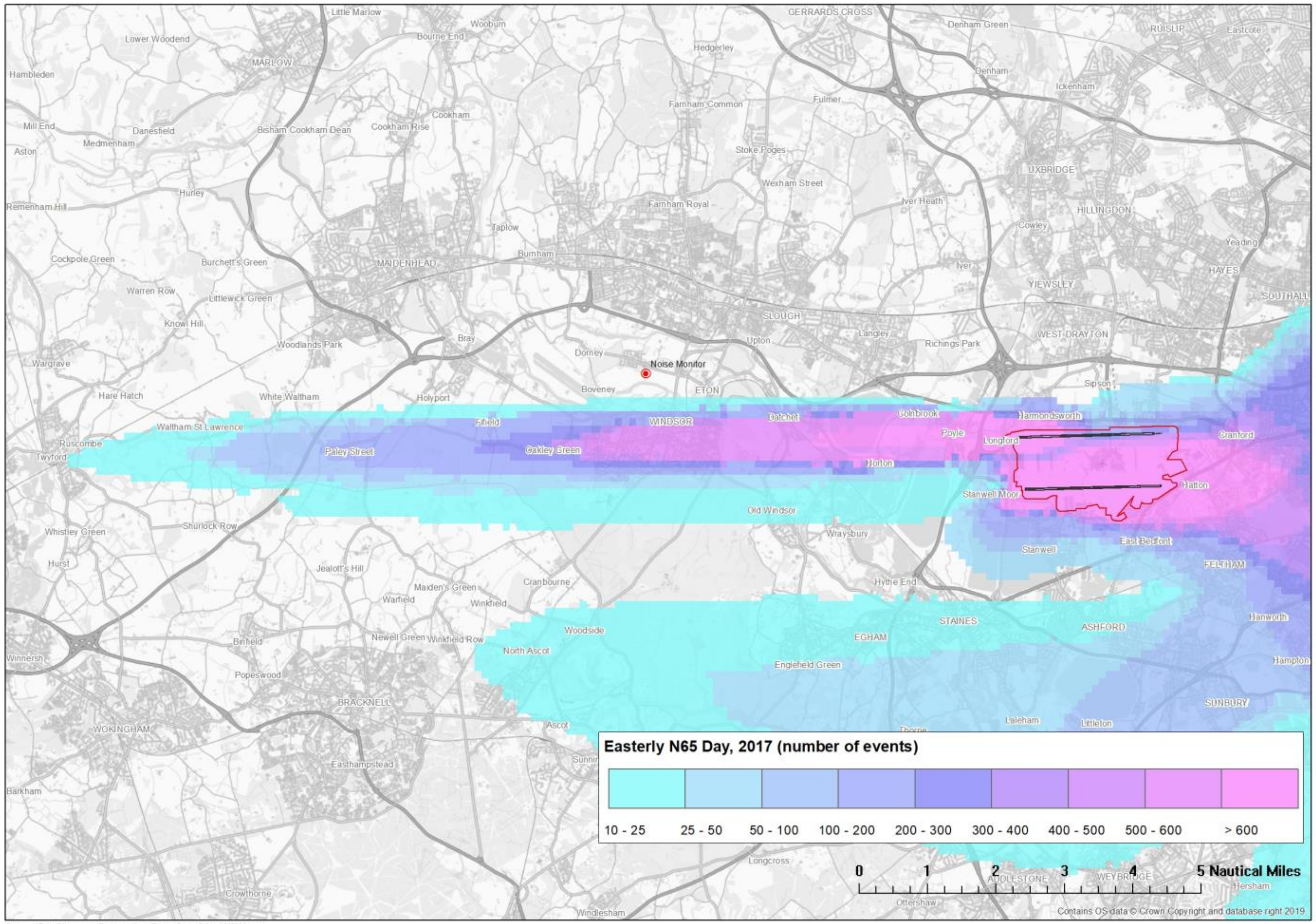
Appendix A: Average easterly day $L_{Aeq,16hr}$ contours (2017)



