AIRSPACE MODERNISATION AIRSPACE CHANGE PROPOSAL

(ACP-2021-056)

STEP 2B INITIAL OPTIONS APPRAISAL

Final 1.0

Heathrow

CONTENTS

All airspace design options in this document are subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, Design Principles, appraisals and stakeholder engagement and consultation.

1. INTRODUCTION

1.1 Background to this Airspace Change Proposal

1.1.1 For detailed background information on this Airspace Change Proposal, including information on the Statement of Need (SoN), Design Principles (DPs) and the Airspace Change Organising Group (ACOG) Masterplan, please refer to the Step 2A Document, which was submitted alongside this document and is available on the Civil Aviation Authority (CAA) Portal here.

1.1.2 This document forms part of the suite of submission documentation Heathrow has produced for the CAA's Stage 2 Gateway of the CAP1616 process and is intended to be read alongside those documents. Heathrow's Stage 2 submission documentation includes:

- ***Step 2A Options Development:***
  - Development of the Comprehensive List of Options (CLOO);
  - Design Principle Evaluation (DPE);
  - Step 2A Engagement on the CLOO;
  - *Step 2A Appendices A to F*, which contain evidence of all CLOO engagement activities.
- ***Step 2B Initial Options Appraisal (this document):***
  - Approach to the Initial Options Appraisal (IOA);
  - The IOA;
  - Shortlisting of options;
  - *Step 2B Appendices A to C*, which contain the IOA for all options.
- ***Stakeholder Engagement Summary Document:***
  - Heathrow's stakeholder engagement throughout Stage 2;
  - *Stakeholder Engagement Appendix A*, which contains a correspondence log listing all engagement activities and associated stakeholder correspondence;
  - *Stakeholder Engagement Appendices B to F*, which contain evidence of all Stage 2 engagement activities

1.1.3 A glossary of all terms is provided in Section 8 of this document.

1.1.4 Additional background information can be found using the links in Table 1.

Airspace Change Stage	Summary	Link to Documents
Stage1 **Step 1A**	In July 2021, Heathrow Airport submitted a Statement of Need (SoN) to the Civil Aviation Authority (CAA).	Statement of Need
	On 19 August 2021, Heathrow Airport had an assessment meeting with the CAA, as part of Step 1A of the CAP1616 process. The purpose of the assessment meeting is for the change sponsor to present and discuss their SoN and to enable the CAA to consider whether the proposal falls within the scope of the formal airspace change process.	Presentation Assessment Meeting Minutes
Stage 1 **Step 1B**	At Step 1B, Heathrow Airport carried out engagement with stakeholder representatives to develop a set of Design Principles for this airspace change. The aim of the Design Principles is to provide high-level criteria that the proposed airspace design options 'must' or 'should' meet. They also provide a means of analysing the impact of different design options and a framework for choosing between or prioritising options.	Step 1B – Design Principle Submission
Stage 2 **Step 2A**	At Step 2A, Heathrow developed and assessed options for the airspace change. Heathrow developed a Comprehensive List of Options (CLOO) which addresses the SoN and aligns with the Design Principles set at Stage 1. Those options were shared with stakeholder representatives (who were previously engaged with at Stage 1). Feedback from this engagement was then used to refine and/or generate further options, where required. The final part of Step 2A was to qualitatively and, where possible, quantitively assess the options against the Design Principles to produce a Design Principle Evaluation (DPE).	Step 2A Submission Document Design Principle Evaluation
Stage 2 **Step 2B**	At Step 2B, Heathrow is required to carry out an Initial Options Appraisal (IOA) on all the options which proceed from the DPE (Step 2A). This is where Heathrow is now. This document explains the methodology used to assess each option and a summary of the outcomes of the IOA. The accompanying Appendices A to C contain the detailed initial appraisal of each option.	Step 2B Initial Options Appraisal – this document Appendix A – IOA PBN Departures Appendix B – IOA PBN Arrivals Appendix C – IOA Vectored Arrivals

Table 1: Summary of CAP1616 work undertaken to date

1.2 Summary of CAP1616 Step 2B

1.2.1 Step 2B of the CAP1616[1] process requires the change sponsor (i.e. Heathrow Airport Ltd) to carry out an 'initial' appraisal of each of the viable options identified in Step 2A, using the design criteria against which the options are being assessed.

1.2.2 The Initial Options Appraisal (IOA) should, as a minimum, contain qualitative assessments of the different options. This highlights to change sponsors, stakeholders and the CAA the relative difference between the impacts, both positive and negative, of each option[2].

1.2.3 The change sponsor assesses each option against a 'Do Nothing' scenario which acts as the baseline for the analysis and enables a consistent comparison of the options.

[1] Based on the fourth edition of CAP1616 published in March 2021.
[2] CAP1616 Para 133

2. HEATHROW'S AIRSPACE DESIGN OPTIONS

2.1.1 Heathrow's Comprehensive List of Options (CLOO) consists of 181 options. These are split into 40 groups of Performance Based Navigation (PBN) Departure options, 93 PBN Arrival options and 48 Vectored Arrival options. These options include 12 baseline 'Do Nothing' options (for PBN Departures, PBN Arrivals and Vectored Arrivals to/from each of Heathrow's four runways – runways 27L, 27R, 09L and 09R). At Stage 2, all options have been developed and evaluated per single runway operation, but not as a complete system of westerly and easterly departures and arrivals to/from both runways combined in operation together. This allows us to consider many more options for a final solution. At Stage 3 Heathrow will develop 'system options'.

2.1.2 As part of Stage 2, at Step 2A, Heathrow undertook a Design Principle Evaluation (DPE), where each option was evaluated against each design principle (DP). Detailed information on Heathrow's DPE can be found in the *Step 2A Options Development* document.

2.1.3 The 'Do Nothing' options would not deliver airspace modernisation for Heathrow, so would not address the Statement of Need nor the objectives for environmental and operational benefits. **The 'Do Nothing' options were therefore discontinued based on the DPE results**.

2.1.4 CAP1616 still requires the baseline 'Do Nothing' scenario to be appraised in the IOA, as it provides a means of testing the options against the current operations to better understand and highlight the benefits and impacts of each new option. Therefore, the 12 baseline 'Do Nothing' options have been retained as 'Do Nothing' ***scenarios*** in the IOA. 'Do Nothing' scenarios will continue to be appraised as part of the Full Options Appraisal at Stage 3, and in the Final Options Appraisal at Stage 4 for the year of implementation and for 10 years post-implementation.

2.1.5 The outcome of the DPE was that **no additional options were discontinued**. Therefore, 169 airspace design options are included in Heathrow's IOA.

3. APPROACH TO THE INITIAL OPTIONS APPRAISAL

3.1 Three Stages of Appraisal

3.1.1 The IOA is the first stage in a three-phase appraisal of airspace change options. As options progress through the airspace change process, the two following appraisals, the Full Options Appraisal and Final Options Appraisal undertaken at Stage 3 and 4, will assess options in further detail. The following sections outline the methodology Heathrow has followed in this 'initial' phase of appraisal.

3.2 Defining the Baseline

3.2.1 As part of the IOA, CAP1616 requires airspace change sponsors to set a baseline which is used for appraisal of the options. A baseline's primary purpose is to enable stakeholders to understand the impact/effect of each option against the environment they currently experience. CAP1616 explains that this will be a 'Do Nothing', and sometimes a 'Do Minimum' scenario, and will largely reflect the current-day environment, although taking due consideration of known or anticipated factors that might affect that baseline, for example a planned housing development close to an airport, forecast growth in air traffic, or expected changes in airlines' fleet mix.

3.2.2 CAP1616 also caters for a potential 'Do Minimum' scenario where "*doing nothing is not a feasible option in reality, for example where airspace has to be changed to reflect the UK's international obligations*"[3]. CAP1616 indicates that in such cases, in addition to the 'Do Nothing' baseline, the change sponsor must set out its informed view of the future and the minimum changes requires to address the issues identified – a 'Do Minimum' option. Appendix C of CAP2492 provides further clarification and describes a 'Do Minimum' option as: *"the minimum changes necessary to address another requirement e.g. a legal obligation".* There may be some legal obligations where a 'Do Minimum' option is applicable, for example to implement a single type of procedure or a requirement to 'implement PBN'. In the latter case, the 'Do Minimum' may be suitable to describe the option of PBN replication of existing, conventional SIDs. However, in the case of Airspace Modernisation, the requirement is not just to 'implement PBN' but is also to undertake a:

- complete redesign of the route network in busy terminal airspace to take account of advances in new technology, especially satellite navigation and alternative position navigation and timing systems for resilience, and to realise the potential for system design optimisation;
- re-design of airport arrival and departure routes at lower altitudes to allow flights to climb and descend continuously, improving CO_2 performance and better management of aircraft noise;
- review of airspace classifications, seeking to ensure that the amount of controlled airspace is the minimum required to maintain a high standard of air safety, and

[3] CAP1616 E21

- development of airspace structures and enabling technologies for greater integration of piloted and remotely piloted operations.[4]

3.2.3 In the case of Heathrow, whilst PBN replication of existing SID centrelines is one of the options, complete PBN replication of all existing arrival and departure flight paths between the ground and 7000ft is unlikely to deliver the benefits set out in the AMS and in Heathrow's Statement of Need. In the case of this ACP, Heathrow does not consider that a 'Do Minimum' option is feasible or appropriate to define at this stage and a 'Do Nothing' scenario provides for a suitable, existing baseline against which to compare design options. As part of the Full Options Appraisal in Stage 3, it may be possible to articulate which of the system options represents the minimum level of change to the baseline.

3.2.4 In Stage 3, sponsors are required to model options for the year of implementation and the following ten years. At present, the exact implementation date for the Future Airspace Strategy Implementation – South (FASI-S) airspace changes is unknown.

3.2.5 Heathrow Airport operates under an annual cap of 480,000 Air Traffic Movements (ATMs) and during the year 2019, the airport operated close to this capacity. Given the impacts of Covid-19 over 2020 to 2022, 2019 is more representative of the airspace operation expected immediately before implementation of this ACP and is therefore selected as the baseline for the IOA.

3.2.6 Table 2 below shows the total number of annual movements (ATMs), including scheduled passenger and cargo flights, charter passenger and cargo flights, and government charter flights between 2018 and 2022. Heathrow's forecast through to 2030 is shown in Table 3.

Heathrow ATMs (Actuals)				
2018	2019	2020	2021	2022
475.6k	475.8k	201.0k	190.0k	376.8k

Table 2: Heathrow ATMs actual 2018-2022

Heathrow ATMs (Forecast)							
2023[5]	2024	2025	2026	2027	2028	2029	2030
420-460k	Pre-pandemic traffic levels (capped at 480k)						

Table 3: Heathrow ATMs forecast 2023-2030

3.2.7 It was not considered appropriate to appraise options against future fleet mix and traffic movements at Stage 2, given the uncertainty of the year of implementation. The forecast currently remains in line with the 480,000 movement cap, which is comparable with the baseline.

3.2.8 The use of 2019 as the baseline provides substantial information on the current airspace arrangements, including patterns of aircraft operations around Heathrow's existing routes and their utilisation, flight profiles, the impact of late running aircraft, schedules, fleet mix and information on how and which locations are currently affected by aircraft noise.

[4] CAP1711 3.26-3.28
[5] The forecast for ATMs in 2023 is still being finalised

3.2.9 As part of the Stage 3 Full Options Appraisal, Heathrow will fully appraise the 'Do Nothing' baseline and the options for the year of implementation and future scenario (plus 10 years).

3.2.10 Data from Heathrow's Noise and Track Keeping system (NTK) from the 2019 92-day summer period (16 June to 15 September inclusive) provides the actual tracks flown by aircraft. These tracks have been used to model the departure and arrival baselines. In addition, the baseline tracks were extended from the first or last recorded NTK track point to an appropriate and consistent network waypoint to allow a common track mileage comparison across the options.

3.2.11 The baseline scenario was modelled to generate a set of environmental metrics that have been used to compare each option against. Each of the options from the CLOO was then modelled and appraised in the same way, by assuming the 2019 operations occurred using the option design. This assessment also assumes that the CLOO adopts the same vertical profiles as flown in 2019 i.e., the CLOO assessments do not assume benefits associated with anticipated improvements to Continuous Climb Operations (CCO) or Continuous Descent Operations (CDO) at this stage. The only variable is the airspace design.

3.3 Planned Local Developments

3.3.1 CAP1616 states[6] that each 'people overflown' metric used in the appraisal must apply national policy and therefore include housing, hospitals, schools etc. which have planning permission. It must also have regard to local plans such as those anticipated under Local Development Frameworks. Therefore, the change sponsor should engage as needed with local authorities and communities to reach agreement on how to interpret and take account of the Local Development Frameworks.

3.3.2 Heathrow conducted an engagement exercise with the 77 local authorities in the current potentially impacted area to identify planned developments, so that these can be considered as part of the appraisal of the benefits and impacts of each option. A table of all engaged authorities, together with response status and type of information received from them, is shown in Table 4. Heathrow did not engage local communities on local developments at this stage, as it would have been disproportionate to do so when we still have so many options.

3.3.3 Communities and local authorities will be engaged further at Stage 3 when Heathrow has system options to share.

[6] CAP1616 Para 139

List of Local Authorities	Local Plan Response Status	Information Received
Barking & Dagenham	No response	
Barnet	No response	
Basingstoke & Deane	No response	Email forwarded but no response received
Bexley	Response received	Link to Local Plan Data on Local Plan housing trajectory
Bracknell Forest	Response received	Link to Local Plan Data on proposed noise sensitive developments
Brent	Response received	Link to Local Plan Link to GLA datahub for Brent noise sensitive developments
Brentwood	Response in progress	Responded to clarification email. Still awaiting data
Bromley	No response	
Broxbourne	Response received	Link to Local Plan Confirmed that residential area development not relevant to Heathrow's ACP
Buckinghamshire County Council	Response received	Link to Local Plan Data (GIS shape files and Excel sheet) on proposed noise sensitive developments
Camden	Response received	Link to draft Local Plan Data (Excel sheet) on local site development trajectories
Central Bedfordshire	No response	
Chichester	Response received	Link to Local Plan Data (Excel sheet and GIS shapefiles) on existing and proposed housing allocations and list of major permissions
City of London	Response received	Link to Local Plan Data on proposed noise sensitive developments
Crawley	Response received	Link to Local Plan Data (GIS shapefiles) on proposed noise sensitive developments
Croydon	Response received	Link to Local Plan No planned future noise sensitive developments
Dacorum	Response received	Link to Local Plan Data on proposed noise sensitive developments
Dartford	Response received	Data (Excel sheet) on proposed noise sensitive developments
Ealing	Response received	Link to Local Plan Data (Excel sheet) on proposed noise sensitive developments
East Hampshire	Response in progress	Email forwarded to Planning team for a response
East Hertfordshire	Response received	Link to Local Plan Data (Excel & GIS shapefile) on proposed noise sensitive developments

Elmbridge	Response received	Link to Local Plan and Land Availability Assessment 2022 Data on proposed noise sensitive developments
Enfield	Response in progress	Email forwarded to Planning Decisions team for response
Epping Forest	Response received	Link to Local Plan and 'site specific requirements document. Links to main modifications consultation and schedule Data on proposed noise sensitive developments
Epsom and Ewell	No response	
Greenwich	Response received	Link to site allocations document
Guildford	Response received	Link to Local Plan and land availability assessment Report and data (GIS shapefile) on planning permissions
Hackney	Response received	Link to Local Plan Data on proposed noise sensitive developments
Hammersmith & Fulham	Response received	Link to Local Plan Data on proposed noise sensitive developments
Haringey	No response	
Harlow	Response received	Link to Current Housing Land Supply Monitor Report 2020-21
Harrow	Response received	Link to Local Plan
Hart	Response received	Link to Local Plan Data on proposed noise sensitive
Havering	Response received	Link to Local Plan Data (Excel) on Brownfield Register of all permissioned residential schemes and housing trajectory
Hertsmere	Response received	Link to Local Plan Data on proposed noise sensitive
Hillingdon	Response received	Link to Local Plan and site allocations and designations document
Horsham	Response received	Link to Local Plan Data (Excel sheet and GIS shapefiles) on proposed noise sensitive
Hounslow	Response received	Link to Local Plan Data on proposed noise sensitive developments
Islington	Response in progress	Email forwarded to Planning Department, awaiting response
Kensington & Chelsea	Response received	Link to Local Plan Data on proposed noise sensitive developments
Kingston upon Thames	No response	
Lambeth	Response received	Data (Excel sheet) on proposed noise sensitive developments pipeline
Lewisham	Response received	Link to Local Plan and Lewisham Authority Monitoring Report 2020-21

Luton	No response	
Merton	Response received	Link to Local Plan Data (Excel sheet) on proposed noise sensitive developments
Mid Sussex	Response received	Link to Local Plan and strategic housing and economic land availability assessment document Data (GIS shapefile) on proposed noise sensitive developments
Mole Valley	Response received	Link to local pan Data (GIS shapefile) on proposed noise sensitive developments
Newham	Response received	Link to local pan Data on proposed noise sensitive developments
North Hertfordshire	Response received	Link to Local Plan Data on proposed noise sensitive developments
Old Oak & Park Royal	No response	
Reading	Response in progress	Email forwarded to interim chief executive for response
Redbridge	Response received	Data (GIS files) on proposed noise sensitive developments
Reigate & Banstead	Response received	Data on one proposed noise sensitive development
Richmond upon Thames	Response received	Link to Local Plan Data (Excel sheet) on proposed noise sensitive developments
Runnymede	Response received	Link to Local Plan Data on proposed noise sensitive developments
Rushmoor	Response received	Link to Local Plan Data on proposed noise sensitive developments
Sevenoaks	Response in progress	Email forwarded to Planning Policy Department for response
Slough	Response received	Link to Local Plan Data on proposed noise sensitive developments
South Oxfordshire	Response received	Link to Local Plan Data (Excel sheets) on proposed noise sensitive developments
Southwark	Response received	Link to Local Plan
Spelthorne	Response received	Link to Local Plan Data on proposed noise sensitive developments
St Albans	Response received	Response letter received – no proposed noise sensitive developments at time of writing (June 2022)
Surrey Heath	Response received	Link to Local Plan Data on proposed noise sensitive developments
Sutton	No response	
Tandridge	Response received	Link to Local Plan Data on proposed noise sensitive developments
Three Rivers	Response received	Link to Local Plan Data on proposed noise sensitive developments

Thurrock	Response received	Data (Excel sheet) on proposed noise sensitive developments
Tower Hamlets	Response received	Link to Local Plan Data (Excel sheet) on proposed noise sensitive developments
Waltham Forest	No response	
Wandsworth	Response received	Link to Local Plan Data (Excel sheets) on proposed noise sensitive developments
Watford	Response received	Link to Local Plan and planning applications website Data (Excel sheet) on proposed noise sensitive developments
Waverley	Response received	Link to Local Plan and 5 Year Housing Land Supply Position Statement Data (Excel sheet) on proposed noise sensitive developments
Welwyn Hatfield	No response	
West Berkshire	No response	
Westminster	Response received	Data (Excel sheet) on proposed noise sensitive developments
Windsor & Maidenhead	Response received	Link to Local Plan, Interactive Policies Map, and Stage 2 Examination Note (RBWM_049) on the Housing Trajectory for data on proposed noise sensitive developments
Woking	Response received	Link to Local Plan Data on proposed noise sensitive developments
Wokingham	Response received	Link to Local Plan Data (GIS Shapefile) on proposed noise sensitive developments

Table 4: List of local authorities engaged for local development plan information

3.3.4 Information on planned developments collected from local authorities was mapped out in a Geographic Information System (GIS). Figure 1 shows all developments identified.

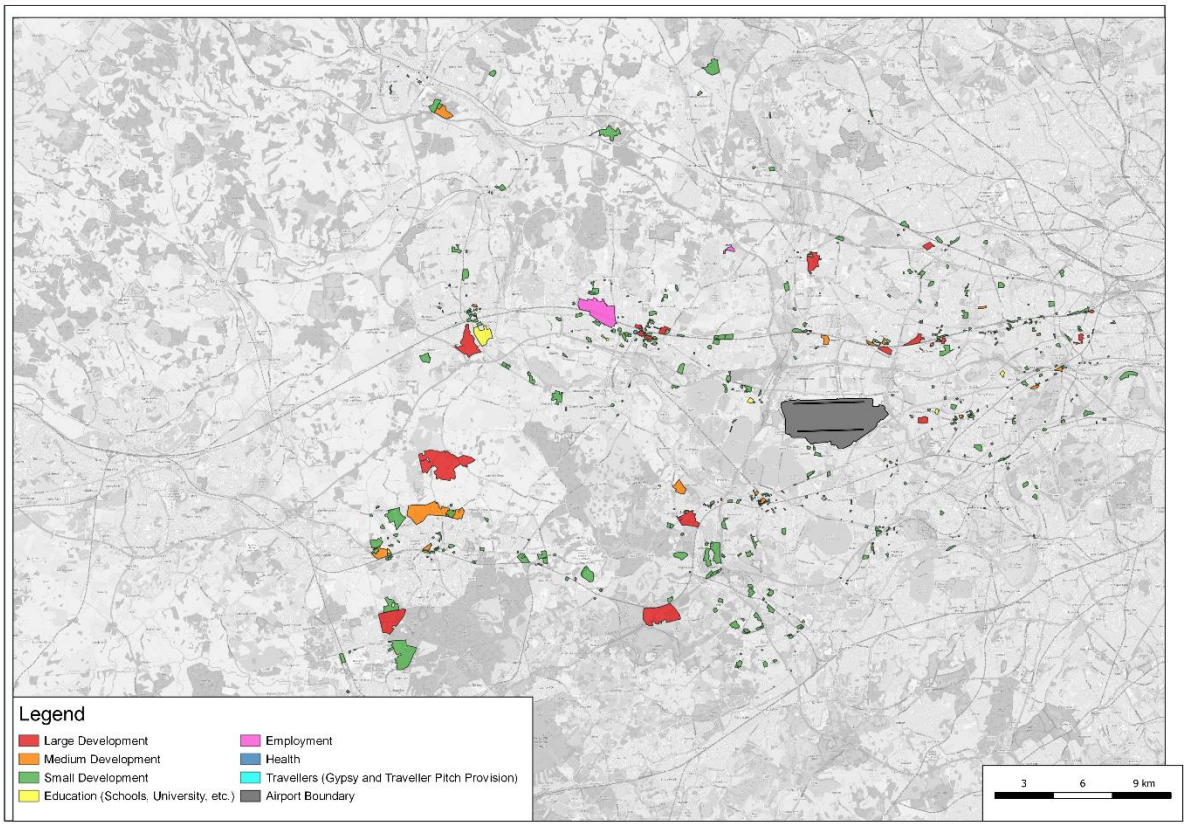


Figure 1: Developments identified through engagement with local authorities

3.3.5 At this stage, metrics contained within the IOA do not include estimated numbers of people in these developments given the fluid nature of local plans, i.e. not all developments have consent and to do this for all options is not reasonably achievable or proportionate at this stage of the appraisal given the number of options that remain under consideration.

3.3.6 At Stage 3 Full Options Appraisal, the local authority engagement exercise will be repeated and estimates of population numbers for new developments will be included within overflight counts where appropriate.

3.4 Environmental Modelling

3.4.1 Each option, including the baseline, has been subjected to a partial Environmental Assessment (EA) which includes noise, fuel burn and associated CO2 emissions, air quality, tranquillity and biodiversity assessments. Data is based on an average of the 2019 92-day summer period for noise, tranquillity and biodiversity, and is annualised for fuel burn.

3.4.2 A full EA would assess the environmental impact of system options (westerly and easterly arrival and departure flight paths that could operate together).

3.4.3 Heathrow has undertaken a 'partial EA' at this stage. Heathrow's partial EA assesses the impacts of one option (or set of options), i.e. the operations to or from a certain runway for an option (e.g. a partial Lowest Observed Adverse Effect Level (LOAEL) is created for Option A departures from Runway 27R only). In policy (ANG17), the LOAEL and other

environmental metrics relate to the airport as a whole and the airspace as a system. The partial LOAEL therefore provides an indication of the option's individual contribution to the total noise impact of the airport's overall operations. They still represent average noise exposure across the day and night periods, but only for the 'component' option. This method has allowed Heathrow to appraise far more 'components' than if full system options had been modelled and developed at this stage. In Stage 3, full system options will be developed from the shortlist of options and Section 7 provides more detail.

3.5 Easterly Operations

3.5.1 Due to the legacy of the Cranford Agreement, Runway 09L is only used for departures exceptional cases. Likewise, use of 09R for arrivals is only used occasionally. Therefore, very little data is available on which to make meaningful comparisons of the options from/to these runways against the baseline.

3.5.2 Heathrow's current plan is that easterly alternation will be operational in a similar time frame to this ACP. Therefore, the actual movements and route utilisation of all 09R departures in 2019 have been adopted for the appraisal of 09L departure options. Similarly, 09L arrival data has been used to represent future use of 09R arrival options.

3.5.3 The dataset for the 'Do Nothing' scenarios is based on what actually happened in 2019. However, the data used to model the options includes more easterly departures and arrivals than could be realistically expected in an operation with easterly alternation since movements would be split across the two runways. Heathrow intends to balance out this effect in the system option assembly at Stage 3, which will assume that Easterly Alternation is in place. However, for Stage 2, our methodology ensures a fair comparison of options where the only variable is the position of the routes, unaffected by runway utilisation.

