London Biggin Hill Airport RNAV (GNSS) Runway 21 Airspace Change Proposal ACP-2019-86 Stage 2 Version 2 Design Options Development Document

Document Details

Reference	Description
Document Title	London Biggin Hill Airport RNAV (GNSS) Runway 21 Airspace Change Proposal ACP-2019-86 Stage 2 Version 2 Design Options Development Document
Issue	Version 2 Design Options Development Document Issue 1 - FINAL
Date	10th March 2022

Table of Contents

Table of Figures

Table of Tables

1 Design Options Development

1.1 Background

London Biggin Hill Airport (LBHA) is progressing through the Airspace Change Process as defined by the Civil Aviation Publication (CAP) 1616. This airspace change, if successful, is to introduce a RNAV(GNSS) arrival route in order to:

- Be compliant with EASA Regulatory requirements detailed within IR(EU) 2018/1048[1]. This will also meet the requirements within the CAA Airspace Modernisation Strategy.
- Add a layer of resilience to the airport operation by providing additional instrument approaches should any of the current procedures/operations be unavailable.

This ACP will only impact a small number of stakeholders as the majority of aircraft will continue to operate as they do today. Specifically, this ACP is to change a rarely used inbound procedure which is utilised by approximately 2[2] aircraft a month, and a Missed Approach Procedure (MAP) that is only used about 30 times a year.

1.2 Progress So Far

As part of this redesign, LBHA must follow the guidance provided by the CAA and successfully complete the first 6 stages of CAP 1616.

The Statement of Need submitted to the CAA to initiate this ACP stated:

LBHA is proposing to implement an RNAV(GNSS) Instrument Approach Procedure (IAP), with LNAV and LPV Minima to Runway 21. The IAP will be designed for aircraft in Speed Categories A, B, and C and will include an RNAV Missed Approach Procedure. The RNAV(GNSS) IAP will replicate/mimic the existing Runway 21 ILS/DME/VOR[3] procedure. The RNAV(GNSS) Procedure for Runway 21 will not only act as a back-up in the event of an ILS failure but will also future proof the airfield and provide an alternative to procedures utilising the BIG VOR, which is due to be removed in the near future.

This is the formal explanation of why LBHA wishes to make changes within the airspace surrounding it.

Stage 1 of CAP 1616 requires that the airport and stakeholders, through a two-way process establish a set of Design Principles (DPs) which will subsequently steer and guide the development of the route options. LBHA successfully completed

[1]The principles of which have been adopted into UK law.
[2] Ensures competency and accounts for reduced staffing at the Radar unit at the end of the day resulting in the need for a Procedural Approach.
[3] ILS/DME/VOR Procedures are conventional procedures that utilise ground-based equipment to define the lateral and vertical guidance for the aircraft.

Stage 1 and the finalized prioritised DPs that passed through the CAP 1616 Gateway 1 are shown in Table 1 below.

This LBHA Airspace Change project is now at the Stage 2 (Develop & Assess).

Priority	
1	SAFETY - New routes must be safe and must not erode current ANSP safety barriers
2	ENVIRONMENTAL CONCERNS - Arrival routes should, where possible, be designed to minimise the impact of noise below 7,000' and should avoid the overflight of populations not previously overflown
3	COMPLIANCE - Routes should, where possible, be designed to be PANS Ops compliant
4	NAVIGATION STANDARDS - New routes must be designed to use PBN
5	EFFICIENT ROUTES - Arrival routes should, where possible, be designed to minimise emissions and optimise operational efficiencies
6	REPLICATION - Procedure should, where possible mimic the existing procedure and/or the existing ILS positioning by ATC vectors

Table 1 Prioritised Design Principles

1.2.1 Previous Gateway 2

This ACP had a Gateway 2 date of 25th June 2021, and the original version of this document and the others associated with that Gateway 2 (all at Version 1) were assessed by the CAA. As part of the CAP 1616 process, the CAA provided feedback on the 3 documents as explained in their CAP1616 Stage 2 Gateway – CAA Response document, which is on the Airspace Change portal. As the ACP did not progress out of Stage 2 in June 2021, LBHA subsequently had to revise the documents for a new Gateway 2.

Consequently, this document, and the 2 other original documents have been updated to Version 2 to reflect that CAA feedback, and additional learning. All/any new information has had to be assessed for impact on the original documents, for example, Version 2 of this document contains scenarios that could be undertaken outside of the CAP 1616 process which were not originally available to LBHA. This new learning is detailed in paragraph 1.6 below.

Version 1 of these 3 documents is therefore no longer valid.

1.3 This Document

This document, now at Version 2, explains how the change sponsor has developed options for the Comprehensive List. LBHA is grateful to the stakeholders who took part in the development of these options, specifically the suggestion from a stakeholder (evidenced in the Engagement document) which is annotated as Option 12.

1.4 Stage 2 Other documents

CAP 1616 requires various information for Stage 2. To enable clear explanation of our engagement throughout Stage 2, including how feedback was addressed, we have produced 4 documents. The documents for this Gateway 2 are:

- This document, which is Design Options Development Version 2
- Design Principles Evaluation Version 2
- Initial Options Appraisal Version 2
- Engagement document Version 1 (which should be read alongside this document)

1.5 Context CAP 1616

CAP 1616 is a seven-stage process published by the CAA, those seven stages are:

- Stage 1 – Define
- Stage 2 – Develop and Assess (current stage)
- Stage 3 – Consultation
- Stage 4 – Update and Submit
- Stage 5 – Decide
- Stage 6 – Implement
- Stage 7 – Post-Implementation Review

1.6 Context – New learning

1.6.1 Letter from NATS

LBHA recently received a letter from NATS (NERL) suggesting that it may be possible, within certain considerations, to prolong the life of the BIG VOR for a specified timescale. While this is not intended as a long-term solution it could facilitate the status quo until implementation of this ACP. Consequently, LBHA has now submitted a formal request to extend the life of the BIG VOR.

1.6.2 CAP 1781

The CAA recently published a document (CAP 1781) that offers a method of mitigation for continued use of a VOR/DME procedure when the radiating navigation facility (in this case the BIG VOR) is removed. If LBHA is assessed by the CAA as a candidate for CAP 1781 the use is specifically for a limited period only, on the condition that a permanent solution is also pursued. LBHA has submitted CAP 1781 paperwork to the CAA and is awaiting a response.

1.6.3 European Geostationary Navigation Overlay Service (EGNOS)

Due to changes under the Brexit agreement, EGNOS is not as fully available within the UK as it previously was, and some elements have been withdrawn. For this ACP, it means that the LPV element of the RNP approach will not be available, which adversely affects the resilience provided by such an approach. To maintain the necessary resilience LBHA has explored an PBN to ILS approach within this ACP. This is explained further within this document.

1.7 Context the LBHA operation

LBHA is supported by 1,800 metres of tarmac which enables 2 runways (one in each direction), Runway 21 and Runway 03. Runway 21 is an instrument runway enhanced by an Instrument Landing System, and Runway 03 is currently a visual runway that will, in the near future, be supported by an RNAV (GNSS)[4] that is an Area Navigation (Global Navigation Satellite System) Approach.

Due to the prevailing southwest wind (about 70% of the time), and the fact that aircraft take off and land into wind, Runway 21 is the most used runway.

1.7.1 Radar Vectoring Arrivals to Runway 21

There are different types of approach typically flown to Runway 21, and the vast majority of arrivals receive radar vectors from NATS (Thames Radar).

During the available Thames Radar hours, approximately 98% of Runway 21 inbound aircraft fly radar vectors to either the Instrument Landing System[5] (ILS) or to a visual[6] landing; this way of arriving at LBHA is not part of this ACP[7]. LBHA does not expect the use of radar vectors to reduce dramatically with the introduction of this ACP, although NATS controllers have suggested that it could result in slightly less.

The radar vectors provided by NATS are out with the control of LBHA.

The swathe shown in Figure 1 is representative of the main vectoring area for arrivals in the vicinity of the current VOR procedure, however, it should be noted that there are also arrival tracks outside of this swathe. Figure 1, shows radar vectors for 5 weeks (9 Sep 19 to 13 Oct 19), for IFR traffic which is considered to be a representation that is typical and average. It should be noted that the swathe shows some positioning of aircraft crossing the London City flightpaths, this is due to LBHA being open outside of the hours of London City and therefore the radar controllers can utilise the airspace differently.

[4] An ACP conducted under CAP 725 awaiting CAA decision.
[5] The ILS is a radio navigation system which provides aircraft with both horizontal and vertical guidance just before landing. It relies on physical infrastructure on the ground at the airport and enables aircraft to land when weather conditions are poor.
[6] Visual approaches require minimum weather requirements
[7] On occasion an aircraft inbound to runway 03 can utilise the radar vectors to ILS for a circling approach.

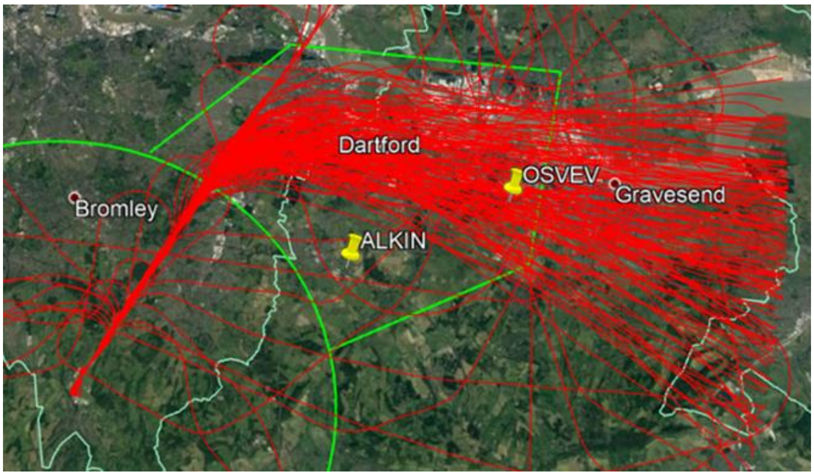

Figure 1 Typical radar vectors for arrivals to Runway 21

1.7.2 Procedural Arrivals to Runway 21

When Thames Radar are unavailable or closed, or as an unusual request, an arrival can use the following procedural approaches:

- VOR/DME to join the ILS
- VOR/DME to land

This means that they follow the instructions on a chart. This procedure starts at ALKIN which is shown in Figure 1. The aircraft do not receive any radar vectors. These procedures are the focus of this ACP as the ground based navigational aid used (in this case, the Biggin VOR) is due to be withdrawn from use along with numerous others in the UK. ALKIN is also used if aircraft have to hold.