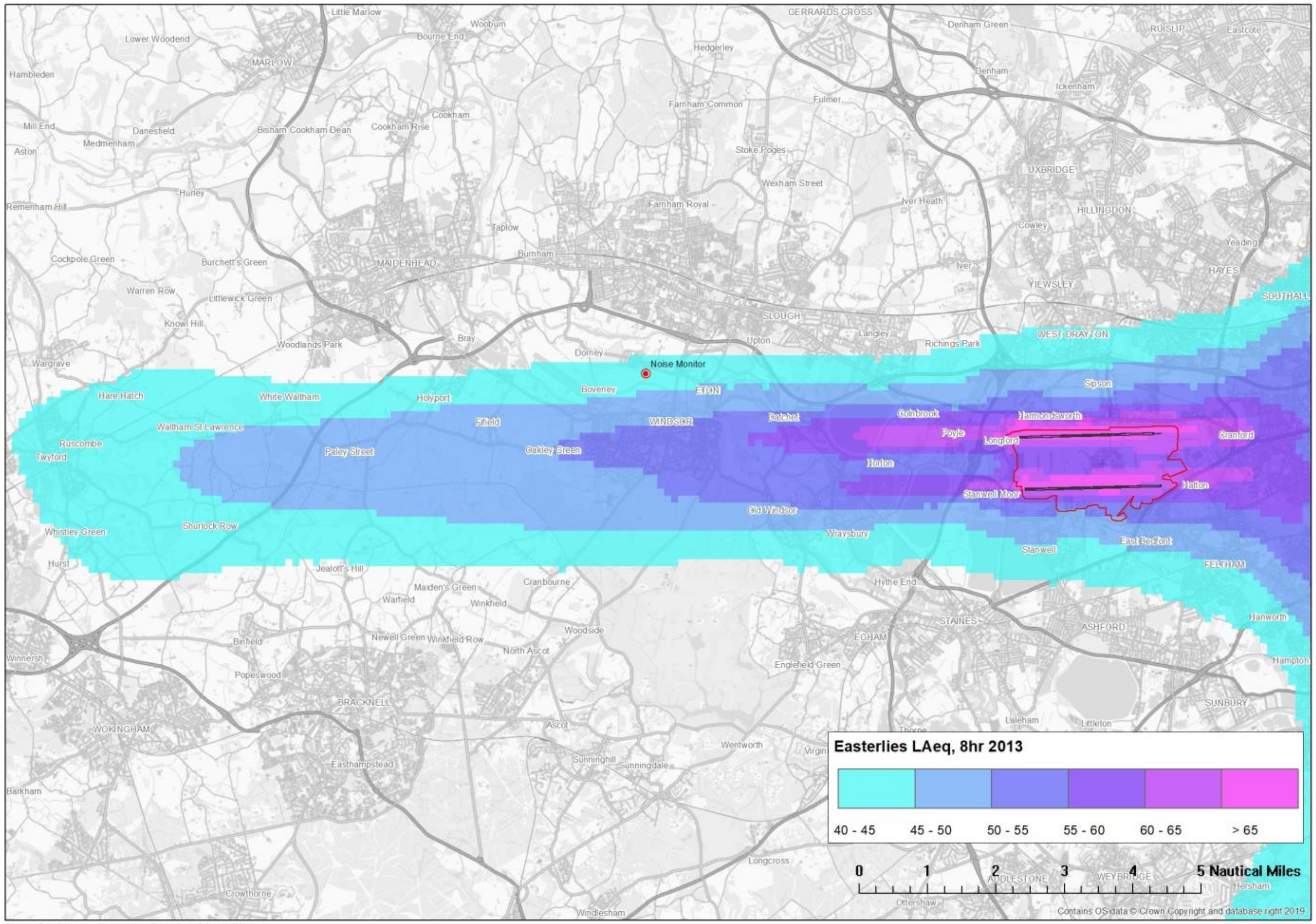
Appendix A: Average easterly day $N65_{16hr}$ contours (2013)



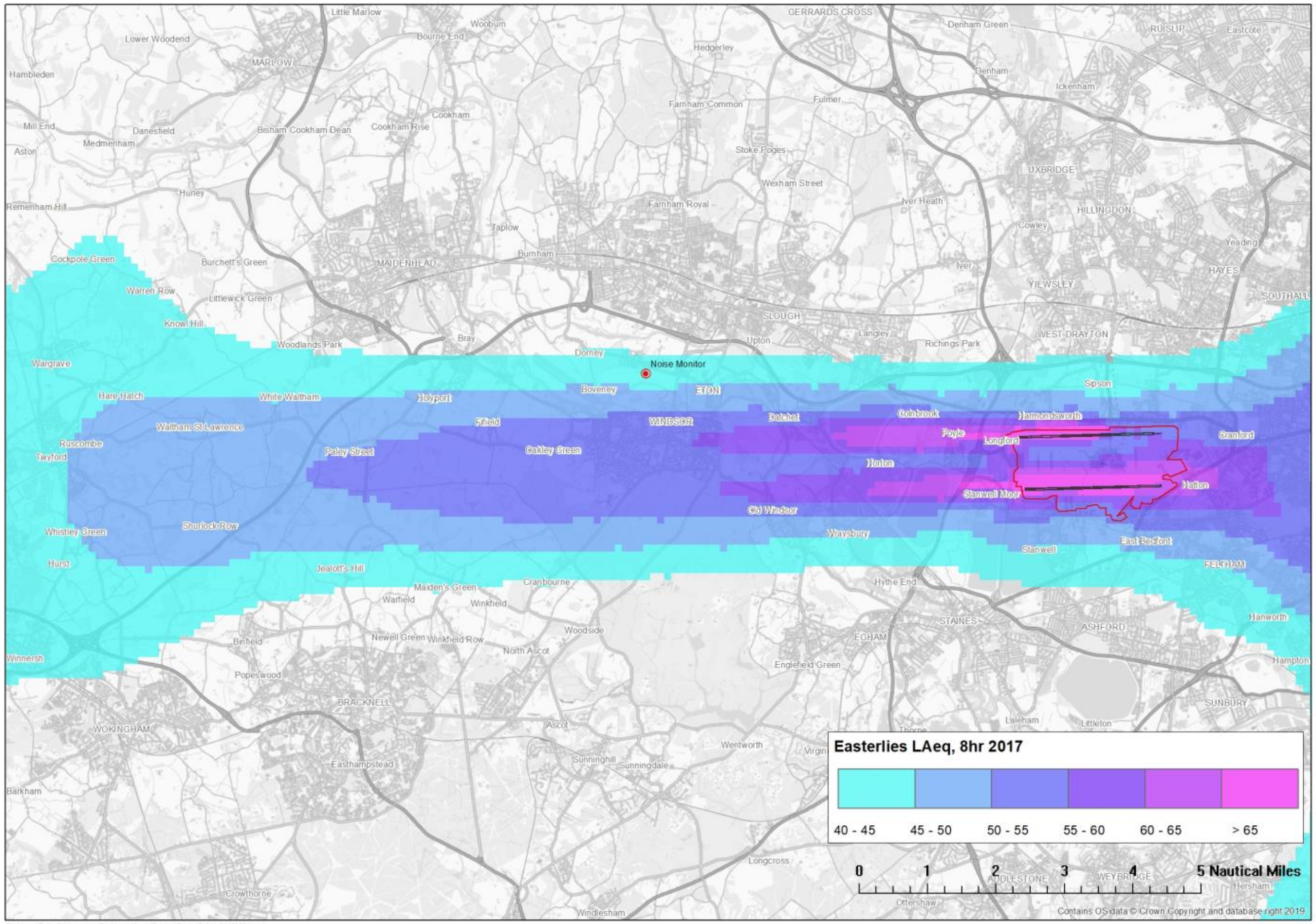
Appendix A: Average easterly day $N65_{16hr}$ contours (2017)