3.6 Criteria for Assessment

3.6.1 At Step 2B Heathrow has carried out an initial appraisal of the benefits and impacts of each option, tested against the 'Do Nothing' baseline scenario. In line with CAP1616 requirements, the initial appraisal is based around a qualitative assessment. Given the nature and maturity of our options as this stage, Heathrow has prepared as much quantitative analysis as was deemed practical and proportionate to address the feedback received through ongoing engagement.

3.6.2 Appendix E in CAP1616 forms the basis of Heathrow's assessment criteria, however additional categories have been added to satisfy requirements related to the AMS. These are 'Interdependencies, conflicts and trade-offs' which considers potential interdependencies with other airports' ACPs, and 'Adherence to Airspace Modernisation Strategy'. The following sections explain the criteria used in Heathrow's IOA to appraise the options.

Communities – noise impact on health & quality of life

3.6.3 Heathrow has addressed this impact with a quantitative assessment of changes to noise impacts of the options compared with the 'Do Nothing' baseline.

3.6.4 The noise models have been developed using the Aviation Environmental Design Tool (AEDT) in accordance with CAP2091 requirements. CAP2091 sets out the minimum requirements for noise modelling.

3.6.5 Within CAP2091, the CAA defines 'categories' of noise modelling based on the likely population experiencing an average noise exposure above the daytime and night-time LOAEL, i.e. 51dB $L_{Aeq,16hr}$ for daytime and 45dB $L_{Aeq,8hr}$ for night.

3.6.6 Heathrow's operation is relevant to CAP2091 Category A, meaning that the noise model is adapted using local noise monitoring and track-keeping data collected by the airport. Using this data, the AEDT model has been modified so that aircraft noise emissions and flight profiles reflect the operational situation at Heathrow Airport.

3.6.7 Track keeping data is used to calculate the mix of aircraft traffic on each departure and arrival route, the actual tracks flown along each route, the dispersion of aircraft either side of the mean track, and the vertical flight profiles. The AEDT model has used this local data obtained from its noise and track keeping (NTK) system to calculate noise exposure (and therefore noise contours) and other metrics such as Nx noise metrics[7]. In line with CAP2091, flight profiles and noise-power-distance information has been validated using operations from 2019 and confirmed representative using a subset of data from 2022.

3.6.8 In parallel to this exercise, modelling has been carried out using the aircraft noise contour (ANCON[8]) to provide additional confidence in the AEDT model. This exercise has shown a good correlation between the outputs of the AEDT and ANCON models.

3.6.9 Heathrow has not used monetised noise impacts in the IOA due to the lack of system options to generate LOAELs and to inform Transport Analysis Guidance (TAG) assessments. Monetising noise using only partial LOAEL information is not considered representative at this stage, given the low fidelity of the options. Heathrow will calculate monetised noise metrics in Stage 3, when a smaller number of system options have been developed and LOAELs can be generated accordingly.

3.6.10 To quantify noise exposure, a population dataset has been obtained from CACI[9] and with a population reference year of 2023 used to calculate the number of dwellings and people exposed to noise.

3.6.11 For the baseline and each of the options, the following noise assessments have been carried out:

- Noise Exposure;
- Change in Noise Exposure;
- Overflight between 0 and 7,000 feet[10], and
- Noise events above 65dB and 60dB L_{Amax} (N65 and N60).

[7] Noise metrics which describe the number of aircraft noise events above a set noise level.
[8] CAA's noise analysis model. For more detail see https://www.caa.co.uk/consumers/environment/noise/features-of-the-ancon-noise-modelling-process/
[9] https://www.caci.co.uk/
[10] For the assessment of airspace change, overflight is defined according to the CAA's report, CAP1498, which outlines a measurement based upon community perception. It does not portray noise impacts.

3.6.12 For each of the above assessments, a series of noise metrics has been produced to support the IOA and the comparison against the 2019 baseline. These are described in detail in the following sections.

Noise Exposure

3.6.13 L_{Aeq} is the most common measure of noise internationally and means 'equivalent continuous noise level'. The L_{Aeq} metric is the measure of noise exposure adopted by the Government for the purpose of considering adverse effects from aircraft noise. LOAEL contours form part of the IOA primary metrics and are used to evaluate the impacts of airspace change.

3.6.14 As part of the IOA, the number of people exposed to aircraft noise for each option (or 'Do Nothing' scenario) has been assessed for decibel[11] (dB) bands.

3.6.15 51dB $L_{Aeq,16hr}$ (daytime noise) and 45dB $L_{Aeq,8hr}$ (night-time noise) contours form part of the Appendix B CAP1616 metrics used to evaluate the benefits and impacts of an airspace change. These contours represent the daytime and night-time LOAEL contours defined in UK airspace policy.

3.6.16 Heathrow's noise assessments start from 45dB L_{den} and 40dB L_{night} respectively. These are the World Health Organisation (WHO) recommended guideline values, which currently are not adopted by UK Policy but their inclusion in Heathrow's IOA was requested by local communities. The WHO thresholds use L_{den} (daytime, evening and night) and L_{night} (night only) metrics. For the IOA these values have been estimated using the L_{Aeq} metrics to provide an indication of option performance at lower levels of noise exposure.

3.6.17 In the case of the 40dB $L_{night,}$ the $L_{Aeq,8hr}$ provides a reasonable worst-case estimate and can be used as a direct proxy i.e. 40 dB L_{night} is considered equivalent to 40 dB $L_{Aeq,\ 8hr}$. In order to estimate L_{den} at Heathrow Airport, it is reasonable to assume that $L_{Aeq,16hr}$ is approximately 2dB lower than the L_{den}. As such, a value of 43dB $L_{Aeq,\ 16hr}$ has been used as a proxy for 45dB L_{den} at this stage[12]. The difference between a 24 hour L_{den} value and the 16 hour Leq value at any given location is not constant, but varies depending on the proportion of noise in the day, evening and night periods and depending on the specific location. For typical UK airports, the L_{den} level is approximately 1.8 dB higher than the 16 hour L_{eq}.

3.6.18 Using these approximations, the number of people exposed to noise above the WHO guideline values have been reported in the IOA to address specific stakeholder requests.

3.6.19 Partial L_{Aeq} contours have been produced based on the daily average movements that take place in the 16-hour period (0700-2300) or 8-hour period (2300-0700), using data from the 92-day period. Figure 2 illustrates the daytime partial LOAEL for PBN departure Option A from runway 27L[13].

[11] A unit of measurement for sound
[12] CAP1165
[13] Partial LOAELs for each option are shown in the IOA in Appendices A, B and C to this document

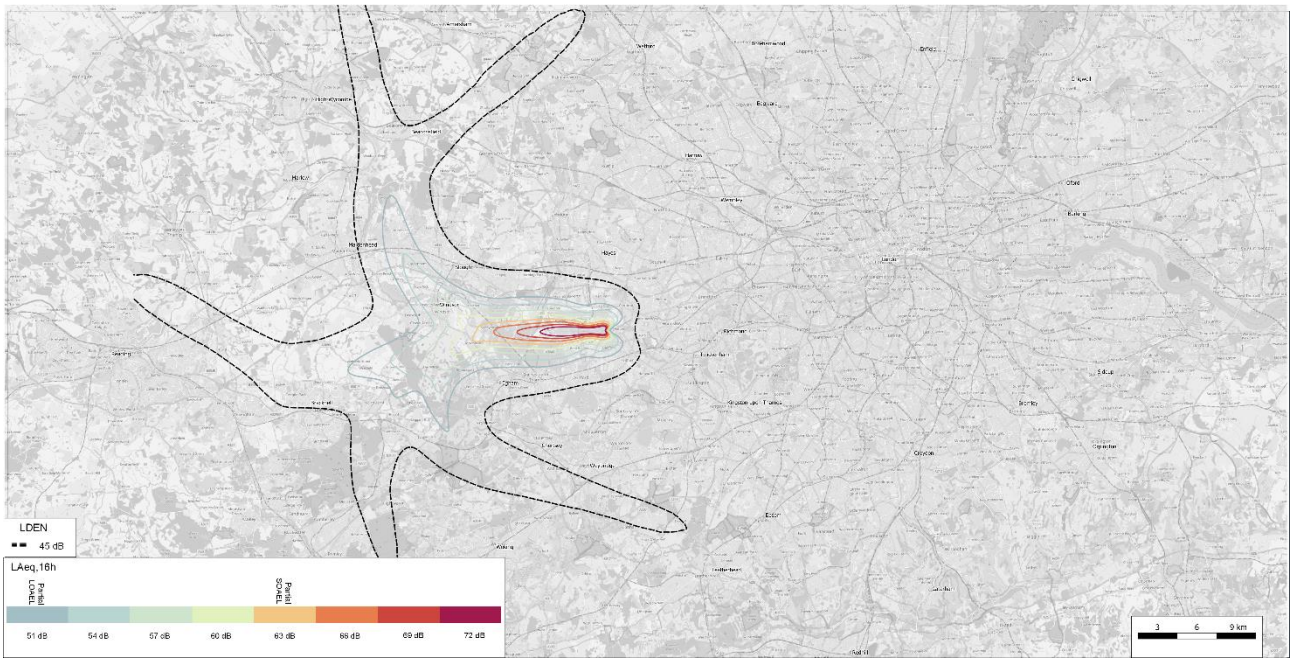


Figure 2: Daytime partial LOAEL and L_{den} for the 27L PBN Departure Option A[14]

3.6.20 Figure 3 shows an example of how this metric is reported on in the IOA, comparing the population within the partial daytime LOAEL and WHO Threshold for the Runway 27L baseline with PBN Departure Option A.

Population count	Baseline	Option A
Estimated total population above WHO Threshold (>45 dB L_{den})	602,400	568,800
Total population within Partial LOAEL (>51 dB $L_{Aeq,16h}$)	174,800	124,700

Figure 3: Numbers of people within the daytime partial LOAEL for Runway 27L PBN Departure Option A compared to the baseline

3.6.21 PBN Arrival options have been assessed for operations between 0430 and 0600, as this period is reflective of the one of the times of day that PBN Arrivals might be used. As a result of this, Partial L_{Aeq} contours for the PBN Arrival options, including the 'Do Nothing' scenario for this period, are based only on the daily average movements that take place in the 1.5-hour period between 0430 and 0600 during the 92-day period in 2019.

3.6.22 CAP1616 requires that for stakeholder engagement purposes, L_{Aeq} counts should include noise sensitive buildings, for example, hospitals, places of worship, and schools. This information has been generated but has not been included in the IOA as it has not been a factor in our decision making at this stage. This information will be produced at the Full Options Appraisal step for stakeholder engagement purposes.

[14] Map can be viewed in *Step 2B Appendix A*

Change in Noise Exposure

3.6.23 Based on discussions with stakeholders in Methods & Metrics workshops, Heathrow included supplementary metrics to further articulate the noise impacts of each option. Further information on Methods & Metrics workshops can be found in the *Stakeholder Engagement Summary Document*.

3.6.24 The change in noise exposure within the partial LOAEL contour between the option and the baseline has been assessed as part of the IOA, quantifying:

- positive changes: when there is a reduction in noise exposure for the option compared to the baseline of at least 1dB or more;
- negative changes: when there is an increase in noise exposure for the option compared to the baseline of at least 1dB or more; and
- no changes: when there is an increase or a reduction in noise exposure compared to the baseline of less than 1dB.

3.6.25 Figure 4 provides an example of the areas exposed to a change of at least 1dB in noise exposure within the partial LOAEL between the 'Do Nothing' scenario and PBN Departure Option A from Runway 27L.

Figure 4: Change in noise exposure for Runway 27L Departure Option A[15] within the Partial LOAEL of at least 1dB compared to the baseline

3.6.26 Data has also been generated for the number of people that are:

- brought out of the partial LOAEL, i.e. this is the number of people that are within the baseline partial LOAEL contour, but could be brought outside the partial LOAEL contour by the option, and

[15] Map can be viewed in *Step 2B Appendix A*

- brought into the partial LOAEL, i.e. this is the number of people that are outside the baseline partial LOAEL contour, but could be brought into the partial LOAEL contour by the option.

Change in Noise Exposure	Population experiencing at least 1 dB reduction within partial LOAEL or brought out of partial LOAEL	Population experiencing no change in noise exposure within partial LOAEL	Population experiencing at least 1 dB increase within partial LOAEL or brought into partial LOAEL
Partial LOAEL	**81,100** (of which 60,200 brought out of PARTIAL LOAEL by Option)	**64,900**	**38,900** (of which 10,100 brought into PARTIAL LOAEL by Option)

Figure 5: Change in noise exposure for Runway 27L PBN Departure Option A within the Partial LOAEL compared to the baseline

Overflight from zero to 7,000 feet

3.6.27 For the assessment of overflight in the IOA, Heathrow has used the definition as set out in CAP1498, where "overflown" is defined as, *"an aircraft in flight passing an observer at an elevation angle of 48.5˚ from the ground at an altitude below 7,000ft."* CAP1498 sets out two elevation angles that can be used (60° or 48.5°) in this definition and Heathrow has chosen to base its IOA assessments on the 48.5° elevation angle as recommended in CAP1616a para 1.42.

3.6.28 Whilst it is not a noise metric, the overflight cone enables calculation of the number of times a location may be considered to be overflown. This is a 'rate-based' metric, which can be used to better understand the rate and location of aircraft overflight that may occur as a result of an option.

3.6.29 Heathrow has calculated population numbers overflown, as considered by the previously outlined definition, at different overflight rates. The IOA presents rates of 1 overflight on average per reference period (daytime or night-time), up to 500 overflights per period.

3.6.30 Figure 6 illustrates the overflight cones for Departure Option A from Runway 27L, where the different rates of overflight are represented by the colour scale[16].

[16] Overflight cones for each option are shown in the IOA in Appendices A, B and C to this document

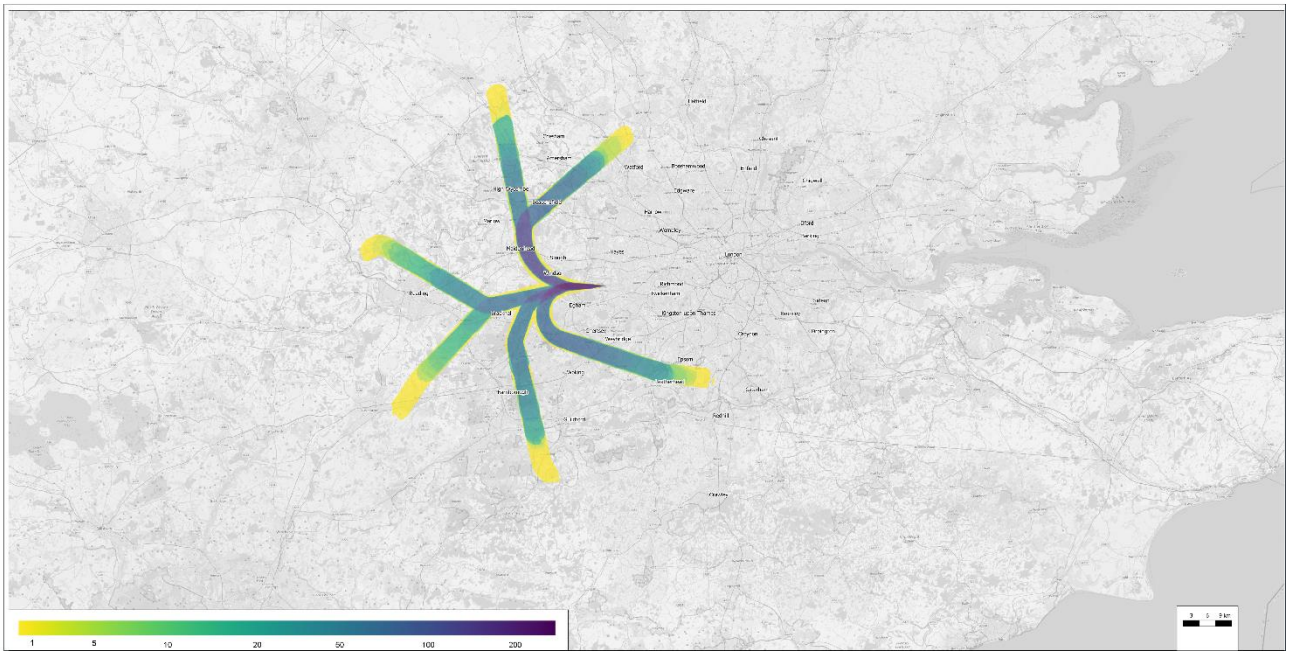


Figure 6: Overflight 0-7000ft Runway 27L Departure Option A[17] (daytime)

3.6.31 In addition to the map shown in Figure 6 for the option, Figure 7 shows how the difference in population overflown for the same option is compared with the baseline for rates 1-200 in the IOA.

Rate	Population Overflown	
	Baseline	Option A
≥ 1	1,483,800	456,800
≥ 5	716,100	360,900
≥ 10	442,000	323,600
≥ 20	280,000	264,600
≥ 50	105,600	113,200
≥ 100	28,300	44,600
≥ 200	400	1,900

Figure 7: Population overflown 0-7000ft at different rates: Runway 27L PBN Departure Option A (daytime) compared to the baseline

Noise Events above 65dB and 60dB L_{Amax} (N65 and N60)

3.6.32 Noise Events have been modelled by Heathrow as a supplementary metric to further articulate the impacts of the options to stakeholders, providing a greater understanding of the number of noise events that would occur and their location.

3.6.33 These describe the number of aircraft noise events (denoted by these metrics as 'N') where the maximum noise level (L_{Amax}) is calculated to be above 60dB during the night-time period

[17] Map can be viewed in *Step 2B Appendix A*

(shown as N60) and 65dB during the daytime period (shown as N65). These metrics, referred to as N60 and N65 respectively, have been modelled for a range of different rates, from 1 to 200 events on average.

3.6.34 Figure 8 shows the N65 noise contours for PBN Departure Option A from Runway 27L, with rates 1-200 illustrated by the coloured contour lines.

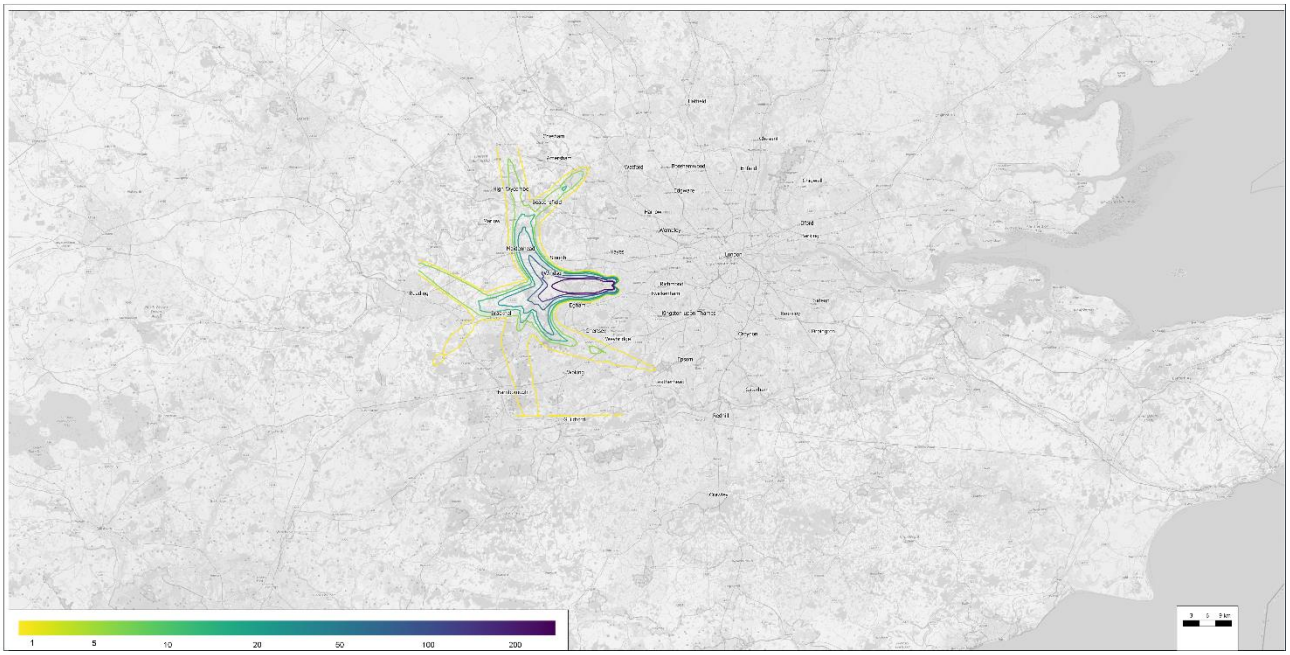


Figure 8: N65 contours for Runway 27L PBN Departure Option A[18] (daytime)

3.6.35 Additionally, Heathrow also presents the population numbers exposed to a noise event rate of 1-200 for the option compared to the baseline, in Figure 9.

Rate	Population experiencing noise events above N65 each day	
	Baseline	Option A
≥ 1	688,900	450,200
≥ 5	317,600	230,300
≥ 10	245,200	148,600
≥ 20	176,100	116,400
≥ 50	67,800	52,000
≥ 100	18,500	26,900
≥ 200	8,000	12,300

Figure 9: Population within various N contours for Runway 27L PBN Departure Option A (daytime) compared to the baseline

[18] Map can be viewed in *Step 2B Appendix A*

Communities – Air Quality

3.6.36 The DfT's Air Navigation Guidance (2017) 3.28 states that: *"Studies have shown that NOx emissions from aviation related operations reduce rapidly beyond the immediate area around the runway. Due to the effects of mixing and dispersion, emissions from aircraft above 1,000 feet are unlikely to have a significant impact on local air quality. Therefore, the impact of airspace design on local air quality is generally negligible compared to changes in the volume of air traffic and that of the local transport infrastructures feeding the airport."* ICAO's Airport Air Quality Manual (International Civil Aviation Organization Doc 9889 Airport Air Quality Manual, Second Edition, 2020) similarly states that 1,000 feet is the typical limiting altitude for ground-level NO_2 impacts from aircraft emissions.

3.6.37 CAP1616a (1.97) states:

"Change sponsors must produce information on local air quality impacts only where there is the possibility of pollutants breaching legal limits following the implementation of an airspace change (or worsening an existing breach of legal limits). The CAA deems that this is only likely to become a possibility where:

- *there is likely to (be) a change in aviation emissions (by volume or location) below 1,000 feet, and*
- *the location of the emissions is within or adjacent to an identified AQMA."* (Air Quality Management Area)

3.6.38 In the IOA, Heathrow identified options where there could be a risk that one of the conditions above is met. In this early stage of appraisal, a qualitative assessment was performed and reported for each option. Further work is required at Stage 3 to better understand the impact of full system options on local air quality. This could result in a full assessment of local air quality for shortlisted system options.

Wider Societal Impact – Greenhouse Gases

3.6.39 Heathrow has assessed this impact by calculating track mileage for each option where possible and comparing these values to the baseline. Given the link between track mileage and fuel burn, Heathrow has also reported the estimated difference in fuel burn between the option and the baseline in the IOA.

3.6.40 For departures, the 2019 NTK tracks and the options were extended and connected to set points in the network to give an indication of anticipated track miles. Data from Base of Aircraft Data (BADA) 3, extrapolated from AEDT, was used to calculate a fuel burn per unit mile for each aircraft type. The fuel burn was calculated for each movement on each route flown in the 2019 baseline, considering all aircraft types within the schedule. An average fuel burn per nautical mile was then applied to the option and multiplied by the option's track mileage and annualised.

3.6.41 CO2 estimates were not generated because improvements to vertical profiles and interactions of arrivals and departures have not been considered in the IOA. Therefore, basing the assessment only on track miles was determined appropriate for the fidelity of the options at this stage.

3.6.42 The fuel burn assessment was carried out for departure options only. Given the uncertainty around Heathrow's future arrivals mechanism, it was not possible to calculate meaningful track mileage for Vectored Arrival options to compare against the baseline.

3.6.43 For PBN Arrival options, a difference in track mileage between the options and the baseline was estimated based on the assumption that during period of assessment, traffic numbers within the LTMA are low enough to enable ATC-directed routings to the start of the PBN Arrivals (7,000 feet) from further away in the network. However, since NTK does not account for these direct routings, fuel burn assessments for PBN Arrival options were not possible at this stage.

3.6.44 Heathrow has not used monetised carbon assessments in the IOA owing to the lack of system options with complete vertical profiles required to inform TAG assessments. Monetising carbon using only partial information is not considered representative given the low fidelity of the options at this stage.

3.6.45 The following information is therefore available within Heathrow's IOA:

- PBN Departure options: a change in track miles and an associated change in fuel burn (in tonnes), indicating the difference between the option and the baseline. A negative change represents a reduction in fuel burn compared to the baseline;
- PBN Arrival options: a change in track miles for each option. A negative change represents a reduction in track miles compared to the baseline, and
- Vectored Arrival options: no information available at this stage.