1.7.3 Local Airspace

To leave the air traffic en-route network aircraft inbound to Runway 21 at LBHA route through OSVEV. The position of OSVEV can be seen in Figure 1.

Currently the only way to route from the network exit point (OSVEV) to ALKIN (to start the VOR/DME procedure or to hold) is with the use of radar vectors, or to self-position. Some of the options developed for this ACP facilitate direct OSVEV ALKIN routing without radar vectors.

1.7.4 The Missed Approach Procedure (MAP)

If an aircraft is unable to land off any of the above inbound approaches (something that happens rarely but is a normal safety procedure) and has to re-join the arrival stream for another attempt it follows the MAP and or any radar vectors from air traffic control (ATC).

The variation of the routes followed by aircraft utilising the MAP are due to a number of different factors such as, when the MAP was initiated, the type of aircraft, the 2000ft wind, how the aircraft Flight Management System is configured and the use of radar vectors. This is illustrated by the blue tracks and one red track (2 necessary MAP due to weather) in Figure 2 below which shows actual MAP events in the last 4 months of 2021.

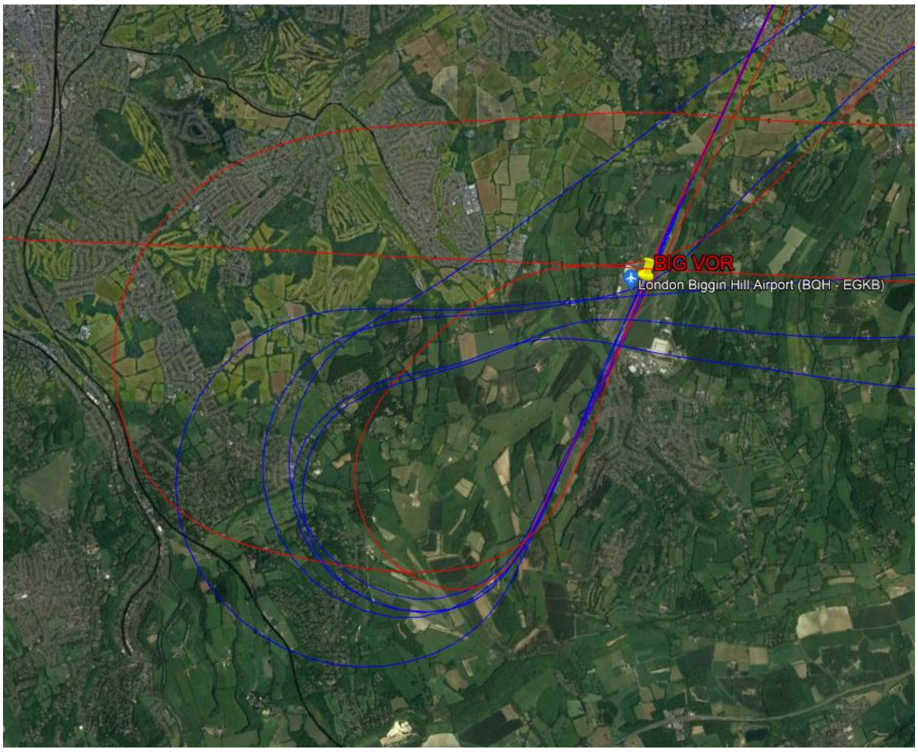

Figure 2 MAP tracks for the last 4 months of 2021

1.7.5 The Radio Communications Failure (RCF) procedure

The RCF procedure is not explored further in this document as it is expected to remain unchanged.

1.8 Context regarding the design of the options

As part of the UK's airspace modernisation strategy[8], and in line with the Statement of Need and Design Principles 3 and 4, all the options will be developed to be compliant with EASA regulatory requirements detailed within IR (EU) 2018/1048.

This means the PBN procedures (previously we have referred to RNAV, but PBN is now the preferred term) are designed to be flown by the automatic systems that the majority of modern aircraft use for navigation. These designs will use waypoints. A waypoint in a procedure is defined positionally by its Latitude and Longitude; generally its position may not represent a physical feature on the ground and will be positioned so that the designed routes are technically flyable by the aircraft and can integrate with the national airways structure. The aircraft navigation systems will automatically direct the aircraft according to the routing designed into the procedure.

LBHA looked at the possibility of utilising the initial PBN routing to enable interception of the ILS. Initially this was dismissed as it has not been deployed successfully within the UK. However, due to the EGNOS situation mentioned previously, LBHA looked to address the fact that the LNAV and LNAV/VNAV

[8] CAA document CAP 1711

approach are likely now to be more impacted by poor/low visibility weather. LBHA elected to mitigate this in 2 ways by investigating:

- the possibility of providing not only an RNP approach but an PBN to ILS approach as these are successfully utilised across the rest of the world.
- the possibility, if in the event of an EGNOS replacement, the options presented in the ACP could allow for a LPV element to replace the ILS.

This work identified that all the arrival options could theoretically accommodate PBN to ILS and LNAV and LNAV/VNAV, with identical routing. Consequently there are 2 ways to fly the options; a full PBN procedure (LNAV or LNAV/VNAV) and an PBN to ILS procedure that follows the same path.

LBHA recognise that the PBN to ILS will require further work including a specific Safety Case which will be completed in due course.

1.9 Next Steps

1.9.1 Reducing the number of options

Within Stage 2 of CAP 1616, the Comprehensive List is refined down, firstly through use of the design criteria and constraints to a Suitable List of options, which is then taken through the Design Principles Evaluation (DPE). The DPE describes how the options respond to the design principles and results in a (Comprehensive) List of Viable Options. These options are then assessed through the Initial Options Appraisal (IOA) which results in a Short List which will include the preferred option. This process is shown below in Figure 3.

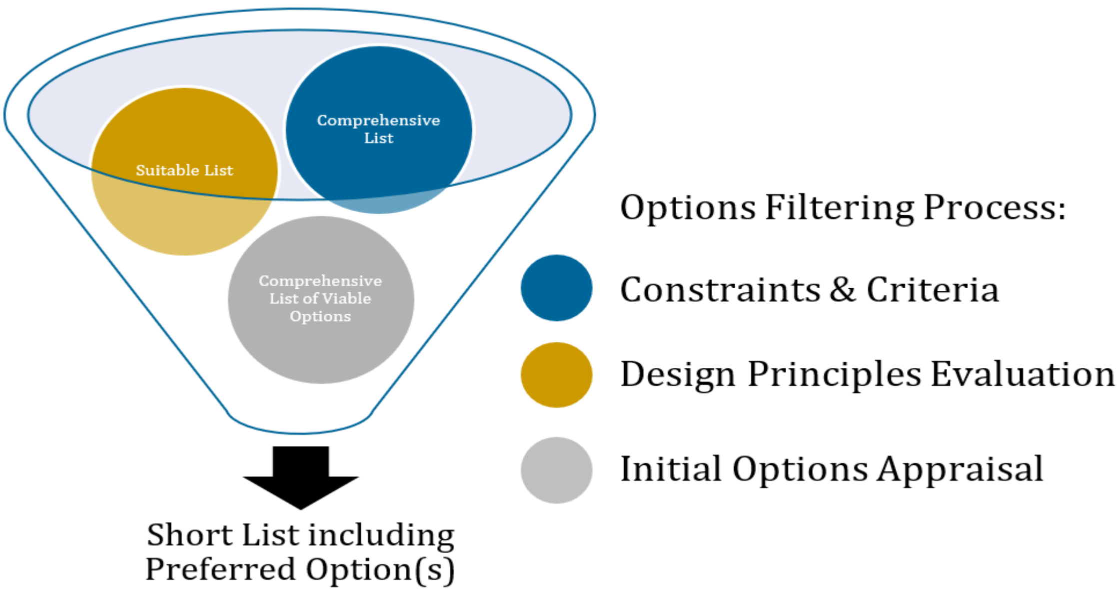

Figure 3 CAP 1616 Options Filtering Process

1.9.2 Design Principles Evaluation and Initial Options Appraisal

The DPE is the next activity to be undertaken and will be produced in the format dictated by Appendix E of CAP 1616. Once that is complete the IOA will be undertaken which tests the Viable Options against the criteria contained within CAP1616, Appendix E, Table E2, including qualitative assessments of noise and safety impacts, as required for a Level 1 change. At the end of the IOA a Short List of options is produced, which will include a preferred option.

1.9.3 Additional Requirements

An additional requirement stated in CAP 2091, CAA Policy on Minimum Standards for Noise Modelling, requires the change sponsor to state at the Stage 2 Gateway what category of noise modelling will be undertaken for further stages of the CAP 1616 process. LBHA proposes to conduct noise modelling to comply with the requirements of Category D.

Category D is considered appropriate as in summer 2019 there were around 2,100 people within the 51 dB $L_{Aeq,16h}$ daytime contour which is just above the mandated minimum threshold of 2,000 for Category D, but well below the recommended minimum threshold of 20,000 for Category C. At night there were around 20 people within the 45 dB $L_{Aeq,8h}$ contour which is well below the recommended minimum threshold of 1,600 for Category D.

2 Comprehensive List

2.1 Engagement Requirement

Please refer to the Engagement document for the detail on how and when the Comprehensive list was shared with stakeholders and to see what the feedback was and how LBHA considered it. The Stage 2 engagement resulted in an additional MAP option that is shown as Option 12 within this document.

2.2 Constraints and Criteria

CAP 1616 requires LBHA to develop a Comprehensive List of options, but also accepts that there may be limited scope for multiple design options due to, for example, the physical constraints of adjacent airspace and/or procedures. Consequently, it is first necessary to set out the constraints that apply in this case.

It is important to state what this change is not about. It is not about increasing the numbers of aircraft that utilise LBHA and it is not about introducing new ground infrastructure at the airport.

In addition, this ACP is bound by the following constraints established in Stage 1:

- Designers are limited to the PANS-OPS design criteria.
- This change should not necessitate any change to any other air traffic procedure
- This change should not change any airspace configuration or classification.
- This change is limited to changes at 3000 feet and below, as procedures above are “owned” by NATS and are not part of this change.