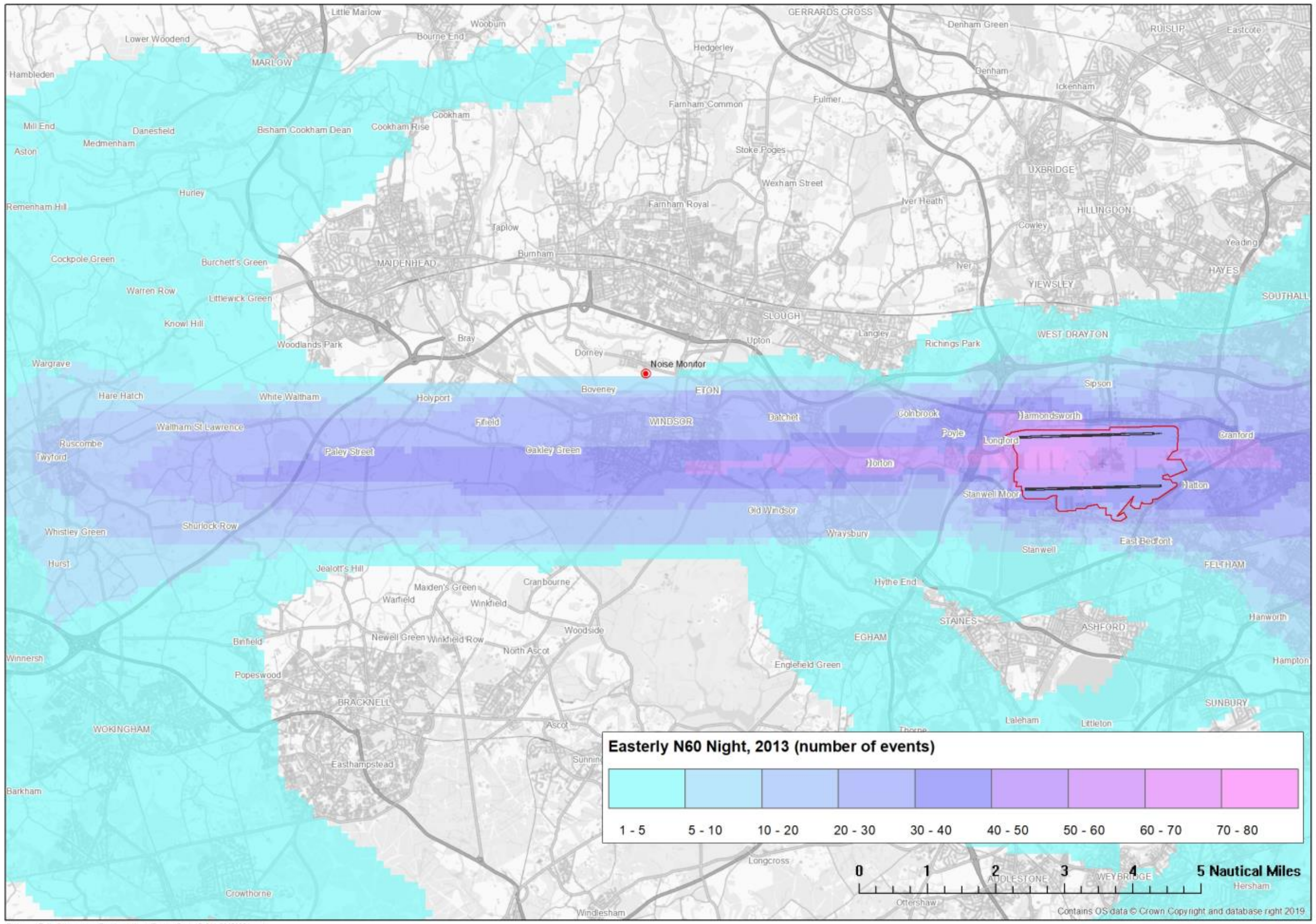
Appendix A: Average easterly night $L_{Aeq,8hr}$ contours (2013)



