# Community Noise Information Report - Draft
# East Molesey

24th January 2018 – 15th October 2018

# Introduction

At the request of local residents, Heathrow Airport Ltd installed a temporary noise monitor to the east of the Neilson Recreation Ground in East Molesey between 24th January 2018 and the 15th October 2018. This report presents an analysis of operational and noise data over this period.

The report is structured using a template developed by Anderson Acoustics 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 above East Molesey 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 2013.
- **Section 5 – Noise Monitor Data** presents an analysis of aircraft noise events 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** This section 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 AEDT. Previous reports have been based on Heathrow's verified noise model using INM. This software has recently been superseded by AEDT.
- **Section 7 – Appendices** will present 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 Heathrow Community Noise Forum (HCNF) for additional analysis.

# Key Findings

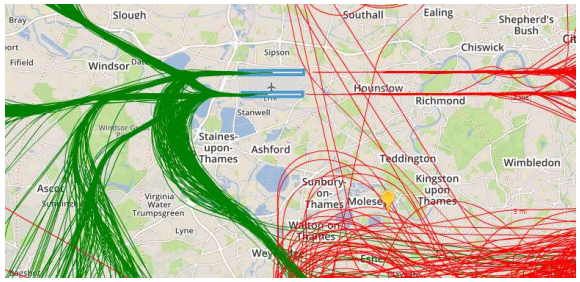
| Operations and the community |
|---|
| The noise monitor in East Molesey is predominantly overflown by easterly departures. It is located close to the centre line of the MID departure route from the southern runway and about 1.5km from the edge of the GAS route. |
| Approximately 16% and 5% of aircraft departing to the east follow the MID and GAS route respectively. |
| On full days of easterly operations, there was a 6% decrease in aircraft passing through the gate compared to the corresponding period in 2013. This reduction occurred between the hours 06:00-09:00 and 18:00-22:00. |
| The position of the main swathe of aircraft following the MID route has moved about 500m to the east. In 2018, the aircraft appeared to follow two distinct paths within the swathe. This is in contrast to 2013 when most aircraft would concentrated along a single path. |
| Aircraft above East Molesey are flying at broadly the same height in 2018 compared to 2013 although there have been more significant changes for individual aircraft types. For example the average height of the B787 has reduced by 700ft. |
| There has been a shift towards the use of large twin engine aircraft passing over East Molesey on easterly departures driven by the increase in use of B787 since 2013. |

| Noise levels in the community based on measurement at the East Molesey monitor | Difference in community noise levels between 2013 and 2017 based on noise modelling |
|---|---|
| Aircraft noise contributes to the ambient noise environment in East Molesey when the airport is on easterly operations. | On easterly operations, there was between a one and two decibel decrease in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017. |
| Daytime average hourly noise levels are between 4 and 12dB higher on easterly days compared to the corresponding hour on westerly days. | The modelling indicates an increase of up to 25 daytime N65 events over the same period. |
| Ambient (aircraft and non-aircraft sources) noise levels are highest in the hour 07:00-08:00 and fall across the day. Average noise levels from aircraft on easterly operations tend to increase over the course of the day and reach a maximum in the hour 22:00-23:00. | There was reduction in average night time noise levels $L_{Aeq,8hr}$ of between 2 and 3 decibels from 2013 to 2018. |
| During full days of easterly operations, there are, on average, 62 aircraft noise events per day. On full days of westerly operations there are less than 1 noise event per day. | Over the same period, the number of aircraft noise events exceeding 60dB on an average night decreased by up to 2 per night. |
| Depending on the metric used, the A380, B747 and A340 (all quad engine aircraft) are the loudest aircraft types at East Molesey. The A319 and A320 are the quietest aircraft types. | |
| On average, the hour 20:00-21:00 experiences the most aircraft noise events, this is during a period when the proportion of larger aircraft are passing over the area. | |

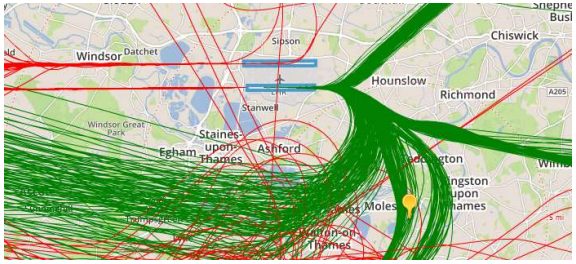
# Understanding how wind direction affects aircraft operations

## 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. The position of the noise monitor is indicated by the yellow pin drop.




**Flight tracks on a westerly day (1st October 2018)**




**Flight tracks on an easterly day (28th September 2018)**

## The proportion of easterly/westerly operations

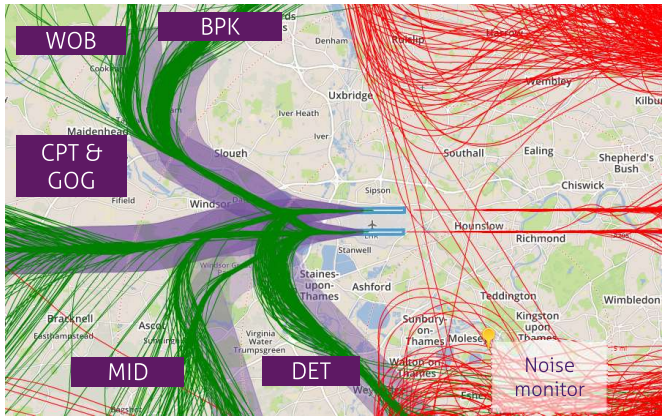
- Around Heathrow, the prevailing wind direction is from the west.
- Heathrow also operates what is known as the 'westerly preference'. Aircraft will continue to operate in a westerly direction until there are tail winds consistently of 5kts or more. This was implemented to protect more densely populated 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 7 full years.


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

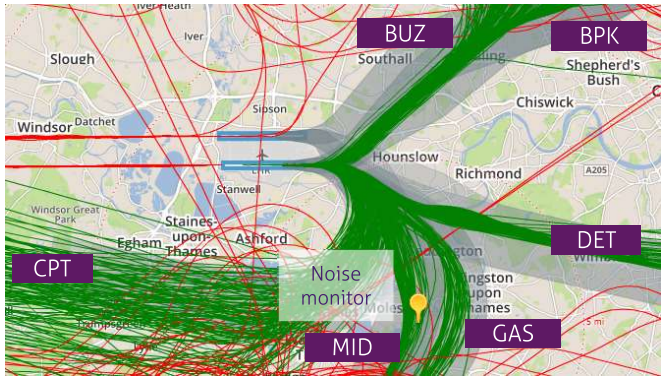
# Understanding where aircraft fly near to East Molesey

- The images to the right present 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 (NPRs), typically based upon their destination. These are represented by the purple and grey corridors.
- East Molesey is predominantly overflown by easterly departures. It is located under the easterly MID noise preferential route (NPR) and not far from the edge of the easterly GAS route
- During westerly operations the area can be overflown by aircraft in the Ockham stack. These aircraft will generally be at an altitude greater than 7,000ft.

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




**Arrival and departure tracks on easterly operations (NPRs shaded in grey)**

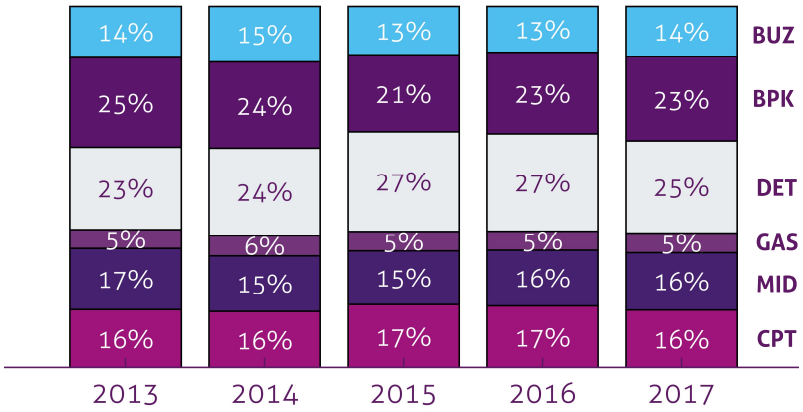



DET and GOG are the new names for the DVR and SAM routes respectively. Throughout this document they are referred to as DET and GOG

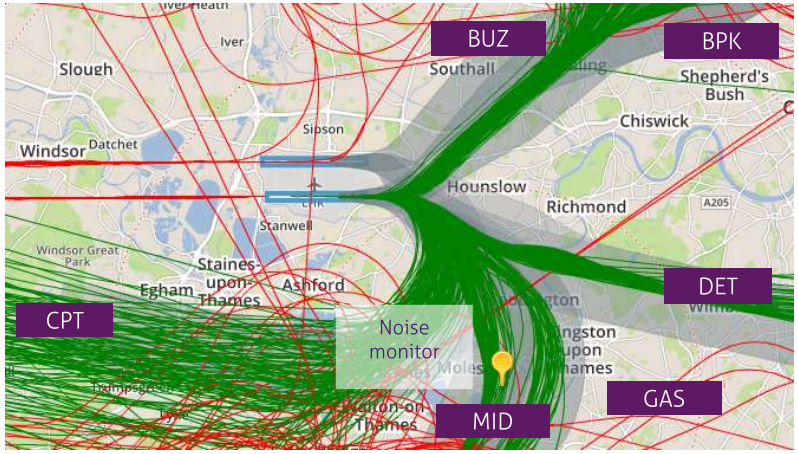
# Understanding where aircraft fly on easterly operations

- The figure to the right shows the proportions of **annual** route usage by easterly operations for each year from 2013-2017.
- In 2017, 16% and 5% of all easterly departures followed the MID and GAS routes respectively, the easterly routes of most relevance to residents of East Molesey.
- There are small fluctuations from year to year, but route usage has remained broadly consistent over the five year period.
- The easterly departure routes and typical tracks are shown again in the bottom right image.

**Annual departure route use during easterly operations**




**Arrival and departure tracks on easterly operations (NPRs shaded in grey)**



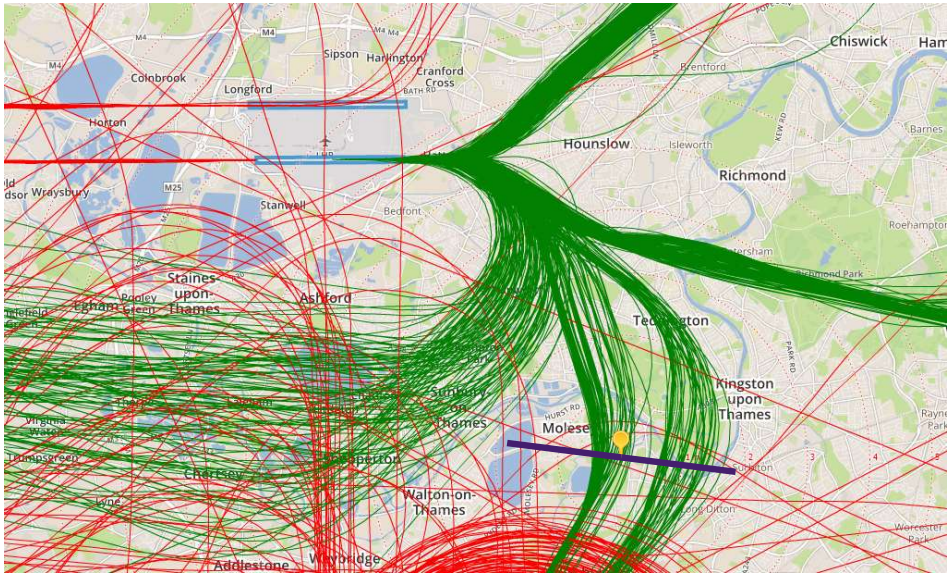
# Understanding operational and gate data

## Operational data.

- The following operational data were provided for the period 24th January 2018– 15th October 2018 and 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 'gate' was drawn over East Molesey centred on the temporary noise monitor; to capture movements while the airport is on easterly operations.




- The gate is approximately perpendicular to the westerly DET route and is 7km wide, centered on the noise monitor 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. 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

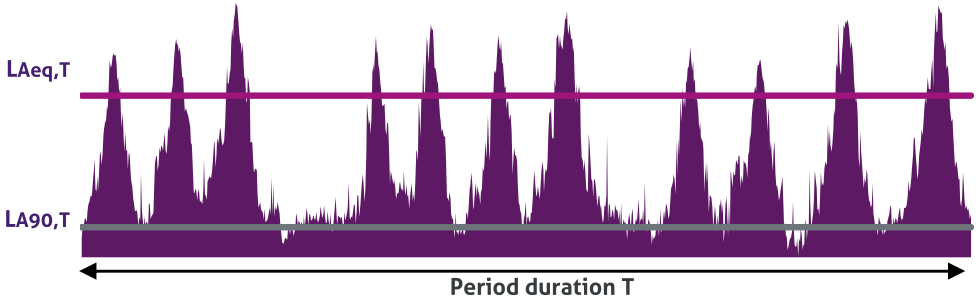
# Understanding measured noise data.

## Measured noise data:

- A 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 has been excluded due to adverse weather conditions.
- For this report, noise data has been provided by Heathrow for the period 24h January 2018 – 15th October 2018. Note that a historical comparison is not available since the noise monitor was not installed at this location in previous years.

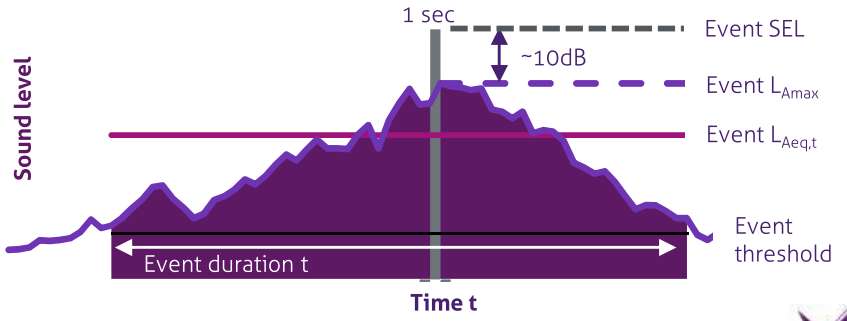
## Ambient and background noise levels:

- 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:

- 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; 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.

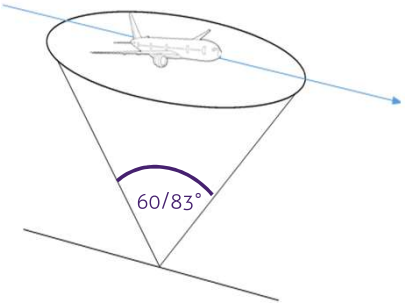


# Analysing noise levels from aircraft in this area

**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. 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 cone above the noise monitor**

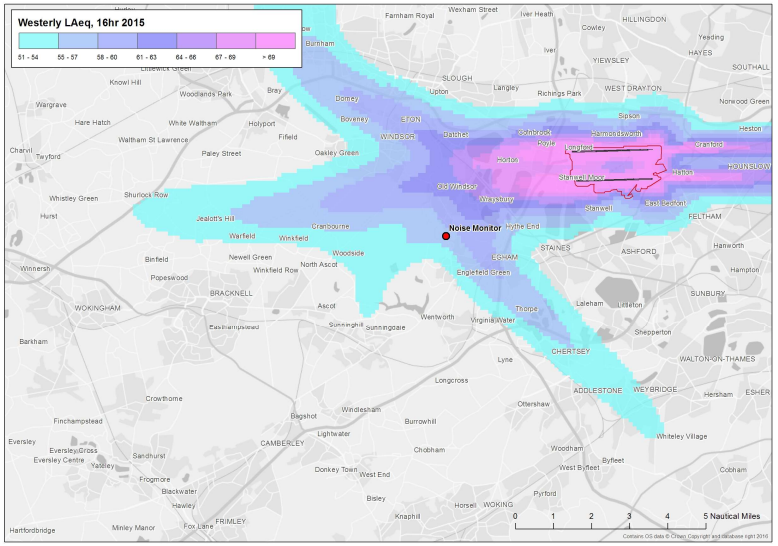



- This community information report will, where applicable, present results for overhead flights based on the 60 degree overhead cone as well as all registered aircraft noise events.