LBHA also considered the DPs and feedback received through engagement and whether these provided constraints or opportunities. For instance, Design Principle 2 led LBHA to explore different vertical profiles to minimise the noise footprint. Table 2 below shows how those agreed Design Principles were utilised as the criteria to explore and develop the options for the Comprehensive List.

Priority	Design Principle	Criteria used during development
1	SAFETY - New routes must be safe and must not erode current ANSP safety barriers	The options should not necessitate ground-breaking safety work or require multiple knock-on changes.

Priority	Design Principle	Criteria used during development
2	ENVIRONMENTAL CONCERNS - Arrival routes should, where possible, be designed to minimise the impact of noise below 7,000' and should avoid the overflight of populations not previously overflown	The options should minimise the impact of noise and should avoid the overflight of populations not previously overflown.
3	COMPLIANCE - Routes should, where possible, be designed to be PANS Ops compliant	Designs should be PANS-OPS compliant; the parameters of the Instrument Flight Procedures (IFP) e.g. shape, accuracy, turn areas and obstacle clearances are predetermined (to a degree) in ICAO document PANS-OPS 8168 Aircraft Operations – Volume 2 Construction of Visual and Instrument Flight Procedures. This is the international standard for all IFPs.
4	NAVIGATION STANDARDS - New routes must be designed to use PBN	PBN standards used should be accessible to the largest number of operators.
5	EFFICIENT ROUTES - Arrival routes should, where possible, be designed to minimise emissions and optimise operational efficiencies	Options should have minimal track miles/fuel burn, and not cause operational complexity.
6	REPLICATION - Procedure should, where possible mimic the existing procedure and/or the existing ILS positioning by ATC vectors	Options should mimic the existing procedure and/or the existing radar vector swathe.

Table 2 Prioritised Design Principles and Development Criteria

2.3 Options Development

The paragraphs below explain how LBHA constructed the Comprehensive List as defined in CAP 1616. This process began by looking at options outside of the CAP 1616 process, then radical options looking at new ideas, and experience at other airports. Only after this did the option work look at the specific vertical and lateral variations that could be utilised in line with the design principles. Throughout LBHA has assumed that the number of aircraft utilising the proposed new procedures would be similar to the small number that use the current procedural VOR/DME procedure, and that the usage of the MAP will not be altered by this proposal.

2.3.1 Options outside of CAP 1616

All ACPs should consider if there are other non-ACP means of achieving the desired outcome. When this was assessed prior to the first Gateway 2 (June 2021) it was considered that it would not be possible to meet the objectives of resilience and regulatory adherence any other way than through an ACP and this is still the case for a long-term permanent solution.

Due to the timescale to implementation growing, this ACP cannot be implemented in time for the proposed VOR removal in Dec 2022 which presents LBHA with a capability gap. However, there are now 2 new possible short-term scenarios (outside of CAP 1616 and previously mentioned at section 1.6) that could be utilised until ACP implementation date:

- NATS have announced that there may be an opportunity to extend the life of the VOR so that it can continue to operate as it does today.
- The CAA recently published a document (CAP 1781) that offers a method of mitigation for continued use of a VOR/DME procedure when the radiating navigation facility is removed. If LBHA is assessed by the CAA as a candidate for CAP 1781, the use is for a limited period on the condition that a permanent solution is also pursued.

Neither of these scenarios effects the options developed below, but the change to the expected implementation date and the use of either or both of these scenarios does impact the baseline used during the IOA. This is explained fully in the IOA document.

2.3.2 Identification of Options

As options were being developed it was necessary to adopt a naming convention. Any new option was assigned a number and then letters were used to denote variations. Those variations are explained in detail in the following paragraphs of this section. The table below summarises the coding of these variations.

Variation Code	Basic Description
A	Utilises a 3° PBN final approach angle, which is currently industry standard.
B	Utilises a 3.2° PBN final approach angle.
C	Utilises a 3.5° PBN and ILS final approach angle.
T	Utilises a T-bar lateral approach philosophy where aircraft join from either the right- or left-hand side (making a T on the map) of the approach.
D	Utilises a direct routing between OSVEV and ALKIN.

Table 3 Variation Coding Explained

2.3.3 Radical ACP options

It was necessary to explore whether any radical airspace change options were appropriate. The use of multiple routes (feedback from Stage 1), offering managed dispersion was considered. However, this would require an enhanced level of safety work, would likely need airspace trials, and may need new ATC tools to even be feasible.

Further possibilities lay outside the constraints of this project as they would entail partial or wholesale change to the airspace in the area. These aspects are under consideration within a different airspace change; the Future Airspace Strategy Implementation South (FASI-S) airspace redesign work.[9]

Consideration was also given to the specification of the PANS-OPS design. A high-end specification (known as RNP-AR) would limit, considerably, the ability of certain aircraft types and crews to undertake such a procedure due to the requirement for specific CAA approval following specific training. Therefore, this would not meet the resilience criteria and has not been further investigated.

The development of the PBN to ILS idea (see paragraph 1.8) could be thought to be radical as it has not been deployed successfully within the UK. However, while not in operation in the UK this is not a new idea and is successfully deployed around the world. It will require a specific Safety Case, but this is not expected to be ground-breaking.

An assessment was made as to whether there were any radical options for the MAP even though as a rarely used routine procedure these would be limited. Due to the constraints of the project regarding airspace construct and not interfering with other procedures, it was apparent that no MAP option could change the current maximum altitude, or position of the hold.

2.3.4 Lateral options

Not all the Design Principles can work together, some options were developed to try and utilise as many DPs as practical while others focussed on specific DPs.

[9] Details can be found on the CAA Airspace Change Portal for each airport involved

For instance, DP6 and additional feedback from Stage 1, suggested the desire to keep arrival aircraft within the current vectoring swathe/replicate the current arrangements. Options developed with these views in mind would also align with the wider constraints of the extant air traffic arrangements and have been progressed within the options development.

However, an option set was also considered that would allow aircraft to arrive at LBHA from any direction, therefore, not utilising either OSVEV or ALKIN. Due to the constraints mentioned above and the desire for options to be within the current swathe, the only possible option was to utilise Figure 1 to identify any possible areas. Figure 4 below clearly shows some aircraft utilising an area to the north, which is circled in orange.

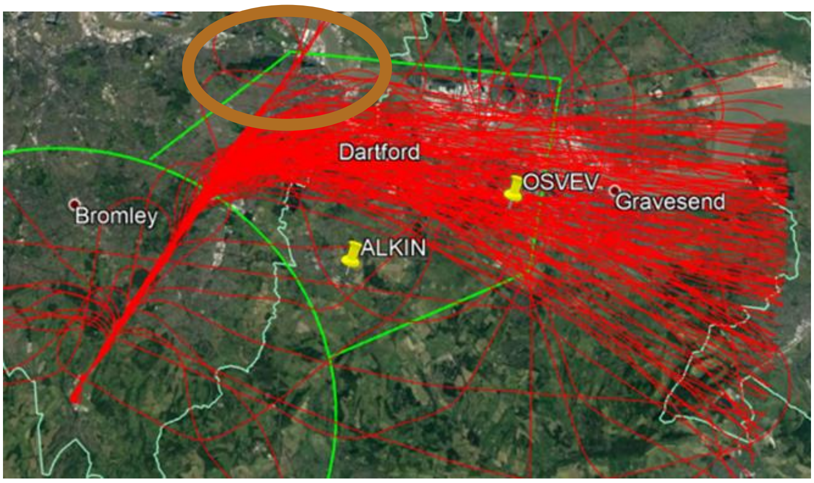

Figure 4 Identification of northerly radar vectors

This option set was progressed for those options not associated with ALKIN, so as to mimic the situation in Figure 4; these are shown by the addition of a T, e.g. Option 5AT.

Further work identified that these T options did not fit into the extant air traffic arrangements that exist during the London City hours of operation and would therefore require additional safety work to understand the consequences and any possible mitigation. Additionally, it would result in complex operational scenarios and limited availability. Therefore, all T options have been discontinued but are included in our Comprehensive List.

During this development stage it became apparent that one subset of options could utilise an OSVEV to ALKIN direct link, instead of the current radar vector arrangement. To identify these options, LBHA utilised the addition of a D e.g. Option 2AD. It was not possible to establish any other options for this link as by default it is a straight line between 2 points. While the introduction of this D element will increase the track mileage of the procedure it is extremely unlikely to increase fuel burn above the extant operation as aircraft currently transit on radar vectors between the same 2 points. Consequently, this option remained within the development criteria as it would be likely to provide operational efficiencies as required by DP5.

Another set of options looked at ignoring ALKIN and just using OSVEV, as this routing is within the main swathe. At this stage of design it was considered that this would not introduce added operational complexity and would be extremely similar to the extant air traffic arrangement. Therefore this option set was further developed, resulting in 3 different lateral routings, Options 5, 6 and 7. As work progressed it became apparent that options 5 and 7 would introduce operational complexities and these were discontinued. Option 6 was maintained until a whole system assessment was undertaken. Option 6 was then discontinued. All are included in our Comprehensive List.

Option 2 was developed to replicate the current VOR/DME procedure from ALKIN, it was subsequently further assessed to see if there was any other possible lateral positioning available. However, due to the design criteria and DP3 and DP4 no further options could be identified.

Another set of options specifically focussed on the possibility of a different lateral positioning for the last 10 nautical miles of the approach. However, these were discontinued due to the noise impact that would result on new communities which would be contrary to the criteria associated with DP2.

The lateral options are numbered 1 to 7, for the inbound/arrival phase, with the addition of a D or a T where applicable. Appendix 1 of this document fully explains all these option.

2.3.5 Vertical options

The DPs and additional feedback from Stage 1 suggest that due to environmental concerns, aircraft should be kept higher for longer. This project is only concerned with aircraft below 3,000 feet[10] due to the extant airspace structure, so this element was investigated as higher final approach gradients (approximately the last 8-10 nautical miles before touchdown if starting descent from 3000 feet).