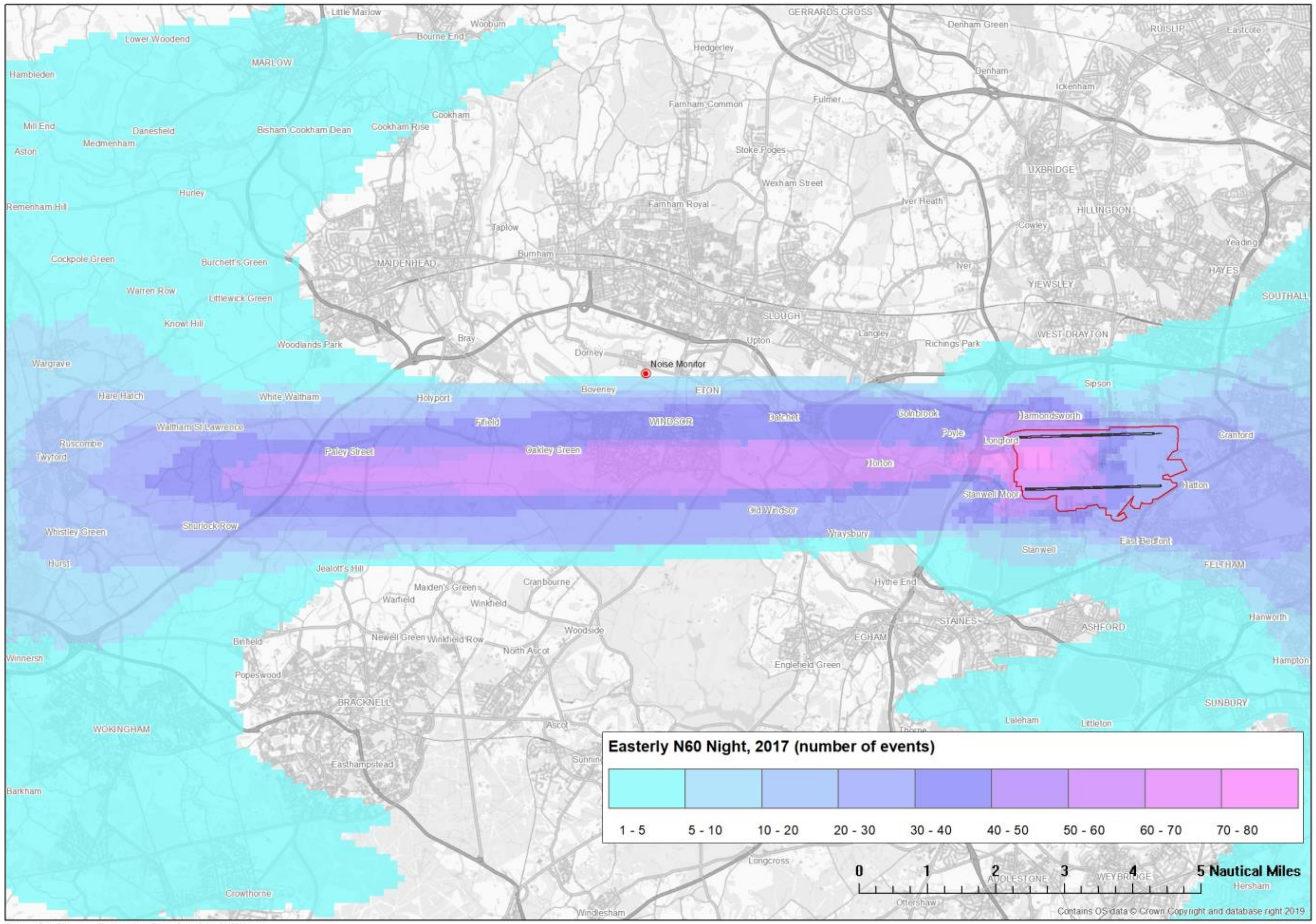
Appendix A: Average easterly night $L_{Aeq,8hr}$ contours (2017)