## Noise Modelling

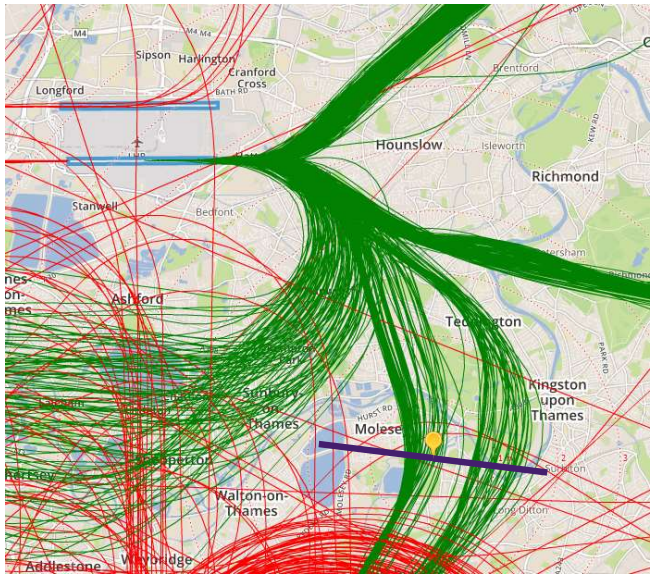
- Aircraft noise modelling has been used to provide an understanding of differences in the noise environment between 2013 and 2017 over the wider geographic area.
- Differences in daytime and night time levels for an **average day and night of easterly operations** across the summer of 2013 and 2017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

**Example contours generated by aircraft noise modelling**



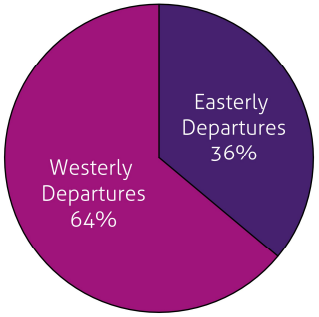
# Overview of flight track data – Easterly Gate

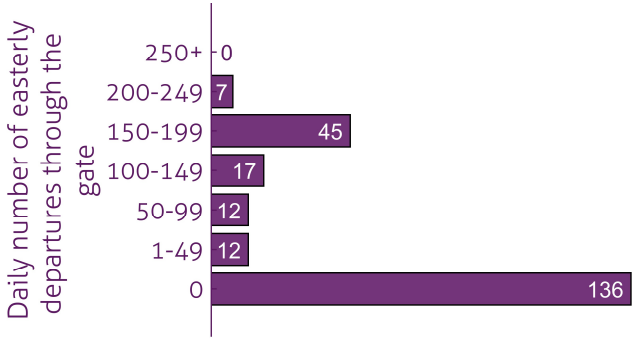
1st March – 15th October 2018 (24th January – 28th February omitted to avoid Operation Freedom Trials in historic comparisons)




**Example day of departing aircraft tracks in the vicinity of East Molesey during easterly operations & the gate position (width 7km)**

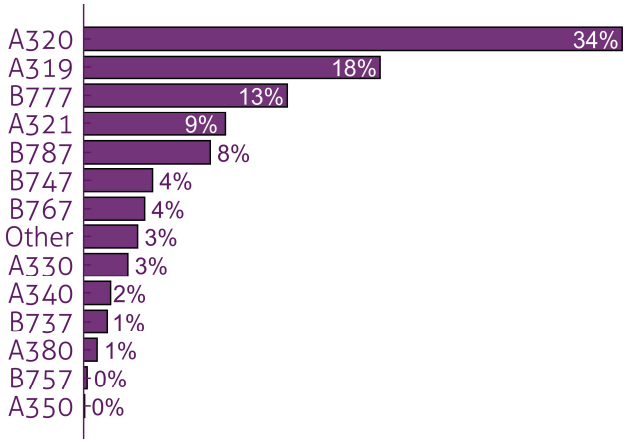
## Total 152,297 departures from Heathrow



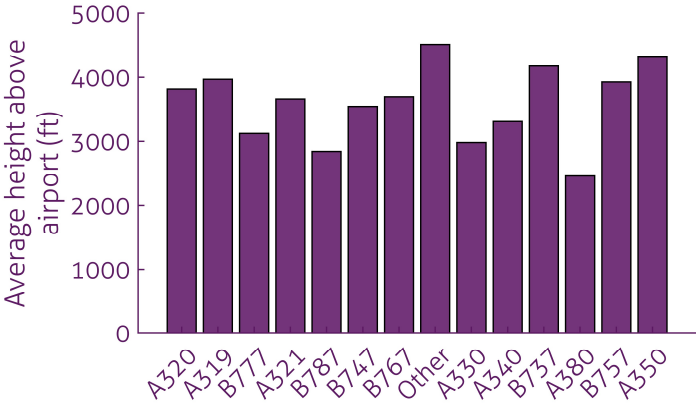




**Number of easterly departures per day passing through the gate (229 days in total)**

## Proportion of departing aircraft types passing through the easterly gate

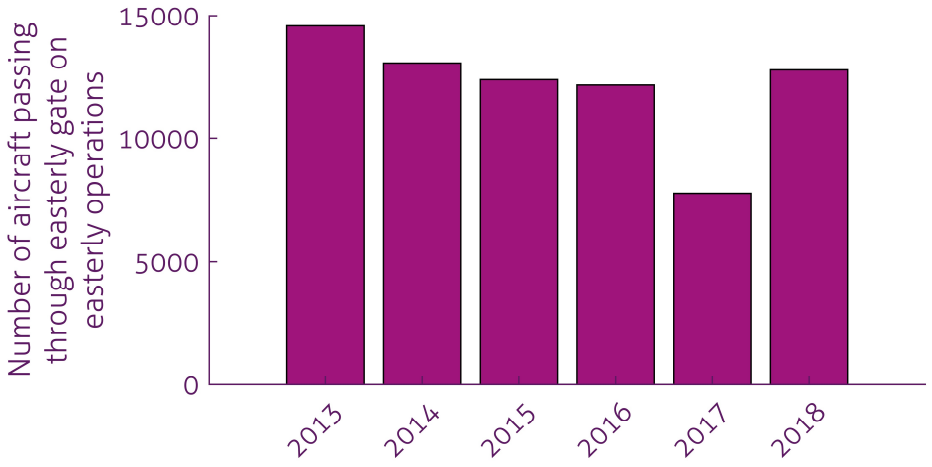



## Average height of departing aircraft as they pass through the gate



# Is the number of flights over the area different in 2018 to 2013?

- The figure to the right shows the total number of departures that passed through the easterly gates in the period from 1st March to 15th October from 2013 to 2018. It should be noted that the data from the period 24th January – 28th February has been omitted in this report to avoid comparing movements in 2018 to a period in which the Operational Freedoms Trial took place in 2013.
- Annually, between around 7,000 and 15,000 movements penetrated the gate on easterly operations departing from the southern runway
- Year to year changes can be attributed to fluctuations in the proportion of easterly/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 easterly operations in 2013 period was 38%, in 2018 36%.
- On a full day of easterly operations;
  - There was a 5% decrease in departures through the gate in the 2018 period compared to 2013.
  - The proportion of departures passing overhead at the monitor also decreased (as indicated by the numbers in parentheses).
- On full days of westerly operations, the number of movements passing through the gate decreased but the numbers are small compared to the westerly operations and are at an altitude greater than 7,000ft.



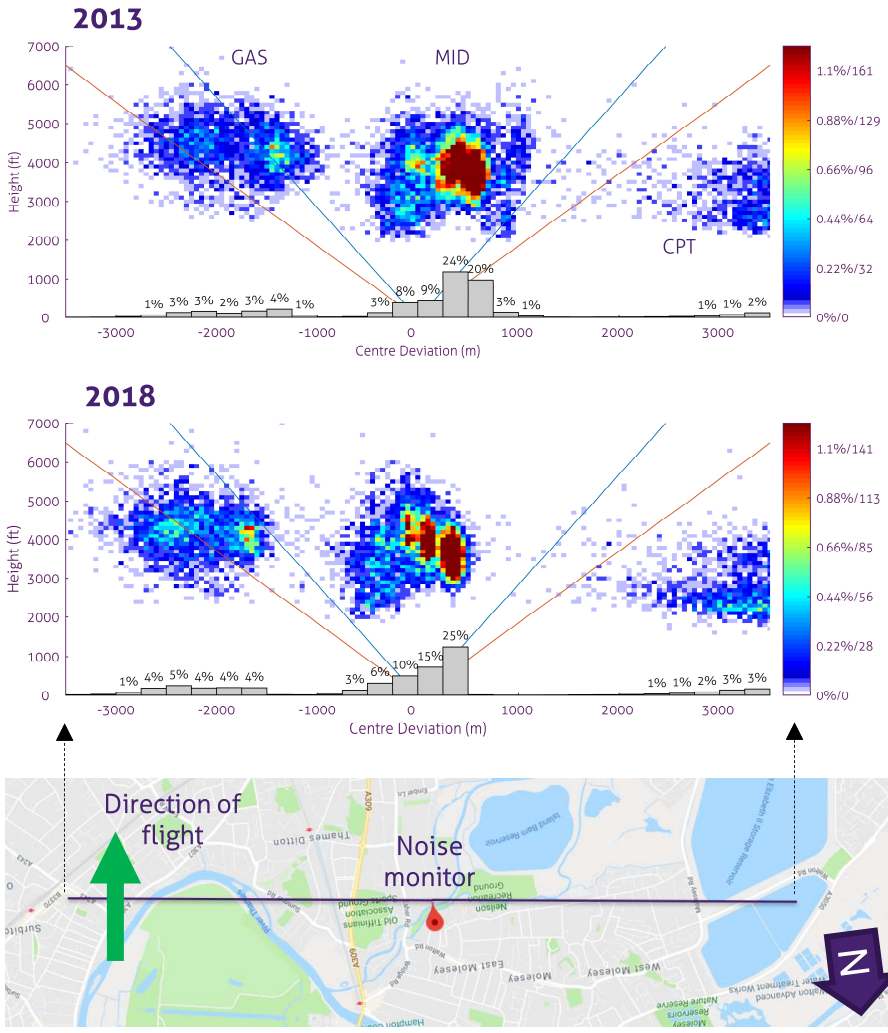

| | 2013 | 2018 | Change | Change (%) |
|---|---|---|---|---|
| Proportion of easterly operations (all Heathrow flights) | 38% | 36% | -2% | N/A |
| Average number of easterly departures passing through the easterly gate during days of 100% easterly operation. | 168 (100)* | 159 (88)* | -9 (-12) | -5% (-12%) |
| Average number of easterly arrivals passing through the easterly gate during days of 100% easterly operations. | 5 (2)* | 5 (1)* | +0 (-1) | +0% (-50%) |
| Average number of westerly departures passing through the westerly gate during days of 100% westerly operations. | 2 (1)* | 2 (0) * | +0 (-1) | +0% |
| Average number of westerly arrivals passing through the westerly gate during days of 100% westerly operations. | 27 (8) | 23 (8) | -5 (-) | -15% (-) |

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

Note: Wherever this section of the report refers to *2018*, it should be noted that this is specifically the measurement period from 1st March 2018 to 15th October 2018. Similarly, 2013 specifically refers to the period from 1st March 2018 to 15th October 2018.

# Is the concentration of easterly operations different between 2013 and 2018?

- The figures to the right are heat maps showing the 2D concentrations of departing aircraft as they pass through the gate during the 2013 (the upper figure) and 2018 (the lower figure) monitoring period in addition to the concentration at different distances from the centre along the length of the gate shown by the grey bars.
- The scale presents colours for the proportion of aircraft in each grid square (pixel). For example a "red" pixel indicates 1.1% of the movements passing through a grid square in the gate in both figures (it should be noted that the number of movements this represents may differ between the figures – in 2013, 161 flights represent 1.1%, in 2018 this figure was 141).
- The gate has been designed to be perpendicular to the route closest to the noise monitor, 09RMID. Since the gate is straight, it will cross the GAS route at a slight angle which will result in a wider swathe on the heat maps and is not representative of actual concentration. Therefore, is not possible to compare the concentration of different routes but may still be useful in comparing changes year to year.
- The figures indicate that there have been changes to the position of flights over East Molesey. In 2013, most aircraft flying down MID fell within a swathe some 500m wide (indicated by the dark red spot). In 2018, it appears that aircraft on MID are following one of two distinct paths (now indicated by two smaller spots).
- The position of the full swathe of MID has also moved about 500m towards the east.

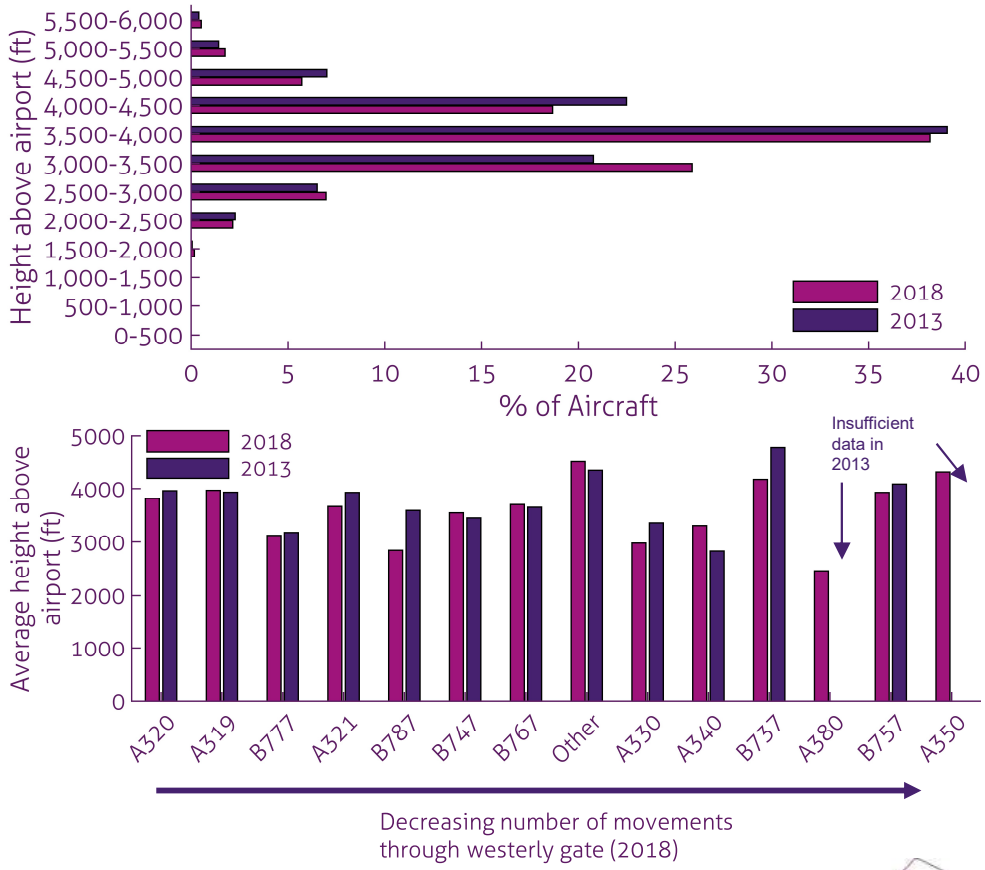



Note: The "heat maps" have been normalised to account for differences between the number of westerly departures in each of the monitoring periods. This allows the concentrations in each graph to be compared. This method does not account for any changes in daily number of movements passing through the gate - these changes are presented on Page 13. The maps are divided into grid squares, 50m horizontally by 60ft vertically.

# Are aircraft heights different between 2013 and 2018?

- The table to the right presents the average height of aircraft on the MID route departing the southern runway (09R) as they passed through the gate in the 2013 and 2018 periods.
- **This indicates that aircraft above East Molesey were on average broadly the same height in 2018 than 2013.**
- The figures present the distribution of these aircraft height through the gate comparing 2013 with 2018 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows that although the proportion of the lowest aircraft were similar in 2013 and 2018, there was a clear shift from the proportion of aircraft flying between 4,000-4,500ft in 2013 to between 3,000-3,500 in 2018.
- The lower figure shows that the height of aircraft varies with type. The B737 is the highest aircraft type while the A380 and A330 are the lowest.
- The B787 experienced the largest decrease in altitude above East Molesey in 2018 compared to 2013 while the A340 had the largest increase in altitude.

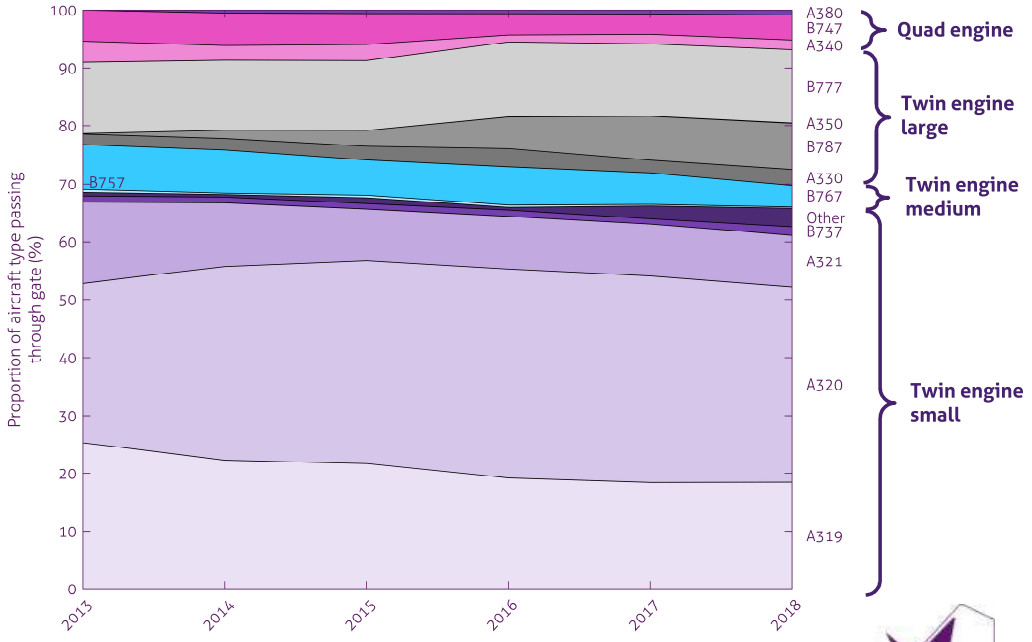
| | 2013 | 2018 | Difference |
|---|---|---|---|
| **Average height of departures through the gate on MID (southern runway)** | 3,760ft | 3,700ft | -60ft |



# Is the fleet mix different between 2013 and 2018?

- The table to the right presents the mix of departing aircraft that passed through the westerly gate and overall at Heathrow in the 2013 and 2018 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, A330)
  - twin engine medium aircraft (B767)
  - twin engine small aircraft (B737, A320 family).
- Previous slides indicated that the number of departing aircraft flying through the easterly gate has decreased on an average day of full easterly operations between 2013 and 2018 by 5%.
- The analysis on this page indicates that there was an increase in the proportion of A380 operations departing through the easterly gate from zero in 2013 to 0.8% in 2018, however this proportion is less than the proportion operating at the airport.
- The proportion of large twin aircraft increased as a result of the increased use of the B787. This resulted in a decrease in the proportion of other quad engine aircraft as well as medium and small twin engine 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.

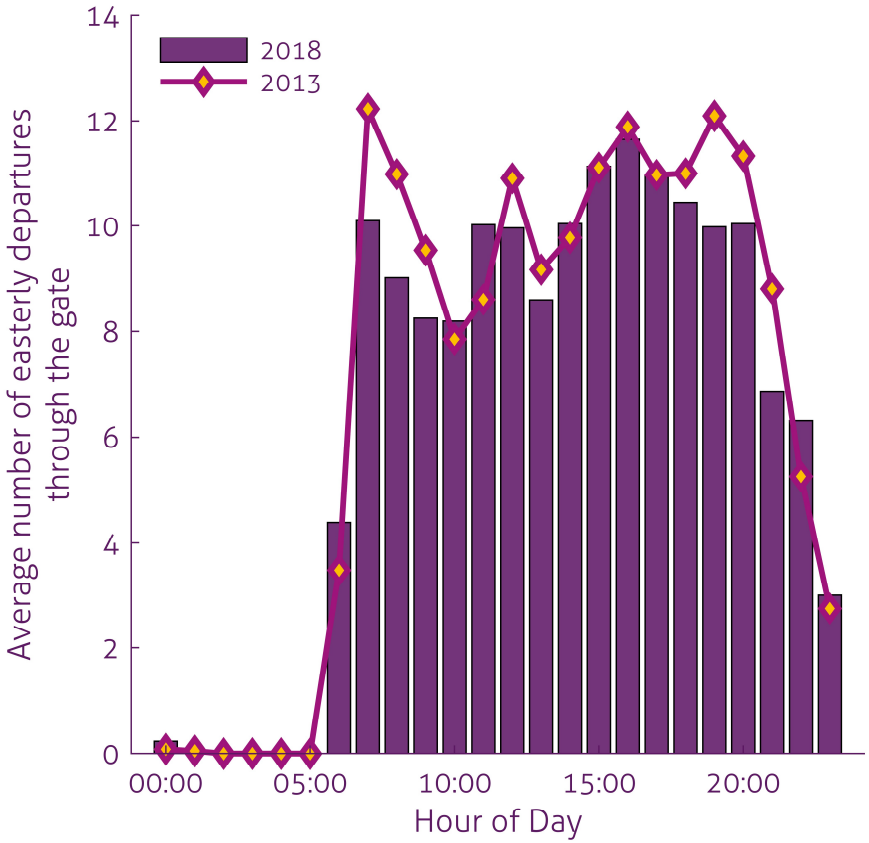
| Fleet mix | | | | |
|---|---|---|---|---|
| Category | Easterly gate | | All Heathrow | |
| | 2013 | 2018 | 2013 | 2018 |
| A380 | 0.0% | 0.8% | 3.8% | 3.5% |
| Quad engine | 9.0% | 6.0% | 9.8% | 5.2% |
| Twin engine large | 14.2% | 23.4% | 17.4% | 27.7% |
| Twin engine medium | 7.9% | 3.9% | 2.9% | 4.1% |
| Twin engine small | 68.9% | 65.8% | 66.1% | 60.5% |




* Days of 100% easterly operations only

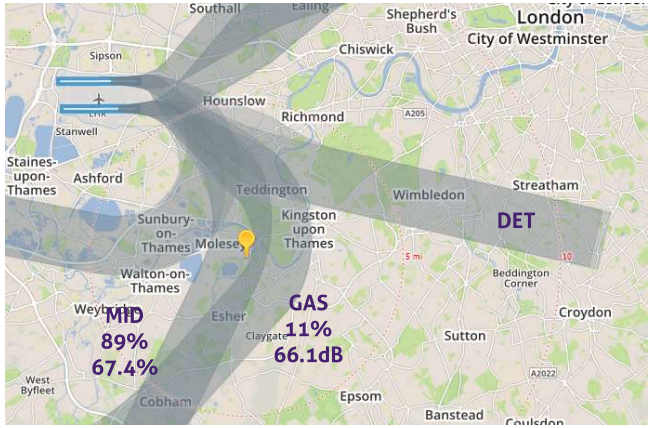
# Does the number of flights over the area vary across the day? Is there a difference between 2013 and 2018?