Wider Societal Impact – Tranquillity and Biodiversity

Tranquillity

3.6.46 CAP1616 references Areas of Natural Beauty (AONB) and National Parks (NP) with respect to impacts upon tranquillity, and states these are, *"designated areas with specific statutory purposes to ensure their continued protection in relation to landscape and scenic beauty."* (CAP1616 B77)

3.6.47 However, CAP1616 Para B78 states *"Given the finite amount of airspace available in the UK and the fixed location of airports and National Parks or AONBs, it will not always be practical to completely avoid overflying National Parks or AONBs – and there are no legislative requirements to do so, as this would be impractical. Government policy in terms of noise impacts is to focus on minimising the number of people significantly affected by adverse impacts of aircraft noise. As a consequence, this is likely to mean that one of the key principles involved in airspace design will be avoiding overflight of populated areas below 7,000 feet Above Meal Sea Level (amsl) where possible. However, when airspace changes are being considered, it is important that local circumstances, including community feedback on specific areas that should be avoided, are taken into account where possible. Therefore, in line with the altitude-based priorities, when sponsors are developing airspace change proposals that have the potential to change overflights of National Parks or AONBs below 7,000 feet (amsl) sponsors must show how they have considered and taken account of this impact as part of their option development and final design".*

3.6.48 CAP1616 also notes that *"There is no universally accepted definition of tranquillity and therefore there is no accepted metric by which it can be measured."* (CAP1616 Appendix J p280)

3.6.49 Heathrow assessed the overall tranquillity impact of each option by considering the total areas of AONBs and National Parks (NPs) overflown (in km2, from 0 to 7,000 feet), compared to the baseline. In addition, areas of AONBs and NPs (km2) exposed to at least one N65 event per day on average were compared to the baseline. Overflight of AONBs and NPs by PBN Arrival options were assessed against the baseline for the 0430 to 0600 night period, using the N60 metric instead of N65.

3.6.50 CAP1616 also states that, "*other areas for consideration"* might be *"identified through community engagement"* (CAP1616 B76). Following community engagement, Richmond Park was identified as a specific area that should be avoided where possible. The tranquillity impact of each option on Richmond Park has been assessed by considering the total area overflown (km^2, 0 to 7,000 feet) compared to the baseline.

3.6.51 The IOA results for overflight of AONBs are likely to be overstated. This is because the IOA modelled actual flight profiles from 2019 with no adjustments made for future CDO/CCO enhancements. Conversely, when developing the options at Step 2A, a 3.0 degree (5.24%) descent and 5.5% climb gradient from/to 7,000 feet was assumed. This means the images used to describe the options differ slightly to the overflight images created in the IOA (see the IOA results in Section 3.7).

3.6.52 This difference does not affect noise metrics such as Partial LOAEL or N60/65 but can exaggerate the expected overflight impacts in the 6,000 to 7,000 feet range. The IOA results therefore suggest greater overflight of AONBs than we expect to see in our Full Options Appraisal modelling at Stage 3, which will take into account the expected improvements in CCO/CDO.

Biodiversity

3.6.53 CAP1616 guidance (B80) states that, *"In general, airspace change proposals are unlikely to have an impact upon biodiversity because they do not involve ground-based infrastructure. As such they are unlikely to have a direct impact that would engage the Birds or Habitats legislation. However, given that all changes below 7,000 feet should take into account local circumstances in the development of airspace structures, the change sponsor should include in its consultations and engagement potential biodiversity implications associated with design options under consideration, and should be mindful of such potential impacts as are identified by stakeholders."* Though there is limited research available on the effects of aircraft noise on wildlife, there is some evidence that disturbance effects associated with aircraft can occur during take-off and landing where aircraft are below around 500 metres (~1,640 feet). *[Drewitt, A. (1999) Disturbance effects of aircraft on birds. English Nature Birds Network Information Note]*

3.6.54 The IOA considers biodiversity impacts at sites recognised within policy as RAMSAR sites, Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

3.6.55 Potential impacts on biodiversity may arise where there is either an increase in aircraft events over the site, and/or a change in the location and potential habitats overflown, particularly between the 0 - 1,640 feet (500m) altitude range. Heathrow's IOA has therefore considered how many sites experience a change in location overflown in the following altitude bands:

- 0 – 1,640ft
- 0 – 3,000ft

Wider Societal Impact – Capacity and Resilience

3.6.56 Heathrow's planning conditions currently allow a maximum of 480,000 ATMs per year. This 'cap' is made up of arrivals and departures. This ACP is based on operating within the current cap, and Heathrow would need to make a separate planning application to increase the cap at any stage in the future. Therefore, for this ACP, the assessment of capacity and resilience focuses on maintaining current capacity and improving resilience and operational efficiency at Heathrow.

3.6.57 For PBN Departure options, this impact has been assessed by considering the positioning of the different SID combinations and the effect they may have, positive or negative, on runway departure throughput.

3.6.58 This is a qualitative assessment where changes to runway departure throughput are compared with the 'Do-Nothing' baseline. This assessment does not consider overall airport capacity, only departure capacity at this time.

3.6.59 PBN Arrival options have been assessed based on the 0430-0600 period, where arrival capacity on each route is not a consideration due to the small number of movements during this time.

3.6.60 For Vectored Arrival options, it is known that the vectoring of arrivals can deliver the required landing rate today, however a qualitative assessment was performed to consider whether the vectored swathe within each option might result in any reduction in the landing rate.

General Aviation – Access

3.6.61 Heathrow undertook a qualitative assessment of changes to General Aviation (GA) access to controlled airspace (CAS) compared with the do-nothing baseline. The assessment considered the potential impact on neighbouring GA airport operations and whether each option has potential to require more or less CAS, or to affect existing helicopter routes.

General Aviation/Commercial Airlines – economic impact from increased effective capacity

3.6.62 For PBN Departure options, based on the Capacity/Resilience assessment, Heathrow provided an initial indication of whether an option is likely to reduce, maintain or increase ground delay.

3.6.63 For PBN and Vectored Arrival options, Heathrow performed a qualitative assessment of whether there are any distinguishing differences between options with regards to the degradation of the required landing rate.

Commercial Airlines – training costs

3.6.64 A qualitative assessment was undertaken to identify potential costs associated with any required re-equipage of fleets or associated licensing and regulatory approval costs.

General Aviation/Commercial Airlines – fuel burn

3.6.65 Please see the Wider Societal Impact – Greenhouse Gases section above.

Commercial Airlines – other costs

3.6.66 A qualitative assessment was undertaken to assess whether an option could result in any other costs being imposed on commercial aviation.

Airport/ANSP - infrastructure costs

3.6.67 A qualitative assessment was undertaken of potential changes to Air Navigation Service Provider (ANSP) or airport infrastructure costs compared with the 'Do-Nothing' baseline. New flight paths may require an increase in the number of noise monitoring devices, or a possible change in their location.

Airport/ANSP – operational costs

3.6.68 A qualitative assessment was undertaken of changes to ANSP/airport operational costs compared with the 'Do-Nothing' baseline. There may be changes to Heathrow's operational costs if there is a change to the number of properties that could require noise insulation.

Airport/ANSP – deployment costs

3.6.69 A qualitative assessment of ANSP/airport deployment costs, such as training, compared with the do-nothing baseline.

Safety

3.6.70 CAP1616 (E49) requires that "*An initial indication of safety implications will need to be included in the Initial options appraisal at Stage 2*".

3.6.71 A qualitative safety assessment of each option was undertaken to identify if new or revised safety assurances may be needed and whether an acceptable safety argument is envisaged to be achievable.

Interdependencies, conflicts, and trade-offs

3.6.72 All ACPs developed as part of the FASI programme should specify any interdependencies with other airspace changes identified in Iteration 2 of ACOG's Airspace Change Masterplan within their Stage 2 submission. This IOA considers other airport's actual Stage 2 design

options, where available, to provide an indication of whether there is the potential for conflicts or trade-offs with other ACP sponsors during Stage 3.

3.7 Presentation of the IOA

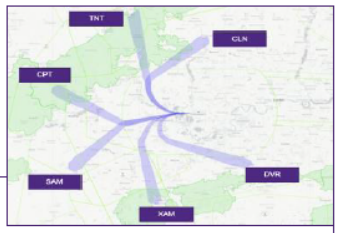
3.7.1 Due to the large number of options and associated volume of appraisals, the IOA is presented with four pages per option, describing and illustrating the qualitative and quantitative assessments. The images required by CAP1616 are included, and these should also support stakeholders' understanding of the data.

3.7.2 As described above, the outputs include supplementary metrics requested by stakeholders to further articulate the impacts of the options. Heathrow felt it valuable to expose stakeholders to a wide range of metrics at Stage 2 to familiarise them with the data and gain feedback on suitability and understanding, to better inform the consultation material that will be developed at Stage 3.

3.7.3 An example of the IOA output for PBN Departure Option A from Runway 27L is shown below. The complete set of IOA options is available in *Step 2B Appendices A, B and C.*

CAP1616 - INITIAL OPTIONS APPRAISAL - APPENDIX E

PBN SIDs – RWY 27L Option A



Option Description

This option was developed to address DP2.

Communities – Noise impact on health & quality of life

Metric	Option Value	Difference to Baseline
Population above Partial LOAEL (daytime, LA_{eq}, 16h)	124,700	-50,100
Population above Partial LOAEL (night-time, LA_{eq}, 8h)	21,800	-4,500
Population experiencing at least one event of N65 (daytime)	450,200	-238,800
Population experiencing at least one event of N60 (night-time)	183,100	-97,600

Communities - Air Quality

Introduction of PBN SIDs at Heathrow could affect track distribution below 1000ft within an AQMA. This may or may not have an effect on Air Quality. This is the same for all departure options and is not a differentiating factor at this stage. Any Air Quality impacts will be investigated at Full Options Appraisal (FOA).

Wider Society – Greenhouse Gas Impact

Metric	Option Value	Difference to Baseline
Overall Track Miles of the option (nm)	455	+3

Wider Society – Tranquillity & Biodiversity

Metric	Option Value	Difference to Baseline
Total Area of AONBs/National Parks (NPs) overflown between 0-7000ft once a day on average (daytime)	109km^2	-184km^2
Total Area of AONBs/NPs overflown experiencing at least one event of N65 on average (daytime)	39km^2	-11km^2
Total Area of Richmond Park overflown between 0-7000ft at least once a day on average (daytime)	0km^2	No change
Number of sites (RAMSAR, SAC, SPA, SSSI) overflown between 0-1640ft which observe a potential change in location overflown	0	No change
Number of sites (RAMSAR, SAC, SPA, SSSI) overflown between 0-3000ft which observe a potential change in location overflown	4	+4

Wider Society – Capacity/Resilience

Expected to perform better than the 'Do Nothing' scenario owing to anticipated improved departure separations.

Heathrow's capacity for this ACP is limited by the existing 480,000 movement cap.

General Aviation – Access

No additional CAS envisaged.

Systemised SIDs requiring less tactical intervention and with improved CCO could facilitate release of portions of CAS.

Option not expected to impact existing helicopter routes.

CAP1616 - INITIAL OPTIONS APPRAISAL - APPENDIX E

General Aviation / Commercial Airlines – Economic impact from increased effective capacity

If this option did enable sponsors to release some portions of CAS there could be a small, positive economic effect on GA operations outside CAS but this is not quantifiable at this stage.

The economic impact on commercial airlines from a reduction in ground delay is expected to provide an overall benefit in comparison to the Baseline.

General Aviation / Commercial Airlines – Fuel Burn

Change in Fuel Burn (compared to the Baseline - annual - tonnes)	+1,070

Commercial Airlines – Other costs

None identified.

Commercial Airlines – Training costs

None identified.

Airport/ANSP – Operational costs

This option is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Heathrow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in Heathrow and NERL's operational costs as it enables VOR rationalisation.

Option may lead to a change in the number of properties eligible for the noise insulation scheme which could lead to a change in operational costs for the airport.

Airport/ANSP – Infrastructure costs

Option may require re-location and/or addition of Noise Monitoring Terminals.

Airport/ANSP – Deployment costs

There will be significant costs associated with deployment in terms of operational training and system upgrades which will be quantified in Stage 3. However, no differences are expected in these costs between the different options.

Safety

No IFP Design issues identified.

Although new or revised safety assurances may be needed, an acceptable safety argument is envisaged to be achievable.

Adherence to AMS

Supports the AMS through increased systemisation and meeting the Government's key environmental objectives by utilising PBN. Used in combination with suitable arrival options, the option supports CCO/CDA operations enabling quicker & cleaner journeys. PBN Departures provide opportunity to potentially reduce CAS & enable integration of UAM in the future. Efficiency benefits to the LTMA are not yet known.

Interdependencies, Conflicts & Trade-Offs

Option is expected to result in conflicts/interdependencies with RAF Northolt, Luton, Biggin Hill, Stansted, London City, Farnborough and Gatwick.

Outcome of PBN SID RWY27L Option A

Option A significantly reduces the population within the Partial LOAEL (daytime) and the population experiencing at least one noise event during the day (N65) and night (N60). The option indicates a reduction in the population above the Partial LOAEL (night) and the overflight of AONBs and NPs compared to the Baseline.

There is a small increase in track miles and a significant number of biodiversity sites between 0-3000ft may potentially experience a change in location overflown. This option will be explored further in Stage 3.

OPTION CARRIED FORWARD TO STAGE 3

CAP1616 - INITIAL OPTIONS APPRAISAL – SUPPLEMENTARY METRICS

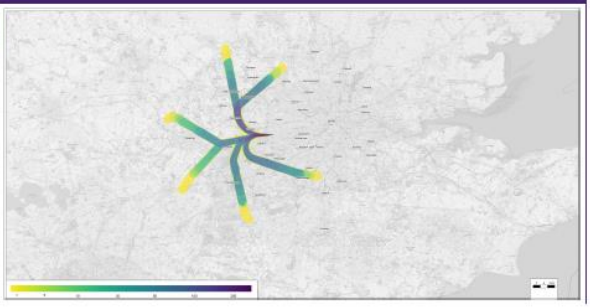
PBN Departures – RWY 27L Option A (Day)

07:00 - 23:00

Overflight

Rate	Population Overflown	
	Baseline	Option A
≥ 1	1,483,800	456,800
≥ 5	716,100	360,900
≥ 10	442,000	323,600
≥ 20	280,000	264,600
≥ 50	105,600	113,200
≥ 100	28,300	44,600
≥ 200	400	1,900

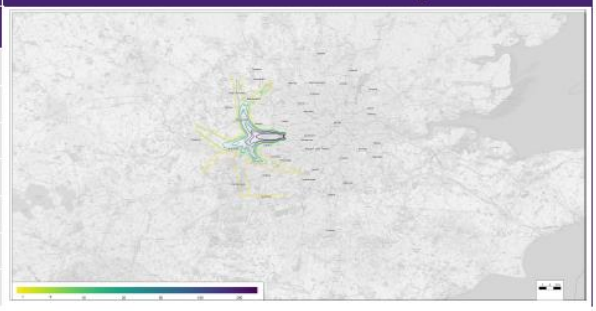
Overflight (0-7000 ft) contour map



Aircraft Noise Events

Rate	Population experiencing noise events above N65 each day	
	Baseline	Option A
≥ 1	688,900	450,200
≥ 5	317,600	230,300
≥ 10	245,200	148,600
≥ 20	176,100	116,400
≥ 50	67,800	52,000
≥ 100	18,500	26,900
≥ 200	8,000	12,300

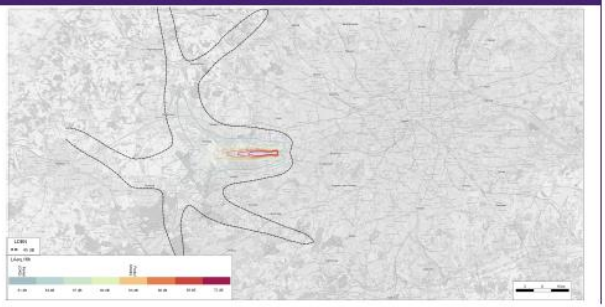
N65 events contour map



Noise Exposures

Population count	Baseline	Option A
Estimated total population above WHO Threshold (>45 dB L_{den})	602,400	568,800
Total population within Partial LOAEL (>51 dB $L_{Aeq,16h}$)	174,800	124,700

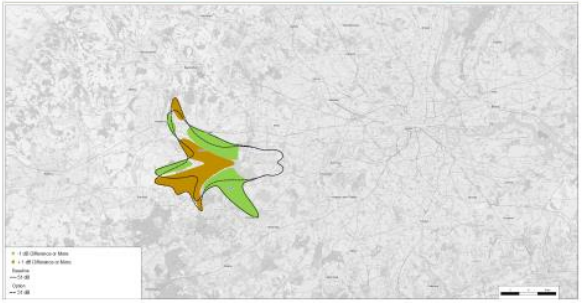
Partial LOAEL contour map



Noise Exposure Change

Change in Noise Exposure	Population experiencing at least 1 dB reduction within partial LOAEL or brought out of partial LOAEL	Population experiencing no change in noise exposure within partial LOAEL	Population experiencing at least 1 dB increase within partial LOAEL or brought into partial LOAEL
Partial LOAEL	81,100 (of which 60,200 brought out of Partial LOAEL by Option)	64,900	38,900 (of which 10,100 brought into Partial LOAEL by Option)

Change in noise exposure map

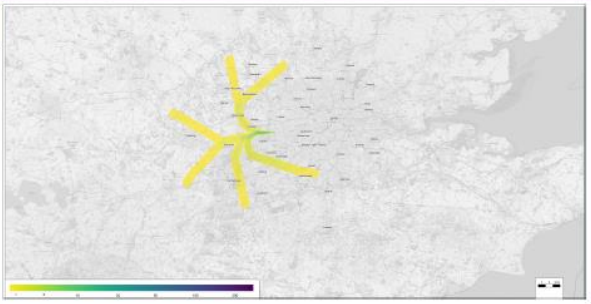


CAP1616 - INITIAL OPTIONS APPRAISAL – SUPPLEMENTARY METRICS

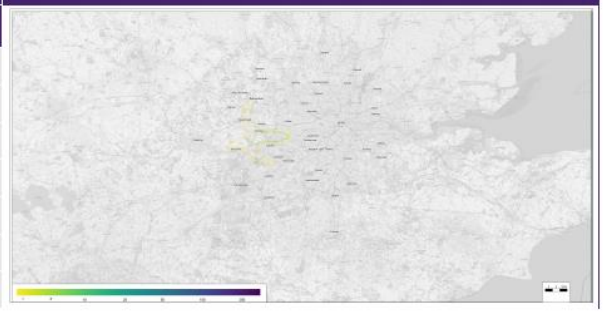
PBN Departures – RWY 27L Option A (Night)

23:00 - 07:00

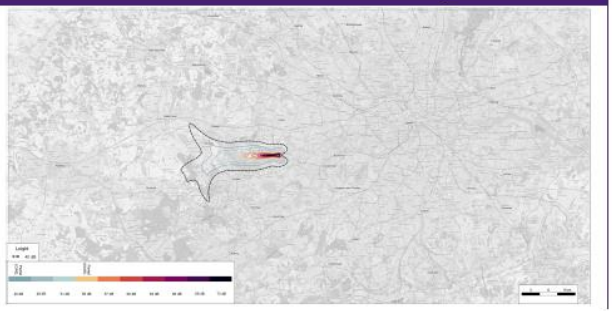
Overflight

Rate	Population Overflown		Overflight (0-7000 ft) contour map
	Baseline	Option A	
≥ 1	164,000	235,600	
≥ 5	1,000	7,000	
≥ 10	0	0	
≥ 20	0	0	
≥ 50	0	0	
≥ 100	0	0	
≥ 200	0	0	

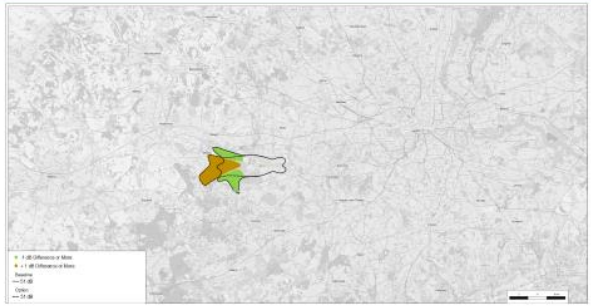
Aircraft Noise Events

Rate	Population experiencing noise events above N60 each day		N60 events contour map
	Baseline	Option A	
≥ 1	280,600	183,100	
≥ 5	20,000	26,400	
≥ 10	0	0	
≥ 20	0	0	
≥ 50	0	0	
≥ 100	0	0	
≥ 200	0	0	

Noise Exposures

Population count	Baseline	Option A	Partial LOAEL contour map
Estimated total population above WHO Threshold (>40 dB L_{night})	105,200	71,800	
Total population within Partial LOAEL (>45 dB $L_{Aeq,8h}$)	26,300	21,800	

Noise Exposure Change

Change in Noise Exposure	Population experiencing at least 1 dB reduction within partial LOAEL or brought out of partial LOAEL	Population experiencing no change in noise exposure within partial LOAEL	Population experiencing at least 1 dB increase within partial LOAEL or brought into partial LOAEL	Change in noise exposure map
Partial LOAEL	9,300 (of which 9,000 brought out of Partial LOAEL by Option)	14,400	7,000 (of which 4,400 brought into Partial LOAEL by Option)	

3.8 Stakeholder Engagement

3.8.1 Heathrow has engaged regularly with community and industry stakeholders throughout Stage 2 and undertook its final phase of engagement following completion of the Initial Options Appraisal and shortlisting process. This consisted of online sessions to inform the same stakeholders as engaged during previous Stage 2 work.

3.8.2 More details on this engagement can be found in the *Stakeholder Engagement Summary Document* as part of Heathrow's Stage 2 submission.

4. THE INITIAL OPTIONS APPRAISAL

4.1 PBN Departure Options

4.1.1 The Initial Options Appraisal for each PBN Departure option and the assessment of the baseline departure scenarios can be found at *Step 2B Appendix A.*

4.2 PBN Arrival Options

4.2.1 The Initial Options Appraisal for each PBN Arrival option and the assessment of the baseline scenarios can be found at *Step 2B Appendix B.*

4.3 Vectored Arrival Options

4.3.1 The Initial Options Appraisal for each Vectored Arrival option and the assessment of the baseline scenarios can be found at *Step 2B Appendix C.*

All airspace design options in this document are subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, Design Principles, appraisals and stakeholder engagement and consultation.

5. SHORTLISTING OF OPTIONS

5.1 CAP1616 Shortlisting Requirements

5.1.1 CAP1616 requires sponsors to qualitatively assess the CLOO and produce a shortlist of flight path options. Sponsors must use the IOA criteria to determine whether an option is shortlisted and progressed to Stage 3 or discontinued at Stage 2.

5.1.2 CAP1616 Appendix E12 sets out the evidence required, as a minimum:

- criteria for assessing the list of options, and the application of those criteria to the list to develop the shortlist of options, and
- shortlisted options to be described qualitatively with an indication of the preferred option.

5.1.3 CAP1616 does not include a methodology for shortlisting options, and there is no single approach that is considered to be 'best practice'. The change sponsor is encouraged to develop its shortlist of options using as much analysis as reasonably possible.

5.2 Heathrow's Approach to Shortlisting Options

5.2.1 Following completion of the IOA, Heathrow created a shortlisting methodology to compare each of the options to the baseline, producing a shorter list of flight path options to take forward into Stage 3. At Stage 3, system options (arrivals and departures together, for both easterly and westerly operations) will be built initially using the shortlisted options.

5.2.2 Heathrow's shortlisting methodology is designed to be:

- logical and accessible to all interested stakeholders;
- robust, since it is based on current policy;
- consistent across all of the options as far as is possible (arrivals/departures, westerly/easterly operations); and
- appropriate for the high-level nature of the CLOO at this stage, since Heathrow's future airspace design will be impacted by other airports' developing airspace designs and NATS' design for Heathrow's future arrivals mechanism ('holding stacks').

5.2.3 Heathrow's approach to the shortlisting of options is based on the key principles set out in CAP1616 and in the Government's Air Navigation Guidance 2017 (ANG17).

5.2.4 ANG17 is Government guidance to the CAA on its environmental objectives when carrying out its air navigation functions and to the CAA and wider industry on airspace and noise management. This guidance must be taken into account by sponsors of airspace change proposals and by the CAA when deciding whether to approve such proposals. This requirement is captured in Design Principle 2 at the request of some of the stakeholders who helped us to develop the Design Principles: "*Our new airspace design must remain in*

accordance with the CAA's published Airspace Modernisation Strategy and any current or future plans associated with it and all other relevant UK policy, legislation and regulatory standards (for example, Air Navigation Guidance). This includes preventing any worsening of local air quality due to emissions from Heathrow's aircraft movements, to remain within local authorities' limits."

5.2.5 Shortlisting options based on ANG17 enables Heathrow to consider the potential environmental impact of the options as much as is practical at this early stage of the ACP.

5.2.6 Para 135 of CAP1616 indicates that the options appraisal must be modelled on the factors that the CAA is required to consider under section 70 of the Transport Act 2000. Under that provision, maintaining a high standard of safety is the priority and a range of other factors are set out which the CAA must take into account when determining an ACP. These include securing efficient use of airspace and expeditious flow of traffic, satisfying the interests of aircraft owners and operators, the interests of other persons (including airports), the ANG on environmental objectives, national security considerations and the UK's international obligations. Our IOA includes initial assessments on safety, capacity, General Aviation and the AMS although there are currently no significant differentiating factors between options and these assessments were not a determining factor in the shortlisting of options.

5.2.7 ANG17 sets out the Government's key environmental objectives in support of a strong and sustainable aviation sector which are to:

a) limit and, where possible, reduce the number of people in the UK significantly affected by adverse impacts from aircraft noise;[19]

b) ensure that the aviation sector makes a significant and cost-effective contribution towards reducing global emissions, and

c) minimise local air quality emissions and in particular ensure that the UK complies with its international obligations on air quality.

5.2.8 ANG17 also sets out "altitude-based priorities" which should be considered when assessing the potential environmental impact of airspace changes. These priorities are intended to inform those responsible for considering and deciding permanent changes to the UK's airspace design. **Error! Reference source not found. Error! Reference source not fo und.** shows Heathrow's approach to shortlisting options aligned to each of the altitude-based priorities.