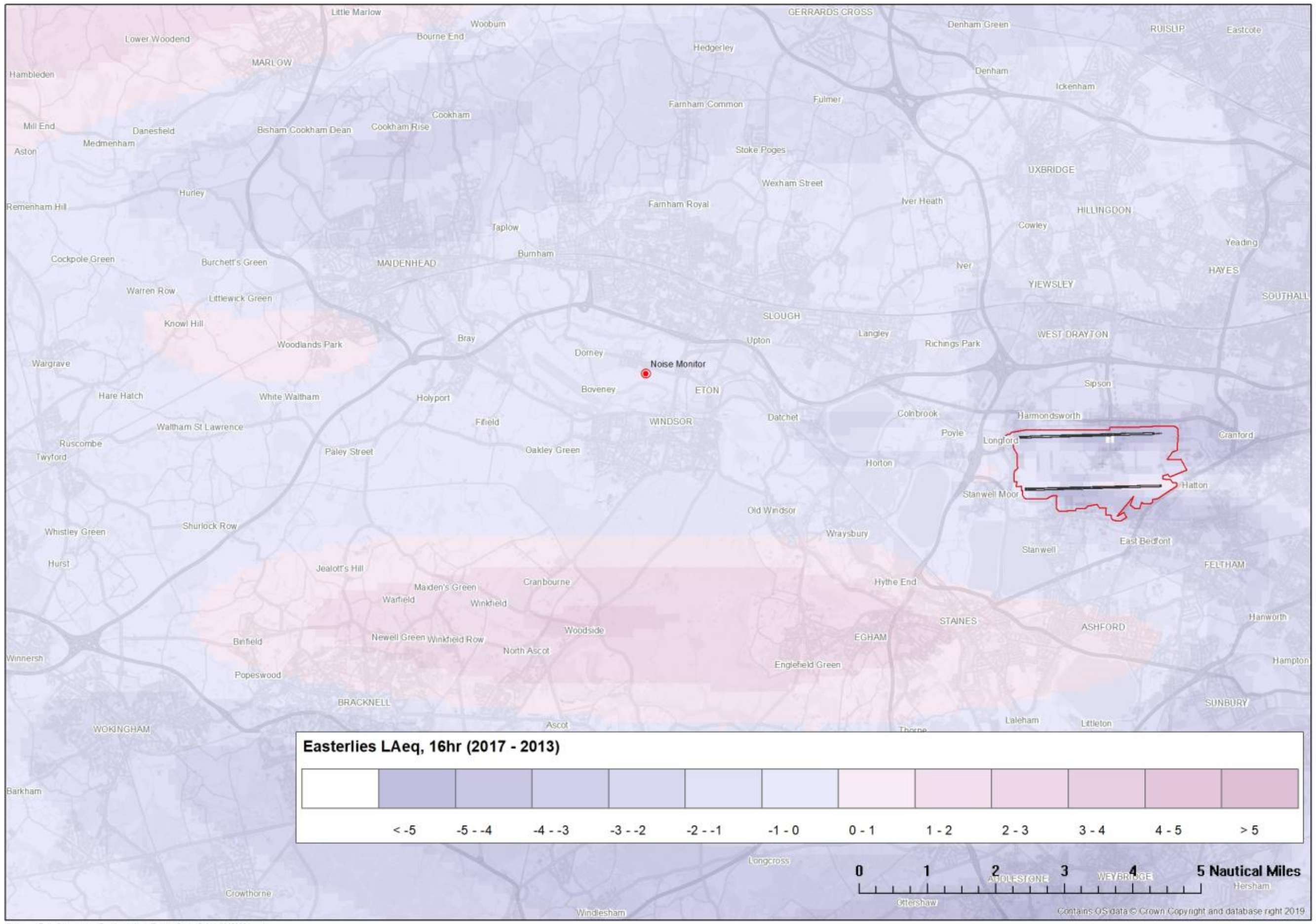
Appendix A: Average easterly night $N60_{8hr}$ contours (2013)