- The figures to the right present the average number of departures through the easterly gate per hour in 2013 and 2018 during days of 100% easterly operations
- The figure shows that, on average, in 2018 between 6 and 12 departures passed through the gate per hour during daytime hours (07:00 – 23:00) . The busiest hour being 16:00-17:00.
- During the shoulder hours of 06:00-07:00 and 23:00-00:00, on average 3 and 4 departures passed through the gate respectively
- The 5% decrease in aircraft passing through the gate on full days of easterly operations (see Page 13) compared to 2013 was generally due to a reduction in departures passing through the gate during the hours 06:00-09:00 and 18:00-22:00.
- Of the total 229 days in the 2018 monitoring period, 109 days (48%) were 100% westerly operations and 54 days (24%) were on 100% easterly operations. A change of direction occurred during the remaining days.



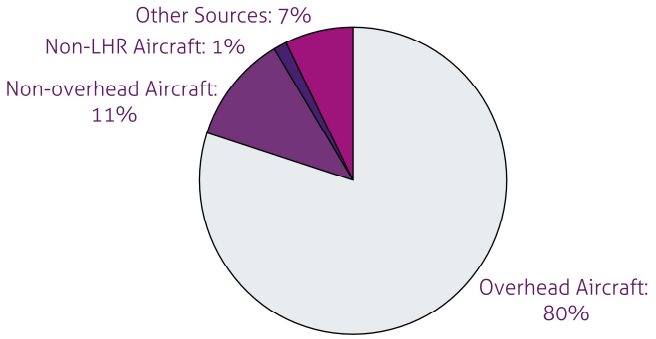
# Overview of noise monitor data recorded at East Molesey

24th January 2018–15th October 2018




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

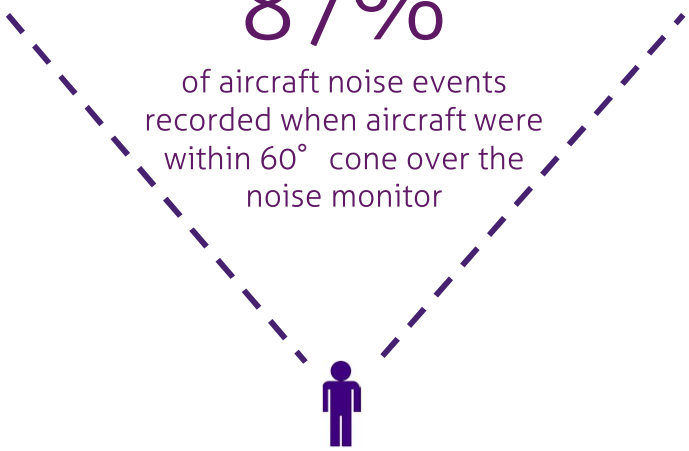
6,927 Measured Noise Events

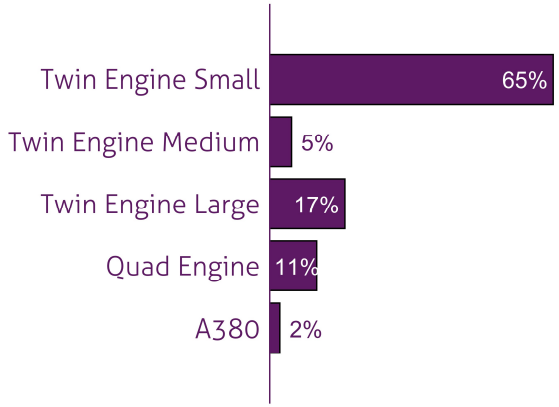



* From all noise sources

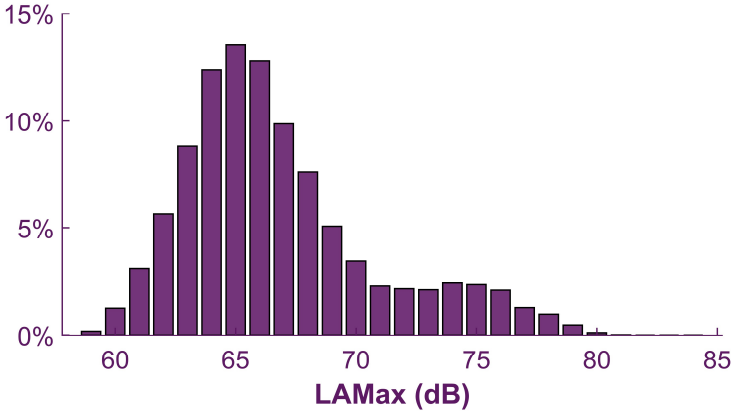
87%

of aircraft noise events recorded when aircraft were within 60° cone over the noise monitor

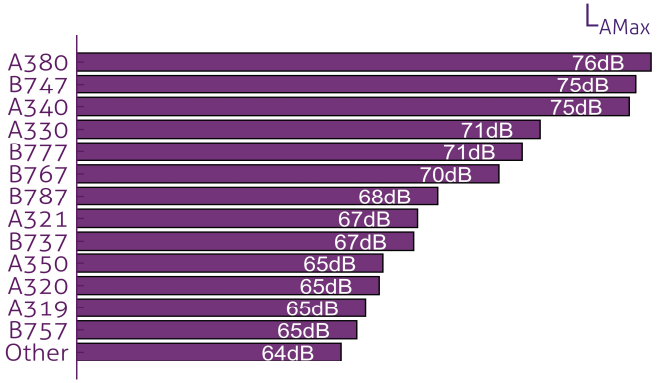





**Noise events by aircraft size**




**Overall distribution of maximum event noise level $L_{Amax}$ - Heathrow aircraft**




**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 Neilson Recreation Ground in East Molesey between 24/01/2018 and 15/10/2108.
- The monitor was set up to record noise events based on a threshold sound pressure level of 58.3 dBA being exceeded for more than 10 seconds.
- The location of the noise monitor is shown in the figure to the right. It is close to the centreline of the MID NPR and just outside the GAS NPR on easterly operations.

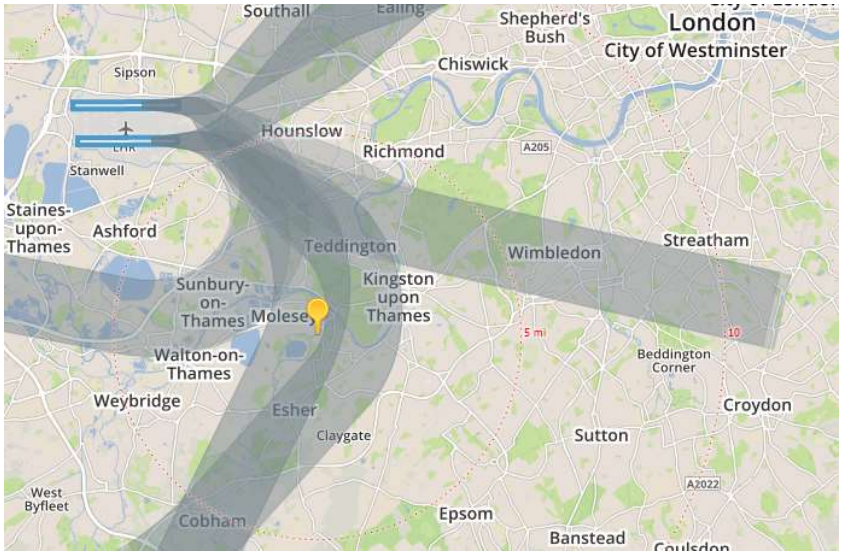
## Noise event summary

- A total of 6,927 noise events were measured during the monitoring period. Of these around 91% were from aircraft using Heathrow and 7% were from non-aircraft sources.
- Almost 87% of the aircraft registering noise events at the noise monitor were using the easterly MID route, the vast majority of the remaining events were easterly departures on the GAS route.
- Overall, 87% of aircraft registering noise events were overhead (based on the 60° cone) - 99% of these were on the easterly MID route.

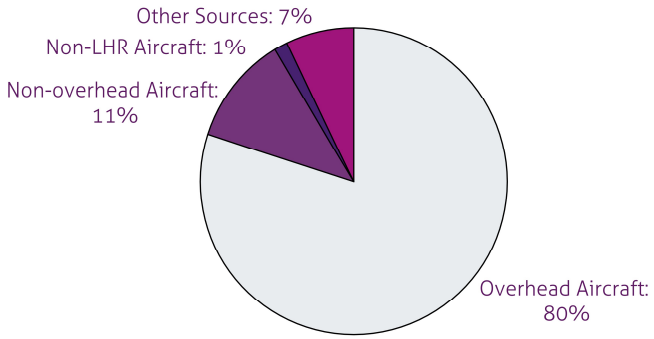
**Percentage of aircraft noise events by route**

| Easterly | | | | Westerly | | Overhead |
|---|---|---|---|---|---|---|
| MID | | GAS | | DET | | |
| 09L | 09R | 09L | 09R | 27L | 27R | |
| 0 | 87 | 0 | 11 | 0 | 1 | 87 |

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

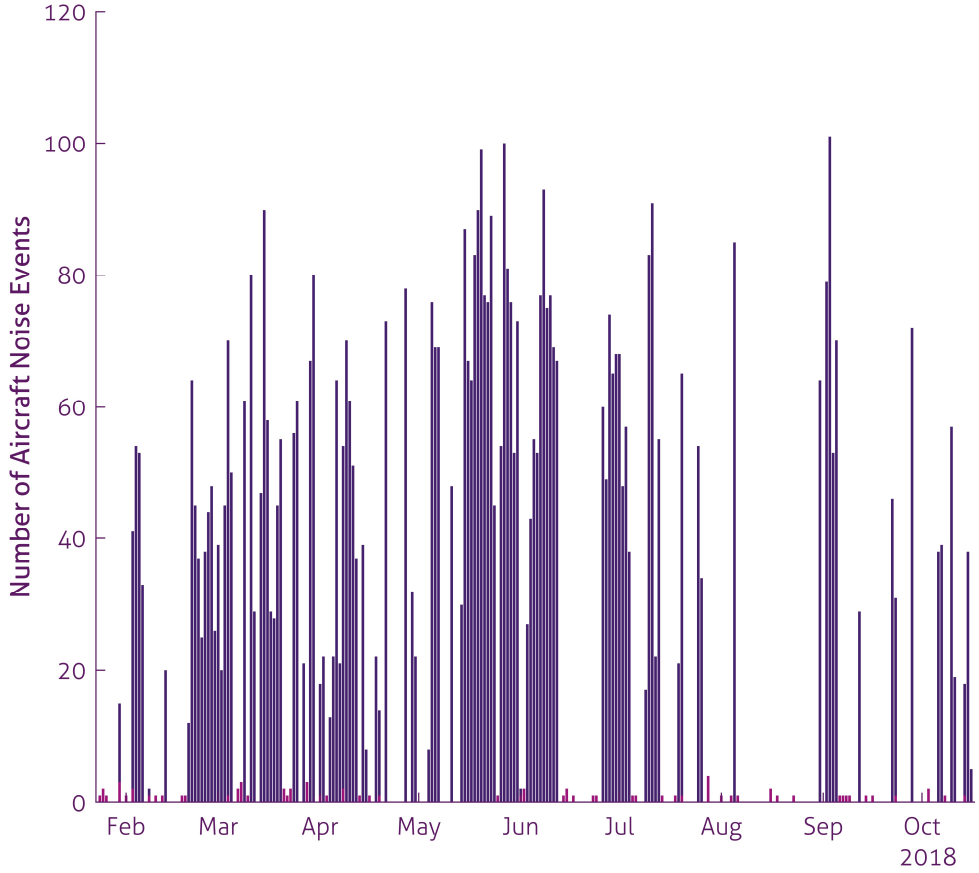



**Measured noise event summary**



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

- Noise events are predominantly captured at East Molesey during periods of easterly operations by aircraft using the MID route. The remainder are generally easterly departures on the GAS route.
- During the monitoring period, 128 out of 265 days (48%) were 100% westerly operations and 64 days (24%) were 100% easterly operations. On the remaining days, the airport switched direction of operation during the day.
- During days of full easterly operations, there were, on average, 62 aircraft noise events triggered per day.
- During days of full westerly operations there was an average of less than one aircraft noise events per day.
- On average, 87% of measured aircraft noise events were recorded by aircraft passing within the 60° overhead cone.
- Over the 265 days for which monitoring was taking place, 25% of days experienced 50 or more aircraft events whilst 55% of days had less than 5 aircraft noise events.
- It is noted that an absence of aircraft noise events does not mean that aircraft would not necessarily be audible. There may be aircraft further away that are audible but have not triggered the noise event detection threshold.



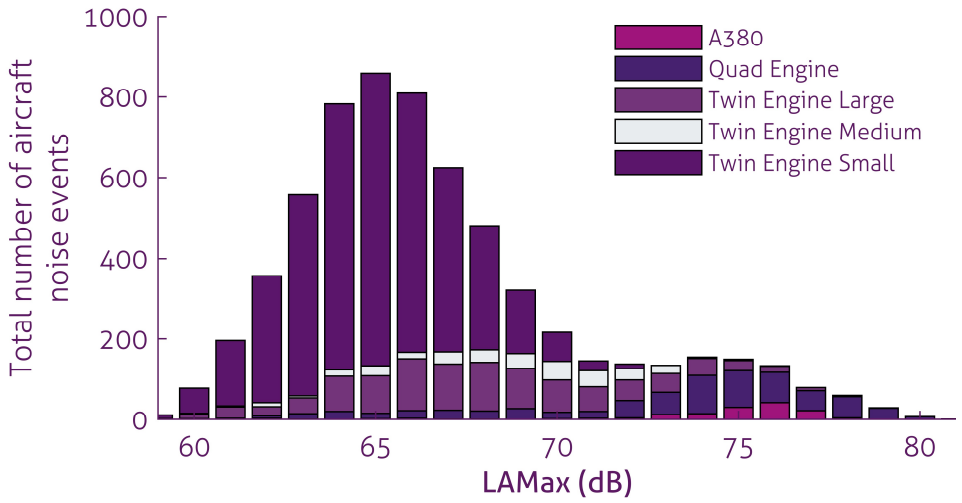
# What was the range of $L_{Amax}$ and SEL noise levels from aircraft events?

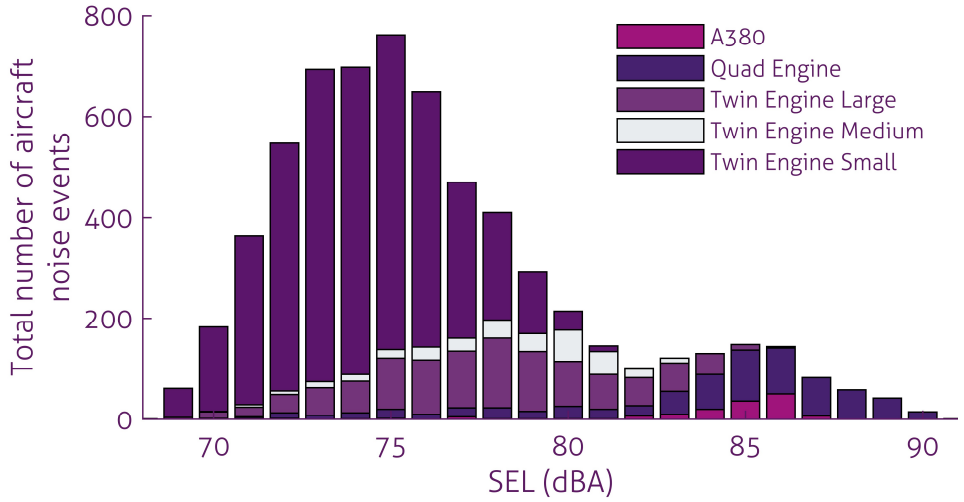
- The figures to the right present the range of $L_{Amax}$ (top) and SEL (bottom) noise levels for all aircraft noise events measured at East Molesey monitor during the monitoring period. An explanation of metrics is given on page 9.
- The table below presents the average* $L_{Amax}$ and SEL for each aircraft type group.
- The average $L_{Amax}$ and SEL of all aircraft events are 67.2 and 76.7dB. The distribution of noise levels is dependent on aircraft size with the larger aircraft generally recording louder events.

| Aircraft group | Average $L_{Amax}$ | Average SEL, dBA |
|---|---|---|
| A380 | 74.7 | 84.5 |
| Quad engine | 73.6 | 84.2 |
| Twin engine large | 68.4 | 78.2 |
| Twin engine medium | 69.1 | 78.7 |
| Twin engine small | 65.5 | 74.6 |

- 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 25.
- For non-aircraft related events, the mean $L_{Amax}$ is 65.7dB reaching a maximum of 85dB.