[19] In March 2023 the Government published a revised overarching aviation noise policy statement: *"The impact of aviation noise must be mitigated as much as is practicable and realistic to do so, limiting, and where possible reducing, the total adverse impacts on health and quality of life from aviation noise."* Source: Overarching aviation noise policy, DfT, 27 March 2023

Altitude-Based Priorities (ANG17)	Heathrow Approach at Step 2B
a. below 4,000 feet the priority is to limit and, where possible, reduce the total adverse effects on people;	1. Are significantly more people in the partial LOAEL than today? 2. Do significantly more people experience noise events than today?
b. where options are similar in terms of the number of people affected, preference should be given to that option which is most consistent with existing published airspace arrangements;	This will be assessed at Stage 3 when Heathrow has a smaller number of system options and will be able to assess how different those options are to the existing airspace design.
c. above 4,000 feet to below 7,000 feet, the priority should continue to be minimising the impact of aviation noise, unless this would disproportionately increase CO2 emissions;	3. Are track miles significantly higher than today?
d. above 7,000 feet, the CAA should prioritise the reduction of aircraft CO2 emissions and the minimising of noise is no longer the priority;	n/a (Heathrow's ACP only considers routes up to 7,000 feet)
e. where practicable, routes below 7,000 feet should seek to avoid flying over Areas of Outstanding Natural Beauty (AONB) and National Parks, and	4. Are AONBs or National Parks overflown significantly more than today?
f. all changes below 7,000 feet should take into account local circumstances in the development of the airspace design and should not be agreed to before appropriate community engagement has been conducted.	5. Are "local circumstances" impacted significantly more than today?

Table 5: Heathrow's approach to shortlisting options based on ANG17 altitude-based priorities

5.3 The Shortlisting Criteria

5.3.1 To illustrate this methodology, Heathrow produced a flowchart which applies six steps to test each option and consider whether it should be shortlisted. This is shown in Figure 10.

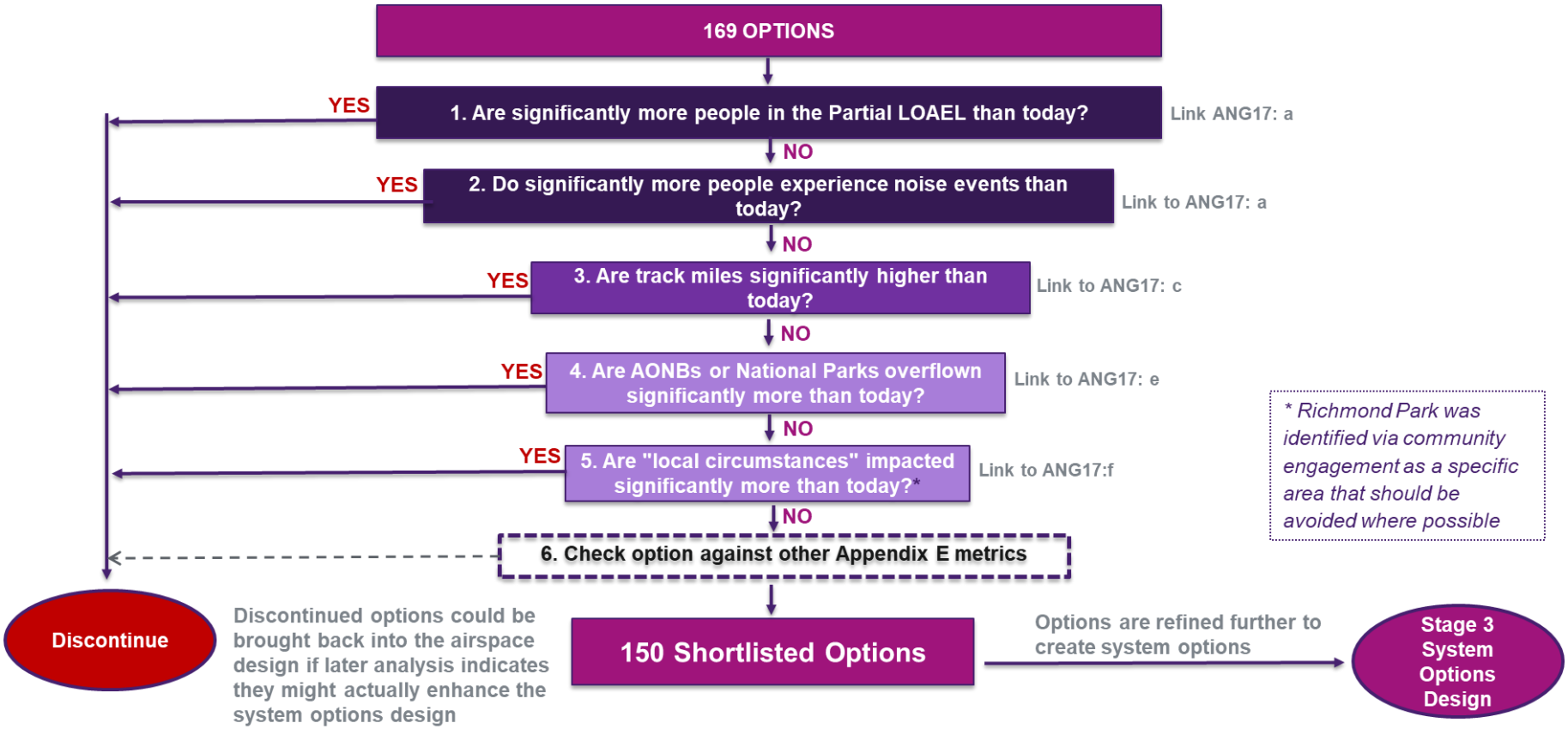


Figure 10: Heathrow's shortlisting methodology process

5.3.2 Heathrow applied the shortlisting methodology to each of the options for PBN Arrivals and PBN Departures to/from each runway end, producing 8 sets of results. The shortlisting methodology was not applied to Vectored Arrival options, and this is explained in section 5.5.14.

5.3.3 At each test in the process, the option is compared to the baseline (or 'Do Nothing'). This allows Heathrow to understand the impact of the option for each test. Heathrow has applied professional judgement to determine the meaning of 'significantly' in each test when deciding if an option should be discontinued. Options were tested in the order shown in Figure 10 and only options that 'passed' a test proceeded to the next test.

5.3.4 Heathrow followed the process set out in Figure 10, however no options were discontinued based on Tests 4 or 5 in practice. These tests relate to overflight of AONBs and National Parks and overflight of Richmond Park[20]. Heathrow took the decision not to discontinue any options based on these tests because:

a) As described in Section 3.6.51, the IOA results for overflight of AONBs are likely to be overstated and Heathrow expects to see a reduction in areas of AONBs and National Parks overflown once assumptions around future use of CCO and CDO have been applied at Stage 3;

b) When reviewing the Test 4 and Test 5 results, Heathrow decided it would be more appropriate to address these local issues when developing system options at the beginning of Stage 3. The compilation of system options at Stage 3 will inevitably result in some refinement of the routes and Heathrow will seek to reduce potential overflight and/or impacts to AONBs, National Parks and Richmond Park at this stage of the process;

c) CAP1616 recognises that *"it will not always be practical to completely avoid overflying National Parks or AONBs – and there are no legislative requirements to do so, as this would be impractical"*[21].

5.3.5 The "check" against other CAP1616 Appendix E metrics at Test 6 did not lead to any options being discontinued. This check considered air quality, biodiversity and airport resilience. None of the options' impacts were considered significant enough to warrant discontinuation based on these criteria at this stage of the process.

5.3.6 The shortlisting process includes a caveat that as options are further refined and appraised at Stage 3, Heathrow may need to bring discontinued options back if later inputs and analysis indicate they might enhance the system options design.

5.3.7 This process resulted in a shortlist of 151 options.

[20] At stakeholder workshops on the IOA, Heathrow informed stakeholders that PBN Arrival Option I to Runway 27R had been discontinued based on overflight of AONBs and Richmond Park. However, on subsequent review of the options prior to Stage 2 submission, the decision was taken to reinstate Option I to ensure consistency across the shortlisting of options. This is explained in Section 7.3 of the Stakeholder Engagement Summary Document.
[21] CAP1616 B78

5.4 The Shortlisting Process: a worked example

5.4.1 The worked example shown in Figures 11 to 16 presents the shortlisting process as applied to the PBN Departure options from Runway 27L. Options from 'Runway 27L' are those options departing Heathrow's southern runway towards the west.

1. Are significantly more people in the Partial LOAEL than today?

Option	DP link	Pop above Partial LOAEL (daytime)	Difference to Baseline	Pop above Partial LOAEL (night time)	Difference to Baseline
Option E	DP9	120,100	-54,700	27,100	800
Option G	DP10	124,400	-50,400	21,700	-4,600
Option A	DP2	124,700	-50,100	21,800	-4,500
Option H	TPI	126,400	-48,400	28,200	1,900
Option B	DP2A	148,300	-26,500	26,500	200
Option F	DP9A	172,700	-2,100	29,400	3,100
Option C	DP4	173,300	-1,500	36,900	10,600
"Do Nothing"/ Baseline	n/a	174,800	0	26,300	0
Option D	DP5	205,300	30,500	29,600	3,300

Figure 11: Shortlisting process: Test 1

5.4.2 For Test 1 shown in Figure 11, the population above, or within, the Partial LOAEL in the daytime and night-time periods have been modelled and then compared to the baseline LOAEL values. The LOAEL is the area exposed to average noise levels above 51dB in the day, and above 45dB at night.

5.4.3 Options shown in orange are discontinued based on the test. For this example, Option C and Option D were discontinued at Test 1. Option C was discontinued as the population within the night-time LOAEL was deemed to be significantly higher than in the baseline. Option D was the only option performing worse than the baseline for the daytime LOAEL and was discontinued.

2. Do significantly more people experience noise events than today?

Option	DP link	Pop experiencing >1 N65 noise events/day (daytime)	Difference to Baseline	Pop experiencing >1 N60 noise events/day (night time)	Difference to Baseline
Option A	DP2	450,200	-238,700	183,100	-97,500
Option G	DP10	457,200	-231,700	183,000	-97,600
Option H	TPI	548,600	-140,300	227,700	-52,900
Option E	DP9	586,000	-102,900	222,700	-57,900
Option F	DP9A	683,500	-5,400	276,600	-4,000
"Do Nothing"/ Baseline	n/a	688,900	0	280,600	0
Option B	DP2A	769,900	81,000	252,300	-28,300
Option D	DP5	803,500	114,600	324,600	44,000
Option C	DP4	916,600	227,700	308,800	28,200

Figure 12: Shortlisting process: Test 2

5.4.4 For Test 2, shown in Figure 12, the population experiencing noise events of N65 (for daytime) and N60 (for night-time) has been compared to the baseline data. Options that have been discontinued at a previous test are shown in grey. Option B has been discontinued at this Test as significantly more people would experience an N65 noise event during the day compared to the baseline. All other remaining options show an improvement compared to the baseline.

5.4.5 The figure also illustrates that Options C and D would have been discontinued based on Test 2 if they had not already been discontinued at Test 1.

3. Are track miles significantly higher than today?

Option	DP link	Track miles	Difference to Baseline
Option C	DP4	433	-18
Option D	DP5	438	-13
Option B	DP2A	441	-10
Option F	DP9A	446	-5
Option E	DP9	450	-1
"Do Nothing"/ Baseline	n/a	451	0
Option H	TPI	452	1
Option A	DP2	455	4
Option G	DP10	455	4

Figure 13: Shortlisting process: Test 3

5.4.6 For Test 3, shown in Figure 13, track miles are used as an indicator of CO_2 emissions. In this example, the best performing options (Options B, C and D) have already been discontinued based on previous noise tests, reflecting ANG17's prioritisation of noise over carbon. No other options were discontinued based on this test and Heathrow will seek opportunities to reduce track miles when developing system options at Stage 3, whilst continuing to prioritise the reduction of adverse effects from noise in line with ANG17.

5.4.7 ANG17's altitude-based priorities include a clause stating that, *"the priority should continue to be minimising the impact of aviation noise (between 4000ft and 7000ft), unless this would disproportionately increase CO_2 emissions."* The values in the figure above indicate that the prioritisation of noise at Tests 1 and 2 has not left options that would "disproportionately increase CO_2 emissions" and it is therefore appropriate for Options B, C and D to be discontinued.

4. Are AONBs or National Parks overflown significantly more than today?

Option	DP link	Total Area overflown (km2) >1 time/day on average	Difference to Baseline
Option H	TPI	79	-214
Option B	DP2A	85	-208
Option F	DP9A	88	-205
Option E	DP9	103	-190
Option C	DP4	106	-186
Option A	DP2	109	-184
Option G	DP10	112	-181
Option D	DP5	117	-175
"Do Nothing"/ Baseline	n/a	293	0

Figure 14: Shortlisting process: Test 4

5.4.8 For Test 4, shown in Figure 14, the total area of Areas of Outstanding Natural Beauty (AONBs) or National Parks overflown more than once per day on average is compared to the baseline. In this case, all options perform better than the baseline and no options were discontinued.

5. Are "local circumstances" impacted significantly more than today?

Option	DP link	Richmond Park overflown (km2) 1x/day	% change
"Do Nothing"/ Baseline	n/a	0	N/A
Option A	DP2	0	N/A
Option B	DP2A	0	N/A
Option C	DP4	0	N/A
Option D	DP5	0	N/A
Option E	DP9	0	N/A
Option F	DP9A	0	N/A
Option G	DP10	0	N/A
Option H	TPI	0	N/A

Figure 15: Shortlisting process: Test 5

5.4.9 For Test 5, shown in Figure 15, Richmond Park was the only "local circumstance" identified via community engagement as a specific area that should be avoided where possible. In this example, no PBN Departure options from Runway 27L overfly Richmond Park.

6. Check option against other Appendix E metrics

Option	DP link	Is AQ affected below 1000ft? a	Are significantly more biodiversity sites overflown? b	Is the airport's operational resilience impacted? c
"Do Nothing"/ Baseline	n/a	-	-	-
Option A	DP2	N	N	N
Option B	DP2A	N	N	N
Option C	DP4	N	N	N
Option D	DP5	N	N	N
Option E	DP9	N	N	N
Option F	DP9A	N	N	N
Option G	DP10	N	N	N
Option H	TPI	N	N	N

Figure 16: Shortlisting process: Test 6

5.4.10 The final test in the shortlisting flowchart is Test 6, shown in Figure 16. This test involved checking all the options against other CAP1616 Appendix E metrics. The metrics chosen are not referred to in ANG17's altitude-based priorities but relate to our Design Principles and/or the key concerns of our stakeholders. Test 6 checks whether an option performs significantly worse than the baseline for the following three metrics:

- qualitative statement identifying the potential for an option to result in changes to local air quality where aircraft are below 1,000 feet;
- quantitative analysis of the number of biodiversity sites overflown from 0 to 3,000 feet which experience an increase in area overflown compared to the baseline. This includes RAMSARs, SACs, SPAs and SSSIs, and
- A qualitative assessment of changes to runway departure throughput capacity and operational resilience compared with the baseline.

5.4.11 Heathrow performed the check using a closed question yes/no approach, using professional judgement to make an informed decision on whether the option was likely to have a significant impact. In the above example, and across all of the options, no additional options

were discontinued on this basis as none were deemed to have a significant impact on air quality, biodiversity or operational resilience.

5.4.12 Overall, in this example for PBN Departure options from Runway 27L, Options B, C and D were discontinued due to the noise metrics, with remaining Options A, E, F, G and H shortlisted for further refinement at Stage 3.

5.5 Shortlisting Results

Summary

5.5.1 The shortlisting process resulted in a total of 18 options being discontinued at Step 2B, with 151 options shortlisted to progress through to Stage 3. The shortlisting results are summarised as follows:

- PBN Departure options: 26 shortlisted, 10 discontinued;
- PBN Arrival options: 81 shortlisted, 8 discontinued; and
- Vectored Arrival options: 44 shortlisted, 0 discontinued.

5.5.2 The following sections provide more detail on the shortlisting outcome. For the PBN Departure options and PBN Arrival options, a high-level summary is provided, followed by eight figures presenting the shortlisting results per runway end for each set of options, alongside a rationale to explain whether the options have been discontinued or shortlisted.

5.5.3 Each table is supported by a map showing the overflight contours for all the options in the CLOO, and another map illustrating the shortlisted options. Full detail on every option is available in *Step 2B Appendices A to C.*

Shortlisting of PBN Departure Options

5.5.4 Overall, Heathrow's PBN Departure options performed positively from a noise perspective, with many options performing better than the baseline for Runway 27L and Runway 27R.

5.5.5 For Runway 09L and Runway 09R, further work is required at Stage 3 to understand the impacts of the options, given the proposed future use of easterly alternation which is different to how these runways are used today.

5.5.6 The results showed some examples of trade-offs between the options, with, for example, options that performed well for noise often performing less well for carbon.

PBN Departure Options from Runway 27L

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	Option A significantly reduces the population within the Partial LOAEL (daytime) and the population experiencing at least one noise event during the day (N65) and night (N60). The option indicates a reduction in the population above the Partial LOAEL (night) and the overflight of AONBs and NPs compared to the Baseline. There is a small increase in track miles and a significant number of biodiversity sites between 0-3000ft may potentially experience a change in location overflown. This option will be explored further in Stage 3.
B	**Discontinued**	Option B reduces the Partial LOAEL (daytime) and the population experiencing at least one N60 night event. It provides a small decrease in track miles. The option indicates a reduction in overflight of AONBs and NPs compared to the Baseline. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and airport resilience performs the same as the Baseline. Critically, the option failed Test 2 of the shortlisting process as it creates an increase of more than 10% in people who would experience noise events during the day.
C	**Discontinued**	Option C offers a small reduction in the population above the Partial LOAEL for daytime and reduces the track miles. The option indicates a reduction in overflight of AONBs and NPs and indicates better airport resilience than the Baseline. Critically, the option failed Test 1 of the shortlisting process as it creates a 40% increase in the total population within the Partial LOAEL for night.
D	**Discontinued**	Option D reduces the total track miles and indicates a reduction in the overflight of AONBs and NPs. The option indicates better airport resilience than the Baseline. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and it performs poorly against all the noise metrics. Critically, the option failed Test 1 of the shortlisting process as it creates a 20% increase in the total population within the Partial LOAEL.

E	**Shortlisted**	Option E performs well against the majority of the noise metrics when compared to the Baseline. It significantly reduces the population within the Partial LOAEL, provides a small decrease in track miles and a reduction in overflight of AONBs and NPs. The option indicates better airport resilience than the Baseline. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and there is a small increase in the population within the LOAEL at night. This option will be explored further in Stage 3.
F	**Shortlisted**	Option F offers small improvements against the majority of the noise metrics when compared to the Baseline. The option indicates a small reduction in track miles and a decrease in overflight of AONBs and NPs. The option indicates similar airport resilience performance to the Baseline. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and there is a significant increase in the population within the LOAEL at night. This option will be explored further in Stage 3.
G	**Shortlisted**	Option G offers significant reductions for the population within the Partial LOAEL (daytime) and the population experiencing at least one N65 (day) or N60 (night) noise event. It indicates a reduction in the population above the Partial LOAEL (night), a reduction in overflight of AONBs and NPs, and an improvement to airport resilience. There is a small increase in track miles and a significant number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
H	**Shortlisted**	Option H significantly reduces the population above the Partial LOAEL (daytime) and overflight of AONBs and NPs. It reduces the population experiencing at least one N65 (day) or N60 (night) noise event. There is a negligible improvement to track miles and an indication of similar airport resilience performance compared to the Baseline. There are increases in the population above the Partial LOAEL (night) and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.

Table 6: PBN Departure Options from Runway 27L

Figure 17: All 27L PBN Departure Options A-H

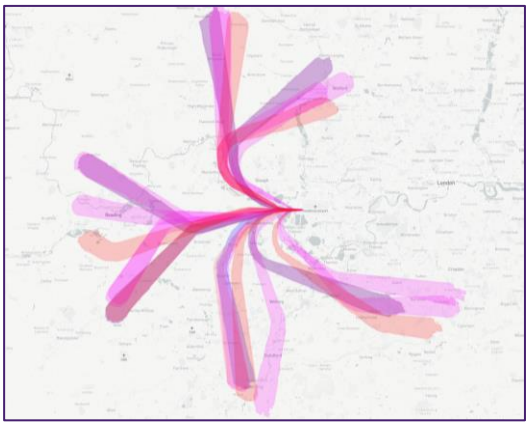


Figure 18: Shortlisted 27L PBN Departures Options A, E, F, G & H

PBN Departure Options from Runway 27R

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	Option A performs well against the majority of noise metrics and reduces the size of the population above the Partial LOAEL (daytime) by almost half. It indicates a decrease in overflight of AONBs and NPs and an improvement in airport resilience when compared to the Baseline. There is a significant increase in the population above the Partial LOAEL (night) and a significant number of biodiversity sites between 0-3000ft may experience a change in location overflown. There is a small increase in track miles. This option will be explored further in Stage 3.
B	**Discontinued**	Option B reduces the population above the Partial LOAEL (daytime) and offers a reduction in overflight of AONBs and NPs. There is a small decrease in track miles and the option indicates an improvement in airport resilience. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and it performs poorly against the majority of the noise metrics. Critically, the option failed Test 1 of the shortlisting process as it would increase population above the partial LOAEL (night) by more than twice the size of the Baseline.
C	**Discontinued**	Option C reduces the number of track miles, indicates a better performance than the Baseline regarding airport resilience and decreases the area of AONBs and NPs overflown. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and it performs poorly against all the noise metrics. Critically, the option failed Test 1 of the shortlisting process as it increases the population above the partial LOAEL (night) to twice the size of the Baseline.
D	**Discontinued**	Option D reduces the number of track miles, indicates better airport resilience performance than the Baseline, and decreases the area of AONBs and NPs overflown. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and it performs poorly against all the noise metrics. Critically, the option failed Test 1 of the shortlisting process as it increases the population above the partial LOAEL (night) to more than twice the size of the Baseline.
E	**Shortlisted**	Option E provides a reduction in overflight of AONBs and NPs, a small reduction in track miles and a negligible decrease in the population experiencing at least one N65 (daytime) noise event. It indicates a better airport resilience performance than the Baseline. There are significant increases in the population above the Partial LOAEL (night) and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. There is an increase in the population experiencing at least one N60 (night) noise event. This option will be explored further in Stage 3.

F	**Shortlisted**	Option F provides a reduction in overflight of AONBs and NPs. There is a small reduction in track miles and similar airport resilience performance to the Baseline. There are increases in the population experiencing at least one N65 (daytime) noise event and the population above the Partial LOAEL (night). There is a significant increase in the population experiencing at least one N60 (night) noise event and there are small increases in the population above the Partial LOAEL (daytime). A significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
G	**Shortlisted**	Option G performs well against the majority of noise metrics and reduces the size of the population above the Partial LOAEL (daytime) by almost half when compared to the Baseline. It indicates a decrease in overflight of AONBs and NPs and an improvement in airport resilience. There are significant increases in the population above the Partial LOAEL (night) and a significant number of biodiversity sites between 0-3000ft may experience a change in location overflown. There are small increases in the track miles. This option will be explored further in Stage 3.
H	**Shortlisted**	Option H provides decreases to the total area of AONBs and NPs overflown and small reductions in the population above the Partial LOAEL (daytime), the population experiencing at least one N65 (daytime) noise event and in track miles. It indicates better airport resilience performance than the Baseline. There are significant increases in the population above the Partial LOAEL (night) and a significant number of biodiversity sites between 0-3000ft may experience a change in location overflown. There is a small increase in the population experiencing at least one N60 (night) noise event. This option will be explored further in Stage 3.

Table 7: PBN Departure Options from Runway 27R

Figure 19: All 27R PBN Departure Options A-H

Figure 20: Shortlisted 27R PBN Departures Options A, E, F, G & H

PBN Departure Options from Runway 09L

5.5.7 All PBN Departure options from this runway perform worse than the baseline. This is because Heathrow does not routinely use this runway for departures today, so the IOA is comparing increased use of 09L for departures against a very low base-case.

5.5.8 When modelling these options, Heathrow allocated all easterly departures to the 09L departure options to assess the impacts of the options for the IOA. However, Heathrow expects to introduce easterly alternation alongside this ACP, so departures would actually be split across Runways 09L and 09R, reducing the number of movements (and impacts) for each runway.

5.5.9 Heathrow has decided not to discontinue any of these options at this stage and will further investigate the likely impacts of them at Stage 3 in collaboration with the intention to introduce easterly alternation.