The options considered are as follows:

- Option A 3° Glideslope – the industry standard and the current approach angle for the VOR/DME and the ILS on Runway 21.
- Option B 3.2° Glideslope – The procedures at Heathrow show that this approach can be flown successfully alongside a 3° ILS and that a small noise reduction is achievable and measurable if monitors are sited in an array under and close to the approach.
- Option C 3.5° Glideslope – the work undertaken by LBHA on the ACP for an RNAV approach to Runway 03 proves that the operators at LBHA can successfully operate with a glideslope at 3.5°. This option requires both the RNAV and the ILS glideslope to be 3.5° to achieve a safe final approach environment. While the FAF is likely to move marginally, the current radar vectoring is not expected to change. This will result in ALL IFR inbounds being higher for longer. As this will in part, be facilitated by an RNAV to ILS approach there is no temperature impact to compromise availability.

Landing on the runway from angles greater than 3.5° is not operationally viable for many aircraft and some require modifications (an example is London City Airport). Design regulations, PANS-OPS 8168 Vol 2; Part 3; Section 3; Chapter 4, Subsection 4.2.1.3, provide information and state that a procedure shall not have a promulgated Vertical Path Angle that is less than 2.5° and that a procedure with a promulgated Vertical Path Angle that exceeds 3.5° is a non-standard procedure.

[10] Above mean sea level

However, there is an evidence base to draw upon; procedures are operational at Heathrow Airport providing higher than the industry standard glideslopes. They are utilising a 3.2° PBN approach for environmental benefit while also operating a 3° ILS. Figure 5 below shows the different glideslope options.

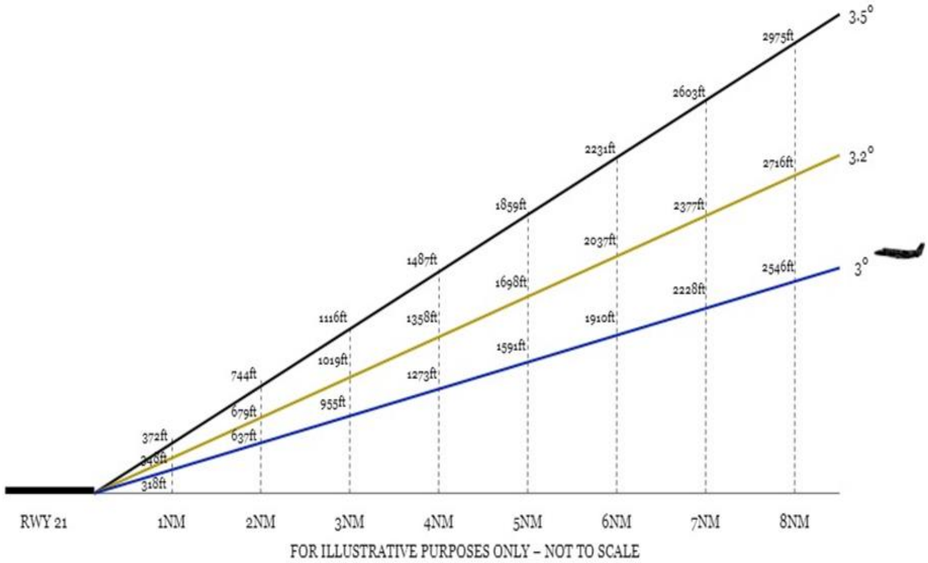

Figure 5 Glideslope options

LBHA consider that to introduce a PBN 3.5° option it would necessitate the raising of the ILS glideslope to 3.5°, which in turn would mean Precision Approach Path Indicators (PAPIs) set at 3.5°. LBHA believe that by having both IFR approaches utilising the same angle of approach the safety barriers will not be breached. LBHA recognise that the ILS Safety Case would require amendment.

The lateral options can now have an associated vertical option of A, B or C added.

It should be noted that LBHA have no plans to increase noise monitor deployment to monitor the noise reduction of any increased glideslope. Additionally, the LBHA annual noise contour report is unlikely to show a change for the B option due to the very small numbers (approximately 2 aircraft a month) that would be utilising the approach. Furthermore, it should be noted that this very small noise reduction will not be discernible to the human ear.

To better understand the possible change due to a 3.5° glideslope, LBHA commissioned a noise contour comparison from Bickerdike Allen Partners, see Figure 6 below. This concludes that contours are very slightly smaller to the north of the airport (under the Runway 21 approach path, in a rural area) with the 3.5° glideslope. The effect on the 57 dB contour being more pronounced than for the higher noise level contours. The 57 dB contour based on the 3.5° approach angle is around 1% smaller in area than the contour based on a 3° approach angle.

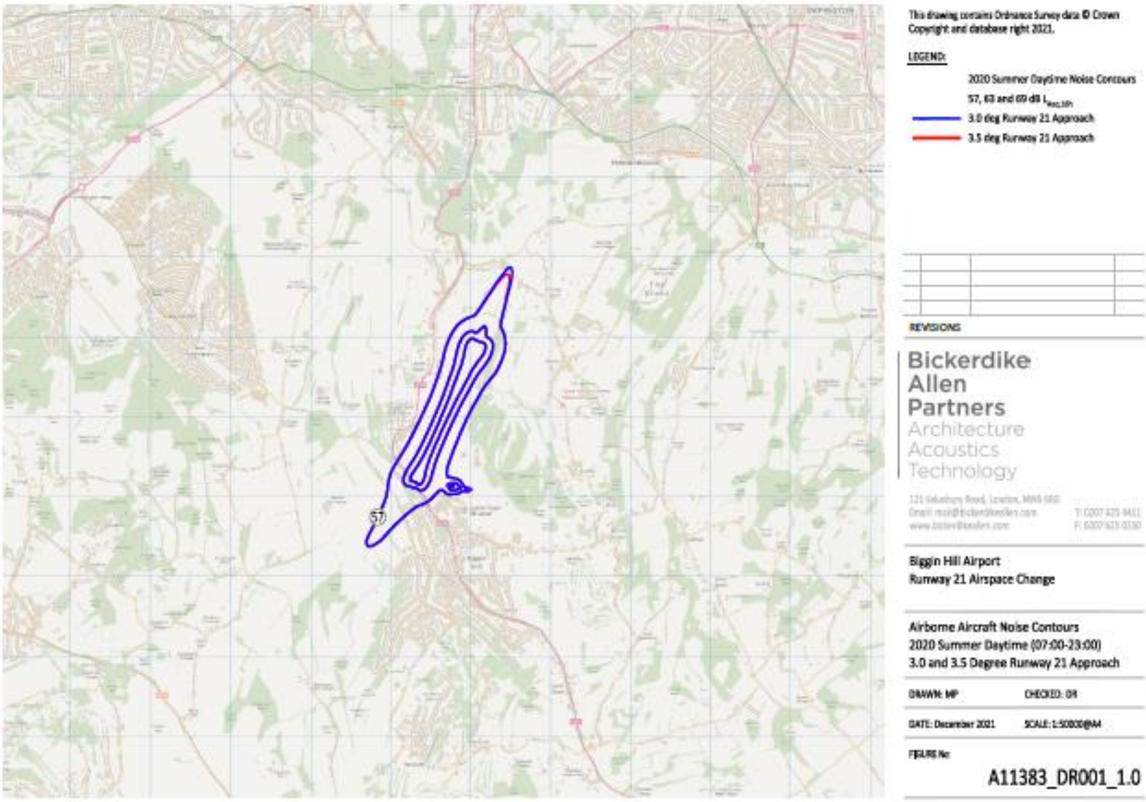

Figure 6 Noise contours

However, an important element to consider is the impact that temperature has on the glideslope angle of an PBN approach. It has a small effect on the altitude that an aircraft's altimeter says the aircraft is at compared to the height it actually is at, because the descent angle is based on the angle at the International Standard Atmosphere (ISA) temperature at mean sea level which is 15°C. Consequently, when the temperature is not exactly 15°C the PBN approach angle will change ever so slightly; colder than 15°C produces a shallower approach angle and warmer than 15°C produces a steeper approach angle.

If utilising a 3.5° PBN it will be necessary to establish and publish the maximum temperature permissible to allow the approach to be flown, which is likely to make it unavailable during some of the summer as the actual Vertical Path Angle would then be non-compliant with the design criteria.

Therefore, due to the periods of unavailability meaning that the Statement of Need will not be met, together with complex operational situation generated, which is contrary to the DP5 criteria, the C option has been discontinued.

2.3.6 MAP Options

When considering options for the MAP, the constraints of this project negate the construction of a hold anywhere else due to the knock-on effect to other procedures and airspace users. In addition the 03 RNAV ACP has already dealt with the change from a conventional to an PBN hold at ALKIN. Consequently, all MAP options utilise the PBN ALKIN hold. The MAP options are numbered 8 to 12.

2.3.7 Considering Systemised Options

Only after the arrival options had been considered in isolation was it necessary to consider how they would fit with the MAP options. A complete system is needed to enable an aircraft to make an approach, execute the MAP and enter the hold and then to make a second approach from the hold.

The constraints around the positioning of the MAP hold results in all remaining options, apart from Option 2 and all associated sub options, being discontinued due to the constraints of the airspace and the safety criteria.

2.4 Number of Options in the Suitable List

The Comprehensive List contains 'Do Nothing' and discontinued options totalling 7 inbound options with numerous sub options, and 5 MAP options. Detailed descriptions are in the following section of this document, the Appendix. The discontinuation of options has occurred through consistent application of the criteria and constraints previously set out and explained in detail in the previous section of this document.

This results in a Suitable List of arrival options as follows:

- 2A
- 2AD
- 2B
- 2BD

These arrival options are all compatible with the only MAP option, Option 9.

This Suitable List will be taken through to the DPE. The do-nothing scenarios will only be used for comparison as required by CAP 1616.

A1 Appendix 1

A1.1 The Options

The Comprehensive List contains all possible options. This appendix gives details of how specific routing options within that Comprehensive List were developed.

A1.2 Option 1

Do Nothing. This will mean that when the VOR is removed from service there will be no IFR approach other than the ILS into LBHA on Runway 21, which would rely on radar vectors from NATS for positioning and have no functioning MAP. In addition, by not implementing a PBN approach LBHA will not be compliant with EASA Regulatory requirements detailed within IR (EU) 2018/1048. Therefore, this is not an option to progress.

A1.3 Option 2A

This is our "do minimum" and would be to replicate/mimic the current VOR/DME approach which starts from ALKIN. This assumes radar vectors by NATS from OSVEV to enable inbounds to exit the network using extant procedures, or radar vectors by NATS for inbounds from the MAP or the south. Exceptionally, if radar vectors were unavailable the aircraft could self-position. This reflects the current practice for the VOR/DME approach. The glideslope is at 3.0°.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. The depiction shows aircraft arrival via the hold at ALKIN.