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

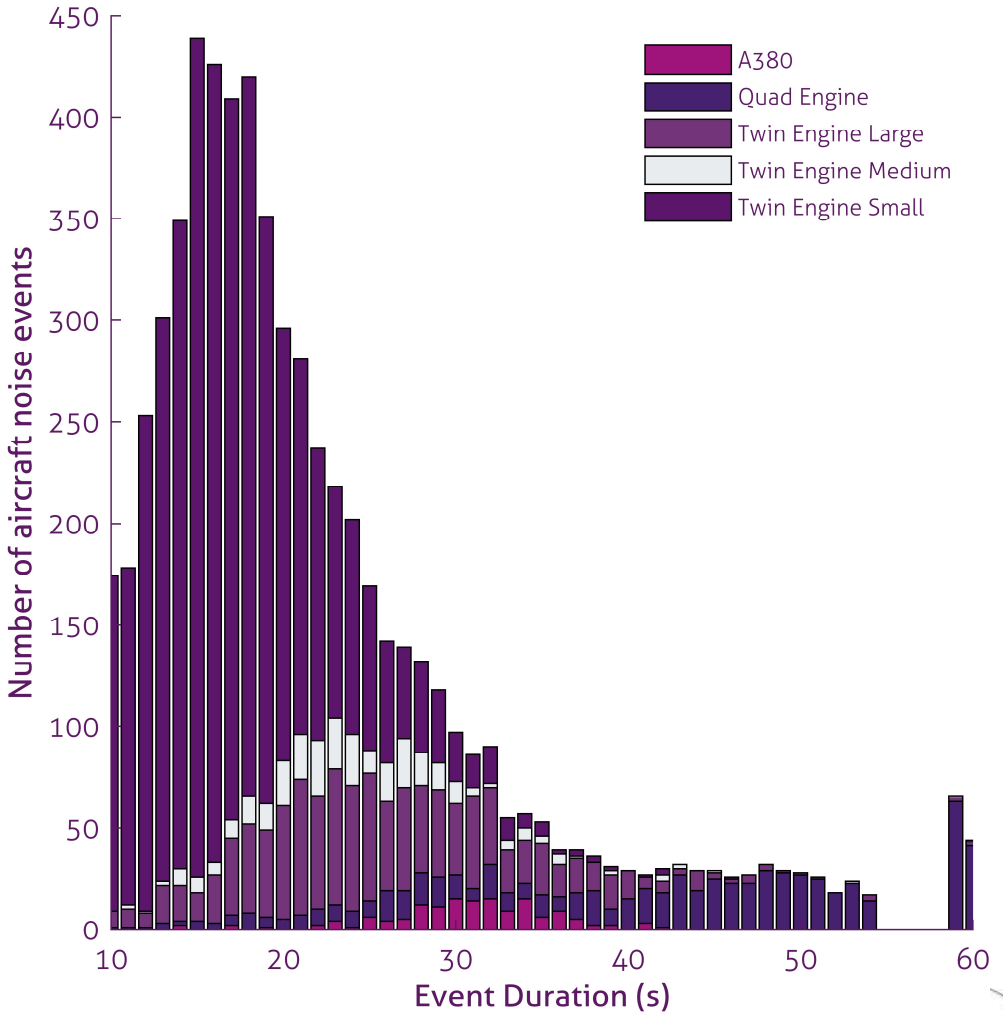


# How does the duration of an aircraft event vary?

- 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 58.3dBA.
- In addition, events are only recorded if the duration is longer than 10s to prevent impulsive sounds which 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 22.2 seconds. The duration is largely dependent on the noise level of the event with the average event duration of the quad engine aircraft, predominantly B747-400s, being around 42 seconds while the duration of the smaller twin engine aircraft is 18 seconds.
- The >60 seconds category includes all events with durations more than 60 seconds, which are most likely to be due to one event combining with another (e.g. one of which may not necessarily be an aircraft event)

| Aircraft group | Average noise event duration (seconds) |
|---|---|
| A380 | 30.8 |
| Quad engine aircraft | 42.2 |
| Twin engine - large | 25.8 |
| Twin engine - medium | 24.3 |
| Twin engine - small | 17.5 |



# 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'.
- As with the Heathrow Airport's traffic in general, the A320 family (A319, A320 & A321) dominate - accounting for 62% of all aircraft noise events detected by the monitor.
- The B777 (twin-engine large) series of aircraft account for around 11% of the measured aircraft noise events, which are measured from both the MID and GAS routes.
- The A380, B747 and A340 are the largest aircraft that operate into Heathrow (and therefore often the loudest) are responsible for 2%, 8% and 3% of the total aircraft noise events respectively.
- The newest aircraft type in service, the A350 only generated 8 noise events during the monitoring period. The B787, another relatively new aircraft type, now accounts for 3% of the noise events
- Approximately 1% of noise events were from aircraft on westerly operations.

| Aircraft Type | Total* | Route | | | Overhead** |
|---|---|---|---|---|---|
| | | Easterly MID | Easterly GAS | Other | |
| A320 | 33 | 32 | 1 | 0 | 32 |
| A319 | 15 | 15 | 0 | 0 | 15 |
| A321 | 14 | 14 | 1 | 0 | 14 |
| B777 | 11 | 4 | 6 | 0 | 5 |
| B747 | 8 | 6 | 1 | 0 | 6 |
| B767 | 5 | 4 | 1 | 0 | 4 |
| A330 | 3 | 3 | 1 | 0 | 3 |
| A340 | 3 | 2 | 0 | 0 | 2 |
| B787 | 3 | 3 | 0 | 0 | 3 |
| A380 | 2 | 2 | 0 | 0 | 2 |
| B737 | 1 | 1 | 0 | 0 | 1 |
| Other | 2 | 2 | 0 | 0 | 2 |
| Total*** | 100% | 89% | 11% | 0% | 87% |

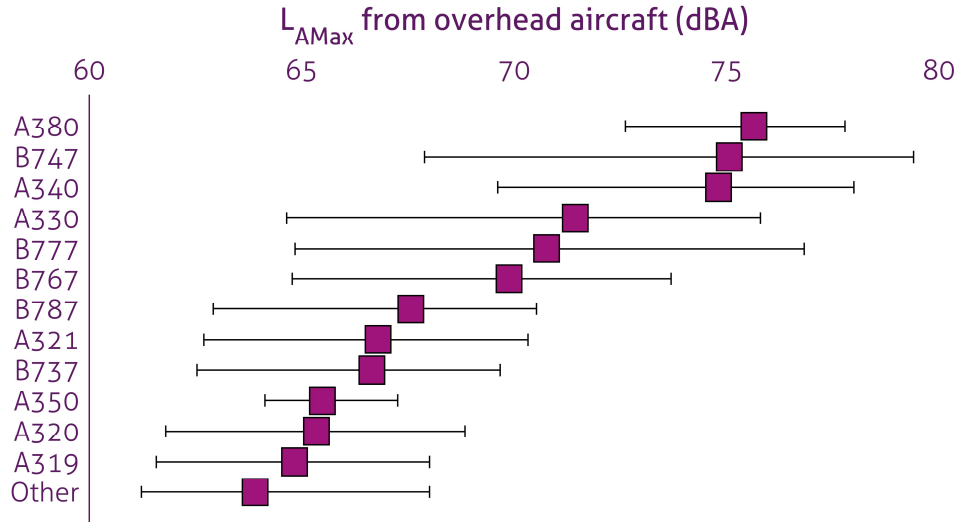
* Percentage based on 6,334 aircraft noise events recorded between 24th January – 15th October 2018
** Defined as being with the 60 degree cone described on page 10
***Totals may differ to sum of aircraft types due to rounding

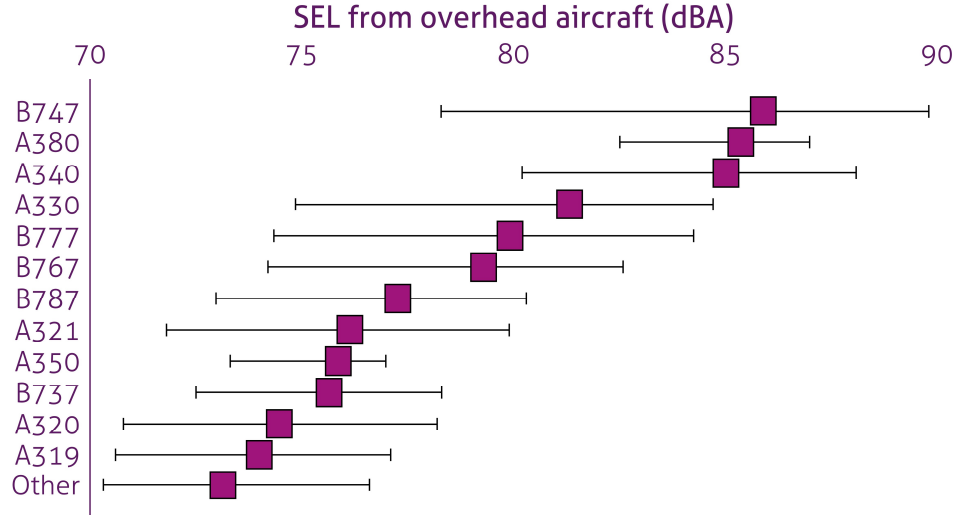
# Comparison of average noise levels for different aircraft types

The plot in the top right show the average (arithmetic mean) $L_{Amax}$ of each aircraft type in addition to the 5th and 95th percentile within the 60° **overhead** cone. The large majority of these were on the easterly MID route.

- The highest average measured noise level is from the A380, which at 76dB $L_{Amax}$ was marginally greater than the B747 and A340, the other two quad engine aircraft operating at Heathrow.
- It should be noted that there is a large range of levels for each aircraft type, typically between 4 and 10 decibels depending on the aircraft type.
- Two members of the A320 family, the A319 and A320, were, on average, the quietest aircraft types over the East Molesey monitor at approximately 65dB.
- The B787 and A350, the newest aircraft types in service (both in the medium twin engine category) generated average $L_{Amax}$ levels of around 66 and 65dB respectively.

The plot in bottom right corner shows the average SEL of each aircraft type. The SEL takes into account of all energy within a noise event. The relationship of aircraft types is similar to that seen in the $L_{Amax}$ plot with the notable exception being the B747 is level is greater – this is likely to be due to longer durations seen on page 23.

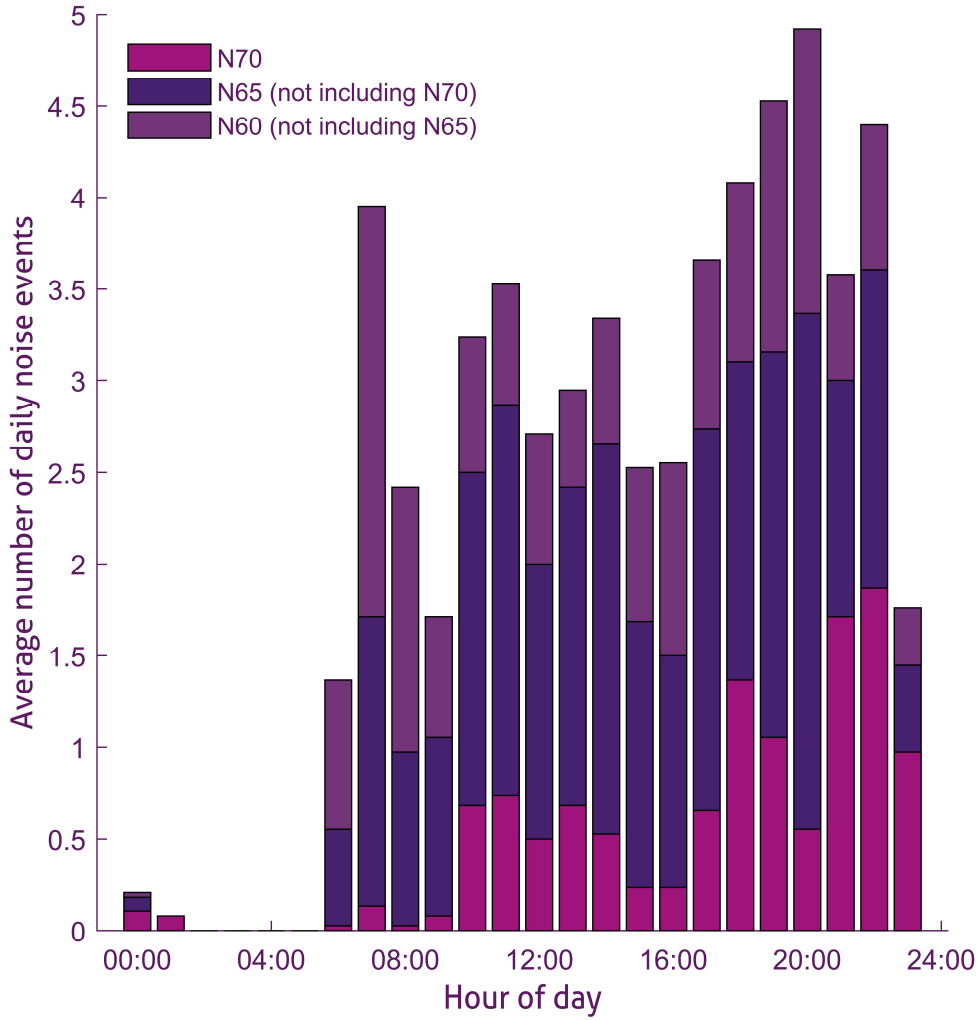



In accordance with CAA guidance, this analysis has used the 60 degree overhead cone.

# 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 65dBA in a single hour.
- The figure to the right shows the average hourly N60, N65 and N70 values across an **average 24hr day for days of 100% of easterly operations**.
- Between the hours of 06:00 and 00:00 there are typically, between 1.5 and 5 events being registered per hour. The busiest period is between 17:00 and 23:00, during which, there is an average of at least 3.5 events in every hour.
- There is also a peak between 07:00 and 08:00 during which there are on average around 4 events in the hour.
- On an average easterly day, the N65 during the 16h day period (07:00-23:00) was 54; the N60 during the 8h night (23:00-07:00) was less than 4.
- The N60 during the night period on easterly days is predominantly made up of schedules departures between 06:00 and 07:00 and late runners between 23:00 and 00:00.



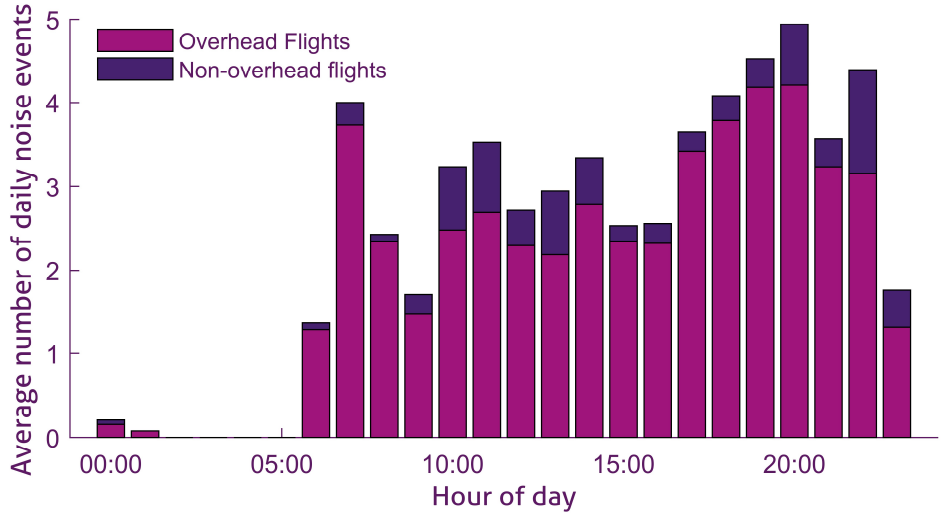
# How does the number of aircraft noise events vary across a day?

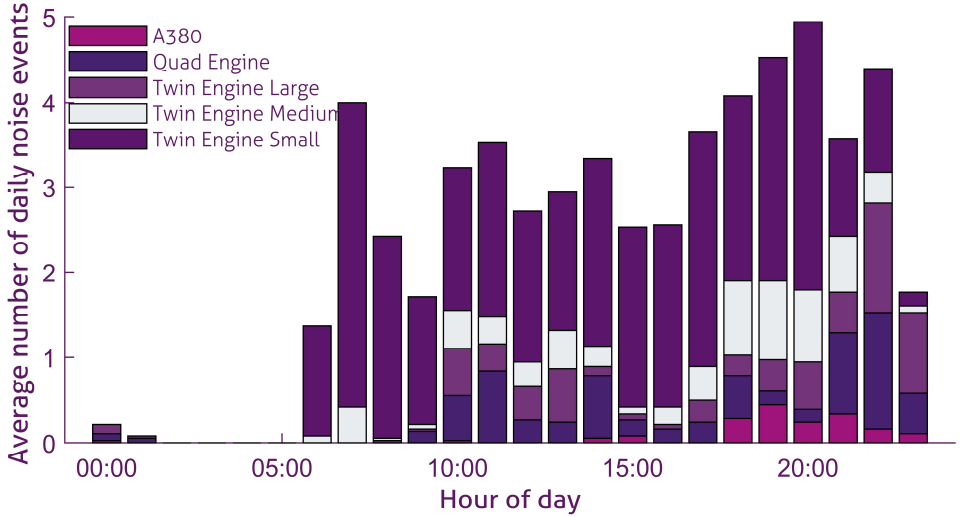
**The top right figure shows the average number of noise events during each hour of the day for days of full westerly operations.**

- During daytime hours, there were typically between 1.5 and 5 aircraft noise events flights per hour of which the majority were overhead (passing within the 60° cone above the monitor).
- The proportion and number of overhead aircraft is greatest in the periods 10:00-12:00 and 22:00-23:00.