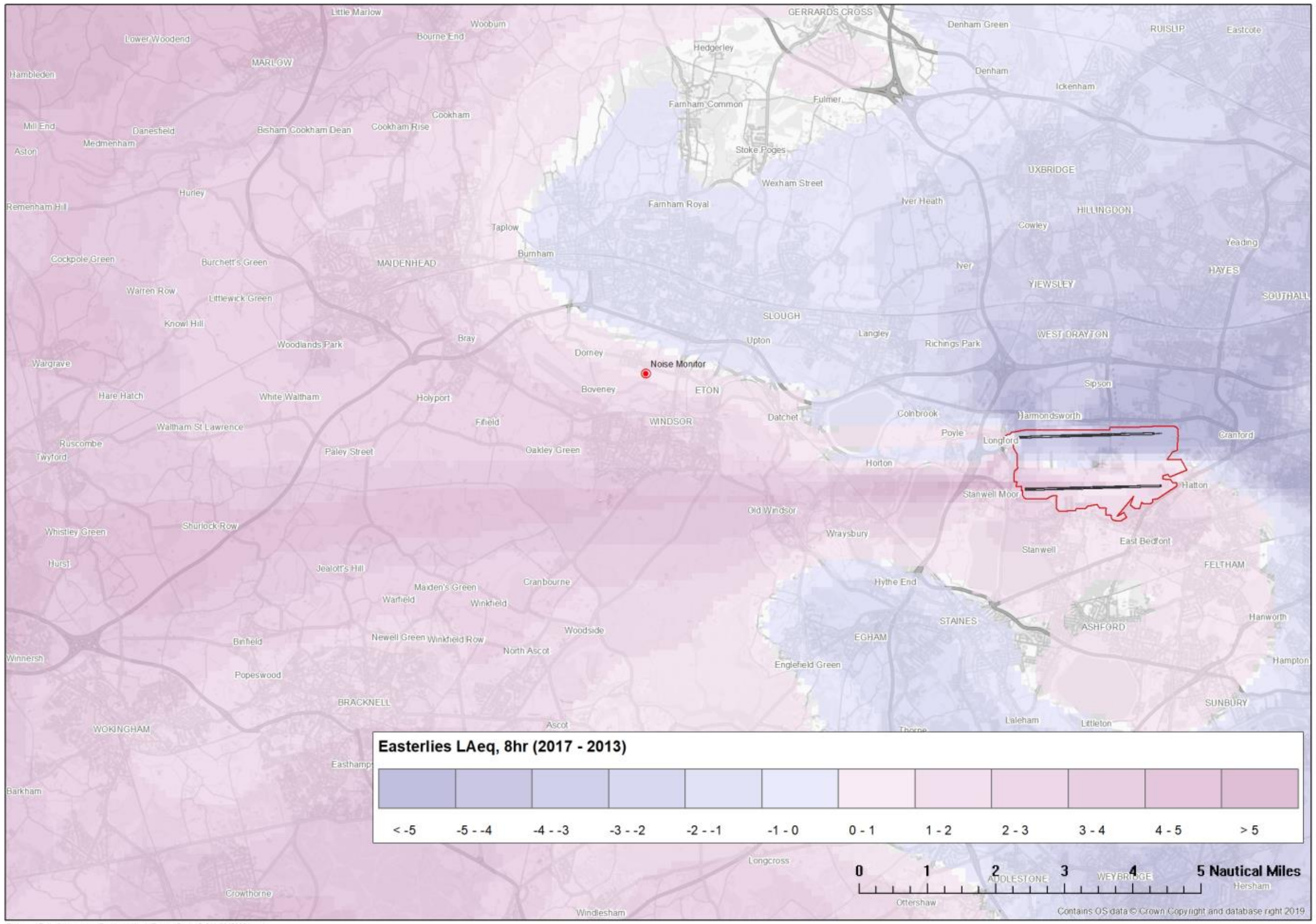
Appendix A: Average easterly night $N60_{8hr}$ contours (2017)



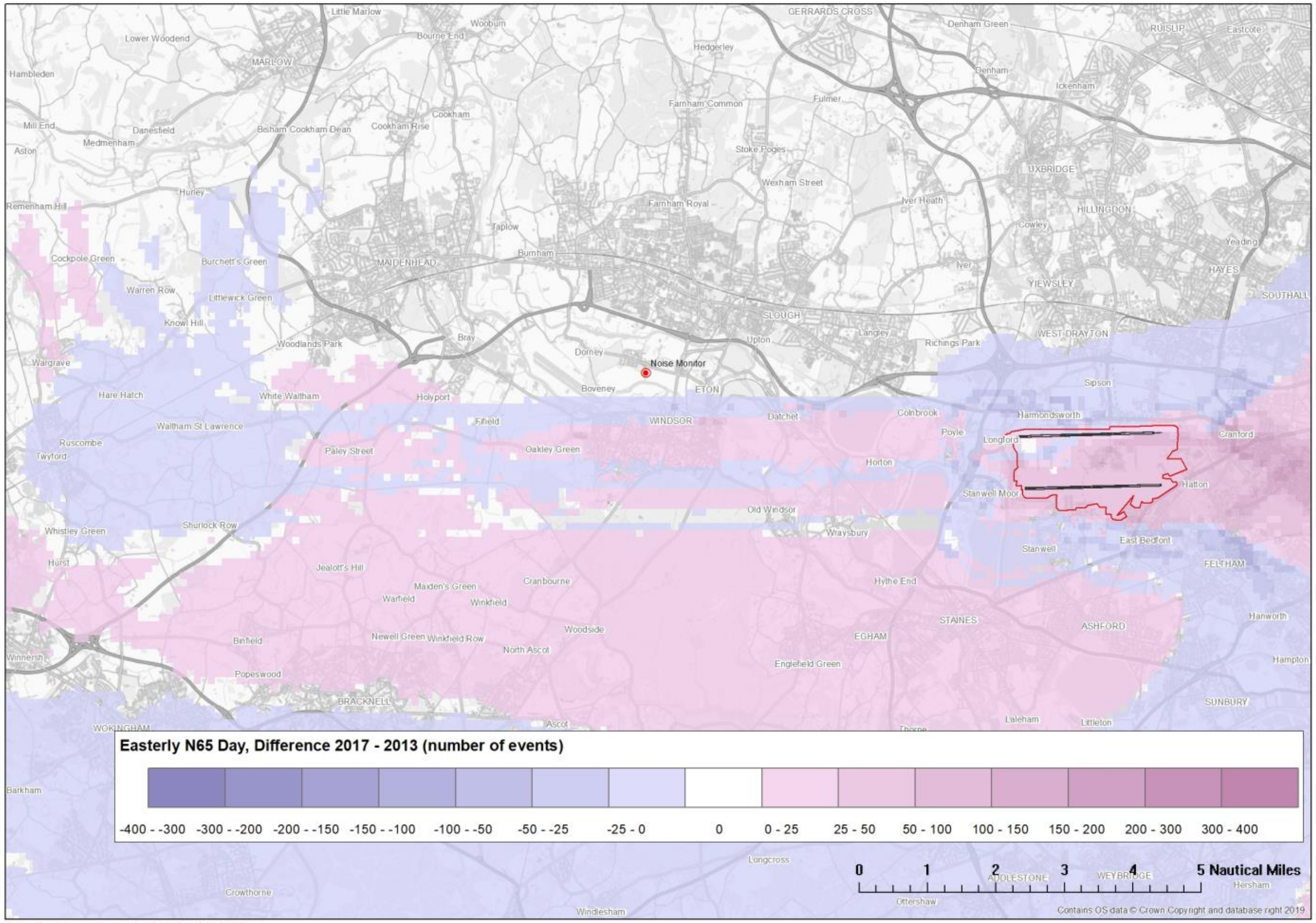
Appendix A: Average easterly day $L_{Aeq,16hr}$ difference (2017 minus 2013)