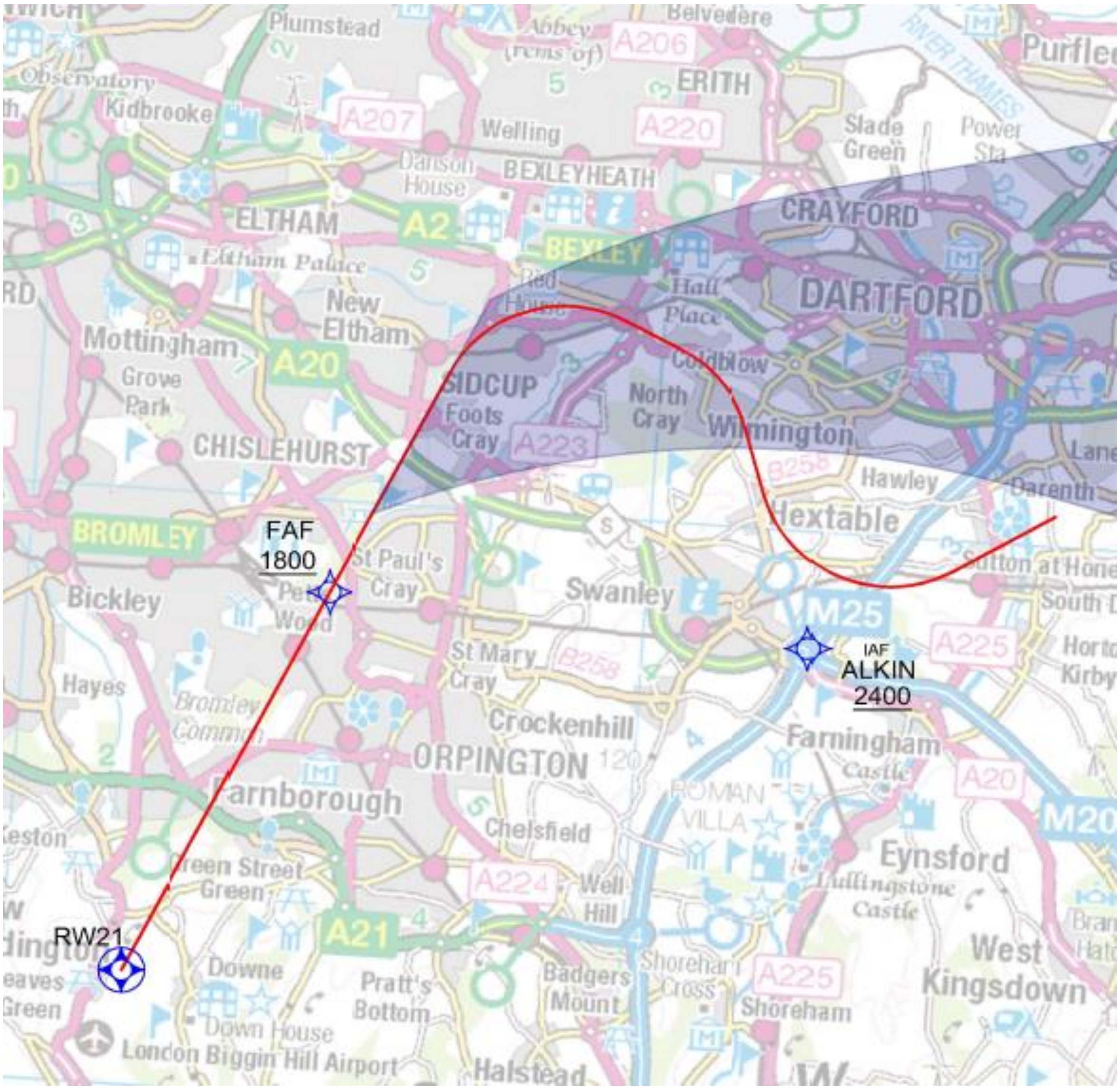

Figure 7 Option 2A

A1.4 Option 2AD

This option would be to replicate/mimic the current VOR/DME approach which starts from ALKIN and utilise a new direct link from OSVEV to enable inbounds to exit the network without radar vectors if necessary.

It is assumed that radar vectors by NATS will be available from OSVEV if necessary/requested, as is the current practice, and that radar vectors by NATS for inbounds from the MAP or the south will be available as they are today. Exceptionally, if radar vectors were unavailable the aircraft could self-position.

The glideslope is at 3.0°.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors.

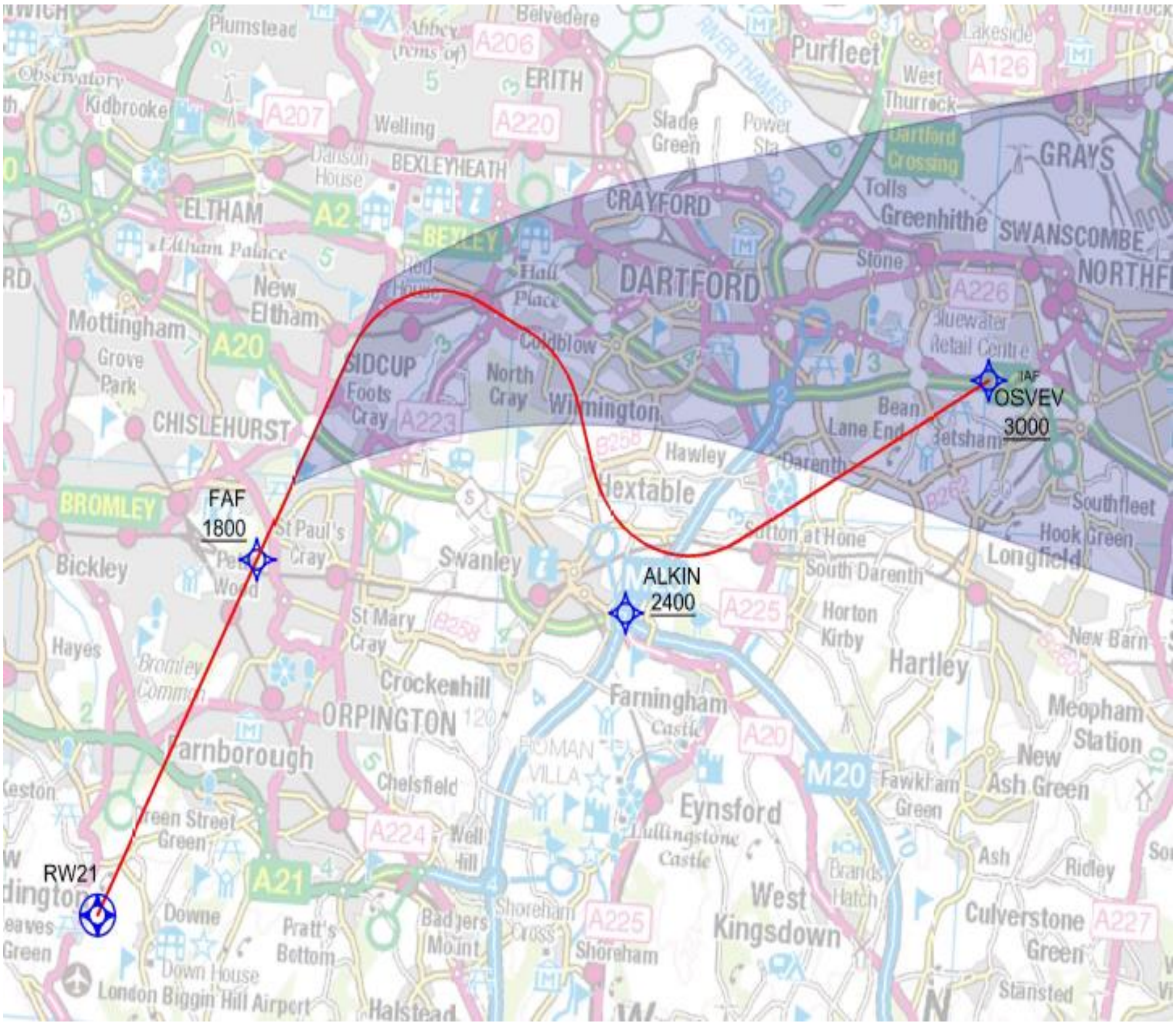

Figure 8 Option 2AD

A1.5 Option 2B

This option would be to replicate/mimic the current VOR/DME approach which starts from ALKIN. This assumes radar vectors by NATS from OSVEV to enable inbounds to exit the network using extant procedures, or radar vectors by NATS for inbounds from the MAP or the south. Exceptionally, if radar vectors were unavailable the aircraft could self-position. This reflects the current practice for the VOR/DME approach. The glideslope is at 3.2° for the full PBN design.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. The depiction shows aircraft arrival via the hold at ALKIN.