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	Runway 09L is not generally used for departures today due to the legacy of the Cranford Agreement. All departure options therefore perform worse than the Baseline. We have not discontinued any of these options and will investigate the likely impacts of them in Stage 3.
B	**Shortlisted**	As above
C	**Shortlisted**	As above
D	**Shortlisted**	As above
E	**Shortlisted**	As above
F	**Shortlisted**	As above
G	**Shortlisted**	As above
H	**Shortlisted**	As above
I	**Shortlisted**	As above
J	**Shortlisted**	As above

Table 8: PBN Departure Options from Runway 09L

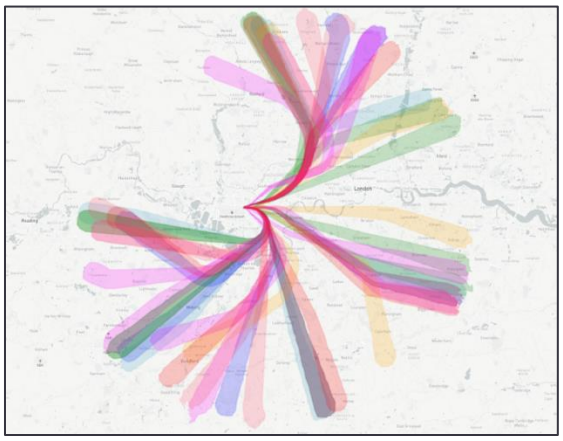


Figure 21: Shortlisted 09L Options A-J

PBN Departure Options from Runway 09R

Option	Shortlisting Outcome	Rationale
A	**Discontinued**	Option A significantly reduces the population experiencing at least one N65 day event, reduces the population experiencing at least one N60 night event and reduced the total area of AONBs and NPs overflown. It indicates a small decrease in track miles and an improvement in airport resilience. There are increases in the population above the Partial LOAEL (daytime), the total area of AONBs and NPs experiencing at least one N65 event on average and an increase in the total area of Richmond Park overflown. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. Critically, the option failed Test 1 of the shortlisting process as it increases the population with the Partial LOAEL (night) by more than 50% compared with the Baseline.
B	**Shortlisted**	Option B performs well against N65 (daytime) and N60 (night) noise events when compared to the Baseline. It indicates decreases in track miles and a decrease in the total area of AONBs and NPs overflown. The option indicates an improvement in airport resilience. There are significant increases in the population above the Partial LOAEL (daytime and night) and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. There is an increase in the total area of Richmond Park overflight. This option will be explored further in Stage 3.
C	**Shortlisted**	Option C decreases the total area of AONBs and NPs overflown and reduces the track miles when compared to the Baseline. The option indicates an improvement in airport resilience. There is a significant increase in the population above the Partial LOAEL (night) and there is a small increase in the population above the Partial LOAEL (daytime). There is an increase in the total area of Richmond Park overflown and the population experiencing at least one N60 (night) noise event and a significant number of biodiversity sites between 0-3000ft that may potentially experience a change in location overflown. This option will be explored further in Stage 3.
D	**Discontinued**	Option D reduces the total area of AONBs and NPs overflown. It indicates a decrease in track miles, in the population experiencing an N60 (night) event and an improvement in airport resilience. There are small increases in the population above the Partial LOAEL (daytime and night) and the total area of AONBs and NPs experiencing at least one N65 event (daytime). There are a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and an increase in the total area of Richmond Park overflown. Critically, the option failed Test 2 of the shortlisting process as it increases the population experiencing N65 events (daytime) by over 20%.
E	**Discontinued**	Option E reduces the total area of AONBs and NPs overflown. It indicates a small decrease in track miles and an improvement in airport resilience. There is no change to overflight of Richmond Park.

		The option performs poorly against all the noise metrics and there is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. Critically, the option failed Test 2 of the shortlisting process as it increases the population experiencing N65 events (daytime) by nearly 40% and N60 events (night) by over 15%.
F	**Shortlisted**	Option F decreases the population experiencing N65 (daytime) and N60 (night) events when compared to the Baseline. It also decreases track miles and the total area of AONBs and NPs overflown. The option indicates improved airport resilience. There is an increase in the total area of Richmond Park overflown. There is an increase in the population above the Partial LOAEL (daytime and night) and in the area of AONBs and NPs experiencing at least one N65 event. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
G	**Shortlisted**	Option G provides small decreases to the population experiencing at least one N65 (daytime) or N60 (night) noise event when compared to the Baseline. It decreases the total area of AONBs and NPs overflown. The option indicates an improvement in airport resilience. There is no change to Richmond Park overflight. There is an increase in the population above the Partial LOAEL (night) and a small increase in the population above the Partial LOAEL (daytime). There is an increase in track miles. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown.
H	**Discontinued**	Option H significantly reduces the population experiencing N65 (daytime) and N60 (night) noise events and indicates an improvement in airport resilience when compared with the Baseline. It reduces the total area of AONBs and NPs overflown and there is a negligible decrease in track miles. There are increases in Richmond Park overflight and a significant number of biodiversity sites. between 0-3000ft that may experience a change in location overflown. There is an increase in N65 events for AONBs and NPs. Critically, the option failed Test 1 of the shortlisting process as it increases the population above the Partial LOAEL (night) by 50%.
I	**Shortlisted**	Option I reduces the total area of AONBs and NPs overflown, reduces the population experiencing at least one N65 (daytime) event, and reduces the track miles. There is a small decrease in the population above the Partial LOAEL (night) and the option indicates an improvement in airport resilience. There are small increases in the population above the Partial LOAEL (daytime) and in N65 noise events over AONBs and NPs. There are increases in the population experiencing at least one N60 (night) noise event and in the total area of Richmond Park overflown. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown.
J	**Shortlisted**	Option J decreases the total area of AONBs and NPs overflown and reduces the population experiencing at least one N65 (daytime) noise event. It

		decreases the track miles, offers a small reduction in the population above the Partial LOAEL (night) and indicates an improvement in airport resilience. There are small increases in the population above the Partial LOAEL (daytime) and in the N65 noise events over AONBs and NPs. There is a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown and a significant increase in the population experiencing at least one N60 (night) noise event. This option will be explored further in Stage 3.

Table 9: PBN Departure Options from Runway 09R

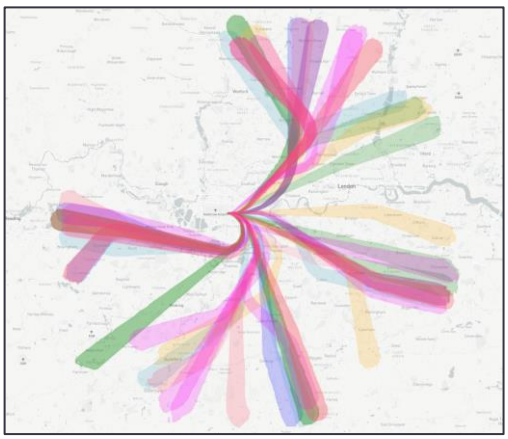


Figure 22: All 09R PBN Departure Options A-J

Figure 23: Shortlisted 09R PBN Departures Options B, C, F, G, I, & J

Shortlisting of PBN Arrival Options

5.5.10 Overall, many of Heathrow's PBN Arrival options performed well in terms of reducing the number of people adversely affected by noise (0430-0600), with reductions of up to 63% for options on Runway 27L and Runway 27R.

PBN Arrival Options to Runway 27L

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	Option A provides significant reductions against all the noise metrics. It indicates a decrease in track miles when compared with the Baseline and no overflight of AONBs or NPs. The option indicates a small increase in Richmond Park overflight and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
B	**Shortlisted**	Option B significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. The option indicates significant increases in overflight of AONBs, NPs and Richmond Park and a number of biodiversity sites between 0-3000ft may experience a change in location overflown. It indicates an increase in track miles. This option will be explored further in Stage 3.
C	**Shortlisted**	Option C significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft may experience a change in location overflown. The option indicates increases in overflight of AONBs and NPs and a small increase in track miles. This option will be explored further in Stage 3.
D	**Shortlisted**	Option D significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles. It indicates no overflight of AONBs or NPs. The option indicates a small increase in Richmond Park overflight and a significant number of biodiversity sites between 0-3000ft may potentially experience a change in location overflown. This option will be explored further in Stage 3.
E	**Shortlisted**	Option E significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and track miles. It indicates a similar area of AONBs and NPs experiencing at least one N60 noise event when compared to the Baseline. The option indicates significant increases in the total area of AONBs and NPs overflown and a significant number of biodiversity sites between 0-3000ft that

		may experience a change in location overflown. It indicates a small increase in Richmond Park overflight. This option will be explored further in Stage 3.
F	**Shortlisted**	Option F reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. It indicates a significant decrease in track miles, indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates a significant increase in overflight of AONBs and NPs. This option will be explored further in Stage 3.
G	**Shortlisted**	Option G significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. It indicates a decrease in track miles compared to the Baseline. The option indicates significant increases in overflight of AONBs, NPs and Richmond Park and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
H	**Shortlisted**	Option H reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared to the Baseline. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates a significant increase in overflight of AONBs and NPs. This option will be explored further in Stage 3.
I	**Discontinued**	Option I indicates a small reduction in track miles. It indicates no overflight of AONBs, NPs or Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates an increase in the population experiencing at least one N60 (night) noise event. Critically, the option failed Test 1 of the shortlisting process as it increases the population above the Partial LOAEL (night) by 10% when compared to the Baseline.
J	**Discontinued**	Option J indicates a small reduction in track miles. It indicates no overflight of AONBs, NPs or Richmond Park. The option indicates a number of biodiversity sites between 0-3000ft that may experience a change in location overflown and a significant increase in the population experiencing at least one N60 (night) noise event. Critically, the option failed Test 1 of the shortlisting process, as it increases the population above the Partial LOAEL (daytime) by more than 10% when compared to the Baseline.
K	**Discontinued**	Option K indicates a reduction in track miles. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates increases in the overflight of AONBs and NPs and in the population above the Partial LOAEL (night). Critically, the option failed Test 2

		of the shortlisting process as it increases the population experiencing at least one N60 noise event (night) by nearly 20% when compared to the Baseline.
L	**Shortlisted**	Option L significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared to the Baseline. It indicates no overflight of Richmond Park. The option indicates a significant increase in overflight of AONBs and NPs and a number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
M	**Shortlisted**	Option M significantly reduces the track miles and decreases the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. It indicates no overflight of AONBs, NPs or Richmond Park and the option indicates that no biodiversity sites between 0-3000ft should experience a change in location overflown. This option will be explored further in Stage 3.
N	**Shortlisted**	Option N reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates increases in overflight of AONBs and NPs and a small increase in track miles. This option will be explored further in Stage 3.
O	**Shortlisted**	Option O significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. The option indicates a negligible increase in track miles, a small increase in overflight of Richmond Park, an increase in the total area of AONBs and NPs overflown and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
P	**Shortlisted**	Option P significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates a small increase in track miles and an increase in overflight of AONBs and NPs. This option will be explored further in Stage 3.
Q	**Shortlisted**	Option Q significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared to the Baseline.

		The option indicates significant increases in overflight of AONBs, NPs and Richmond Park and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
R	**Shortlisted**	Option R significantly reduces the population above the Partial LOAEL (night) and the track miles when compared to the Baseline. It decreases the population experiencing at least one N60 (night) noise event. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates a significant increase in the total area of AONBs and NPs overflown. This option will be explored further in Stage 3.
S	**Shortlisted**	Option S significantly reduces the population above the Partial LOAEL (night), and the population experiencing at least one N60 (night) noise event. It indicates a negligible increase in track miles when compared to the Baseline. The option indicates significant increases in overflight of AONBs, NPs and Richmond Park and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
T	**Shortlisted**	Option T reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates a negligible increase in track miles and a significant increase in overflight of AONBs and NPs. This option will be explored further in Stage 3.
U	**Shortlisted**	Option U significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. It indicates no overflight of Richmond Park. The option indicates an increase in the total area of AONBs and NPs overflown and small increases in track miles. A number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
V	**Shortlisted**	Option V significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise events and the track miles when compared to the Baseline. It indicates no AONB or NP N60 (night) noise events and no overflight of Richmond Park. The option indicates a negligible increase in the total area of AONBs and NPs overflown and a small number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
W	**Shortlisted**	Option W reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared to the Baseline. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown.

		The option indicates an increase in the total area of AONBs/NPs experiencing at least one N60 (night) noise event and a small increase in track miles. This option will be explored further in Stage 3.

Table 10: PBN Arrival Options to Runway 27L

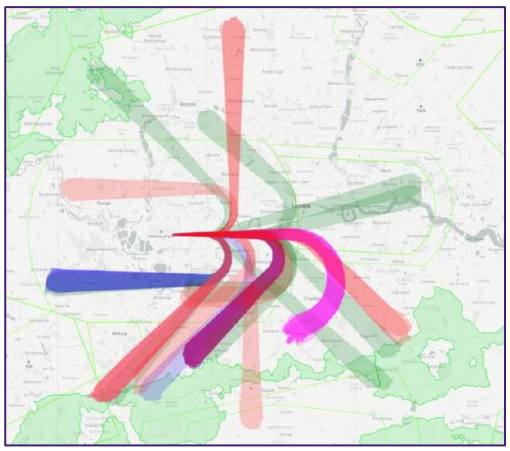


Figure 24: All 27L PBN Arrival Options A-W

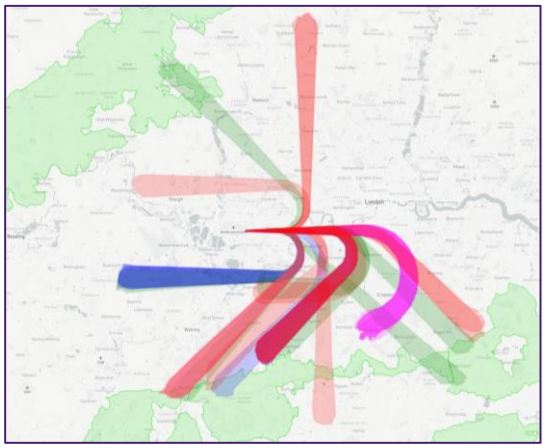


Figure 25: Shortlisted 27L PBN Arrival Options A-H & L-W

PBN Arrival Options to Runway 27R

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	Option A significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared with the Baseline. The option indicates small increases in the total area of AONBs, NPs and Richmond Park overflown and a significant increase in the track miles. A number of biodiversity sites between 0-3000ft may experience a change in location overflown.
B	**Shortlisted**	Option B significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared with the Baseline. The option indicates increases in the total areas of AONBs, NPs and Richmond Park overflown. A number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
C	**Shortlisted**	Option C significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared with the Baseline. The option indicates increases in overflight of AONBs, NPs and Richmond Park and increases in track miles. It indicates a number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
D	**Shortlisted**	Option D significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared with the Baseline. It indicates no overflight of Richmond Park. The option indicates a number of biodiversity sites between 0-3000ft may experience a change in location overflown. It also indicates an increase in overflight of AONBs and NPs and a significant increase in track miles. This option will be explored further in Stage 3.
E	**Shortlisted**	Option E significantly reduces the track miles, decreases the population above the Partial LOAEL (night) and reduces the population experiencing at least one N60 (night) noise event. It indicates no overflight of AONBs or NPs when compared with the Baseline. The option indicates small increases in the overflight of Richmond Park and a number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
F	**Shortlisted**	Option F significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles. It indicates no overflight of AONBs or NPs. The option indicates a small increase in the overflight of Richmond Park and a significant number of biodiversity sites between 0-3000ft that may

		experience a change in location overflown. This option will be explored further in Stage 3.
G	**Shortlisted**	Option G significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared with the Baseline. The option indicates a small increase in the overflight of Richmond Park and significant increases in AONB and NP overflight. A number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
H	**Shortlisted**	Option H reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. It significantly reduces the track miles when compared with the Baseline and indicates no overflight of Richmond Park. The option indicates an increase in overflight of AONBs and NPs and a small number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
I	**Shortlisted**	Option I significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and decreases the track miles when compared to the Baseline. The option indicates increases in the overflight of AONBs, NPs and Richmond Park. It also indicates a number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
J	**Shortlisted**	Option J reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. There is a decrease in track miles, and it indicates no overflight of Richmond Park. The option indicates a small number of biodiversity sites between 0-3000ft may experience a change in the location overflown. It also indicates an increase in the total area of AONBs and NPs overflown. This option will be explored further in Stage 3.
K	**Shortlisted**	Option K reduces the population above the Partial LOAEL (night) and there is a decrease in track miles. It indicates no overflight of AONBs, NPs or Richmond Park. The option indicates an increase in the population experiencing at least one N60 (night) noise event and a small number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
L	**Discontinued**	Option L reduces the population above the Partial LOAEL (night) and there is a decrease in the track miles. It indicates no overflight of AONBs, NPs or Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. Critically, the option failed Test 2 of the shortlisting process since the population experiencing at least one N60 (night) noise event increases by nearly 20% when compared to the Baseline.

M	**Shortlisted**	Option M significantly reduces the track miles and decreases the population above the Partial LOAEL (night). It indicates no overflight of Richmond Park. The option indicates an increase in the population experiencing at least one N60 (night) noise event. It indicates small increases in overflight of AONBs and NPs. A number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
N	**Shortlisted**	Option N significantly reduces the population experiencing at least one N60 (night) noise event, the population above the Partial LOAEL (night) and the track miles. It indicates no overflight of Richmond Park and no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates an increase in AONB and NP overflight. This option will be explored further in Stage 3.
O	**Shortlisted**	Option O significantly reduces the track miles and decreases the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. It indicates no overflight of AONBs, NPs or Richmond Park. The option indicates a small number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
P	**Shortlisted**	Option P reduces the population above the Partial LOAEL (night) and indicates no overflight of Richmond Park. The option indicates increases in track miles and in the population experiencing at least one N60 (night) noise event. There is an increase in overflight of AONBs and NPs and a number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
Q	**Shortlisted**	Option Q reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event. It indicates no overflight of AONBs or NPs. The option indicates an increase in track miles and small increases in overflight of Richmond Park. A number of biodiversity sites between 0-3000ft may experience a change in the location overflown. This option will be explored further in Stage 3.
R	**Shortlisted**	Option R significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared with the Baseline. The option indicates a small increase in track miles, increases in overflight of AONBs and NPs, and a number of biodiversity sites between 0-3000ft that may experience a change in the location overflown. There is an increase in Richmond Park overflight. This option will be explored further in Stage 3.

S	**Shortlisted**	Option S significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles. It indicates no overflight of Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates an increase in AONB and NP overflight. This option will be explored further in Stage 3.
T	**Shortlisted**	Option T significantly reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared with the Baseline. The option indicates a small increase in Richmond Park overflight, an increase in AONB and NP overflight and a significant number of biodiversity sites between 0-3000ft that may experience a change in location overflown. This option will be explored further in Stage 3.
U	**Shortlisted**	Option U reduces the population above the Partial LOAEL (night), the population experiencing at least one N60 (night) noise event and the track miles when compared with the Baseline. It indicates no overflight of Richmond Park. The option indicates a small number of biodiversity sites between 0-3000ft that may experience a change in location overflown and an increase in overflight of AONBs and NPs. This option will be explored further in Stage 3.
V	**Shortlisted**	Option V significantly reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared with the Baseline. The option indicates a negligible increase in track miles and an increase in overflight of AONBs, NPs and Richmond Park. A number of biodiversity sites between 0-3000ft may experience a change in location overflown. This option will be explored further in Stage 3.
W	**Shortlisted**	Option W reduces the population above the Partial LOAEL (night) and the population experiencing at least one N60 (night) noise event when compared with the Baseline. It indicates no overflight of Richmond Park and there is a negligible decrease in track miles. The option indicates a small number of biodiversity sites between 0-3000ft that may experience a change in the location overflown and an increase in overflight of AONBs and NPs. This option will be explored further in Stage 3.
X	**Shortlisted**	Option X significantly reduces the population experiencing at least one N60 (night) noise event and decreases the population above the Partial LOAEL (night) when compared with the Baseline. It indicates no overflight of AONBs, NPs or Richmond Park and that no biodiversity sites between 0-3000ft should experience a change in location overflown. The option indicates a significant increase in track miles. This option will be explored further in Stage 3.

Table 11: PBN Arrival Options to Runway 27R

Figure 26: All 27R PBN Arrival Options A-X

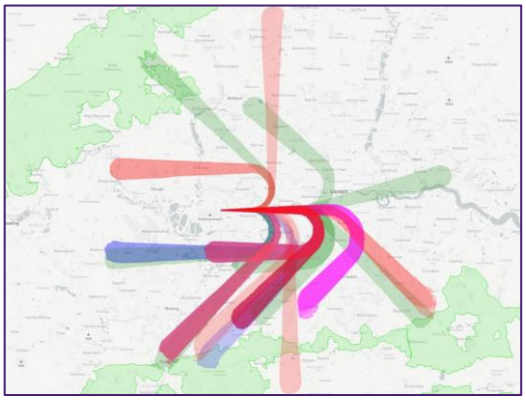


Figure 27: Shortlisted 27R PBN Arrival Options A-H, J-K & M-X

PBN Arrival Options to Runway 09L

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	Option A provides a small reduction in the population above the Partial LOAEL (night) and a decrease in the track miles when compared with the Baseline. The option indicates an increase in the population experiencing at least one N60 noise event and in the overflight of AONBs and NPs. There is a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
B	**Shortlisted**	Option B provides a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. It indicates that no biodiversity sites between 0-3000ft may experience a change in location overflown. The option indicates significant increases in the population experiencing at least one N60 noise event and in the overflight of AONBs and NPs. There is also an increase in the track miles. The option will be explored further in Stage 3.
C	**Shortlisted**	Option C provides a significant decrease in the population above the Partial LOAEL (night) and a decrease in track miles when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event. There is an increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown and the overflight of AONBs and NPs is increased. The option will be explored further in Stage 3.
D	**Shortlisted**	Option D provides significant decreases in the population above the Partial LOAEL (night) and in track miles when compared to the Baseline. The option indicates significant increases in the population experiencing at least one N60 noise event and the number of biodiversity sites between 0-3000ft that may experience a change in location. It indicates an increase in the overflight of AONBs and NPs. The option will be explored further in Stage 3.
E	**Shortlisted**	Option E significantly decreases track miles and offers a small reduction in the population above the Partial LOAEL (night) when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event and an increase in the overflight of AONBs and NPs. It indicates a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
F	**Shortlisted**	Option F offers a reduction in track miles and a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. It indicates no overflight of AONBs and NPs. The option indicates a significant increase in the population experiencing at least one N60 noise event. There is a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.

G	**Shortlisted**	Option G provides a significant decrease in the population above the Partial LOAEL (night) and a reduction in track miles when compared to the Baseline. It indicates no overflight of AONBs and NPs. The option indicates a significant increase in the population experiencing at least one N60 noise event and an increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
H	**Shortlisted**	Option H provides a decrease in track miles and a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event. It indicates an increase in the overflight of AONBs and NPs and a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
I	**Shortlisted**	Option I provides significant decreases in the population above the Partial LOAEL (night) and in the track miles when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event. It indicates increases of the overflight of AONBs and NPs and the number of biodiversity sites between 0-3000ft that may experience a change of location overflown. The option will be explored further in Stage 3.
J	**Discontinued**	Option J significantly reduces the track miles and provides a small reduction in population above the Partial LOAEL (night). It indicates no overflight of AONBs and NPs and no biodiversity sites between 0-3000ft that may experience a change in location overflown. Critically, the option failed Test 2 of the shortlisting process, as it significantly increases the population experiencing at least one N60 noise event by more than 8 times.
K	**Shortlisted**	Option K provides a reduction in the track miles and a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. It indicates no overflight of AONBs and NPs. The option indicates a significant increase in the population experiencing at least one N60 noise event and a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
L	**Shortlisted**	Option L provides a significant decrease in track miles and a negligible reduction in the population above the Partial LOAEL (night) when compared to the Baseline. It indicates no biodiversity sites between 0-3000ft that may experience a change in location overflown. The option indicates a significant increase in the population experiencing at least one N60 noise event and shows an increase the overflight of AONBs and NPs. The option will be explored further in Stage 3.
M	**Shortlisted**	Option M provides a significant decrease in track miles and a small reduction in the population above the Partial LOAEL (night) when compared to the Baseline.

		The option indicates a significant increase in the overflight of AONBs and NPs and in the population experiencing at least one N60 noise event. There is a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
N	**Shortlisted**	Option N provides a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event. It indicates an increase in the track miles and the overflight of AONBs and NPs. There is a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
O	**Shortlisted**	Option O provides a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. The option indicates increases in track miles, the overflight of AONBs and NPs and in the population experiencing at least one N60 noise event. There is an increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
P	**Shortlisted**	Option P provides a significant decrease in the population above the Partial LOAEL (night) when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event. It indicates an increase in track miles and in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. There is a small increase in the overflight of AONBs and NPs. The option will be explored further in Stage 3.
Q	**Shortlisted**	Option Q provides a significant reduction in track miles and a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. There is no overflight of AONBs and NPs indicated. The option indicates a significant increase in the population experiencing at least one N60 noise event. There is an increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
R	**Shortlisted**	Option R provides a significant decrease in the population above the Partial LOAEL (night) and in track miles when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event. There are increases in the overflight of AONBs and NPs and the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
S	**Shortlisted**	Option S provides a significant decrease in the population above the Partial LOAEL (night) and a decrease in the track miles when compared to the Baseline. There is no overflight of AONBs & NPs indicated. The option indicates a significant increase in the population experiencing at least one N60 noise event and an increase in the number of biodiversity sites between

		0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
T	**Shortlisted**	Option T provides a small decrease in the population above the Partial LOAEL (night) and a negligible reduction in track miles when compared to the Baseline. There is no overflight of AONBs and NPs indicated. The option indicates a significant increase in the population experiencing at least one N60 noise event. There is a small increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. The option will be explored further in Stage 3.
U	**Shortlisted**	Option U provides a reduction in track miles and a small decrease in the population above the Partial LOAEL (night) when compared to the Baseline. The option indicates a significant increase in the population experiencing at least one N60 noise event and an increase the overflight of AONBs and NPs. It indicates the number of biodiversity sites between 0-3000ft that may experience change in location overflown. The option will be explored further in Stage 3.