**The lower figure shows the same data broken down by aircraft size.**

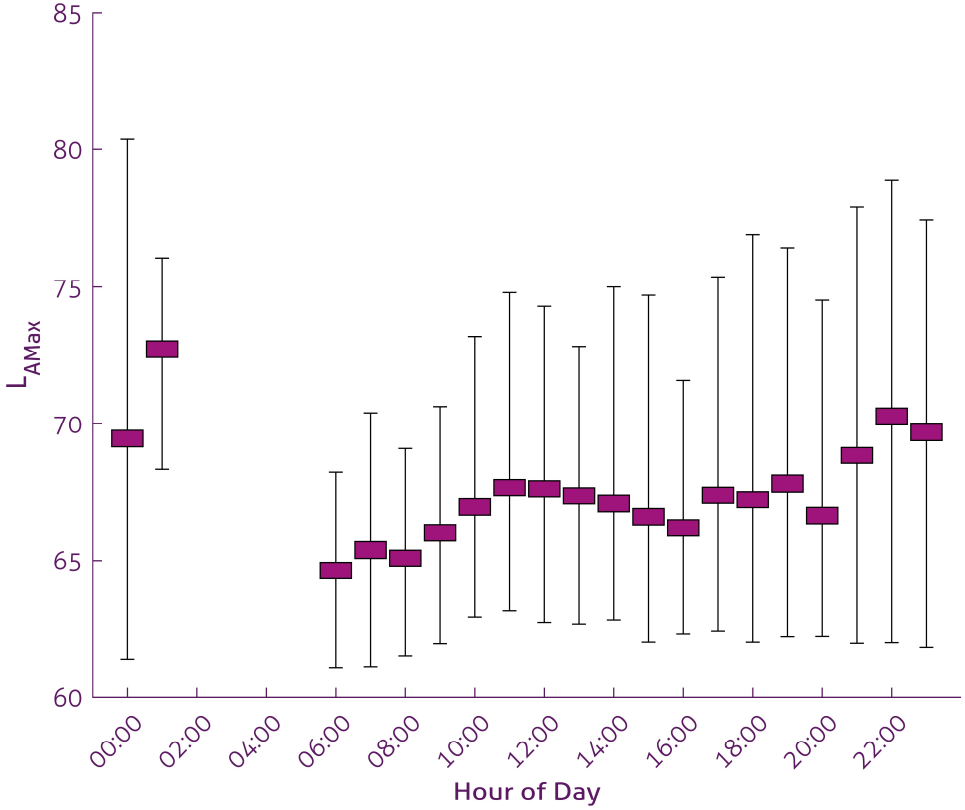
- Before 10:00, the vast majority of noise events were from small twin engine aircraft; predominantly the A320 family.
- Small twin engine aircraft account for more than half the aircraft noise events throughout the day until 21:00 at which point the proportion of medium and large twin engine aircraft, and quad engine aircraft increases significantly.
- The majority of A380s pass over East Molesey between 18:00 and 23:00.



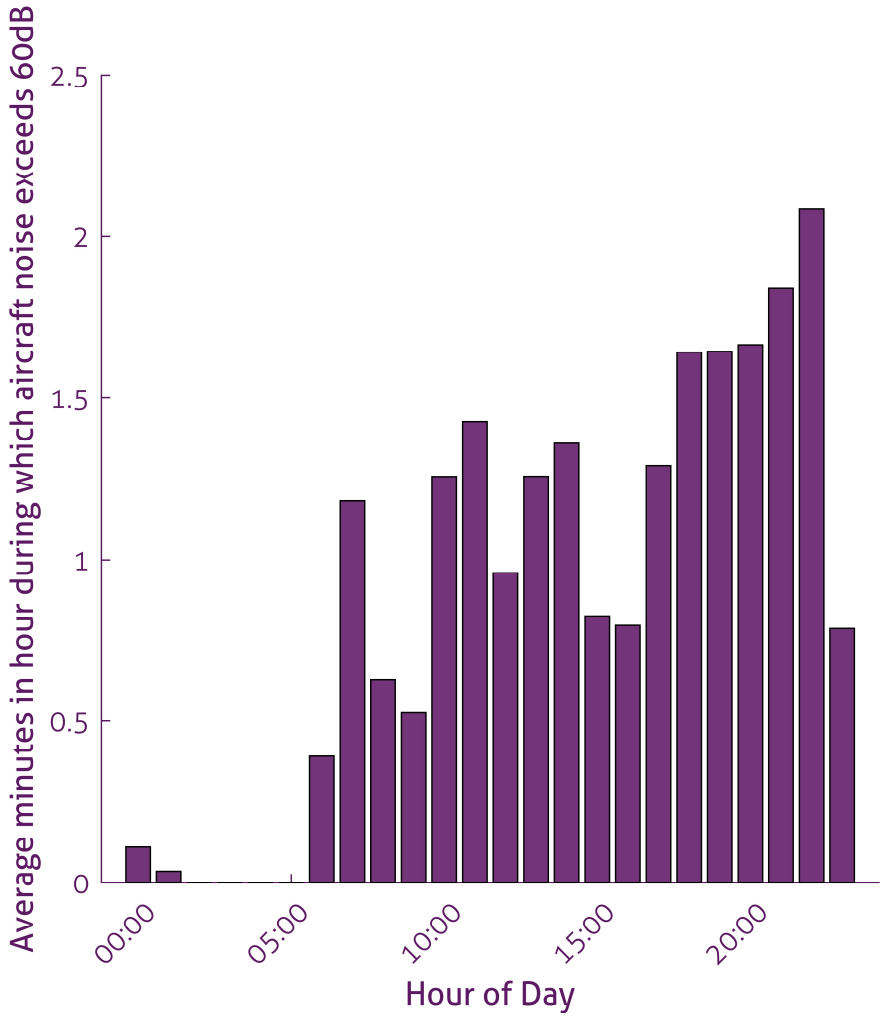
# How does the $L_{Amax}$ vary across a day?

- 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.
- At 06:00 the average $L_{Amax}$ is approximately 65dB and increases to about 68dB at midday. This is followed by a slight decrease until 17:00 after which the average $L_{Amax}$ increases to 70dB by 23:00.
- In any given hour, the range of $L_{Amax}$ is generally between 7 and 15dB. The range is a function of the fleet mix in any given hour; in periods when there are only small twin engine aircraft passing over East Molesey, the range is relatively small (08:00-09:00), this increases during the day as the proportion of aircraft sizes become more equal.
- The average $L_{Amax}$ of aircraft between 00:00 and 02:00 reaches 73dB however the sample size is very small in this period (14 noise events).



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

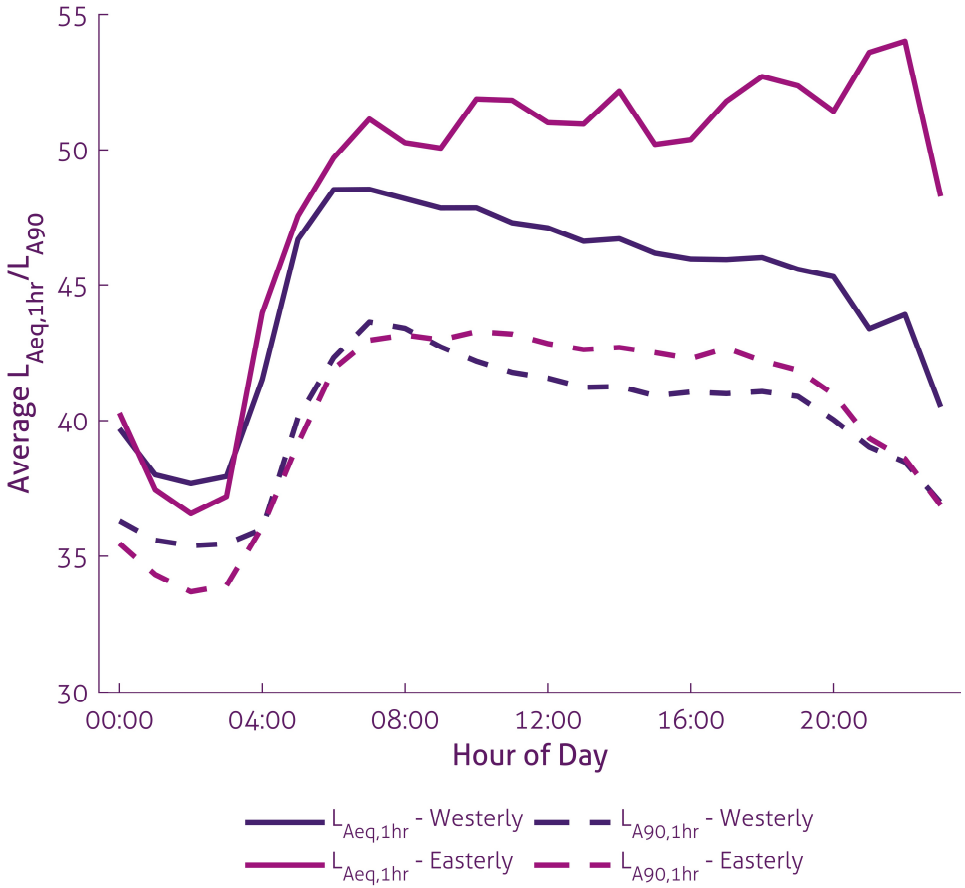
- The figure to the right shows the average number of minutes in each hour when the sound level within an aircraft noise event exceeding the measured noise event threshold - in this case 58.3dBA – on a day of full easterly operations. At this location this could be described as the amount of time (in minutes) that the aircraft noise level exceeds 58.3dBA.
- 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 100% easterly days aircraft noise exceeded the monitor threshold for a total of between 0.5 and 2 minutes in each hour between the hours of 6am and midnight.
- The monitor threshold was exceeded for the greatest total duration between 22:00 and 23:00 for a total of slightly greater than 2 minutes. There is also a peak between 07:00 and 08:00; a period when there a lot of small twin engine aircraft departing the airport




* 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 on days of 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 the period, from 00:00 to 07:00 there is a small difference between the easterly and westerly operations suggesting the night time noise environment is not dominated by aircraft noise.
- Across the course of the day, the difference in noise level between easterly and westerly operations increases to a maximum of 10dB between 21:00 and 23:00. This suggests that during these hours, on easterly operations, the overall noise environment is governed by aircraft noise.
- During this period the $L_{Aeq,1hr}$ reaches it's maximum level of 54dB. This occurs at a time when background noise is reducing (as indicated by the $L_{A90}$).
- During the period the monitor was in place, the average daytime $L_{Aeq,16hr}$* between 07:00 and 23:00 was 52dB on easterly operations and 47dB on westerly operations from all noise sources.
- During the night, the average $L_{Aeq,8hr}$ between 23:00 and 07:00 was 45dB on easterly operations and 43dB on westerly operations.



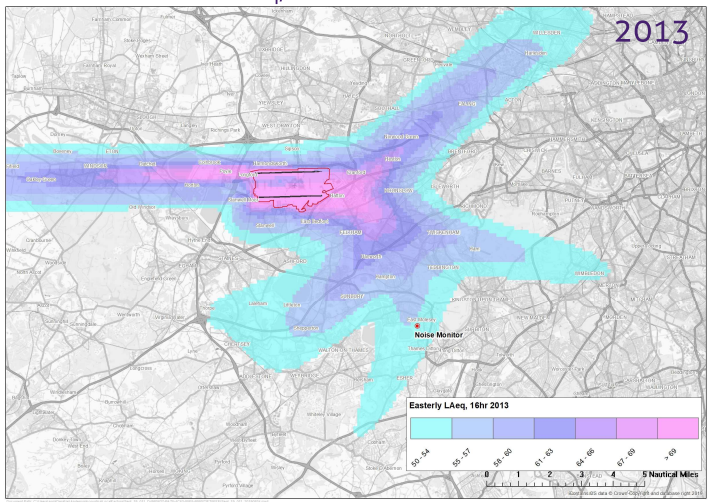

*It should be noted that the $L_{Aeq,16hr}$ has been calculated using the average of the hourly values for easterly and westerly days during the monitoring period. This is different to the published annual contours which calculate the LAeq,16hr over a 92 day period over the summer.

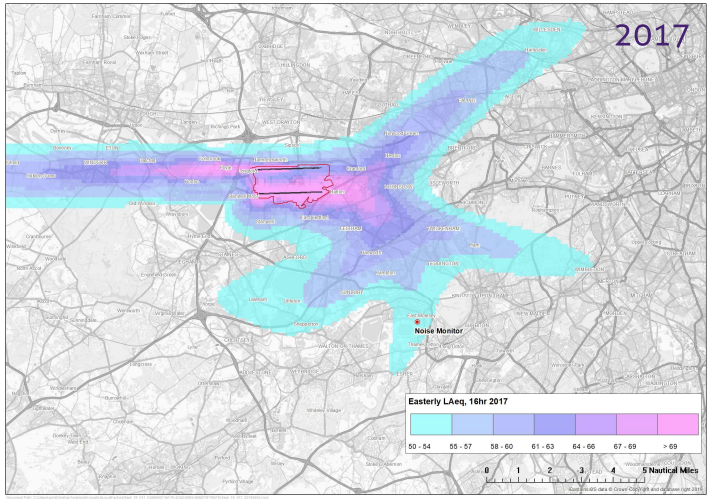
# Average **daytime** aircraft noise levels – easterly operations

- 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 easterly summer day when the airport is on 100% easterly operations**.
- The position of the noise monitor is marked by the orange 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.

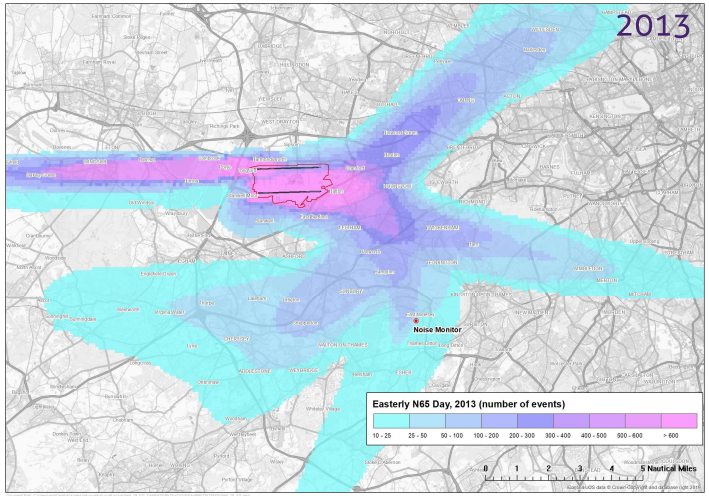
- Larger figures are shown in Appendix A.

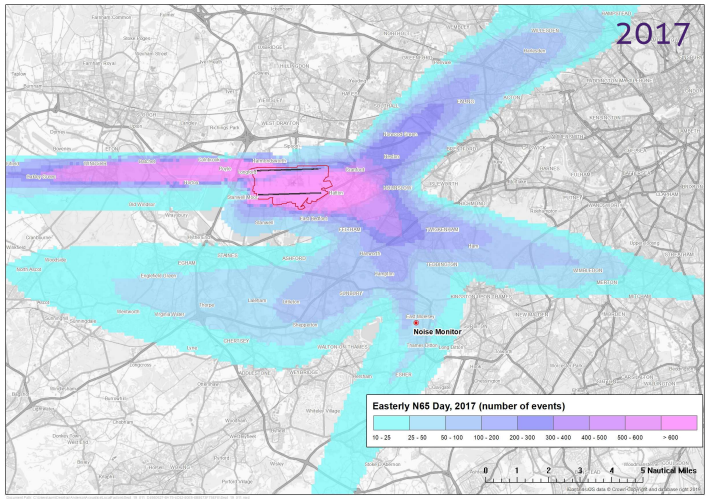
$L_{Aeq,16hr}$




N65, Daytime

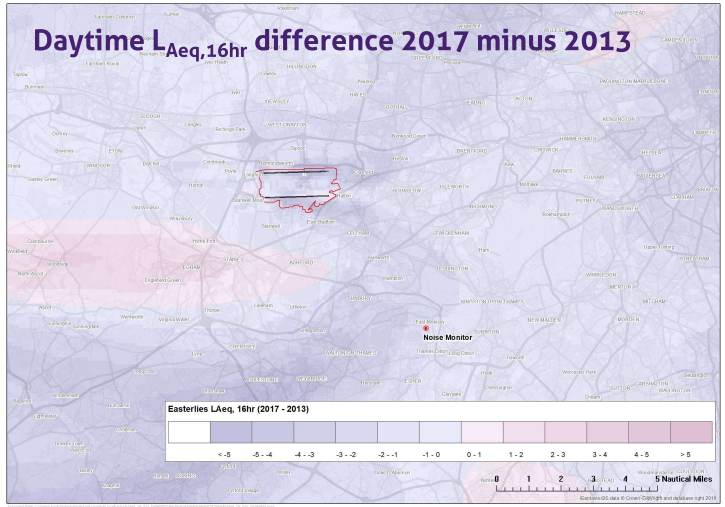


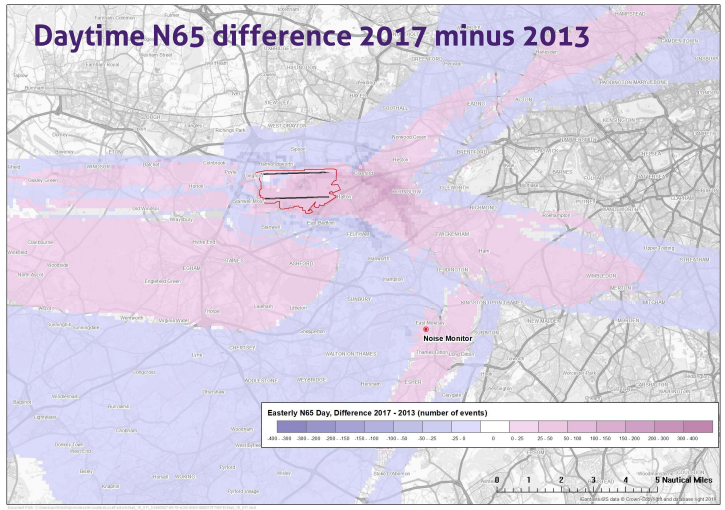



# Differences in average **daytime** aircraft noise levels – easterly operations

- The difference in the modelled average $L_{Aeq,\ 16hr}$ and $N65_{16\ hr}$ contours around Heathrow between 2013 and 2017 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 $L_{Aeq,16hr}$ 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 East Molesey there was between a one and two decibel decrease in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017 however 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 100% increase would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.

- Larger figures are shown in Appendix A.



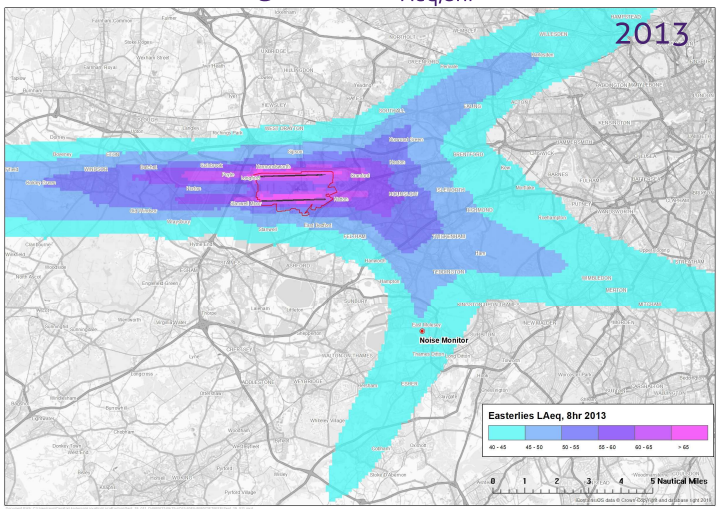



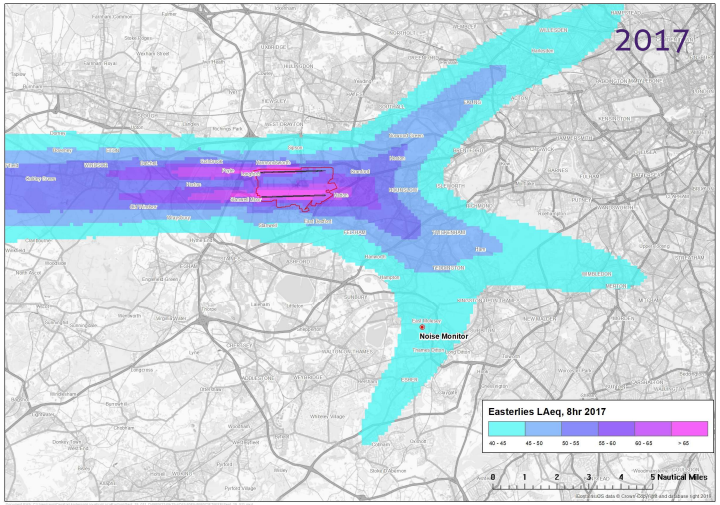
# Average **night-time** aircraft noise levels – easterly operations

- 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 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.