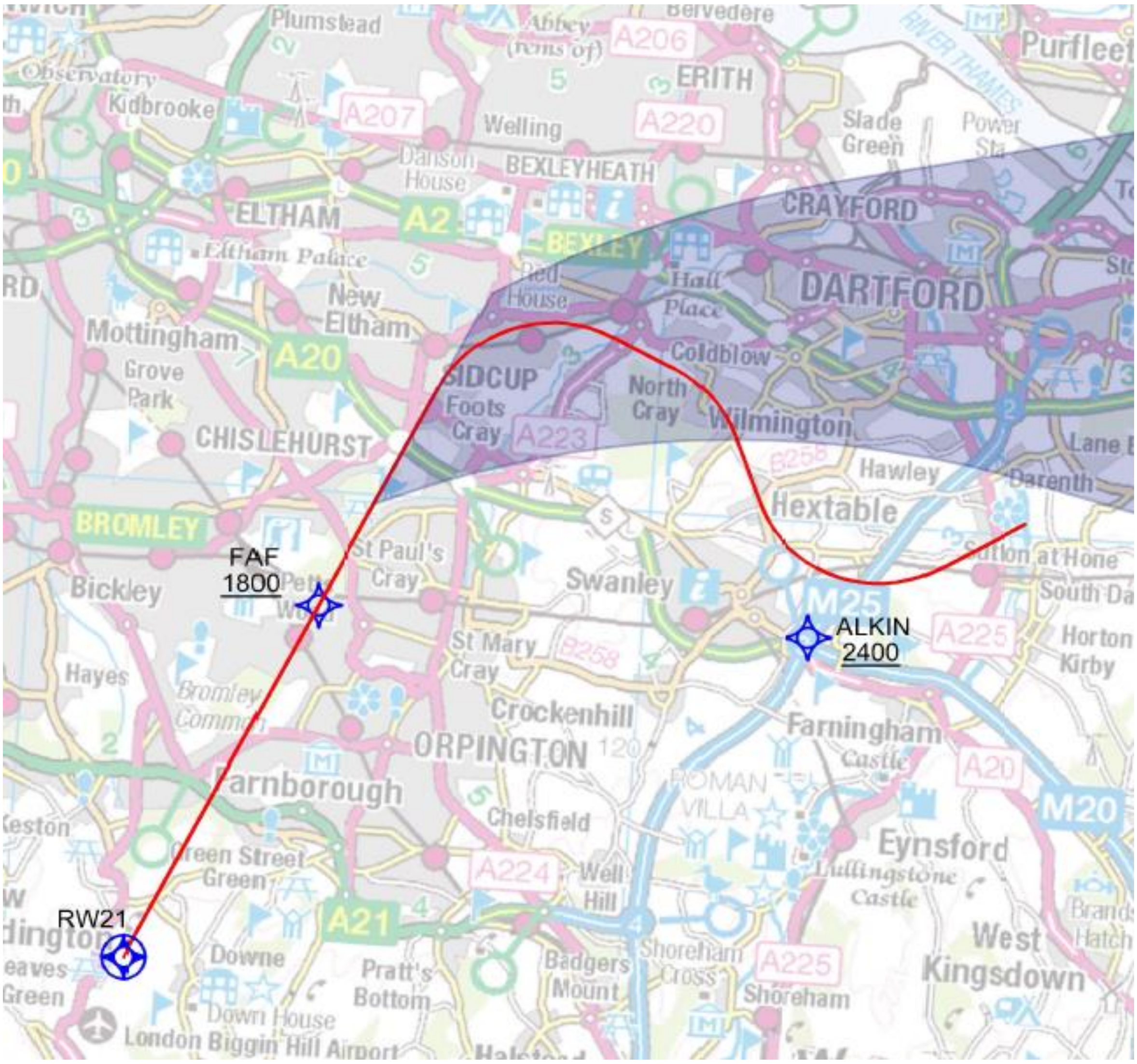

Figure 9 Option 2B

A1.6 Option 2BD

This option would be to replicate/mimic the current VOR/DME approach which starts from ALKIN and utilise a new direct link from OSVEV to enable inbounds to exit the network without radar vectors if necessary.

It is assumed that radar vectors by NATS will be available from OSVEV if necessary/requested, as is the current practice, and that radar vectors by NATS for inbounds from the MAP or the south will be available as they are today. Exceptionally, if radar vectors were unavailable the aircraft could self-position.

The glideslope is at 3.2° for the full PBN design.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors.

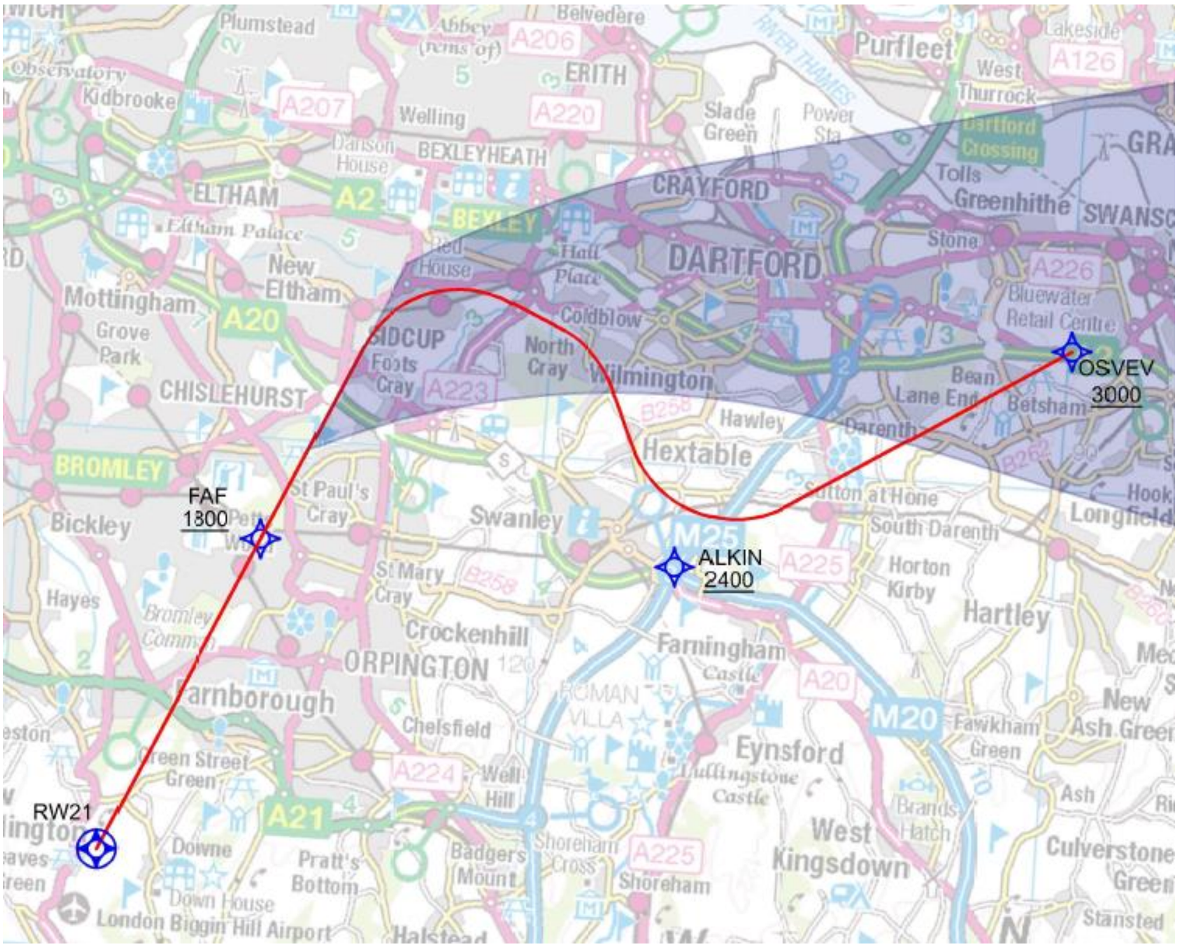

Figure 10 Option 2BD

A1.7 Option 2C

This option would be to replicate/mimic the current VOR/DME approach which starts from ALKIN. This assumes radar vectors by NATS from OSVEV to enable inbounds to exit the network using extant procedures, or radar vectors by NATS for inbounds from the MAP or the south. Exceptionally, if radar vectors were unavailable the aircraft could self-position. This reflects the current practice for the VOR/DME approach. The glideslope is at 3.5°.

The use of this option would require the ILS glideslope to also be increased, this would not change the lateral positioning.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. The depiction shows aircraft arrival via the hold at ALKIN.

Discontinued as it proved impossible to design within the constraints and criteria; it would not support the Statement of Need due to the unavailability and would introduce operational complexity.

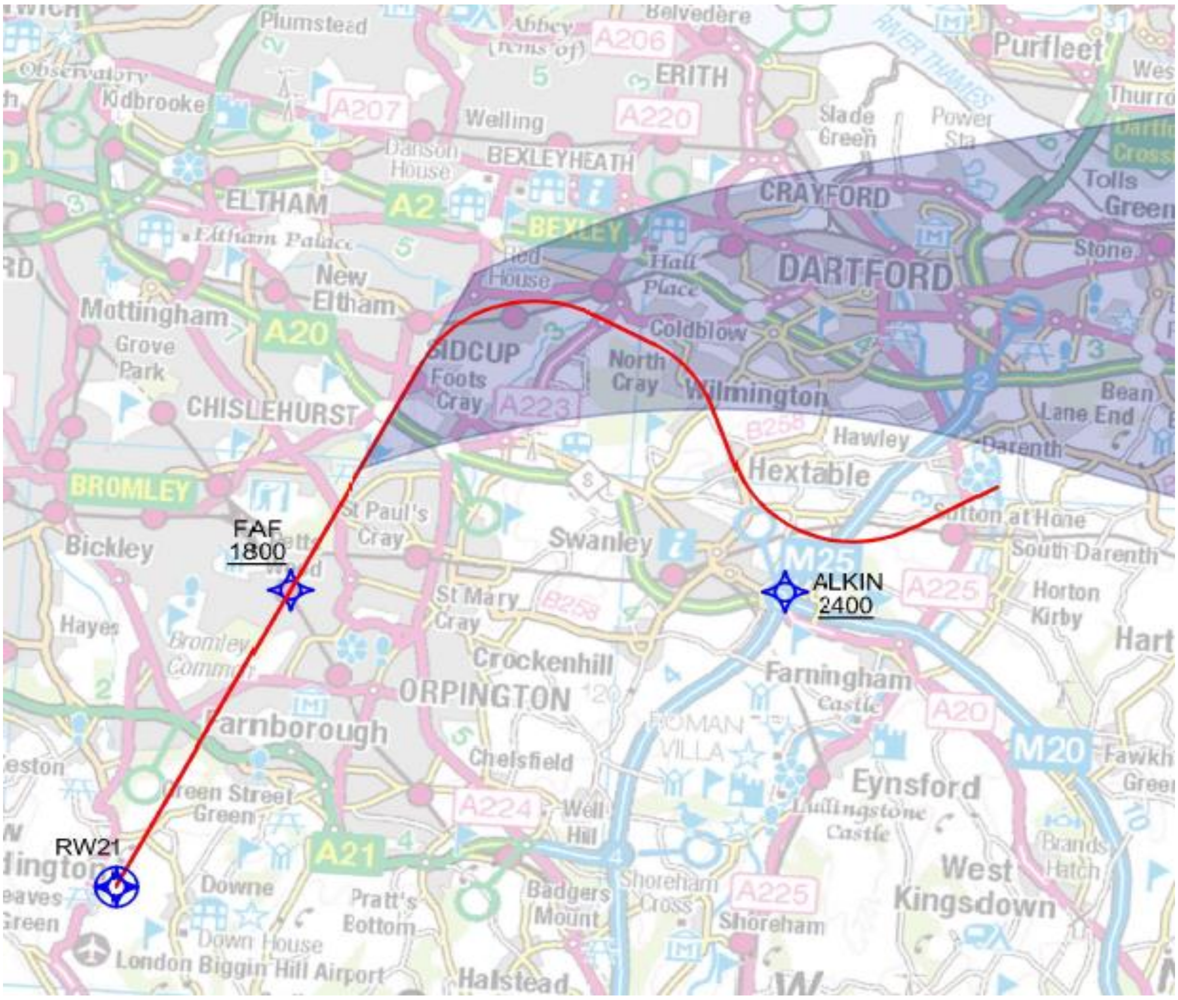

Figure 11 Option 2C

A1.8 Option 2CD

This option would be to replicate/mimic the current VOR/DME approach which starts from ALKIN and utilise a new direct link from OSVEV to enable inbounds to exit the network without radar vectors if necessary.