Table 12: PBN Arrival Options to Runway 09L

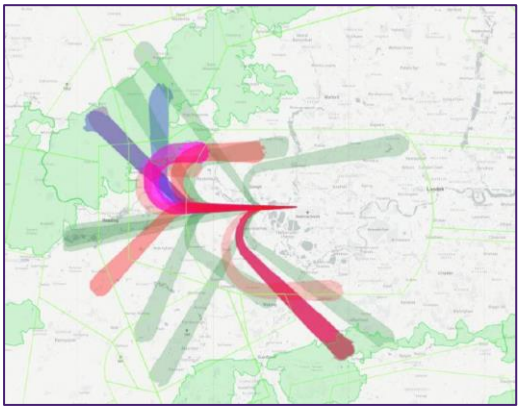


Figure 28: All 09L PBN Arrival Options A-U

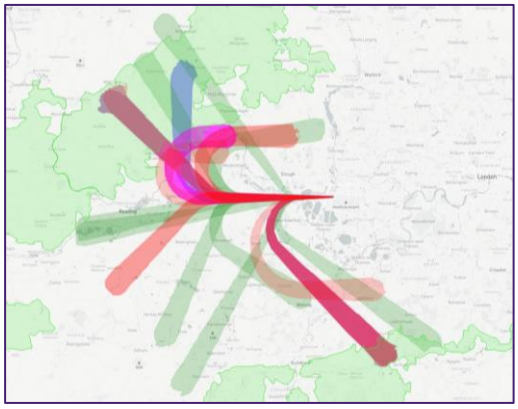


Figure 29: Shortlisted 09L PBN Arrival Options A-I & K-U

PBN Arrival Options to Runway 09R

5.5.11 All PBN Arrival options to 09R perform worse than the baseline. Heathrow does not routinely use this runway for arrivals today, so the IOA is comparing increased use of Runway 09R for arrivals against a very low base case.

5.5.12 When modelling Runway 09R arrival options in the IOA, it was assumed that the full schedule of easterly arrivals (from 2019) used the options from this runway. However, Heathrow expects to introduce easterly alternation alongside this ACP, so arrivals would actually be split across Runways 09L and 09R, reducing the number of movements (and impacts) for each runway.

5.5.13 Heathrow decided to only discontinue options that perform much worse than the baseline (i.e. four or five times as many people within the Partial LOAEL for the option as are in the 2019 baseline LOAEL).

Option	Shortlisting Outcome	Rationale
A	**Shortlisted**	All 09R PBN arrivals perform worse than the Baseline for noise metrics, since this runway is not routinely used for arrivals today. Options that perform relatively well (i.e. when compared with each other) have been retained for further development at Stage 3.
B	**Shortlisted**	As above
C	**Shortlisted**	As above
D	**Shortlisted**	As above
E	**Shortlisted**	As above
F	**Shortlisted**	As above
G	**Shortlisted**	As above
H	**Shortlisted**	As above
I	**Discontinued**	Option I offers a significant reduction in track miles. It indicates no overflight of AONBs and NPs. The option indicates a significant increase in the population experiencing at least one N60 (night) noise event and an increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. Critically, the option failed Test 1 of the shortlisting process as it increases the population above the Partial LOAEL by more than 5 times when compared to the Baseline.
J	**Shortlisted**	As Option A
K	**Discontinued**	Option K offers a significant reduction in track miles. However, the option indicates a significant increase in the population experiencing at least one N60 (night) noise event. There are increases in overflight of AONBs and NPs and in the number of biodiversity sites between 0-3000ft that

		may experience a change in location overflown. Critically, the option failed Test 1 of the shortlisting process, as it increases the population above the Partial LOAEL by nearly 5 times when compared to the Baseline.
L	**Shortlisted**	As Option A
M	**Shortlisted**	As Option A
N	**Shortlisted**	As Option A
O	**Shortlisted**	As Option A
P	**Shortlisted**	As Option A
Q	**Shortlisted**	As Option A
R	**Discontinued**	Option R offers a significant reduction in track miles. It indicates no overflight of AONBs and NPs. The option indicates a significant increase in the population experiencing at least one N60 (night) noise event and an increase in the number of biodiversity sites between 0-3000ft that may experience a change in location overflown. Critically, the option failed Test 1 of the shortlisting process, as it increases the population above the Partial LOAEL by 4 times when compared to the Baseline.
S	**Shortlisted**	As Option A
T	**Shortlisted**	As Option A
U	**Shortlisted**	As Option A

Table 13: PBN Arrival Options to Runway 09R

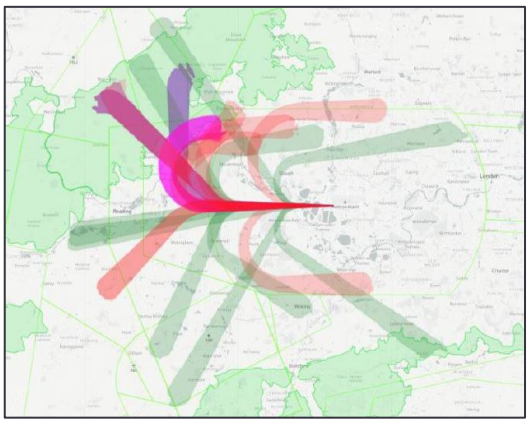


Figure 30: All 09R PBN Arrival Options A-U L-Q & S-U

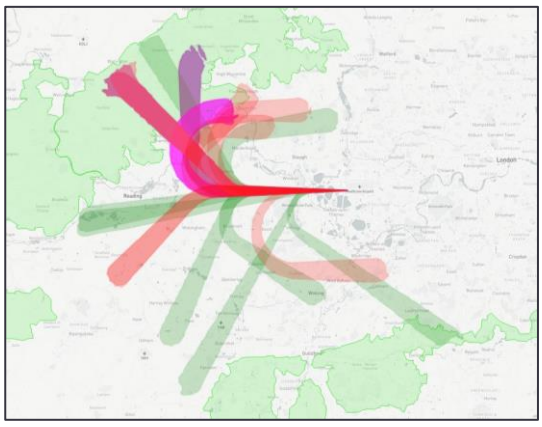


Figure 31: Shortlisted 09R PBN Arrival Options A-H, J,

Shortlisting of Vectored Arrival Options

5.5.14 The discontinuation methodology was not applied to Vectored Arrival options due to the uncertainty of the position of Heathrow's future holding stacks and the wider network design.

5.5.15 As a minimum, Heathrow expects to continue arrival vectoring in the future airspace design to maintain the required throughput during the core hours of the day. Therefore, no Vectored Arrival options have been discontinued at Step 2B. All options are retained to better inform the Stage 3 system assembly.

5.5.16 As part of Heathrow's work looking at concepts for delivering respite from noise, Heathrow has undertaken initial sensitivity testing at Step 2B. This includes consideration of alternating the point at which Vectored Arrivals join final approach, to determine whether it would be beneficial and/or feasible to use different vectoring areas during different periods to provide respite or relief from noise. This concept would be used in combination with runway alternation.

5.5.17 Heathrow's initial work on this has indicated that there could be more benefit to alternating vectored approaches when on easterly operations, given population numbers are lower under these approaches than when on westerly operations. Heathrow will conduct further analysis on the Vectored Arrival options at Stage 3 when more information is available on:

- NATS' (NERL's) design for Heathrow's future arrivals mechanism ('holding stacks'), and
- Other airports' proposed airspace designs.

5.6 Preferred Options

5.6.1 As the options are still currently in runway direction groupings, Heathrow does not have a preferred option at this stage.

6. TESTING OF OPERATIONAL CONCEPTS

6.1 Concepts Developed at Stage 2

6.1.1 As part of the CLOO, Heathrow shared a number of concepts that might be applied to the identified options to help meet some of the Design Principles. The concepts were developed to address Design Principles 3, 6 and 8 since these principles cannot be met solely through the position of flight paths over the ground, but through how those flight paths are used. The potential concepts could be applied to any of the flight path options to help meet these Design Principles and at Step 2A Heathrow stated that concepts would be explored further during Stage 2 and Stage 3.

Design Principle		Consideration during options development
3	Use noise efficient operational practices to limit and, where possible, reduce adverse impacts from aircraft noise	Concepts developed: to be applied to any of the flight path options
6	Provide predictable and meaningful respite to those affected by noise from Heathrow's movements	Concepts developed: to be applied to any of the flight path options
8	Seek to avoid overflying the same communities with multiple routes including those to/from other airports	Concepts developed: to be applied to any of the flight path options

Table 14: Design Principle's considered by concepts during options development

6.1.2 Some operational concepts were developed to demonstrate how Heathrow could potentially address Design Principle 6. Heathrow shared these with stakeholders in the Step 2A engagement and asked for feedback. These concepts included:

- Relief[22] or respite[23] from Departure noise via:
    - Departure noise relief via PBN dispersion: dispersion of flight paths within an allocated route would not give the predictable break in noise required for 'respite', but it could offer 'relief' from noise for some overflown communities;
    - Departure respite through route alternation: use of different flight paths for a departure route at different times to offer respite to overflown communities ('respite routes');
    - Departure routes from adjacent runways following different tracks for longer to increase the number of people who benefit from runway alternation.
- Relief or respite from Arrivals noise via:

[22] A break from, or a reduction in, aircraft noise.
[23] Scheduled relief from aircraft noise for a set period of time.

- A variable vectoring area which could see different final approach joining points being used during different periods of the day, or on different days;
- Use of PBN arrival flight paths for early morning (pre-0600) arrivals. Flight paths could be alternated to ensure the same communities are not overflown each morning.

6.1.3 Concepts for Design Principles 3 and 8 will be developed and explored further at Stage 3. For DP3, noise efficient operational practices need to be applied and assessed against a system design. Similarly, for DP8, Heathrow can only assess whether communities are overflown by multiple routes at a system design stage (with arrivals, departures, easterly and westerly operations together) and a better understanding of other airports' proposed airspace designs will be needed to assess whether communities are potentially affected by routes to/from multiple airports.

6.1.4 At Step 2B, Heathrow used sensitivity testing to overlay some of the concepts for respite on some of the options, to assess whether the concept might improve the noise impacts of that option.

6.1.5 The testing of these concepts does not confirm operational viability of the concept, only the likely effects of the concept if it was to be applied to the airspace design. Further work at Stage 3 will determine how feasible these concepts are once system options have been developed.

6.2 Definitions of Respite

6.2.1 Respite research commissioned by Heathrow[24] indicates that respite is best defined as, "Scheduled relief from aircraft noise for a set period of time". It has also identified that respite should be predictable (as delivered through Heathrow's runway alternation pattern) whereas relief from noise can be unpredictable (as occurs when there is a change in operation due to a change in prevailing winds).

6.2.2 Three types of respite have been identified as part of emerging research[25], which are based on noise level changes measurable by the time difference in L_{Aeq} noise level between different modes of operation. These types are:

- 'Valued': where L_{Aeq} differences between modes are greater than 9dB;
- 'Noticeable': where L_{Aeq} differences between modes are between 4-9dB inclusive; and,
- 'Worth Having': where L_{Aeq} differences between modes are less than 4dB.

6.2.3 The CAA has also published research[26] which has indicated that for communities located under Heathrow's westerly arrivals, those experiencing 8-9dB differences in arrival noise between modes are less likely to be highly annoyed by aircraft noise.

[24] Respite_research_overview_and_technical_report.pdf (heathrow.com)
[25] Anderson Acoustics
[26] CAP2251 Survey of Noise Attitudes 2014: Aircraft Noise and Sleep Disturbance, Further Analysis

6.2.4 The following sensitivity tests do not seek to identify whether the introduction of respite would change annoyance, but to identify the degree to which the concept could provide the types of respite outlined above.

6.2.5 To demonstrate where differences occur, any differences of less than 1dB are not shown and all other differences are categorised using the definitions outlined above.

6.3 Departure Noise Relief Through PBN Dispersion

6.3.1 A sensitivity test was undertaken to consider how noise outcomes could change if departures were dispersed across multiple PBN flight paths. The operational viability of achieving this dispersal in the LTMA is untested.

6.3.2 The dispersion patterns around Heathrow's departure routes are currently based on Area Navigation (RNAV) overlays and a high degree of vectoring by ATC above 4,000 feet[27]. This means that current dispersion patterns are generally larger than would occur within a PBN environment.

6.3.3 The noise modelling used to appraise options in the IOA has assumed that PBN dispersion would be similar to the smallest dispersion patterns that occur today, and that aircraft will be left to follow the route centrelines, i.e. ATC will not undertake tactical vectoring. This is similar to the dispersion patterns which were found to occur during the DOKEN PBN trials at Heathrow in 2014. In general, aircraft following a PBN route tend to be within 150 metres of the centreline, i.e. a dispersion of 300 metres in total.

6.3.4 This concept assumes that a greater degree of departure dispersion could be created by having three PBN routes. At this stage the assumption is that three PBN routes in combination could create a departure swathe which has a similar width of dispersion to today's routes (up to 1,500m). An illustration is presented in Figure 32 below.

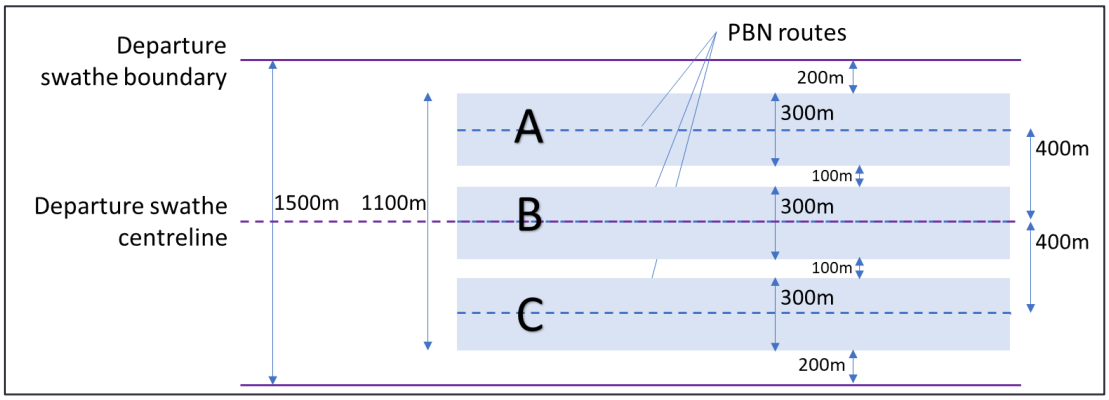


Figure 32: PBN dispersal illustration

6.3.5 To help understand how such a concept could change the noise outcomes associated with Heathrow's options, Option F from Runway 27R Departures has been modified to include two additional PBN routes either side of the current option centreline, as per the pattern presented in Figure 32. It has been assumed that each of these routes could be used equally to create the effect of further dispersing aircraft across a swathe.

[27] The exception to this is easterly Compton (CPT) departures. See the Step 2A document for more detail.

6.3.6 The modelling focussed on the $L_{Aeq,16hr}$ and N65 metrics to help articulate how the concept may change noise exposure outcomes and events.

6.3.7 Figure 33 presents the $L_{Aeq,16hr}$ partial noise exposure contours for scenarios with and without PBN dispersion applied to Option F. The same comparison is presented in Figure 34 for the N65 metric.

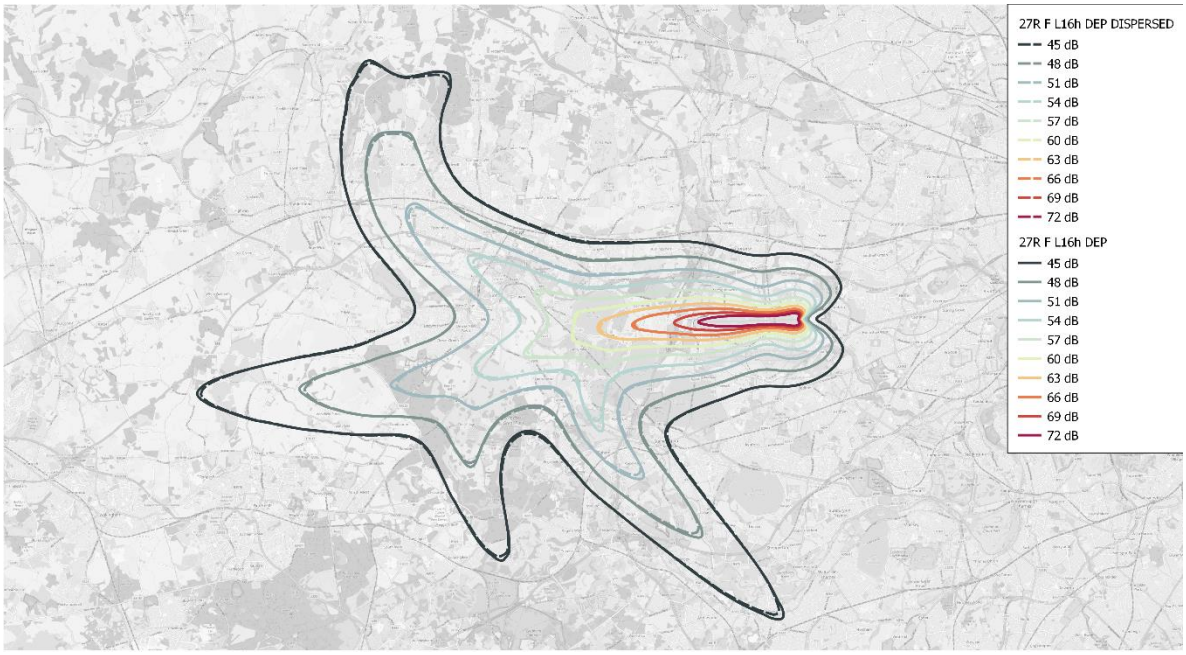


Figure 33: Comparison of LAeq,16hr noise outcomes with and without PBN dispersion for Option F from Runway 27R

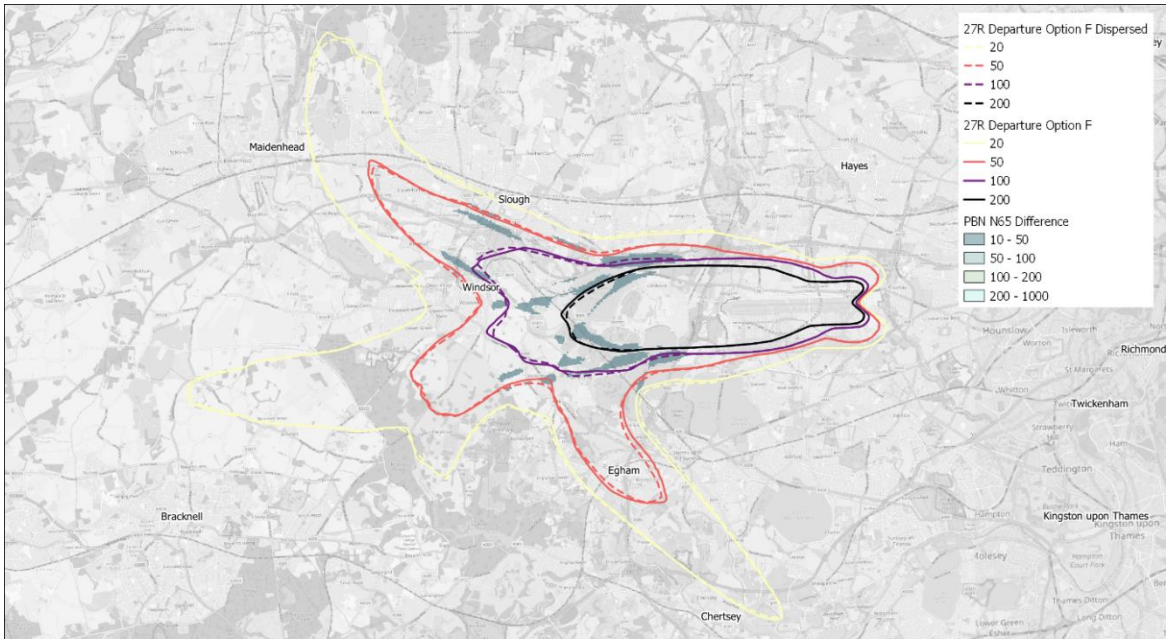


Figure 34: Comparison of N65 noise events with and without PBN dispersion for Option F from Runway 27R

6.3.8 Figures 33 and 34 indicate that increasing dispersion using multiple PBN routes would result in limited differences to the pattern of noise exposure. There are locations (marked in blue) where a measurable change (either positive or negative) in N65 noise events could occur.

6.3.9 The findings of this sensitivity test are dependent upon the dispersion pattern which has been tested. There may be other ways in which PBN dispersion could be delivered, for example through wider corridors but with fewer routes. This requires further investigation so this concept has been retained, and it will be assessed further at Stage 3.

6.4 Departure Respite Through Route Alternation

6.4.1 Heathrow is exploring whether the alternation of different flight paths could be used to provide noise respite. For departures, this could be done by:

- alternating between different departure options, or
- adding respite routes to certain departure options.

6.4.2 To test the potential for respite through route alternation, a sensitivity test was carried out. This test assumed that it is possible to alternate between two different departure designs. To test this, alternation between Option A and Option F of the Runway 27L Departure options has been considered, as shown in Figure 35. These options were selected for the test as they have a range of separations between each comparable route.

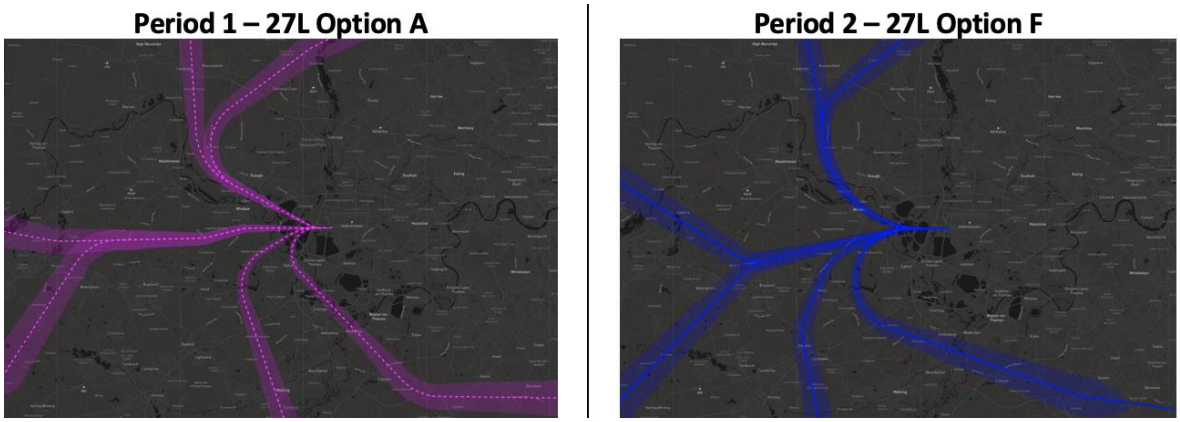


Figure 35: Route Alternation Sensitivity Test Cases

6.4.3 The differences in daytime L_{Aeq} between modes as a result of moving from Runway 27L Option A to Runway 27L Option F (and vice versa) have been calculated and are presented as respite that is 'Valued', 'Noticeable' or 'Worth Having' in Figure 36. To provide context, the partial LOAEL contours for both options are also shown in red.

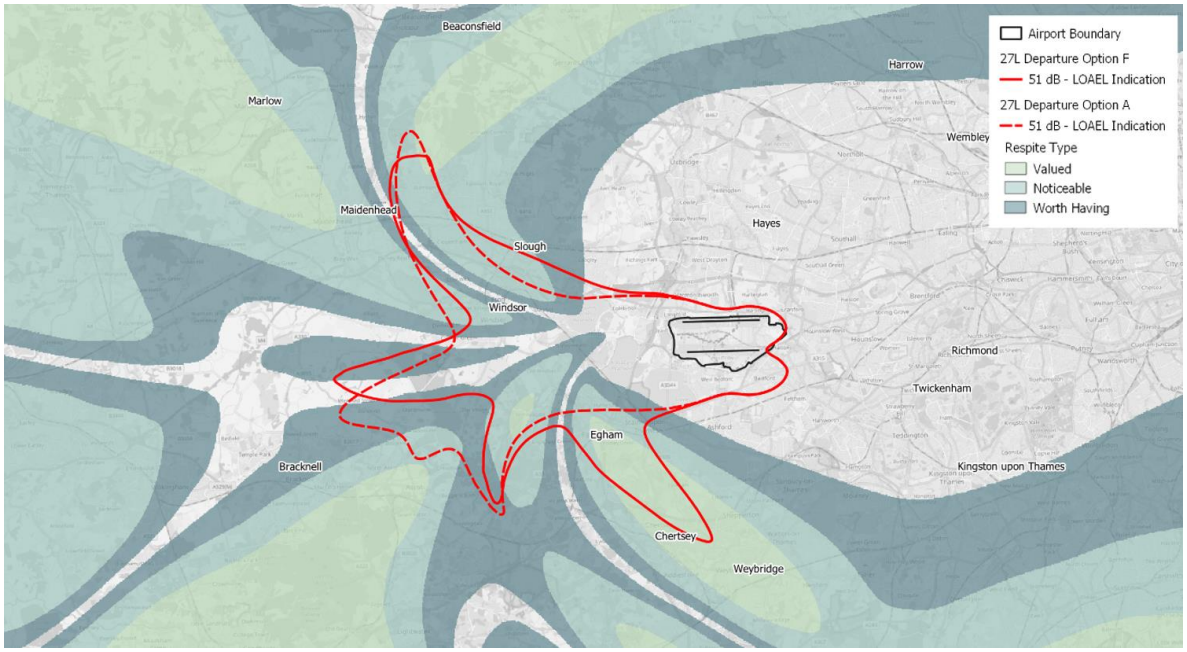


Figure 36: Partial LOAEL contours for Runway 27L Option A and Runway 27L Option F and associated LAeq differences between mode

6.4.4 Figure 36 shows that alternating between the two options could achieve noise level differences considered ‘valued’ or ‘noticeable’ within the LOAEL contour. However, there is greater opportunity for achieving ‘valued’ or “noticeable” respite for overflown communities beyond the LOAEL, since these areas are less likely to be impacted by more than one set of departure routes.