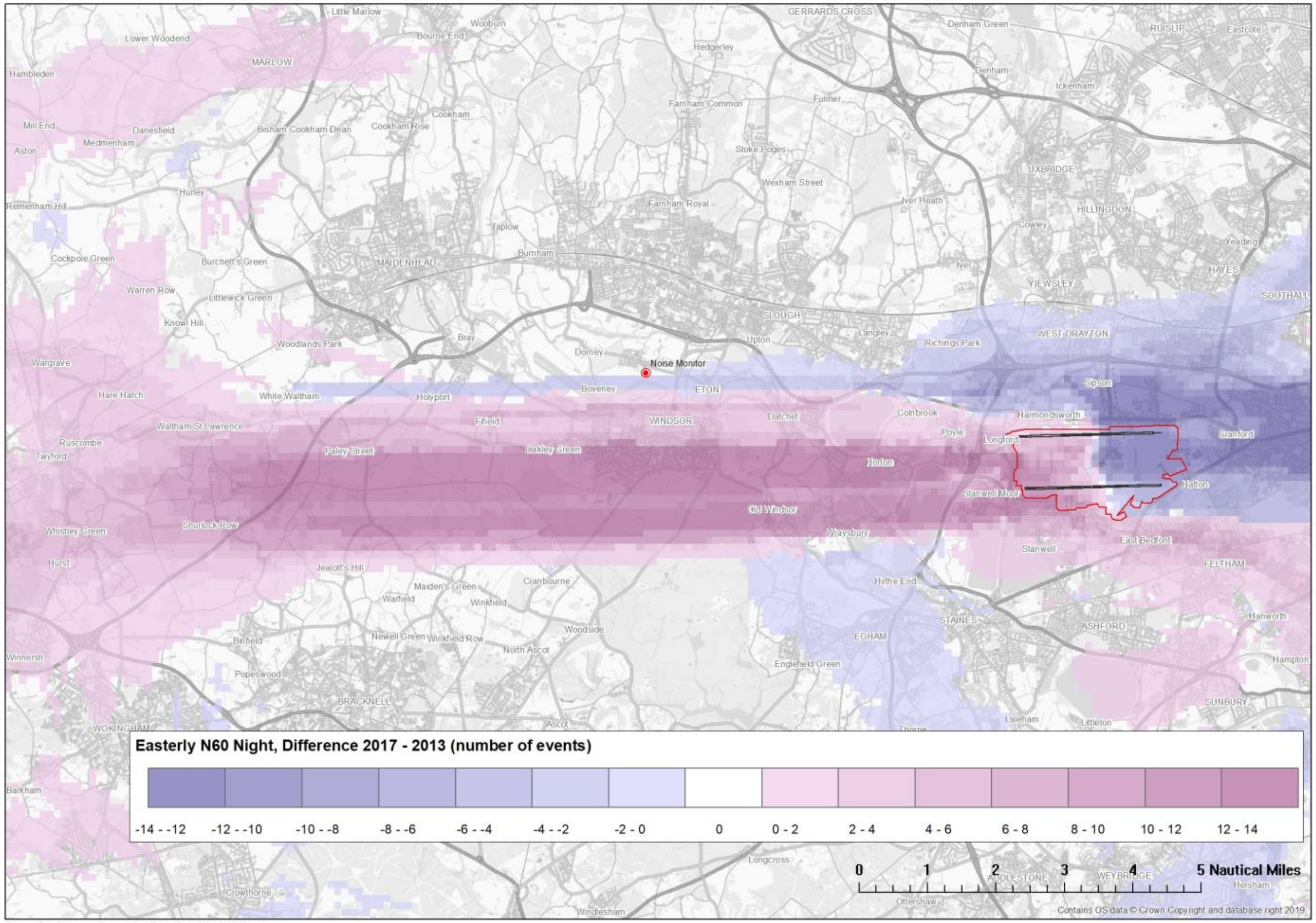
Appendix A: Average easterly night $L_{Aeq,8hr}$ difference (2017 minus 2013)



Appendix A: Average easterly day $N65_{16hr}$ difference (2017 minus 2013)