It is assumed that radar vectors by NATS will be available from OSVEV if necessary/requested, as is the current practice, and that radar vectors by NATS for inbounds from the MAP or the south will be available as they are today. Exceptionally, if radar vectors were unavailable the aircraft could self-position.

The glideslope is at 3.5°.

The use of this option would require the ILS glideslope to also be increased, this would not change the lateral positioning.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors.

Discontinued as it proved impossible to design within the constraints and criteria; it would not support the Statement of Need due to the unavailability and would introduce operational complexity.

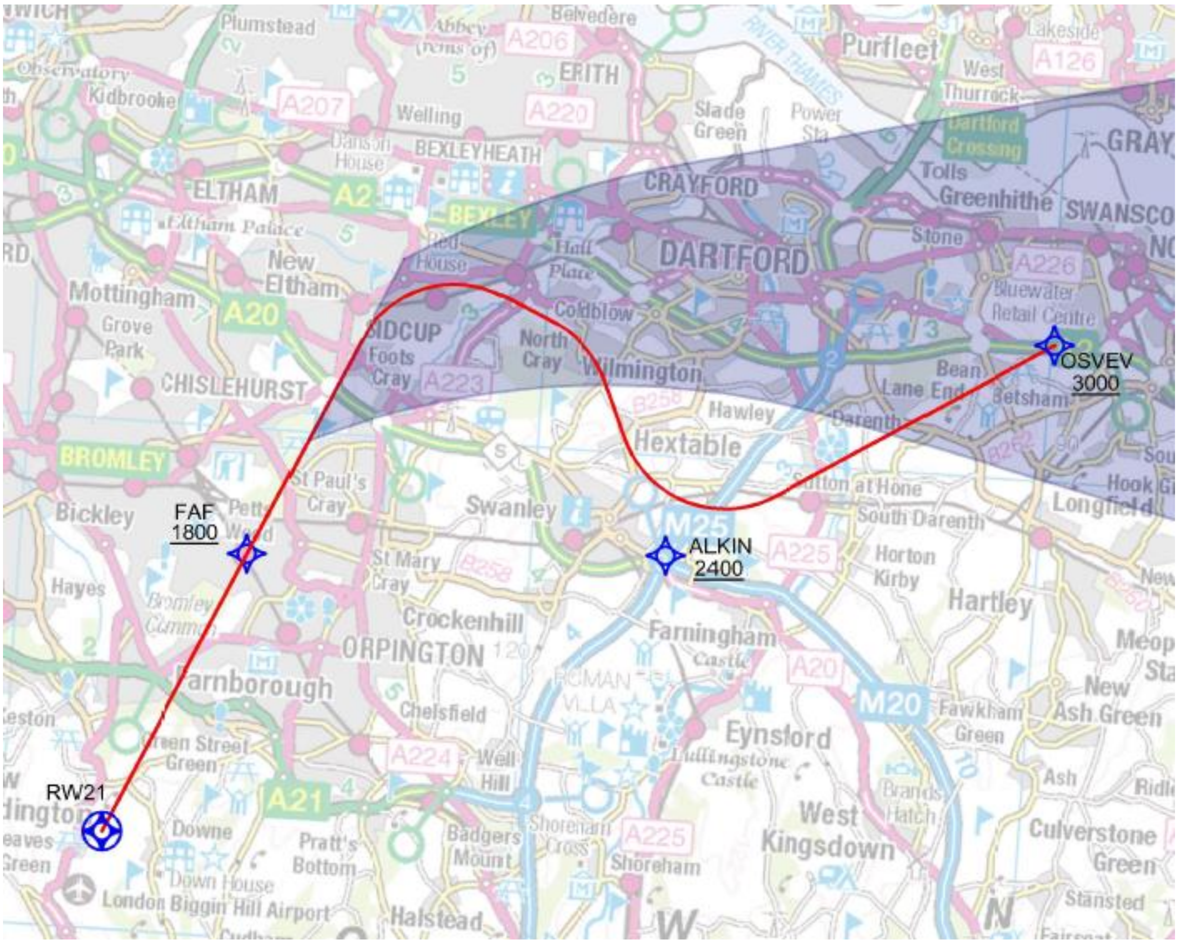

Figure 12 Option 2CD

A1.9 Option 3A/B/C

Laterally left of the current VOR plate, starting from ALKIN but remaining within current ILS vectoring swathe, final approach at 3°/3.2°/3.5°. This assumes radar vectors from OSVEV to enable inbounds to exit the network using extant procedures, or radar vectors by NATS for inbounds from the MAP as is the current practice for the VOR/DME approach.

Discontinued as it proved impossible to design within the constraints and criteria as it would result in a change to the positioning of aircraft as they prepared to land resulting in overflying new people, as shown by the red line in Figure 13 below.

A1.10 Option 4A/B/C

Laterally right of the current VOR plate, starting from ALKIN remaining within current ILS vectoring swathe final approach at 3°/3.2°/3.5°. This assumes radar vectors from OSVEV to enable inbounds to exit the network using extant procedures, or radar vectors by NATS for inbounds from the MAP as is the current practice for the VOR/DME approach.

Discontinued as it proved impossible to design within the constraints and criteria as it would result in a change to the positioning of aircraft as they prepared to land resulting in overflying new people, as shown by the green line in the Figure 13 below.

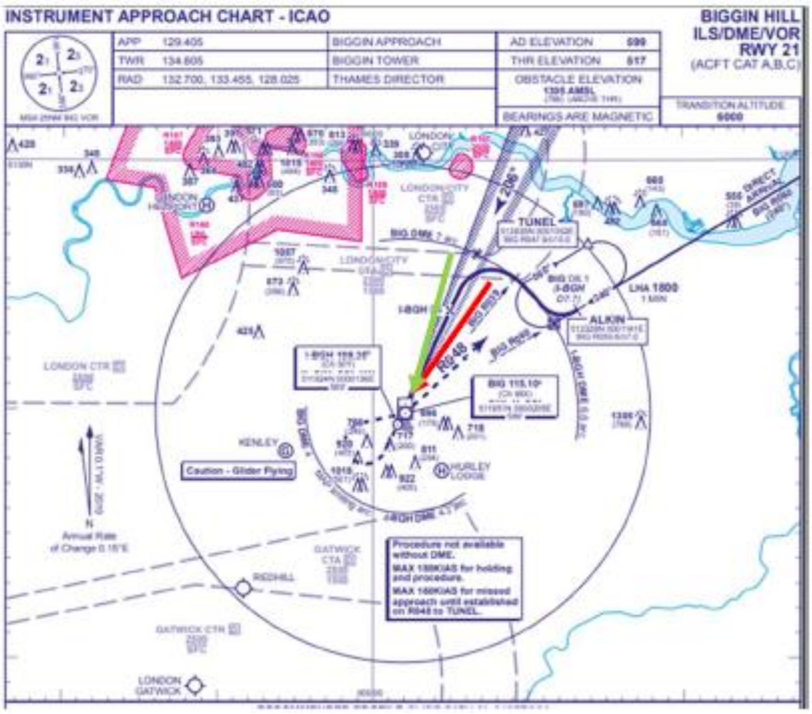

Figure 13 Option 3 and 4

A1.11 Option 5A/B/C

From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing through the centre of the current ILS vectoring swathe, final approach at varying angles.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. This option was developed to route as close to the centre of the swathe as possible.

Discontinued as it proved impossible to design within the constraints and criteria; it would introduce operational complexity and necessitate additional safety work to:

- understand the impact on London City operations due to the increased probability of dependent operations and increased controller workload.
- assess whether extant or new procedures could be utilised to exit the network at OSVEV.