6.4.5 The research referred to in Section 6.2 indicates that respite value is linked to the level of original noise exposure, as well as to the level of noise reduction achieved. This means that noise reductions for those outside the LOAEL, whilst potentially ’valued’, may not be as beneficial in terms of adverse effects as noise reductions achieved within the LOAEL.

6.4.6 Nevertheless, this sensitivity test indicates that respite through route alternation has the potential to create ‘noticeable’ and ‘valued’ respite in areas which experience adverse effects. Therefore, this concept has been retained and will be revisited at Stage 3.

6.5 Departure Respite Through Runway Alternation

6.5.1 Runway alternation is an important part of noise management at Heathrow. It is a measure which has been in place during westerly operations since the 1970s. Heathrow has also committed to introducing runway alternation during easterly operations by 2028 as part of the Heathrow 2.0 Sustainability Strategy.

6.5.2 However, the current departure route structure from the northern and southern runways has departure routes converging shortly after departure. This impacts the level of respite offered to those overflown further from the airport, since many of the same areas are overflown by routes from the northern and southern runways.

6.5.3 Figure 37 shows Option F from Runway 27L and Runway 27R. This is an example of routes that converge soon after departure from the runway.

Figure 37: Illustration of Runway 27L Option F and Runway 27R Option F, routes that converge after departure

6.5.4 In the new airspace design it may be possible to keep departure routes from each runway apart for much longer. As an example, this is illustrated in Figure 38 which shows the routes for Option A from Runway 27L and for Option F from Runway 27R. These routes do not converge, so use of these routes may provide communities with greater respite from runway alternation by ensuring that the same areas are not overflown by departures from both runways.

Figure 38: Illustration of 27L Option A and 27R Option F, routes which do not converge

6.5.5 Figure 39 and Figure 40 illustrate the different levels of respite that could be delivered by keeping departure routes further apart, showing the L_{Aeq} differences achieved by alternating between:

a) Option F for Runway 27R and Option F for Runway 27L, and

b) Option F for Runway 27R and Option A for Runway 27L.

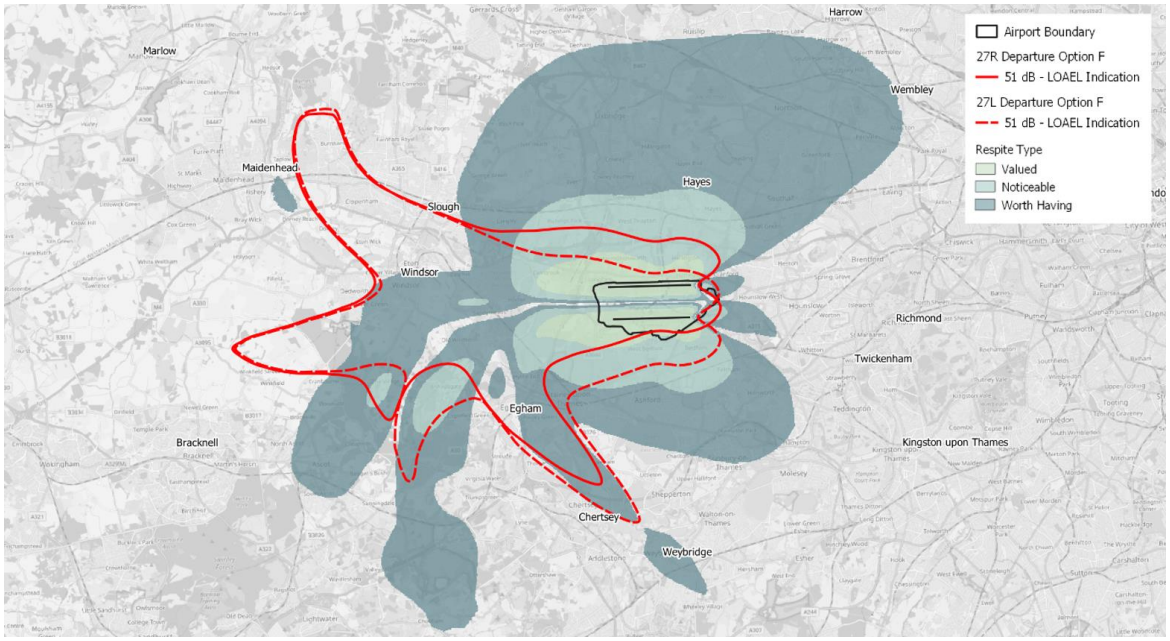


Figure 39: Respite types arising from runway alternation between Runway 27R Option F and Runway 27L Option F

6.5.6 Figure 40 illustrates that respite is provided to many more communities when routes are kept separate for longer, with more 'valued' and 'noticeable' respite achieved both within the LOAEL and further afield. Noise level differences are much greater beyond the LOAEL. As with route alternation, the respite offered is dependent upon the degree of separation of the routes and the level of noise being generated by each route. Figure 38 shows that between Slough and Windsor, a route separation of around 0.8nm produced 'noticeable' respite in an area assessed to be exposed to adverse effects (within the LOAEL). For a location such as Egham, a route separation of around 2.5nm could produce '"valued' respite.

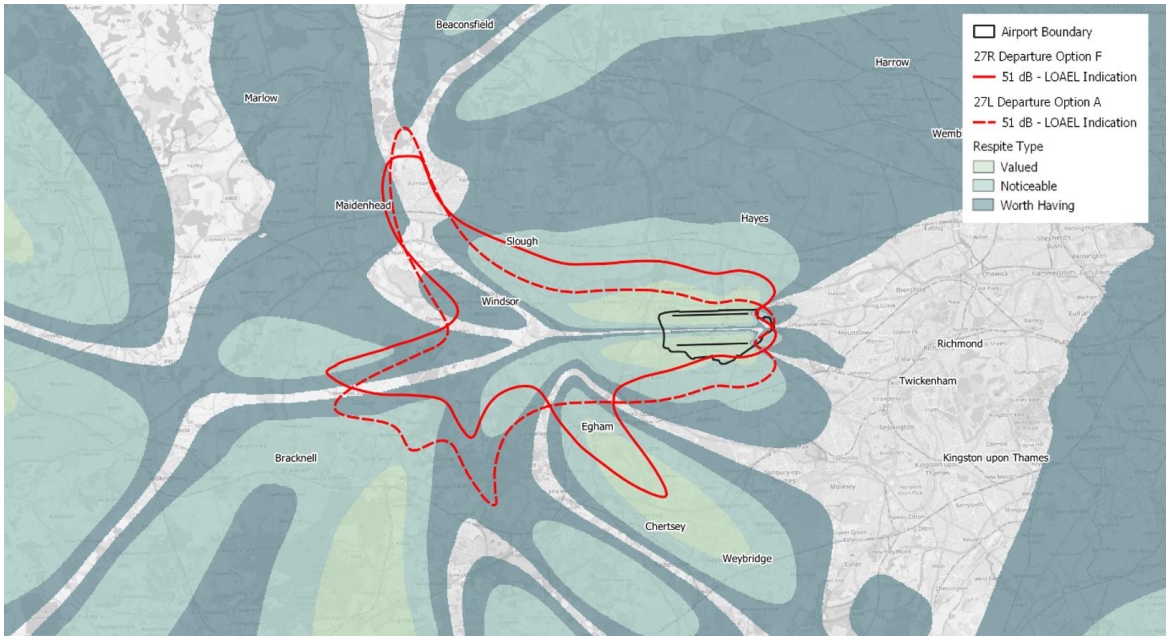


Figure 40: Respite Types arising from runway alternation between Runway 27R Option F and Runway 27L Option A

6.5.7 It's important to note that this test assesses two sets of departure route options only. It does not consider the arrival routes that would be in operation at the same time, potentially reducing the level of respite offered directly north and south of the runway.

6.5.8 The consequence of this concept would be to overfly more areas, as shown in the bottom picture of Figure 41, since the routes stay separate for longer. However, the rates of overflight of those routes would be reduced due to alternation, as indicated by the colours within Figure 41.

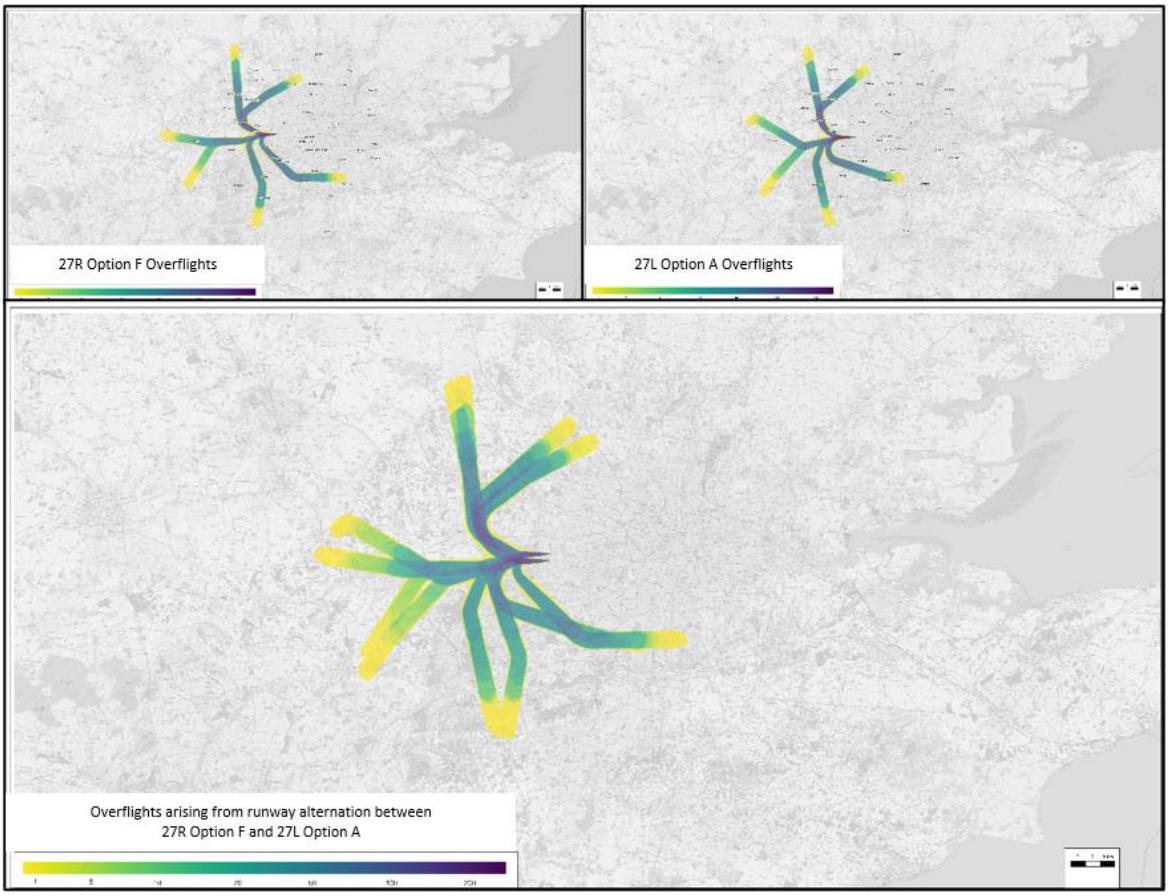


Figure 41: Rates of Overflights arising from runway alternation between Runway 27R Option F and Runway 27L Option A

6.5.9 This work has demonstrated that there may be respite benefits provided by keeping departure routes from the two runways separated for longer. Therefore, this concept has been retained and will be assessed further at Stage 3 to consider the feasibility of this concept in a full system design.

6.6 Respite Through Alternation of Vectored Arrivals

6.6.1 Aircraft currently join final approach between 8 and 18 nautical miles, with most traffic joining at around 10-16nm. A range of vectored arrival options have been generated, joining the final approach in 4nm swathes from 8nm to 22nm.

6.6.2 One respite concept considered as part of Heathrow's options development, is whether respite can be achieved by systematically varying the point at which vectored arrivals join final approach.

6.6.3 To test this concept, two cases have been considered. Figure 42 presents the first case, where for one period, vectored arrivals to Runway 27L join final approach at 8-12nm, and for the second period they join final approach at 18-22nm. Figure 43 presents a second case, where for one period vectored arrivals to Runway 27L join final approach at 8-12nm, and for the second period they join final approach only slightly further away at 11-15nm.

6.6.4 The purpose of this is to assess whether Test Case 1 provides more respite to communities overflown by arrivals by providing a greater variation in arrival routes across the two periods. For this test we have assumed the vectored arrival routes would be alternated in tandem with the existing runway alternation period.

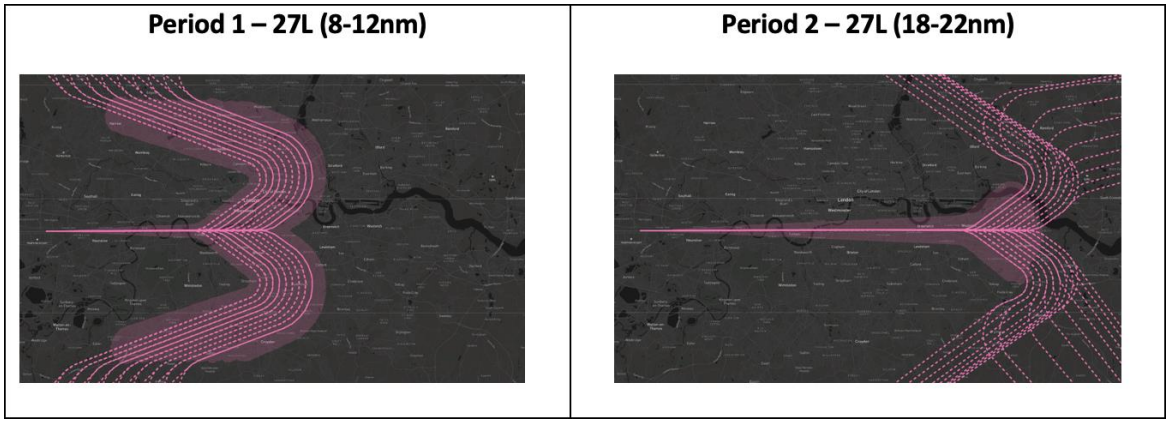


Figure 42: Vectored Arrivals Alternation Concept Test Case 1

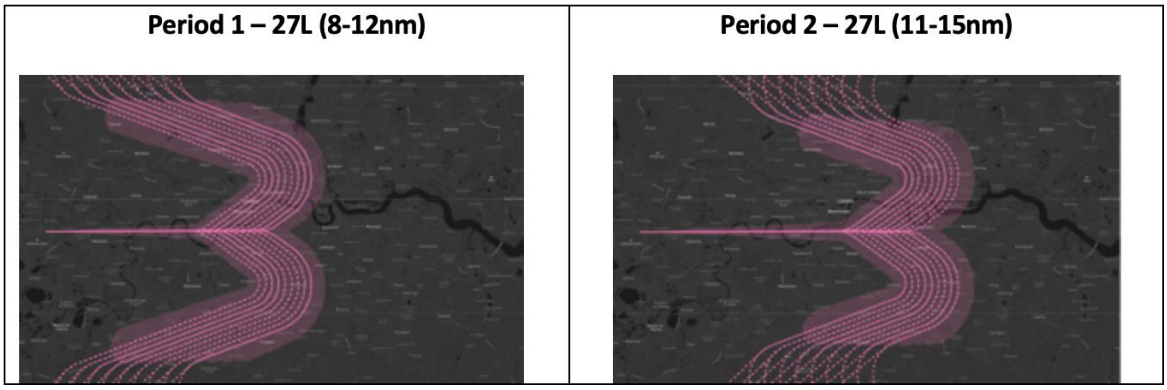


Figure 43: Vectored Arrivals Alternation Concept Test Case 2

6.6.5 Any respite provided by this concept would be for communities located beyond the point at which aircraft converge on to final approach. Communities located close to the airport under final approach will not benefit during Period 2, since aircraft will still need to use the final

approach path. However, areas to the north and south of the final approach might receive more valued respite, as indicated in Figure 44 and Figure 45 below.

6.6.6 For Test Case 1, Figure 44 shows that it is possible to deliver large areas of 'valued' respite both within and beyond the LOAEL, in locations where vectored arrival traffic are separated. Figure 45 shows results for Test Case 2 and indicates a similar effect, but with fewer areas receiving 'valued' respite.

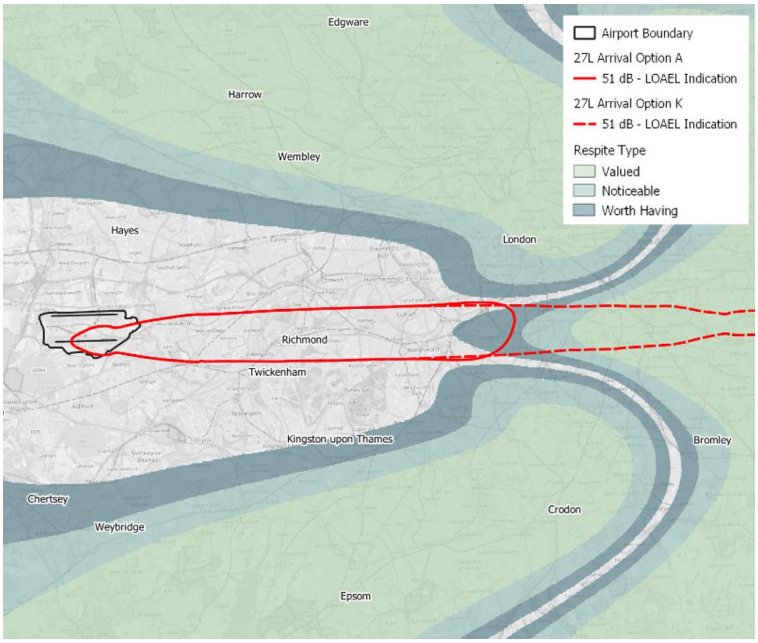


Figure 44: Respite types arising from alternation between two Vectored Arrival options (Test Case 1, 8-12nm, and 18-22nm)

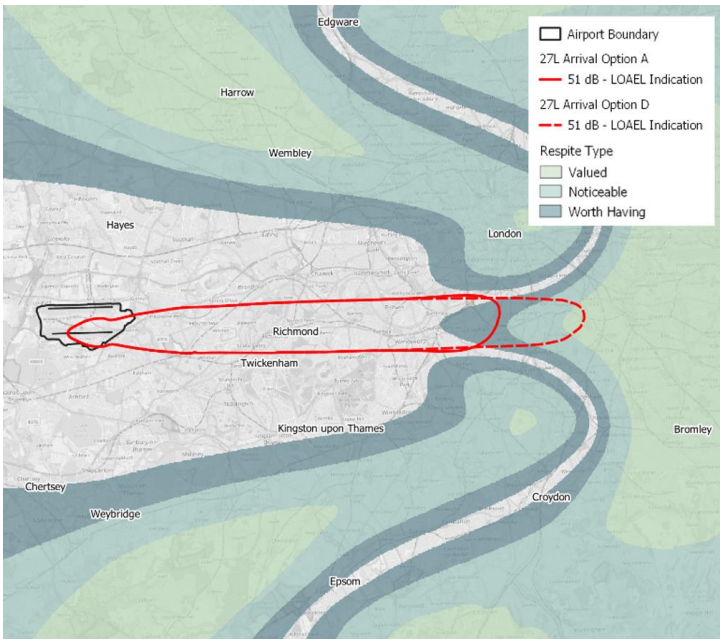


Figure 45: Respite types arising from alternation between two Vectored Arrival options (Test Case 2, 8-12nm, and 11-15nm)

6.6.7 To maximise the potential benefits of this concept, alternation of vectored arrivals would need to be undertaken in addition to runway alternation, in a predictable manner.

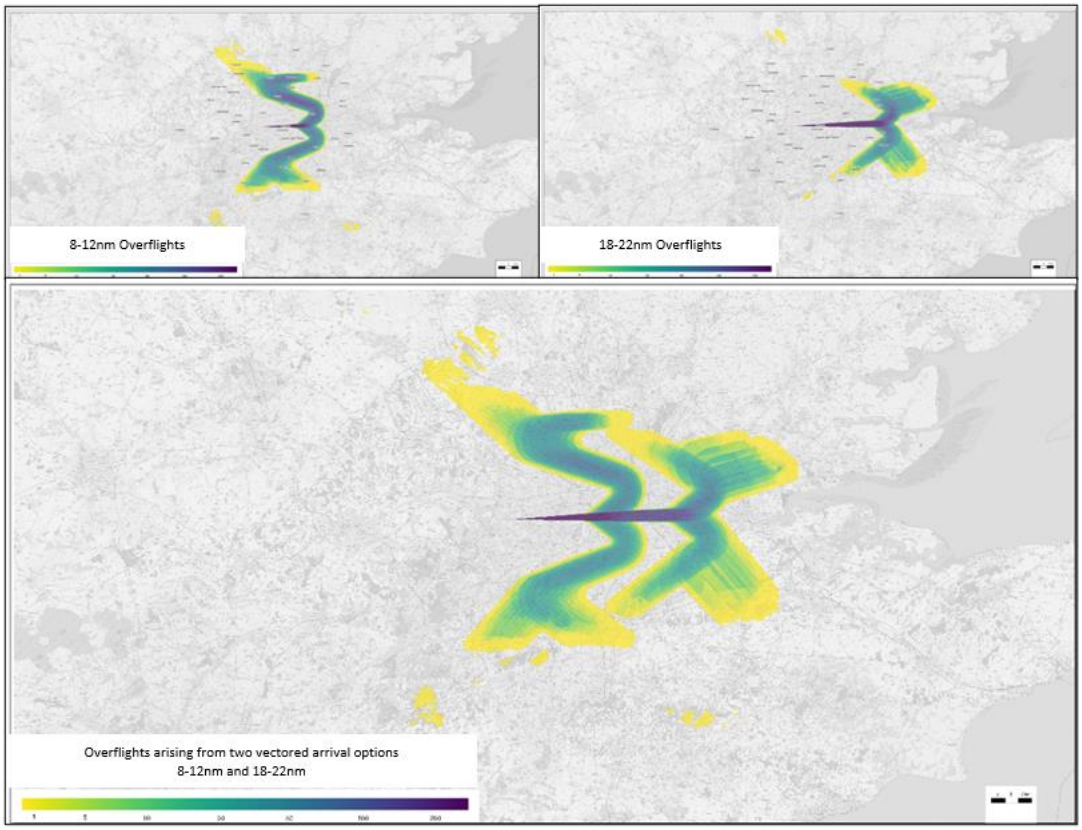


Figure 46: Overflights arising from alternation between two Vectored Arrival options (Test Case 1, 8-12nm, and 18-22nm)

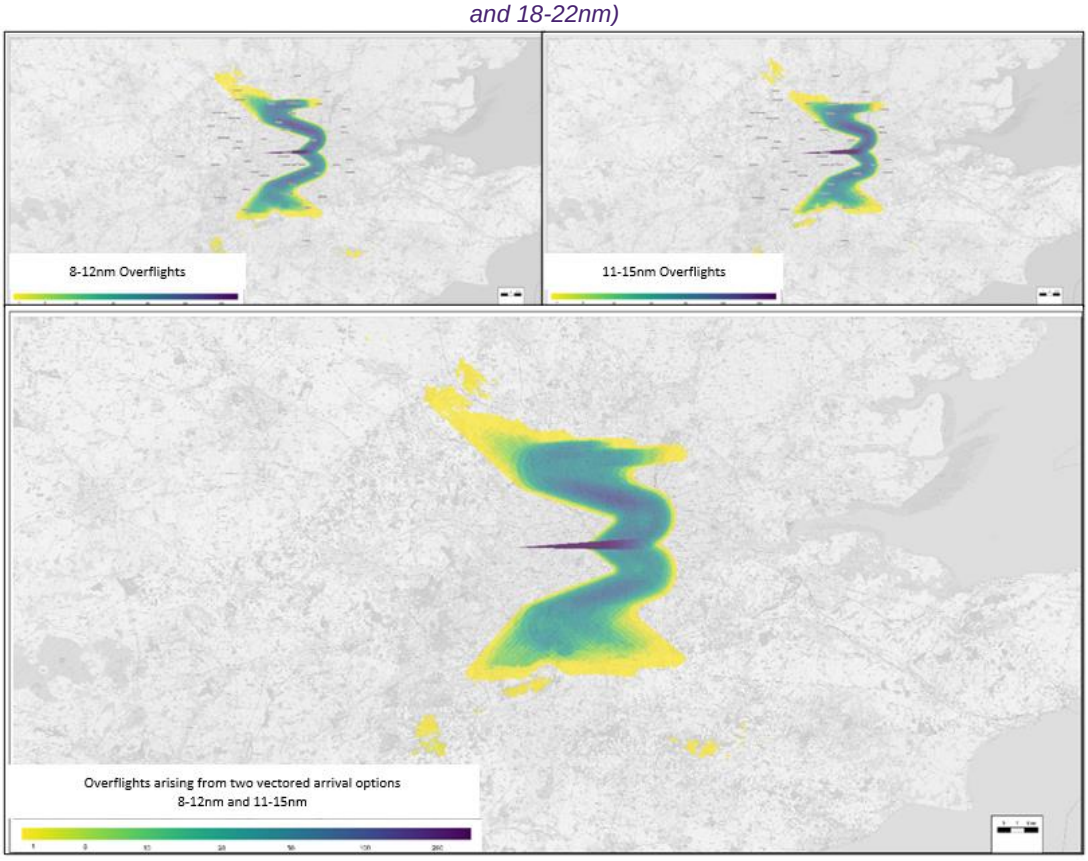


Figure 47: Overflights arising from alternation between two Vectored Arrival options (Test Case 2, 8-12nm, and 11-15nm)

6.6.8 Any benefit provided by this concept needs to be considered against the adverse effects associated with some of the vectored arrival options. Figure 44 and Figure 45 show that the LOAEL will increase as the joining point extends further from the airport, particularly to the east due to the population density of central London. Figure 46 and Figure 47 illustrate the increase in area (and population) overflown which results from operating with greater variation in arrival routes in Test Case 1, compared with Test Case 2.