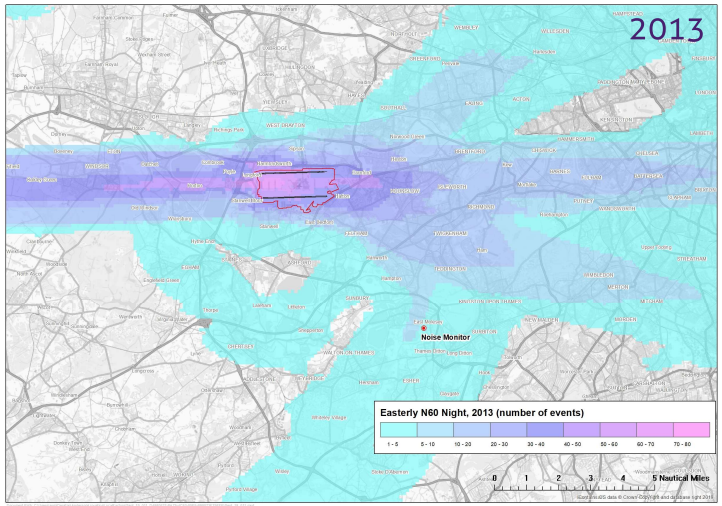
- Larger figures are shown in Appendix A.

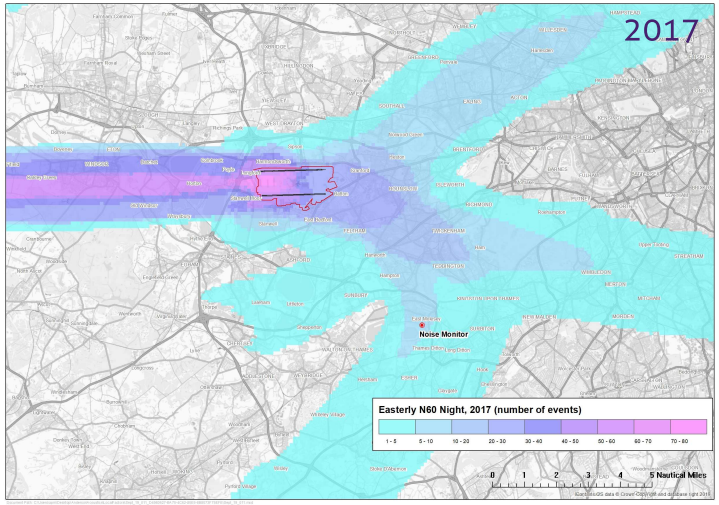
Night-time $L_{Aeq,8hr}$




N60, night-time

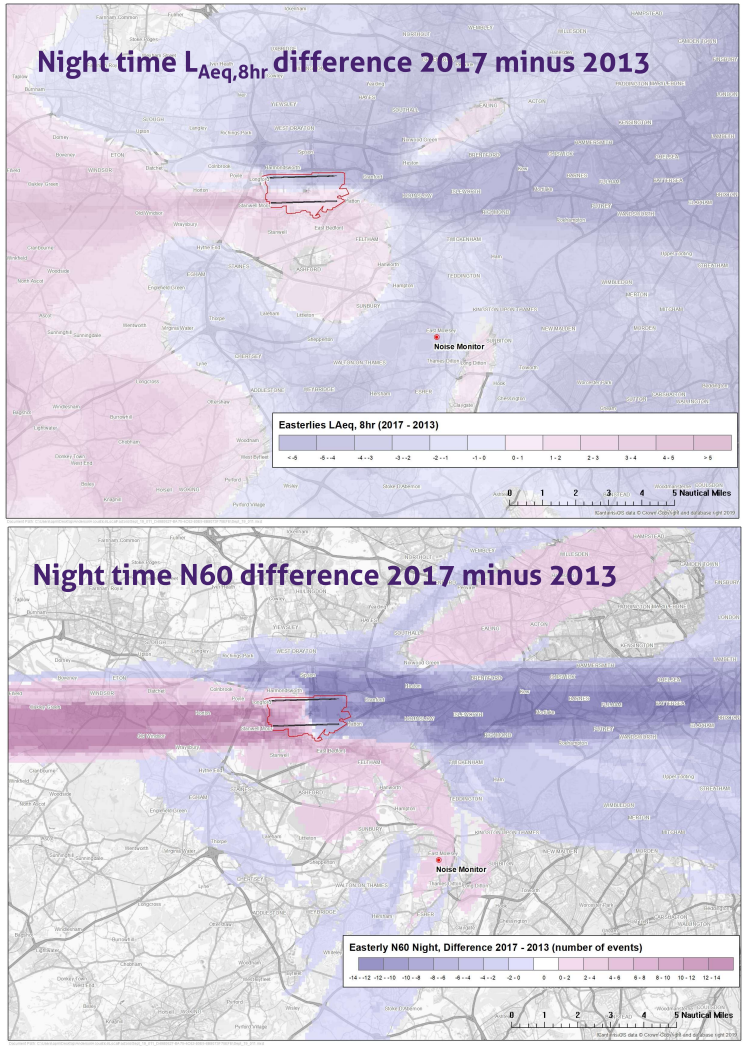


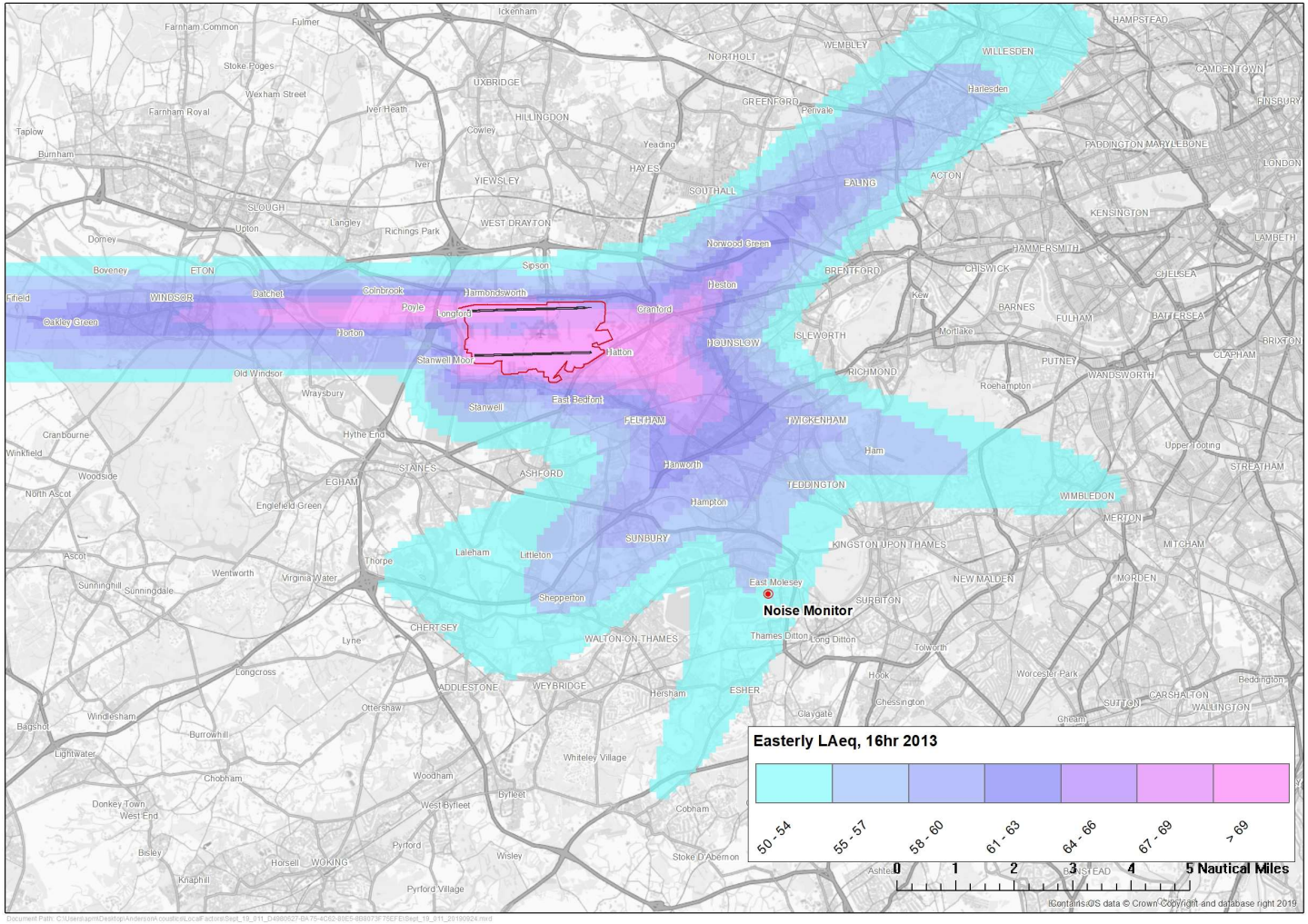
# Differences in average **night-time** aircraft noise levels – easterly operations

- The difference in the modelled average $L_{Aeq, 8hr}$ (upper figure) and $N60_{(8\ hr)}$ (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 decrease in average night-time aircraft noise $L_{Aeq,8hr}$ of between two and three decibels however the modelling indicates there was an increase in N60 of less than 2 at Chertsey from 2013 to 2017.

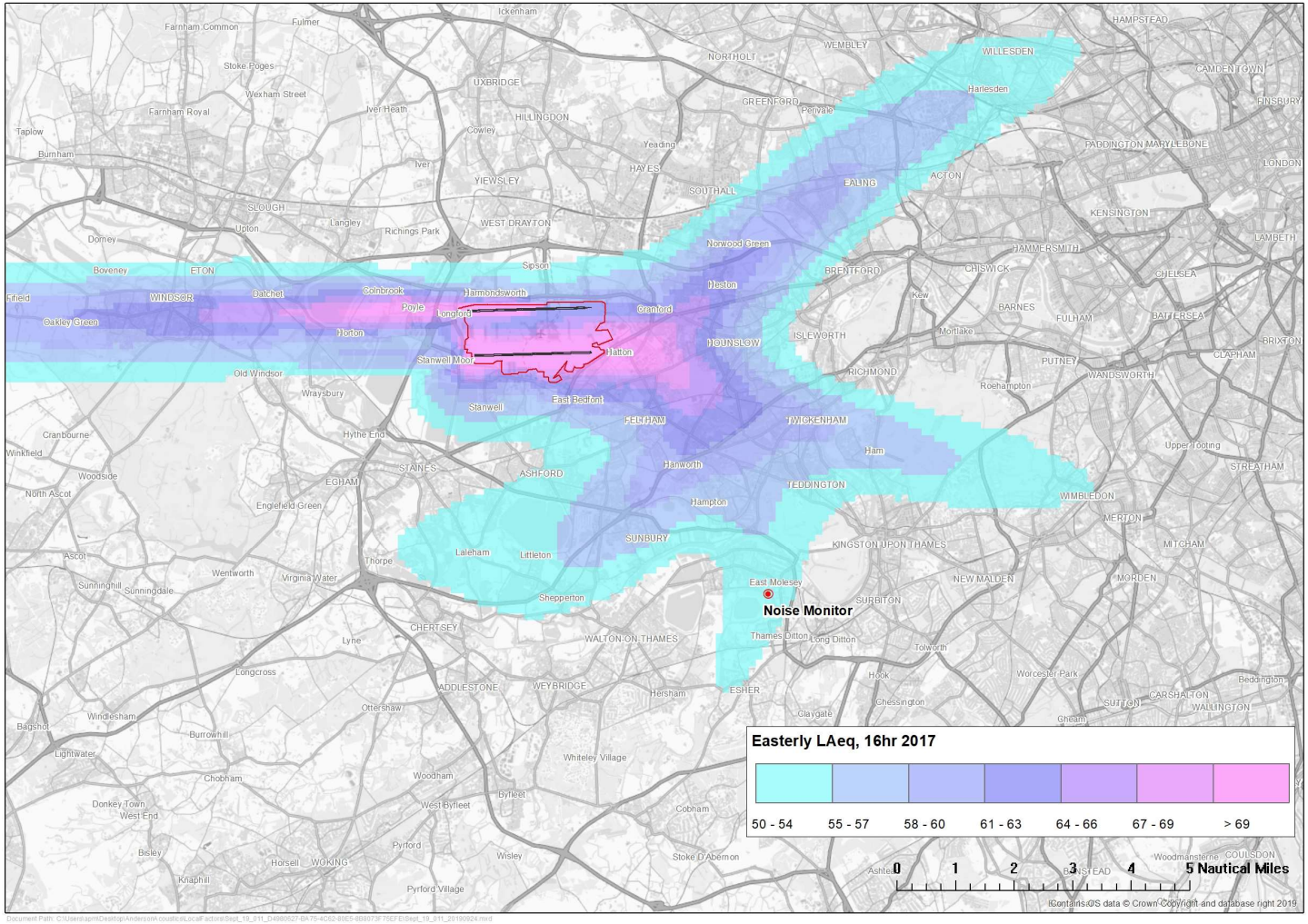
- Larger figures are shown in Appendix A.



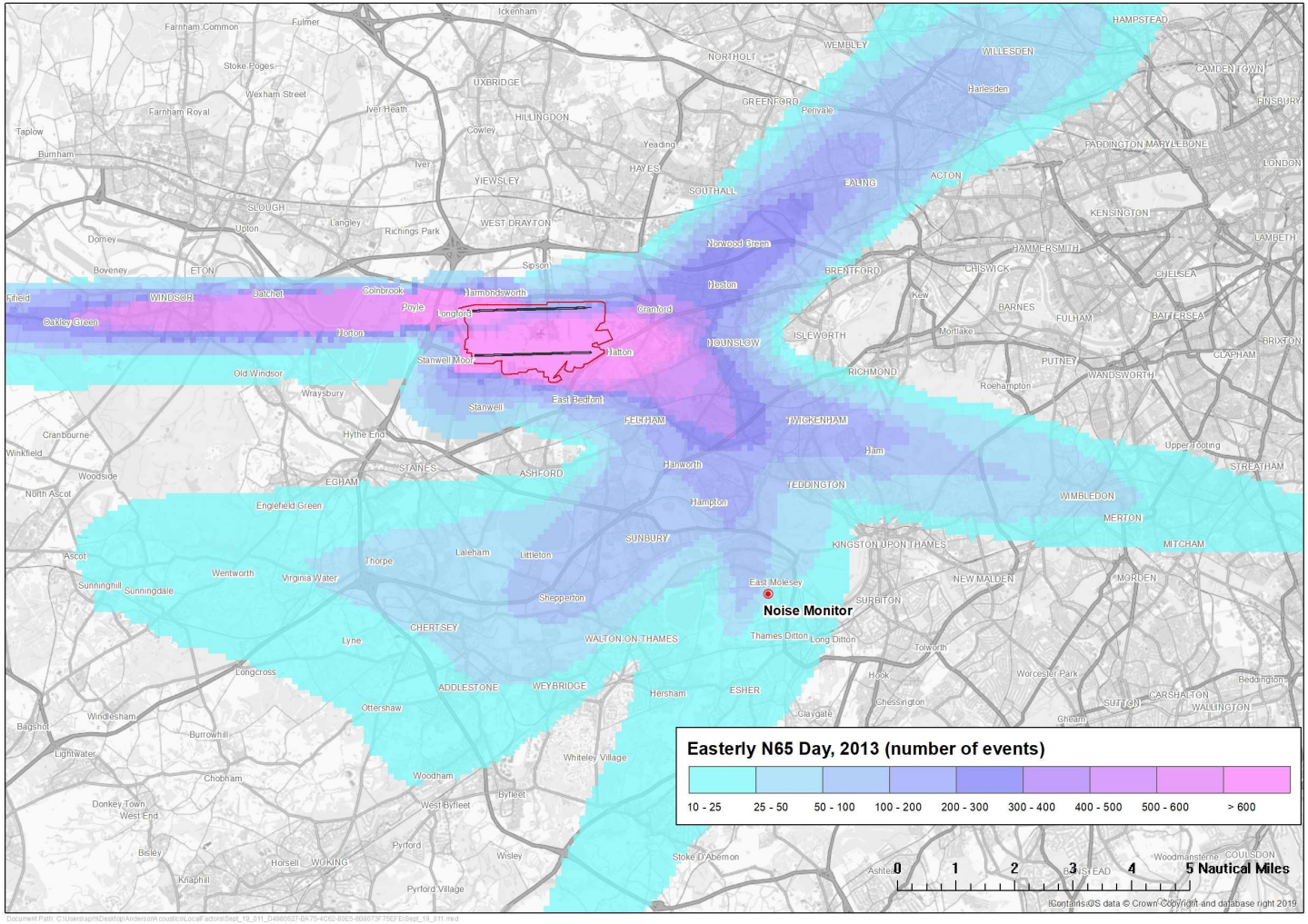
# Appendix A: Average easterly day $L_{Aeq, 16hr}$ contours (2013)