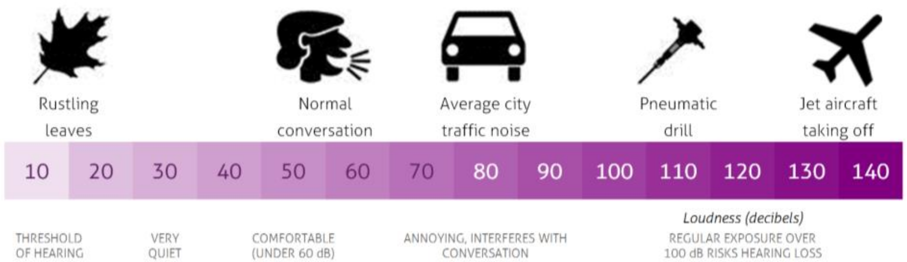
Appendix A: Average easterly night $N60_{8hr}$ difference (2017 minus 2013)



Appendix B: Noise Terminology

How is sound/noise measured?

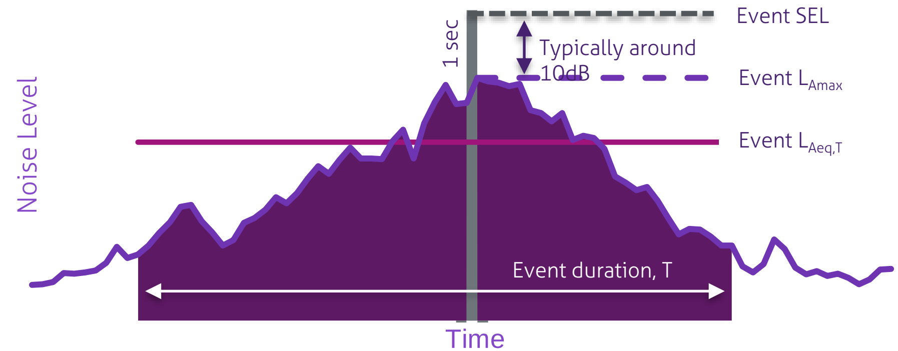
There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Furthermore, the ear mechanism responds in a non-linear manner: more efficiently to lower sounds than to higher sounds. Sound is therefore measured using a logarithmic scale, which accounts for both these features, called the decibel (dB) scale. Typical levels of everyday sounds are shown in the figure below.



As well as the large range of levels, the human ear is capable of detecting sound over a wide 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 sound (and where a single figure value is required) is therefore weighted across the frequency bands to represent the sensitivity of the ear. This is called 'A-weighting' and is represented as dBA, dB(A) or dB $L_{Aeq,T}$, for example. All units in this report use this A-weighting.

How is aircraft noise measured?

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



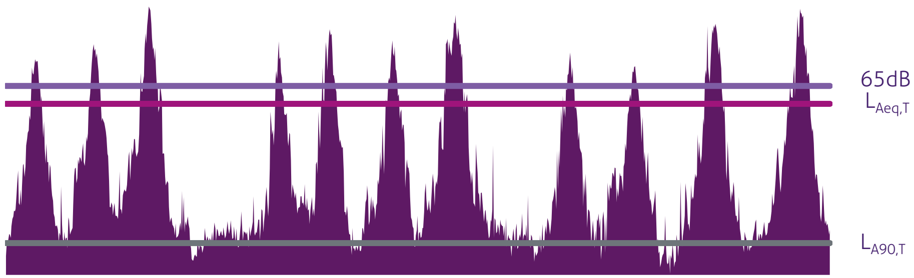
There are a number of metrics that can be used to characterise a noise event. The main ones in current use are shown above and described below. All of which can be derived from monitoring and modelling.

- The L_{Amax} is the highest A-weighted sound pressure level during the event. It is broadly an instantaneous value based on a response time of 125ms as per the Fast-time response. Can also be written L_{AFmax} or $L_{Amax,fast}$.
- The $L_{Aeq,T}$ is the equivalent continuous sound pressure level that would generate the same energy as that of the fluctuating level during the event of period, T. It is in effect the average level over the time of the event.
- The SEL (sound exposure level or single event level) is the sound pressure that would arise if all the energy of the event was to be delivered in 1 second. It is a form of normalisation.

Appendix B: Noise Terminology

How is long term noise exposure measured?

The L_{Amax} and SEL metrics 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, primarily using the L_{Aeq} metric in the UK. The L_{Aeq} for a period of aircraft overflights, together with a particular threshold and L_{A90} (background) level, is demonstrated in the figure below. More on these below.



Although the L_{Aeq} plays a role in policy and planning assessment, it does not necessarily fully describe community experience. Supplementary noise metrics have been developed to further reflect community experience in, hopefully, understandable language. For example, the N65 describes the number of events that 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 exceeded for more 90% of monitored period and is demonstrated by the grey line in the figure above.

How does sound level 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, which is small compared to the distance from it, 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 increased 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 sound/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 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 sound/noise level relate to number of events?

Average sound 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 sound is measured, a doubling of sound 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
x10	+10dB
x4	+6dB
x2	+3dB
0	0
÷2	-3dB
÷4	-6dB
÷10	-10dB