6.6.9 This concept has been retained into Stage 3 and will be considered further as part of the process undertaken to assemble options into systems. Further consideration will be given to how Vectored Arrival options could be alternated to provide respite to areas overflown by arrivals.

7. PLANS FOR STAGE 3

7.1 Assembly of System Options

7.1.1 The Heathrow two-runway ACP has so far developed options for the *component parts* of a full and complete airspace system. These component parts are identified as PBN Departures, PBN Arrivals and Vectored Arrival options.

7.1.2 In Stage 3, the generation of system options will require the assembly of component parts into systems. That is, a suite of combined easterly and westerly arrival and departure flight paths, safely working together.

7.1.3 The shortlisting of PBN Departure, PBN Arrival and Vectored Arrival options in Step 2B somewhat reduces the complexity of system assembly process in Stage 3. Principally, the discontinuation of some options aims to remove options that are, by virtue of their performance with respect to the 'Do Nothing' scenario, unlikely to contribute to a high performing system option that meets the criteria set out in ANG17.

7.1.4 Following the Stage 2 shortlisting exercise as described in this document, there remain many potential system combinations that could be generated from the existing departure and arrival options. In Stage 3, Heathrow is required to undergo a Full Options Appraisal (FOA) on the assembled system options.

7.1.5 A range of operationally viable systems will be built from the shortlisted options, identifying features that could work well in a system design, taking into consideration the DPs developed at Stage 1. For example:

- the proximity of Vectored Arrival options and PBN Departure options to each other may impact the Continuous Climb capability of departures or Continuous Descent of arrivals;
- components that perform well individually (within the IOA) could overfly the same communities, which may provide a cause for discontinuing one or more options, and
- component routes close to the boundaries of neighbouring airports' flight paths could result in the option being discontinued during integration with the wider network.

Network integration

7.1.6 Masterplan Iteration 2 identifies the interdependencies between the constituent ACPs based on analysis of "the broad sections of airspace where a flight path could conceivably be positioned within the scope of each proposal." Based on this broad assessment, the Masterplan identifies that Heathrow has likely/possible dependencies below 7,000 feet with flight paths to and/or from Gatwick, Luton, Stansted, London City, Biggin Hill, RAF Northolt and Southampton airports. Since the publication of Masterplan Iteration 2, Farnborough Airport has commenced an ACP and has been accepted into future iterations of the Masterplan. Heathrow expects there also to be interdependencies between Heathrow and Farnborough design options.

7.1.7 During Stage 3 and ahead of the Full Options Appraisal, options from the various airports' ACPs will be matured into full system proposals which integrate with the wider network. It is these systems which are expected to be the subject of aligned public consultation exercises.

7.1.8 Compromises and trade-offs may be necessary between sponsors. These will be guided by the advice and tools provided by the Airspace Change Organising Group (ACOG), the organisation tasked with coordinating the redesign of the UK's airspace. It is highly likely that the route centrelines presented so far will require adjustments during the system assembly process.

7.1.9 Therefore, all airspace design options developed so far are subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, Design Principles, appraisals and stakeholder engagement and consultation.

7.2 Full Options Appraisal

7.2.1 Throughout this document, Heathrow has highlighted where it plans to undertake further detailed appraisal as part of its Stage 3 Full Options Appraisal.

7.2.2 In accordance with CAP1616 para E12, Heathrow plans to collect additional evidence as part of the assessment in the Full Options Appraisal, including:

- generating forecasts for the 'Do Nothing' and 'Do Something' scenarios (pre-implementation and 10 years post-implementation), which take into account forecast changes to the aircraft fleet;
- quantitative L_{Aeq} contours, reporting population data and the number of noise sensitive buildings and their size, including for consented developments where applicable;
- detailed fuel burn and equivalent CO_2 emissions data taking account of anticipated changes to vertical profiles;
- TAG assessments to monetise noise and carbon;
- full assessment of local air quality impacts, if required;
- detailed biodiversity assessments, where required. Habitats Regulation Assessment (HRA) screening undertaken as a minimum;
- quantitative overflight contours showing frequency of overflight, including scenarios with 100% runway usage. Overflight contours will include anticipated vectoring patterns;
- further information around the interdependencies with the upper network and neighbouring airports, including assessments of cumulative impacts for local communities;
- quantified ATC deployment and training costs;

- quantified ANSP/airport infrastructure or operational costs;
- quantitative information on impacts to Heathrow's capacity/operational resilience, and
- quantified impacts on, or benefits to, Controlled Airspace (CAS).

7.3 Identifying the Impacted Audience

7.3.1 At the 'Develop and Assess' Gateway, the Initial Options Appraisal must set out impacted audiences, as this information will be a key feature in developing the consultation strategy required during Step 3A and at the Stage 3 'Consult' Gateway.

7.3.2 Figure 48 below shows the overflight for all of Heathrow's options at the end of Stage 2, as well as encompassing existing operations up to 7,000 feet (red circle). Heathrow will use this mapping as a starting point to identify impacted audiences and to inform the consultation strategy at Stage 3 – while noting that the system option(s) eventually consulted on could be expected to affect a smaller area than suggested by this image.

7.3.3 Heathrow is aware that factors other than overflight will also need to be considered when identifying the audience, such as various noise measures and changes to controlled airspace etc.

Figure 48: Overflight for all Heathrow options at the end of Stage 2 and existing operations up to 7,000ft

7.4 Stage 3 Stakeholder Engagement

7.4.1 As a minimum, Heathrow will continue to update the same stakeholders engaged throughout Stages 1 and 2 with progress on the system options assembly, ahead of Full Options Appraisal.

8. GLOSSARY OF TERMS

Acronym	Term	Description
ACOG	Airspace Change Organising Group	Established in 2019 at the request of the Department for Transport and the Civil Aviation Authority to coordinate the delivery of key elements of the UK's Airspace Modernisation Strategy. ACOG is a fully independent organisation and is responsible for coordinating airports' individual airspace changes via an Airspace Masterplan.
-	Airspace Change Portal	The CAA's Airspace Change Portal is a publicly-accessible website where all ACP Sponsors are required to upload information on their ACPs.
-	Airspace Change Process	The CAA's airspace change process is known as 'CAP1616'. The process is designed to ensure that the CAA meets modern standards for regulatory decision-making, and is fair, transparent, consistent and proportionate. The process ensures that when the CAA decides whether or not to approve a proposal to change UK airspace, it does so in an impartial and evidence-based way that takes proper account of the needs and interests of all affected stakeholders.
ACP	Airspace Change Proposal	Airspace change proposals (ACPs) are requests from a 'change sponsor', usually an airport or a provider of air navigation services (including air traffic control), to change the notified airspace design. ACPs must follow the CAA's CAP1616 airspace change process.
-	ACP Sponsor	An organisation that proposes, or sponsors, a change to the airspace design in accordance with the CAA's airspace change process. Heathrow is the sponsor of this airspace change.
-	Altitude Based Priorities	Altitude based priorities are a set of rules, incorporated in statutory guidance and used by the CAA. They are designed to ensure that potential noise impacts are prioritised over other factors such as carbon emissions in airspace change proposals up to 7,000 ft above sea level.
AMS	Airspace Modernisation Strategy	The Airspace Modernisation Strategy, or AMS, is co-sponsored by the CAA and DfT. It sets out the 'ends', 'ways', and 'means' of modernising the design, technology, and operations of airspace. A nationwide airspace modernisation programme is underway across UK airports in support of the AMS.
AMSL	Above Mean Sea Level	A measure of the vertical distance of a location in reference to a historic mean sea level taken as a vertical datum.
ANSP	Air Navigation Service Provider	An organisation that provides an air traffic service of managing aircraft in flight or on the manoeuvring area of an airport and which is the legitimate holder of that responsibility.
AONB	Area of Outstanding Natural Beauty	An area of countryside in England, Wales or Northern Ireland that has been designated for protection by the Countryside and Rights of Way Act 2000 (CRoW Act) due to its significant

		landscape value. The Act protects the land to conserve and enhance its natural beauty.
ATC	Air Traffic Control	Air Traffic Control, or ATC, is a service provided by ground-based air traffic controllers who direct aircraft on the ground and through a given section of controlled airspace and can provide advisory services to aircraft in non-controlled airspace.
ATM	Air Traffic Movement	An aircraft take-off or landing at an airport. For airport traffic purposes one arrival and one departure are counted as two movements. Heathrow airport currently operates under an annual cap of 480,000 ATMs, which is set by the government.
-	Baseline	As part of the IOA, CAP1616 requires airspace change sponsors to set a baseline which is used for environmental evaluation of the options. Heathrow has used a 'Do Nothing' scenario which uses 2019 data to best reflect the current environment. The baseline scenario was modelled to generate a set of environmental metrics that have been used to compare each option against.
-	Biodiversity	Biodiversity is the variety of all life on Earth including all species of animals and plants. Biodiversity supports the vital benefits humans obtain from the natural environment.
CAA	Civil Aviation Authority	The CAA is the UK's aviation regulator, overseeing and regulating all aspects of civil aviation in the UK. The Secretary of State for Transport placed a statutory duty upon the CAA to have a strategy and plan for modernising airspace.
CAP1616	Civil Aviation Publication 1616	CAP1616 is the CAA's airspace change process guidance, introduced in December 2017. CAP1616 established additional CAA scrutiny and validation of sponsors' work and evidence as they develop proposals; increased requirements relating to transparency and engagement; and introduced new opportunities for those impacted by proposals to have their voices heard.
CAP2250	Civil Aviation Publication 2250	CAP2250 is the CAA's "Survey of Noise Attitudes 2014: Aircraft Noise and Annoyance, Further Analysis" published in December 2022. It sets out recommended categories for noise levels and annoyance that can be used by ACP sponsors when carrying out noise modelling.
-	Capacity	A term used to describe how many aircraft can be accommodated within an airspace area without compromising safety or generating excessive delay.
CAS	Controlled Airspace	A defined area of airspace in which Air Traffic Control (ATC) services are provided. Controlled airspace usually exists in the immediate vicinity of busier airports and at higher levels where air transport flights would tend to cruise.
-	Centreline	The nominal track for a published route.
-	Concentration	Refers to a density of aircraft flight paths over a given location, this generally refers to high density where tracks are not spread out; this is the opposite of dispersal.

CCO	Continuous Climb Operations	CCO is a departure procedure whereby the aircraft climbs continuously to its cruising level without levelling off. Heathrow's Comprehensive List of Options assumes that aircraft will perform a CCO to at least 7,000ft.
CDO/ CDA	Continuous Descent Operations/ Continuous Descent Approaches	An aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight to the extent permitted by the safe operation of the aircraft, and compliance with published procedures and ATC instructions. Also known as Continuous Descent Approaches.
-	Climb Gradient	The climb gradient is how steeply the aircraft climbs on departure. It is the ratio between distance travelled over the ground and altitude gained, and is usually expressed as a percentage.
CLOO	Comprehensive List of Options	Airspace change sponsors are required to develop a Comprehensive List of Options at Stage 2 of the CAP1616 process. The CLOO should include a comprehensive set of airspace design options that address the Statement of Need and align with the Design Principles set at Stage 1.
-	Conventional navigation	The historic navigation standard where aircraft fly with reference to ground-based radio navigation aids.
-	Conventional route	Routes defined to the conventional navigation standard, i.e. using ground based radio navigation beacons to determine their position.
-	Cranford Agreement	Runway alternation currently only happens on westerly operations (when aircraft come into land over London and take off towards Windsor). This is because of the legacy of the Cranford Agreement which was established in the 1950s. Cranford is a village at the eastern end of the northern runway. The agreement prevented aircraft from taking off over the village except in exceptional circumstances and applied when Heathrow was on easterly operations. This means that during easterly operations, most arriving aircraft will land on the northern runway, with most departures taking off from the southern runway. In 2009, the Government announced that the Cranford Agreement should end following consultation with local residents.
dB	Decibels	A unit used to measure the intensity of a sound (or the power level) of an electrical signal by comparing it with a given level on a logarithmic scale.
DfT	Department for Transport	The Department for Transport (DfT) is the United Kingdom government department responsible for the English transport network (and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved).
DP	Design Principle	Design Principles encompass the objectives that the airport seeks to achieve through the airspace change. They are set through stakeholder engagement in Stage 1 of the CAP1616 process and guide the airspace designers to create suitable flight path options at Stage 2.
DPE	Design Principle Evaluation	The Design Principle Evaluation is a requirement of the CAP1616 airspace change process at Stage 2. It involves

		assessing the Comprehensive List of Options against each Design Principle.
-	Dispersion	The dispersion patterns around Heathrow's departure routes are a result of ground-based navigation technology and a high degree of vectoring by ATC. This means that current dispersion patterns are generally larger than would occur within a PBN environment, where modern satellite navigation technology results in the aircraft flying a narrower flightpath.
-	Easterly Alternation	A Heathrow project to enable respite for easterly operations. The timescales to deliver full easterly alternation will be subject to both the ACP and the process for seeking permission for revised planning requirements and associated groundworks.
-	Easterly Operation	When a runway at Heathrow is operating such that aircraft are taking off and landing in an easterly direction.
ft	Feet	The standard measure for vertical distances used in air traffic control.
-	Final Approach	The final part of an arrival flight path that is directly lined up with the runway.
FL	Flight Level	The Altitude above sea-level in 100 feet units measured according to the international standard atmosphere. A flight level is an indication of pressure, not of altitude. Only above the transition level (which depends on the local QNH but is typically 4,000 feet above sea level) are flight levels used to indicate altitude; below the transition level feet are used.
-	Flight Path Options	Flight path options are operationally viable (flyable) flight paths developed by Heathrow's technical team.
FASI	Future Airspace Strategy Implementation	Heathrow is part of the 'Future Airspace Strategy Implementation-South' programme to re-design airspace in the south of the UK. There is also a 'FASI-N' programme for the north of the UK.
FOA	Full Options Appraisal	The FOA is required at Stage 3A of the CAP1616 process. It requires a quantitative assessment of the shortlist of flight path options.
GA	General Aviation	All civil flying other than commercial airline operations, encompassing a wide range of aviation activity from powered parachutes, gliding and ballooning to corporate business jets, and including all sport and recreational flying.
-	Holding Stack	Holding stacks are areas of airspace used as a waiting room which allow air traffic controllers to organise the planes before they land. Heathrow has four holding stacks located over navigation beacons that lend them their names. The locations of Heathrow's stacks have been the same since the 1960s.
ICAO	International Civil Aviation Organisation	An agency of the United Nations that coordinates the principles and techniques of international air navigation.

ILS	Instrument Landing System	The Instrument Landing System is a precision radio navigation system that provides short-range guidance to arriving aircraft on approach to the runway.
IOA	Initial Options Appraisal	The IOA is required at Step 2B of the CAP1616 process. It involves an assessment of the impacts (costs and benefits) of each of the viable options. The appraisal must use TAG, the DfT's appraisal guidance, which includes consideration of environmental impacts, economic impacts and health impacts associated with noise.
L_{Aeq}		LAeq is the most common international measure of noise and means 'equivalent continuous noise level'. 51dB LAeq 16hr (daytime noise) and 45dB LAeq 8hr (night-time noise) contours form part of the primary CAP1616 metrics used to evaluate the benefits and impacts of an airspace change. These contours represent the daytime and night-time Lowest Observable Adverse Effect Level (LOAEL) contour defined in UK airspace policy. LAeq contours are the equivalent sound level of aircraft noise in dB. This is based on the daily average movements that take place in the 16hr daytime period (0700-2300) or 8hr night period (2300-0700).
L_{Amax}		LAmax is the maximum sound level measured during a single noise event.
LOAEL	Lowest Observed Adverse Effect Level	Lowest Observed Adverse Effect Level: This is the level above which adverse effects on health and quality of life can be detected. It is set at 51 dB LAeq for daytime periods and 45 dB LAeq for night-time periods. The LOAEL and the LAeq metrics which underpin it are based on average noise measured over a 92-day period, taking into account all arrival and departure operations.
-	Lower Airspace	Airspace in the general vicinity of the airport containing arrival and departure routes below 7,000 feet. Airports have the primary accountability for the design of this airspace, as its design and operation is largely dictated by local noise requirements, airport capacity and efficiency.
Nx	N60/N65 noise events	A noise metric which describes the number of aircraft noise events above a noise level of 60 LAmax for night-time periods and 65 LAmax for daytime periods. These are event-based metrics which can be used to better understand the number of noise events that occur and where.
NADP 1/2	Noise Abatement Departure Procedures 1/2	A noise abatement departure procedure defines the height at which the flight crew will reduce engine power after take-off and the height at which acceleration from the take-off speed commences. The balance between how much energy is put into gaining altitude and speed, and at what altitudes power reduction and acceleration are initiated and in what order, impacts the noise footprint of the aircraft. ICAO guidance provides two examples, NADP1 and NADP2.
NATS (ATC)	NATS Air Traffic Control	NATS ATC is the air navigation service provider at Heathrow under commercial contract for the aerodrome control provision.
NATS (NERL)	NATS En-Route Limited	NATS is the air navigation service provider responsible for the UK's airspace above 7,000ft, and at many airports (including

		at Heathrow). NATS is the parent company of NERL who provide ATC services to aircraft flying in airspace over the UK and the eastern part of the North Atlantic.
nm	Nautical Mile	A nautical mile is a unit of length used in air, marine, and space navigation.
-	Network Airspace/Upper network	En-route airspace above 7,000 feet in which NATS has accountability for safe and efficient air traffic services for aircraft travelling between UK airports and the airspace of neighbouring states.
-	Night Flights	There is no formal ban on night flights at Heathrow, but the Government has placed restrictions on them since the 1960s. Night-time (23:30 - 06:00) operations at Heathrow are heavily restricted by the Government, which sets a limit of 5,800 night-time take-offs and landings a year. A night quota limit is also in place, which caps the amount of noise the airport can make at night. Around 80% of the night flights at Heathrow are between 04:30 - 06:00 with an average of 16 aircraft arriving each day between these hours. Heathrow has a voluntary ban in place that prevents flights scheduled between 04:30 - 06:00 from landing before 04:30. We also do not schedule any departures between 23:00 - 06:00.
-	Noise Efficient Operational Practices	Noise efficient operational practices are considered to be: Continuous Climb Operations (CCO), Continuous Descent Operations (CDO), Noise Abatement Departure Procedures (NADPs), Steeper Approaches, Steeper Climbs, Landing Gear Deployment, and Low Power Low Drag.
NPR	Noise Preferential Route	Aircraft taking off from some airports are required to follow specific flight paths called Noise Preferential Routes (NPRs), unless directed otherwise by Air Traffic Control (ATC). The NPRs at Heathrow are designated and overseen by the Secretary of State for Transport (not the CAA) and were designed to avoid the overflight of built-up areas where possible. They set a path for the aircraft to take-off from the runway until they reach the main UK air traffic routes.
NTK	Noise Track Keeping	A system that monitors and records radar data to monitor aircraft operations and report statistics focused on noise.
-	Overflight	CAA's CAP1498 document sets out a definition of overflight for use in ACPs. “Overflown” is defined as “an aircraft in flight passing an observer at an elevation angle of 48.5˚ from the ground at an altitude below 7000ft” (CAA). The overflight metric enables the number of overflights experienced at locations on the ground to be calculated according to the agreed definition.
-	Overflight cones	The CAA's CAP1498 document states that overflight above a given location should be measured using a cone. The cone identifies the airspace above a given location within which an aircraft might be perceived as "overflying" that location. This is because an aircraft does not need to be directly overhead to have an impact (noise and/or visual) on the local population.
Partial LOAEL	Partial Lowest Observed Adverse Effect Level Contour	At Stage 2 we have quantified the number of people adversely affected by noise impacts of options using Partial LOAEL contours. This is because the options are being

		assessed per single runway operation (e.g. an arrival route to one runway end) and a complete system of westerly and easterly departures and arrivals to/from both runways is required to develop a LOAEL contour
PBN	Performance Based Navigation	PBN improves the accuracy of where aircraft fly by using modern satellite navigation and moving away from outdated and conventional navigation techniques using ground-based beacons (it is similar to GPS "sat nav" devices that most people use in their cars today). PBN is being adopted worldwide through International, Regional and State level initiatives and regulations.
-	Qualitative analysis	A method of assessment based on observations and expertise of the technical team, including non-numerical information such as air traffic control procedures or other airports' design options.
-	Quantitative analysis	A method of assessment based on numerical data and metrics.
QC	Quota Count	The amount of Quota (QC points) assigned to an individual night movement at Heathrow.
RAMSAR	Ramsar sites	A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention (also known as "The Convention on Wetlands"), an intergovernmental environmental treaty established in 1971 by UNESCO in Ramsar, Iran.
-	Relief	A break from, or a reduction in, aircraft noise.
-	Respite	Scheduled relief from aircraft noise for a set period of time.
RNAV/RNAV 1	aRea NAVigation	This is a generic term for a particular specification of Performance Based Navigation. The suffix '1' denotes a requirement that aircraft can navigate to with 1nm of the centreline of the route 95% or more of the time. In practice the accuracy is much greater than this.
-	Runway Alternation	Heathrow has two runways, with one used for arrivals and one used for departures at most times. During the day, when planes are landing and taking off to the west (westerly operations), we alternate the use of our two runways to provide local communities with respite. The alternation pattern means that for part of the day we use one runway for landings and the other for take-offs, then halfway through our operational day (at 15:00) we switch over. Runway alternation is not currently possible when planes are landing and taking off to the east (easterly operations).
SAC	Special Areas of Conservation	Protected areas in the UK designated under Government environmental regulations. These sites are classified as making a significant contribution to conserving habitats and species identified in the Habitats Directive.
SEL	Sound Exposure Level	Occasional loud noise measure in the UK. An SEL footprint can be created to show the geographical area over which a particular SEL is reached from a single noise event.

-	Separation	Aircraft under Air Traffic Control are kept apart by standard separation distances, as agreed by international safety standards. Participating aircraft are kept apart by at least 3nm or 5nm lateral separation (depending on the air traffic control operation), or 1,000 feet vertical separation.
-	Shortlisting	At Stage 2 CAP1616 requires sponsors to assess the CLOO against criteria and use the IOA results to narrow down the list of options, producing a shorter list of options that will be progressed to Stage 3 for further analysis.
SID	Standard Instrument Departure procedures	Heathrow's Standard Instrument Departures are air traffic control (ATC) procedures that provide a clear path from the runway end to 6 common network points in the airspace for flights to depart.
SoN	Statement of Need	At the first stage of the airspace change process, airport sponsors are required to outline the objectives of the ACP, by setting out the airspace issue or opportunity it is seeking to address and what outcome it wishes to achieve.
SPA	Special Protection Areas	Protected areas in the UK for migratory birds and certain particularly threatened birds.
SSSI	Sites of Special Scientific Interest	An area that is of particular interest to science due to the rare species of fauna or flora it contains – or important geological or physiological features that may lie in its boundaries. These areas have high conservation value and need to be protected. Natural England is the official authority in England determining which sites have SSSI status.
-	Supplementary Metrics	Supplementary metrics are those that have been used to better articulate the likely noise impacts of the options to stakeholders. These include overflight, noise exposure contours and single aircraft noise events.
System Option	System Option	At Stage 3 Heathrow will design system options which are arrivals and departures together, on easterly and westerly operations.
TAG	DfT's Transport Appraisal Guidance	TAG (formerly known as WebTAG) is the DfT's suite of guidance on how to assess the expected impacts of transport policy proposals and projects. As part of the CAP1616 process, Heathrow is required to apply specific noise metrics and quantify the benefits and impacts on an airspace change using the TAG tool. The TAG tool is a workbook using calculations and formulae that are set by DfT. The CAP1616 process requires TAG analysis methods to be used for evaluation of quantified noise benefits and disbenefits.
TMA/LTMA	Terminal Manoeuvring Area (Terminal Airspace)/London Terminal Manoeuvring Area	An aviation term to describe a designated area of controlled airspace surrounding a major airport or cluster of airports where there is a high volume of traffic. The LTMA is the name given to the airspace that surrounds the major London airports, including Heathrow.
-	Vector/Vectoring	Vectoring is the provision of navigational guidance to aircraft by air traffic controllers (ATC). Vectoring helps to maximise use of available airspace. ATC instruct the pilot to fly on a given compass heading and at a specific altitude.

-	Westerly operation	When a runway at Heathrow is operating such that aircraft are taking off and landing in a westerly direction.
WHO	World Health Organisation	WHO is a specialised agency of the United Nations responsible for international public health. WHO has provided guidance on recommended maximum noise levels for sleep and education.