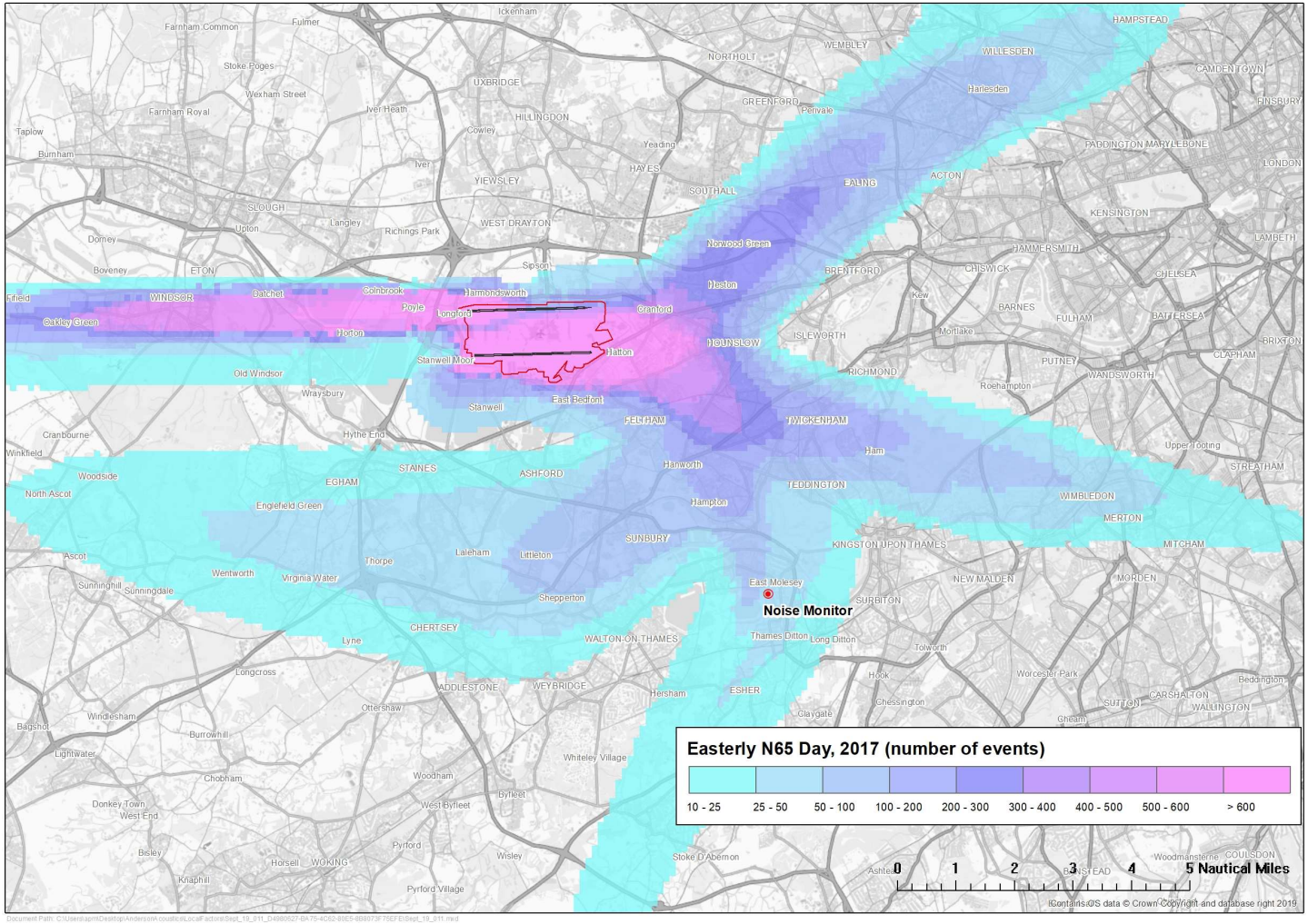
# Appendix A: Average easterly day $L_{Aeq, 16hr}$ contours (2017)



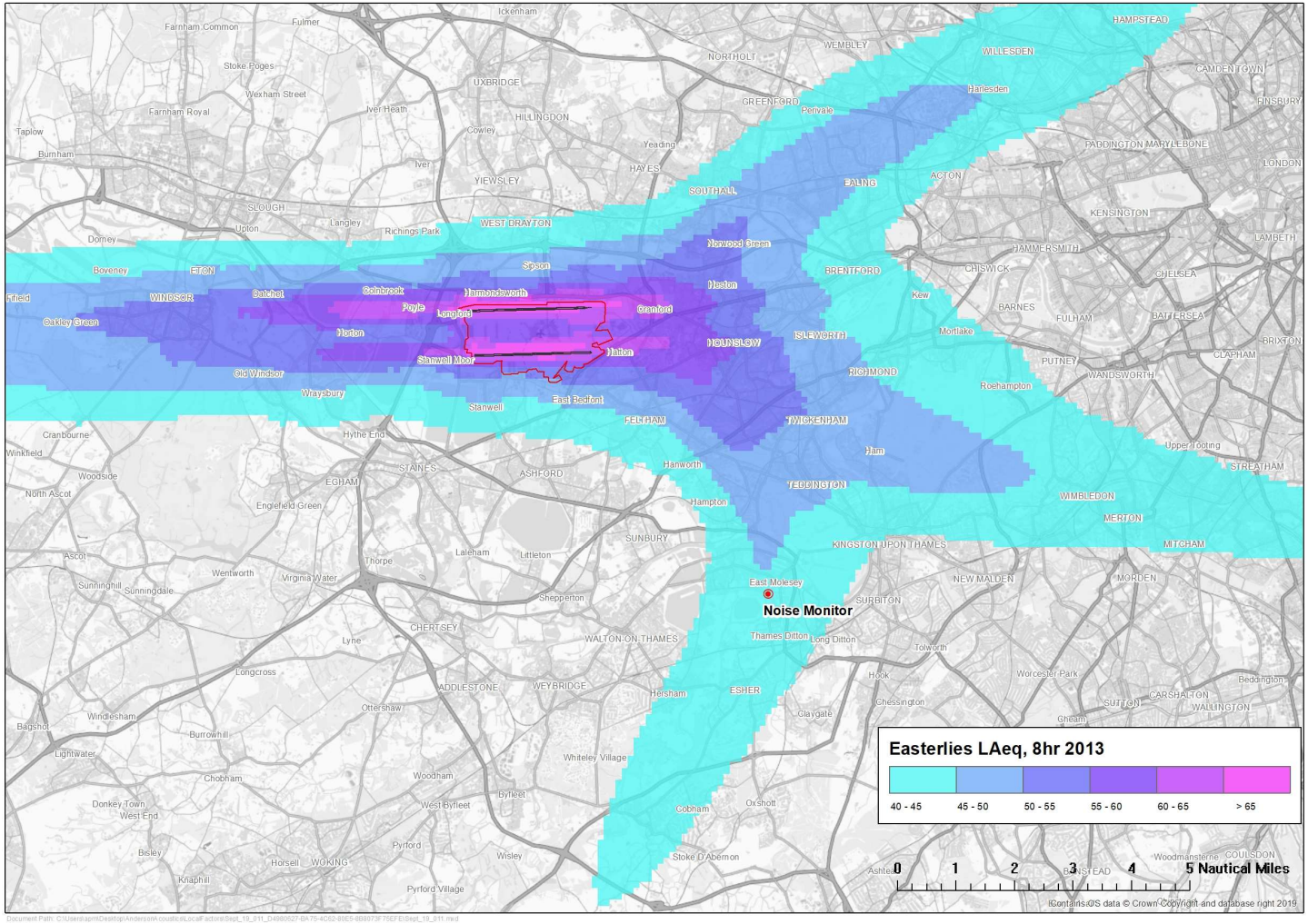
# Appendix A: Average easterly day $N65_{16hr}$ contours (2013)



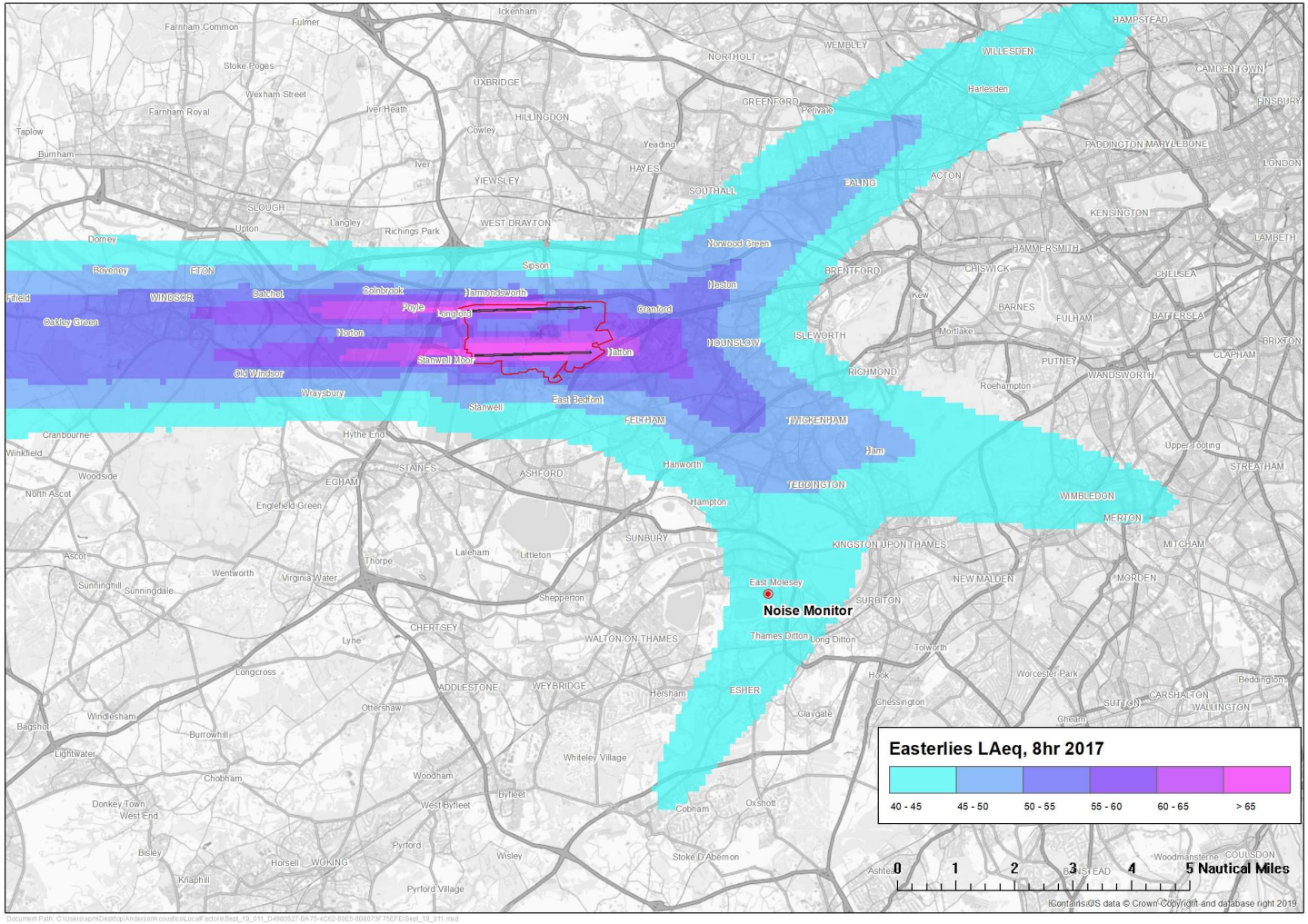
# Appendix A: Average easterly day $N65_{16hr}$ contours (2017)



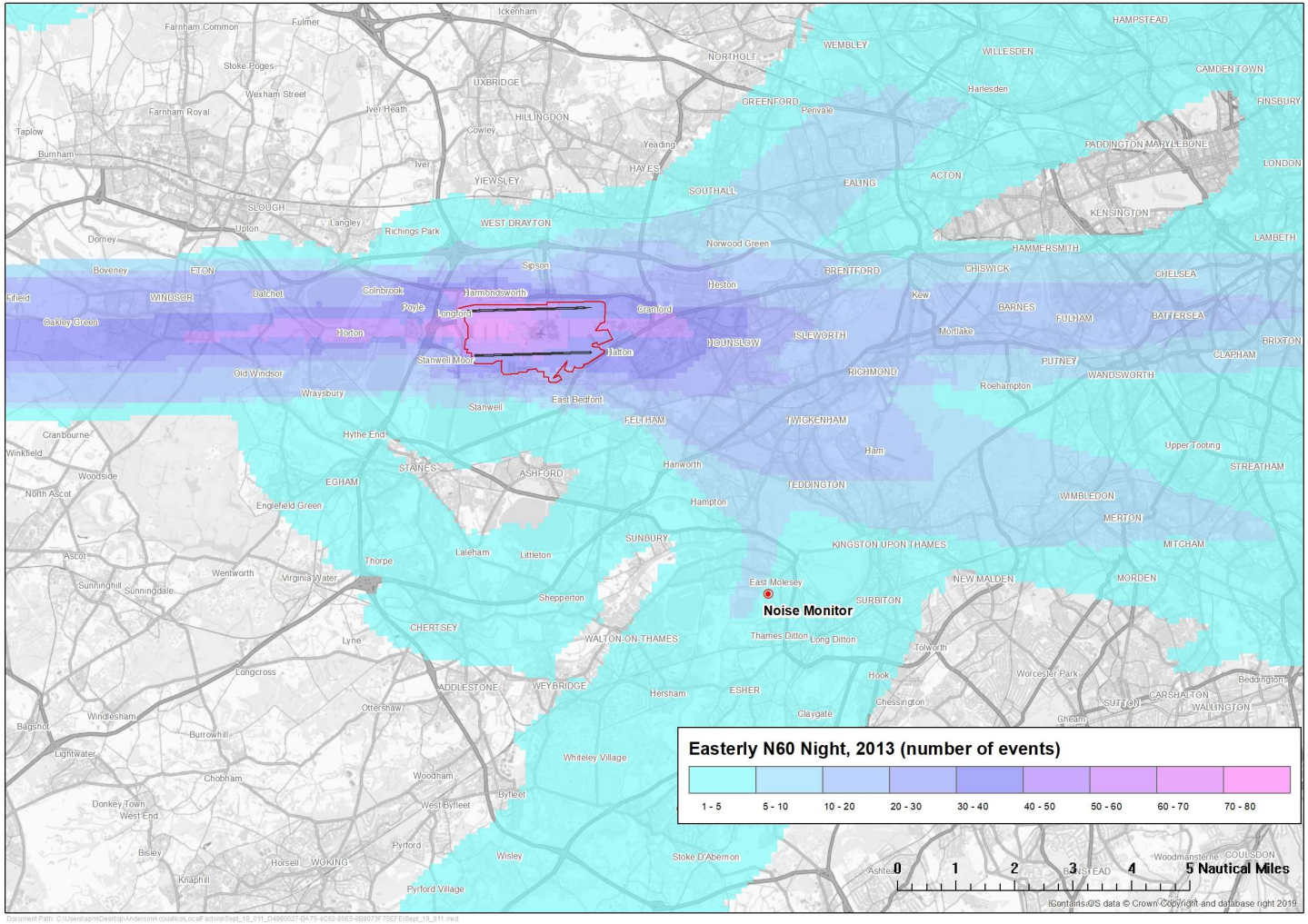
# Appendix A: Average easterly night $L_{Aeq, 8hr}$ contours (2013)



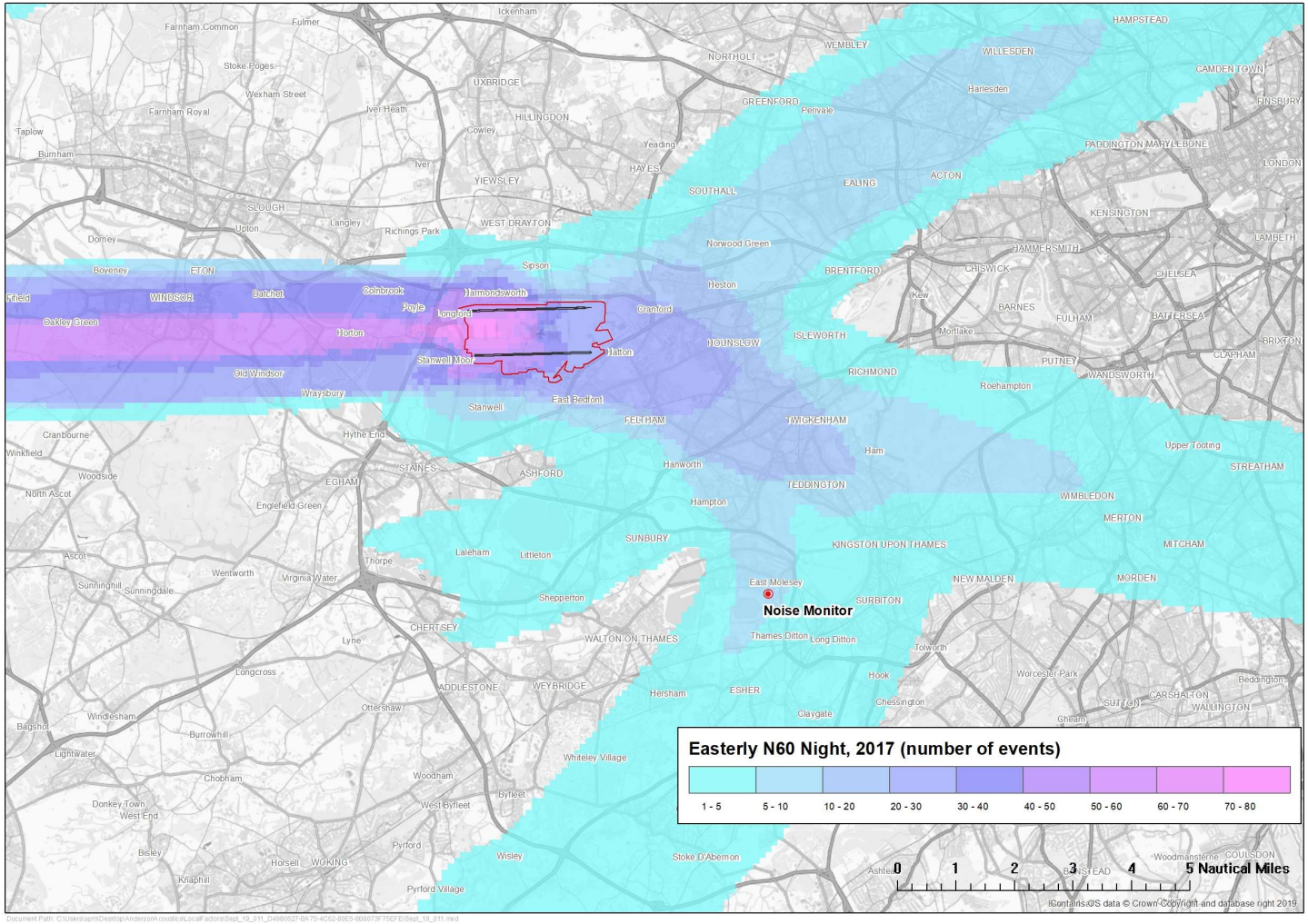
# Appendix A: Average easterly night $L_{Aeq, 8hr}$ contours (2017)



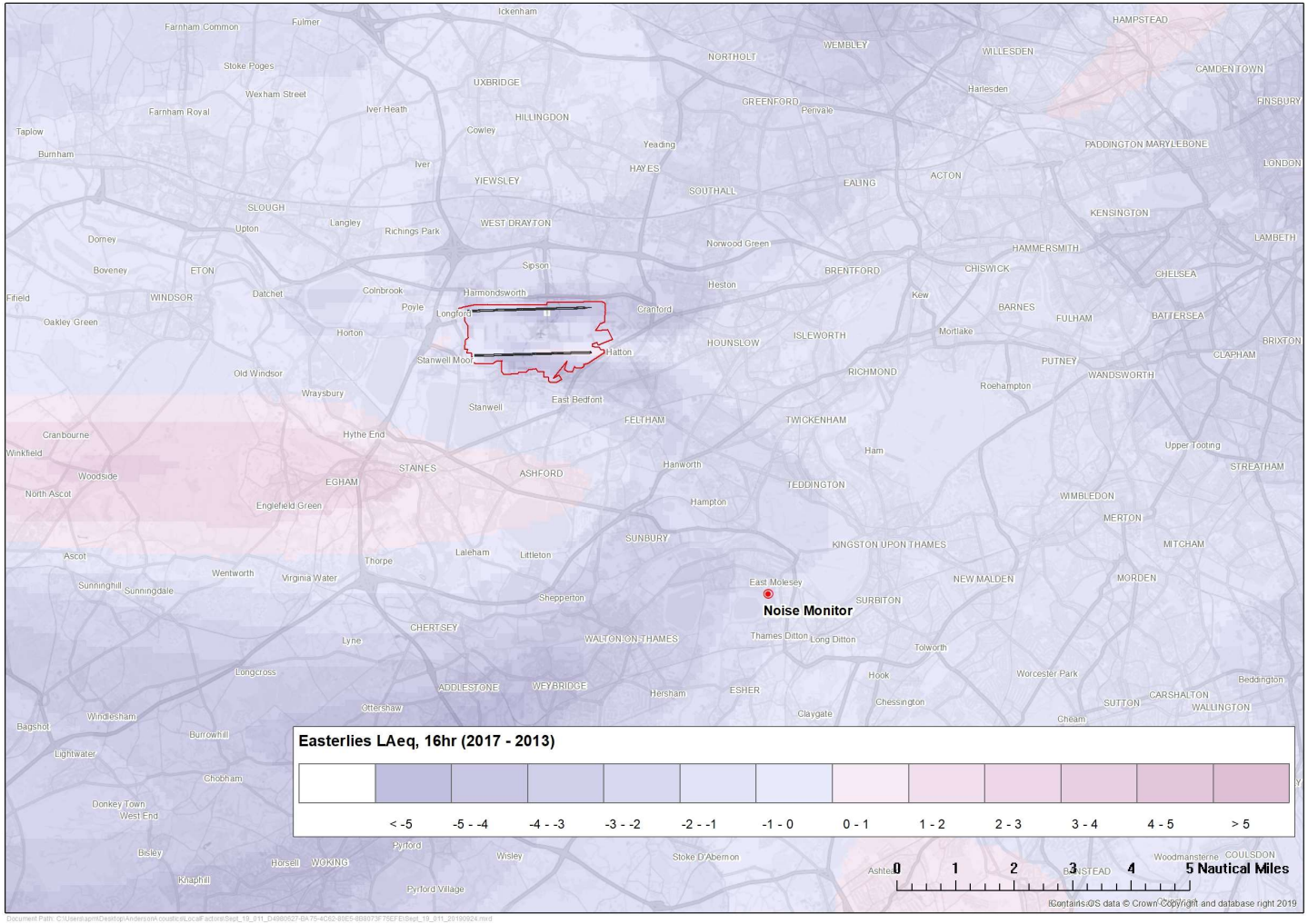
# Appendix A: Average easterly night $N60_{8hr}$ contours (2013)



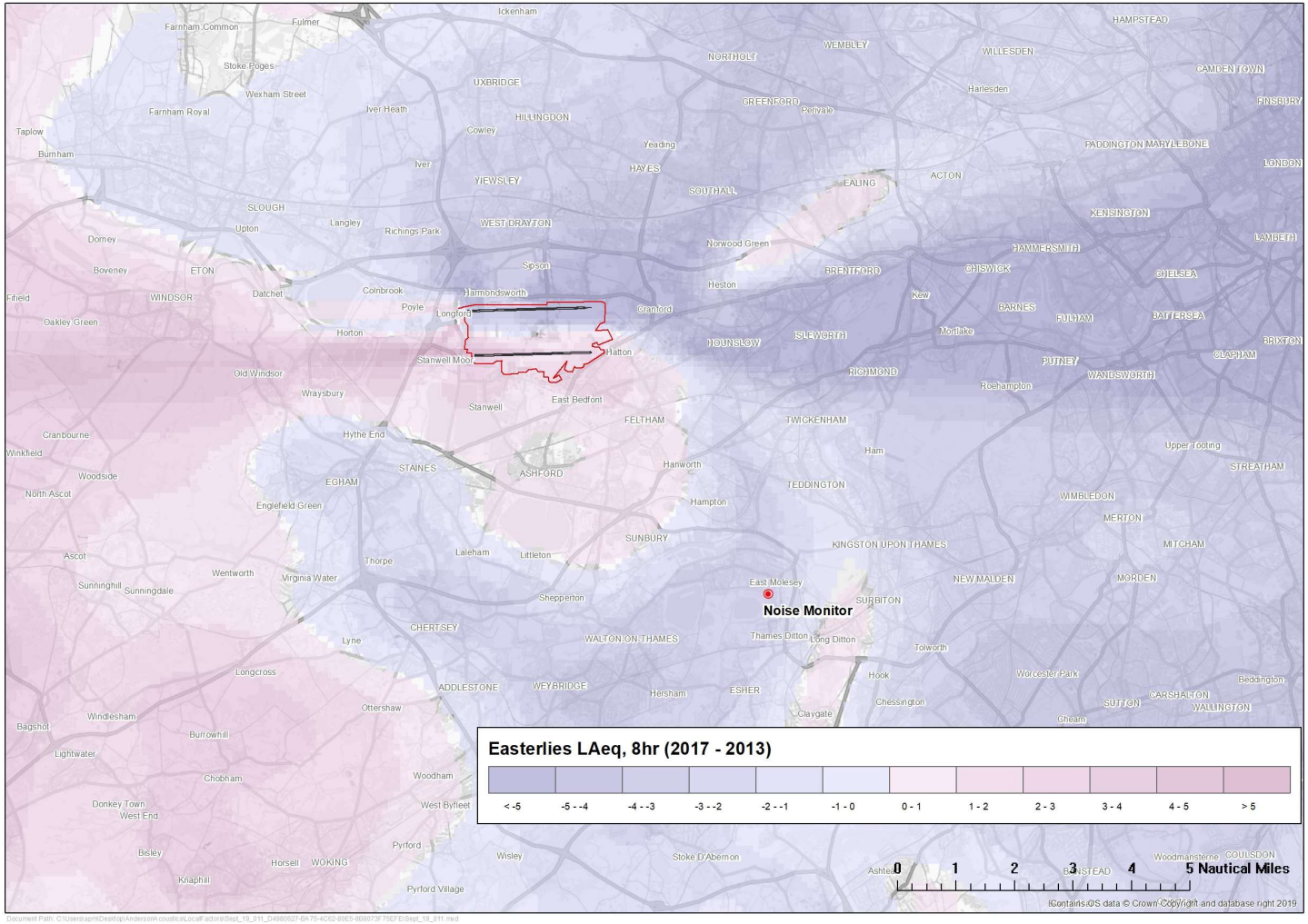
# Appendix A: Average easterly night $N60_{8hr}$ contours (2017)



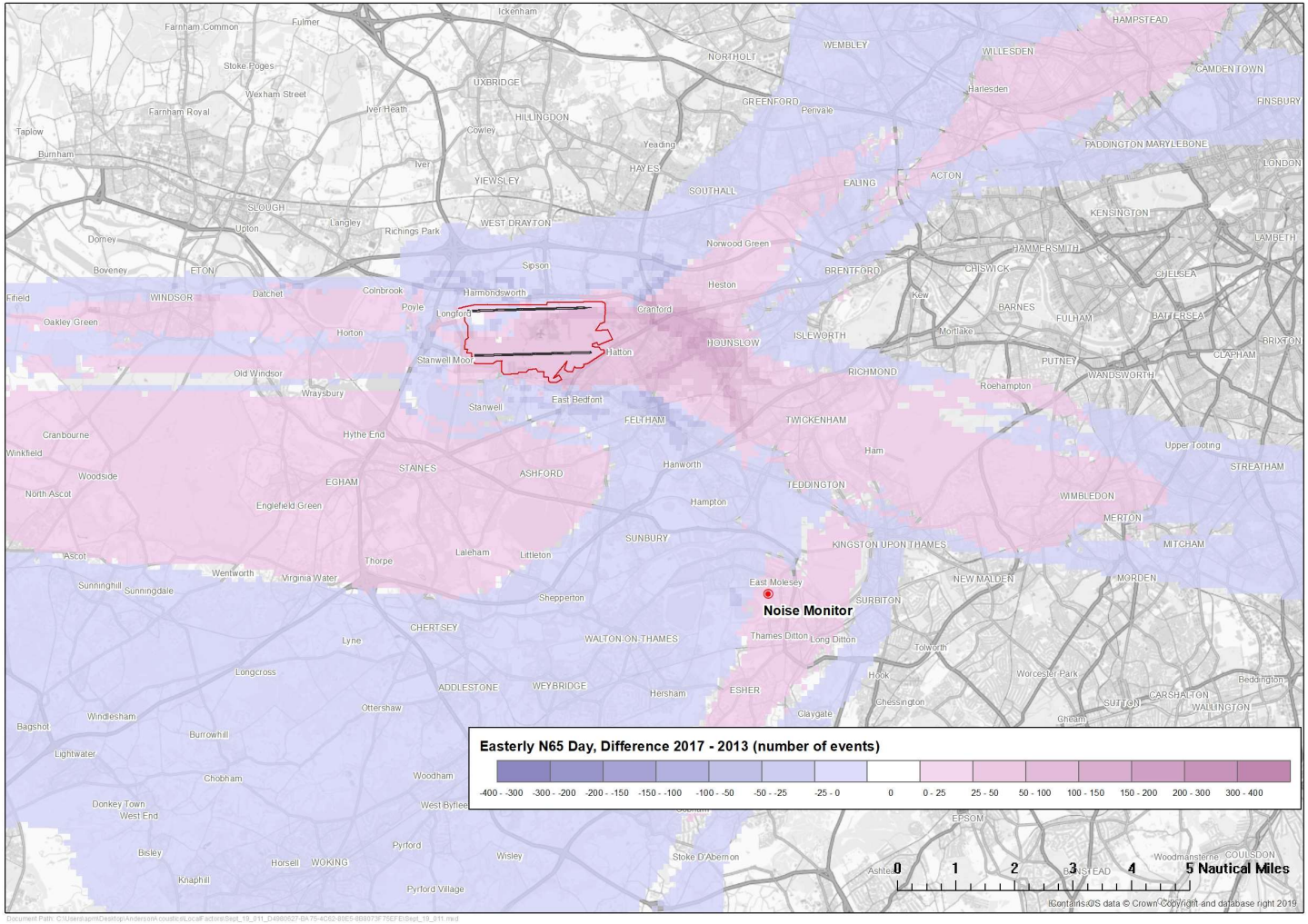
# Appendix A: Average easterly day $L_{Aeq, 16hr}$ difference (2017 minus 2013)



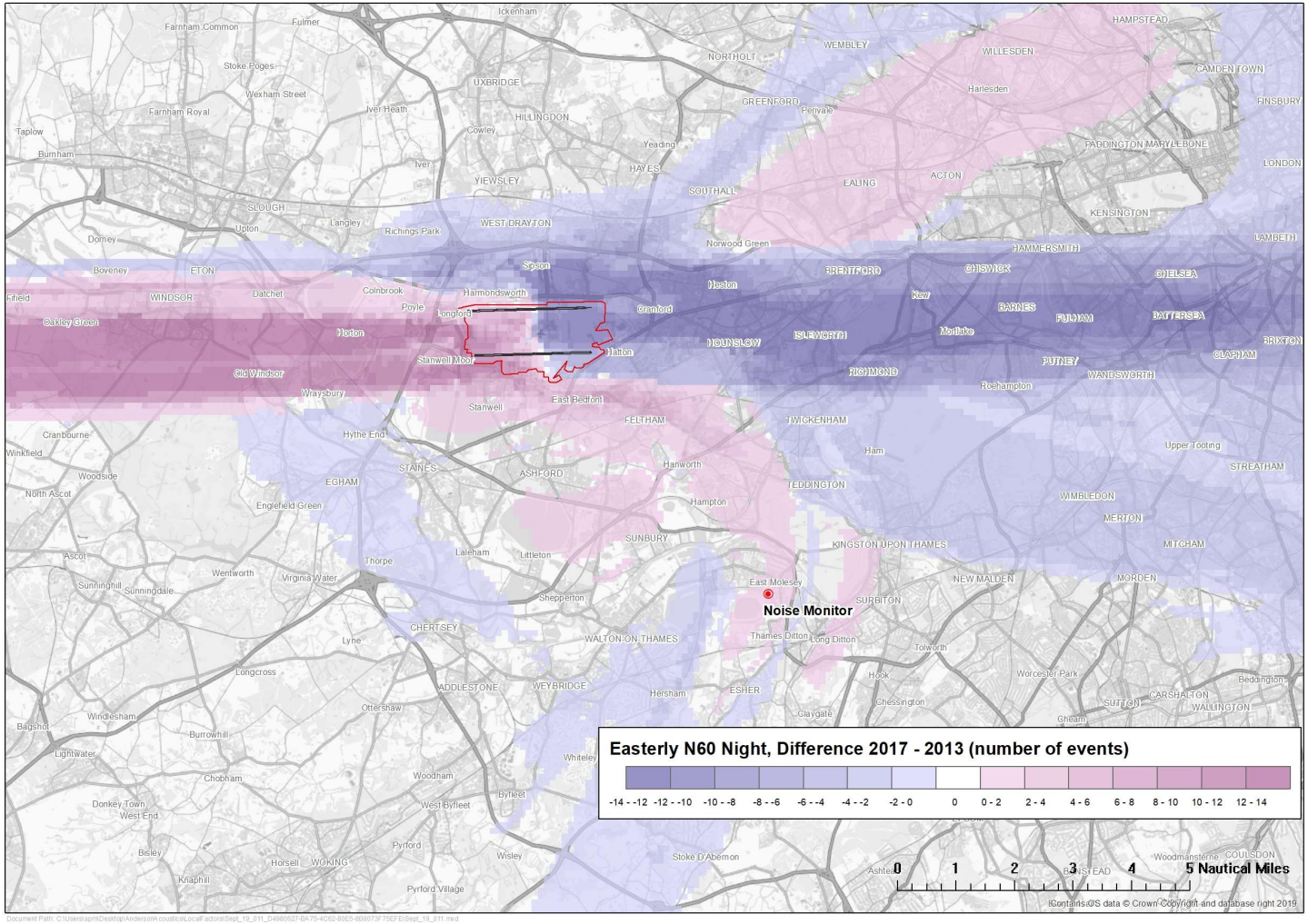
# Appendix A: Average easterly night $L_{Aeq, 8hr}$ difference (2017 minus 2013)



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



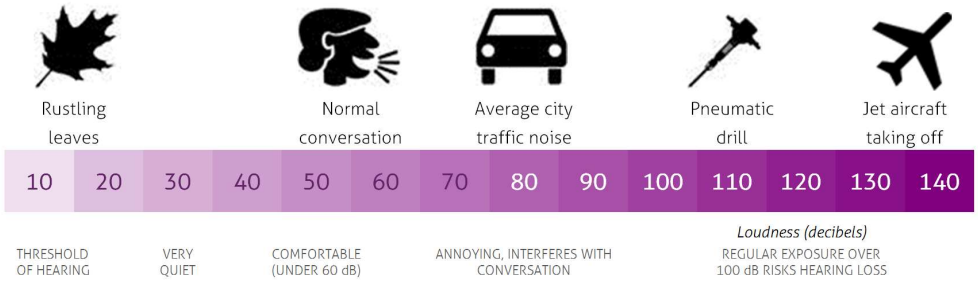
# Appendix A: Average easterly night $N60_{8hr}$ difference (2017 minus 2013)



# Appendix A: Noise Terminology

## How is noise measured?

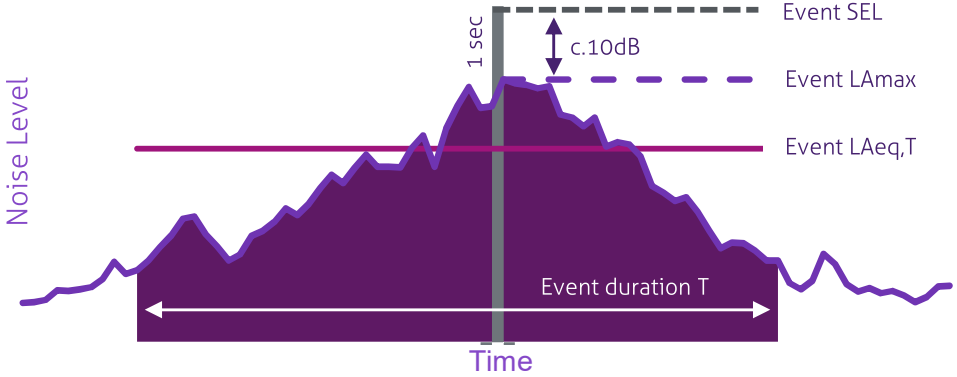
There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Noise is therefore measured using a logarithmic scale, to account for this wide range, called the decibel (dB). Typical noise levels of everyday sounds are shown in the figure below.




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.



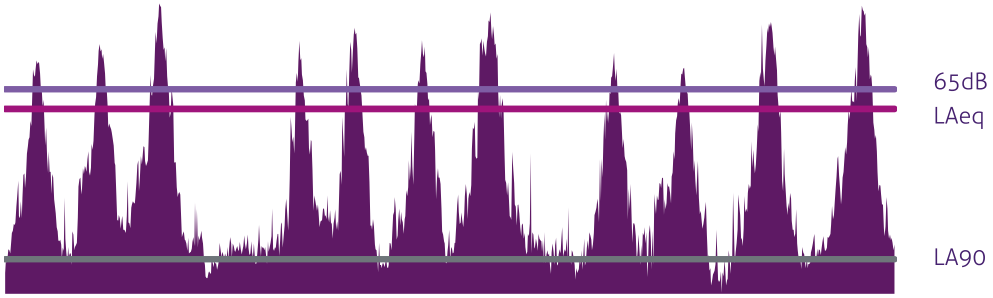

There are a number of metrics that can then be used to characterise a noise event all of which can be derived from modelling:

- 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 A: 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 A: 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 |