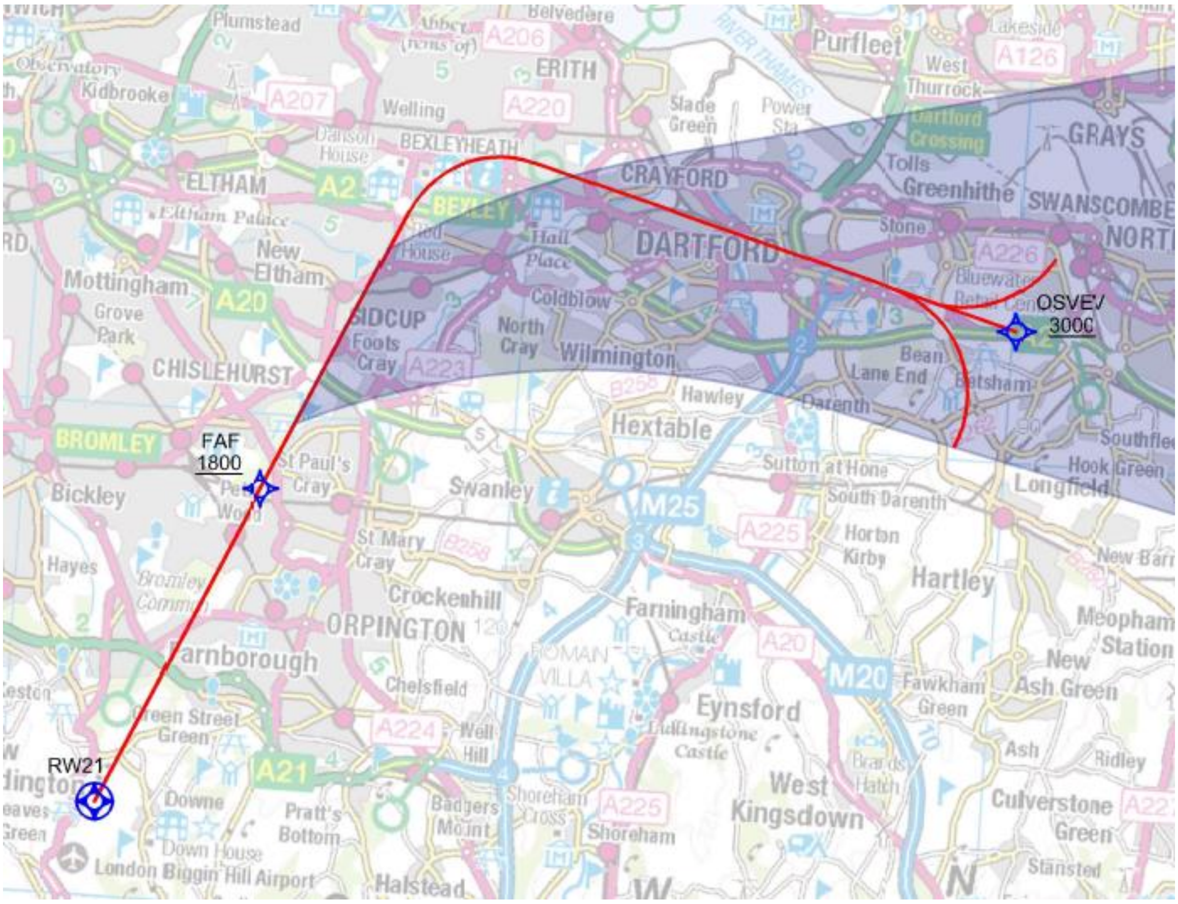

Figure 14 Option 5A

A1.12 Option 5AT/BT/CT

From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing through the centre of the current ILS vectoring swathe, with the addition of a new route positioned from the north/northeast. Final approach at varying angles. The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. This option was developed to route as close to the centre of the swathe as possible.

Discontinued as it proved impossible to design within the constraints and criteria; it would introduce operational complexity and necessitate additional safety work to:

- understand the impact on London City operations due to the increased probability of dependent operations and increased controller workload.
- assess whether extant or new procedures could be utilised to exit the network at OSVEV.
- Understand the limited availability of the IAF North and associated complex operational scenarios.

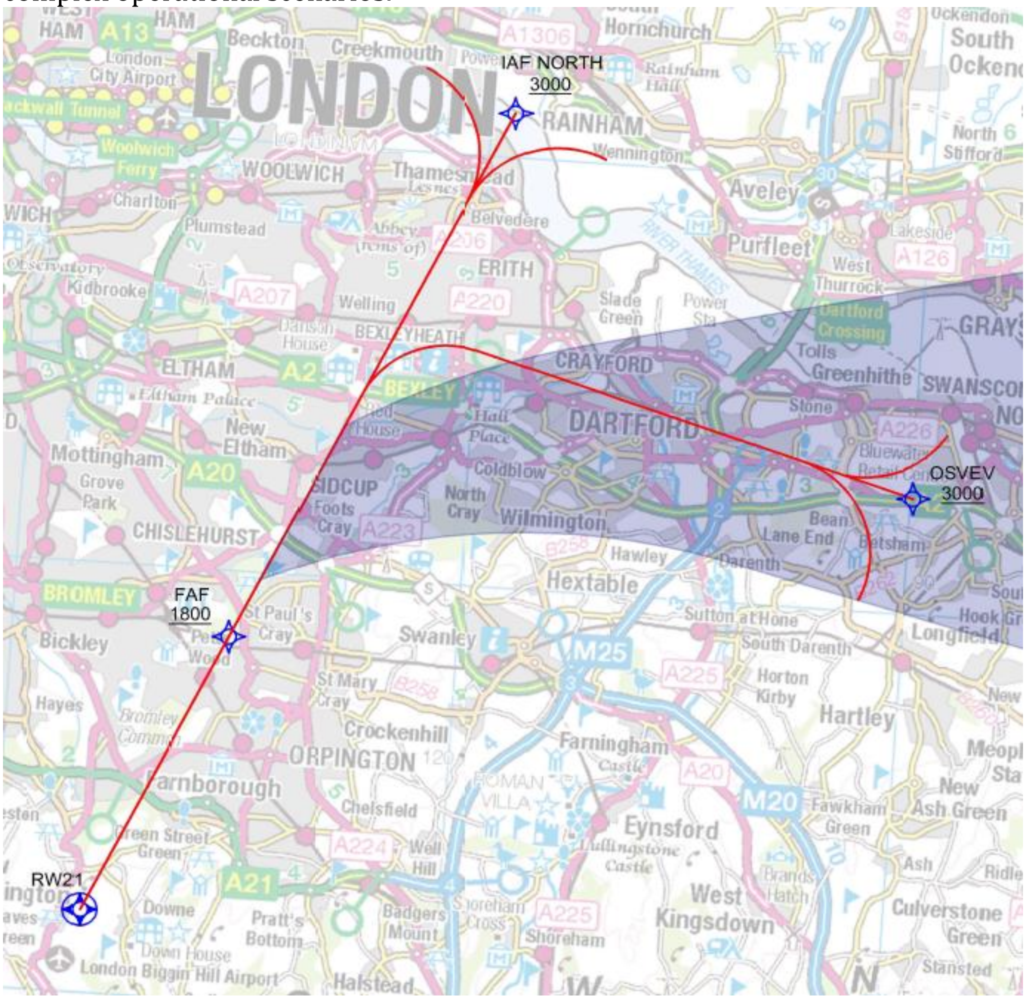

Figure 15 Option 5AT

A1.13 Option 6A/B/C

From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing down the left of the current ILS vectoring swathe, final approach at varying angles.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors.

Unable to route further left (which means this is the furthest south possible) due to the PBN design criteria.

Discontinued as it proved impossible to link this design with an ALKIN MAP hold (other hold options not possible due to the constraints of adjacent airspace/operations). Additionally, this option would require safety analysis to assess whether extant or new procedures could be utilised to exit the network at OSVEV.

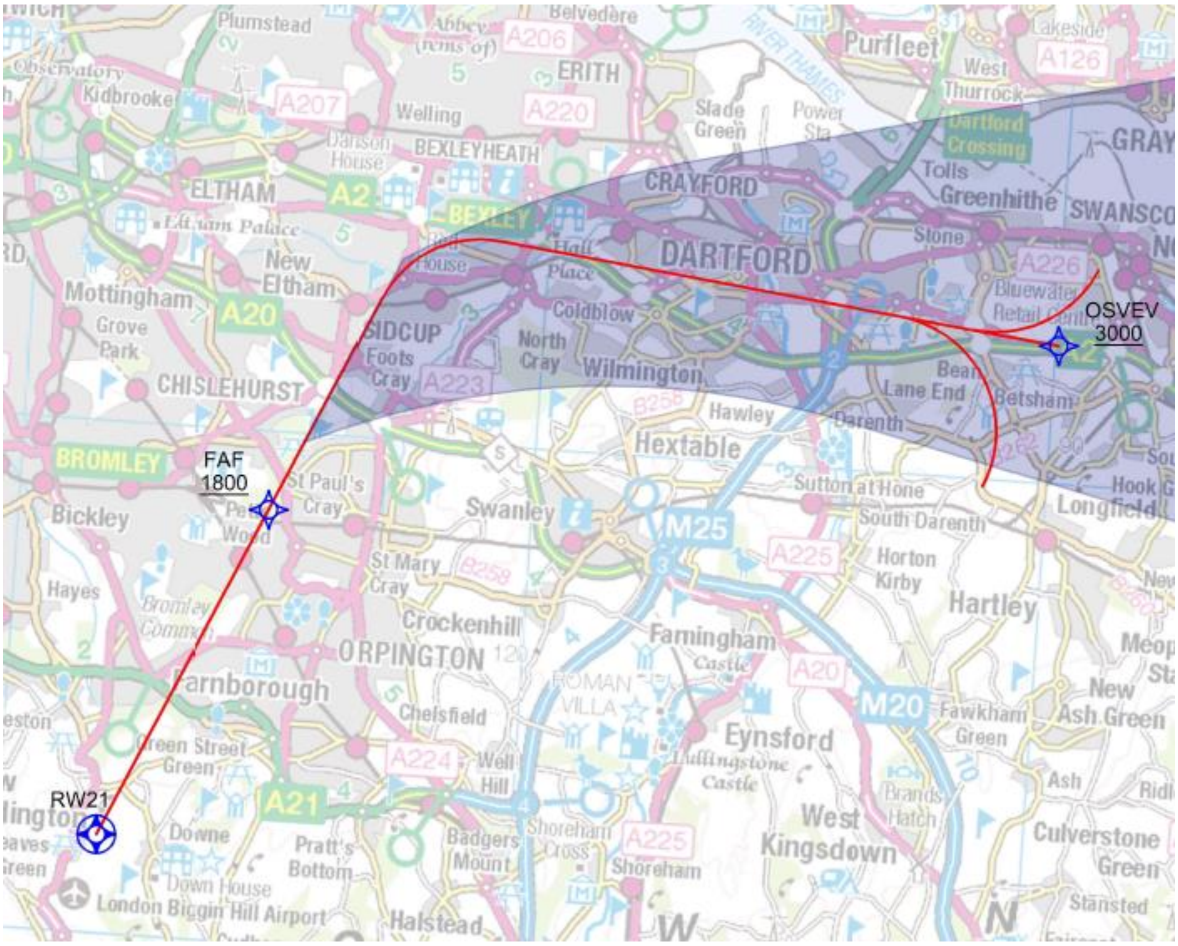

Figure 16 Option 6A

A1.14 Option 6AT/BT/CT

From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing down the left of the current ILS vectoring swathe, with the addition of a new route positioned from the north/northeast. Final approach at 3°. The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. Unable to route further left (which means this is the furthest south possible) due to the design criteria.

Discontinued as it proved impossible to design within the constraints and criteria, this option cannot be utilised from the ALKIN hold (other hold options not possible due to the constraints of adjacent airspace/operations). Additionally, it would introduce operational complexity and necessitate additional safety work to:

- understand the impact on London City operations due to the increased probability of dependent operations and increased controller workload.
- assess whether extant or new procedures could be utilised to exit the network at OSVEV.
- Understand the limited availability of the IAF North and associated complex operational scenarios.

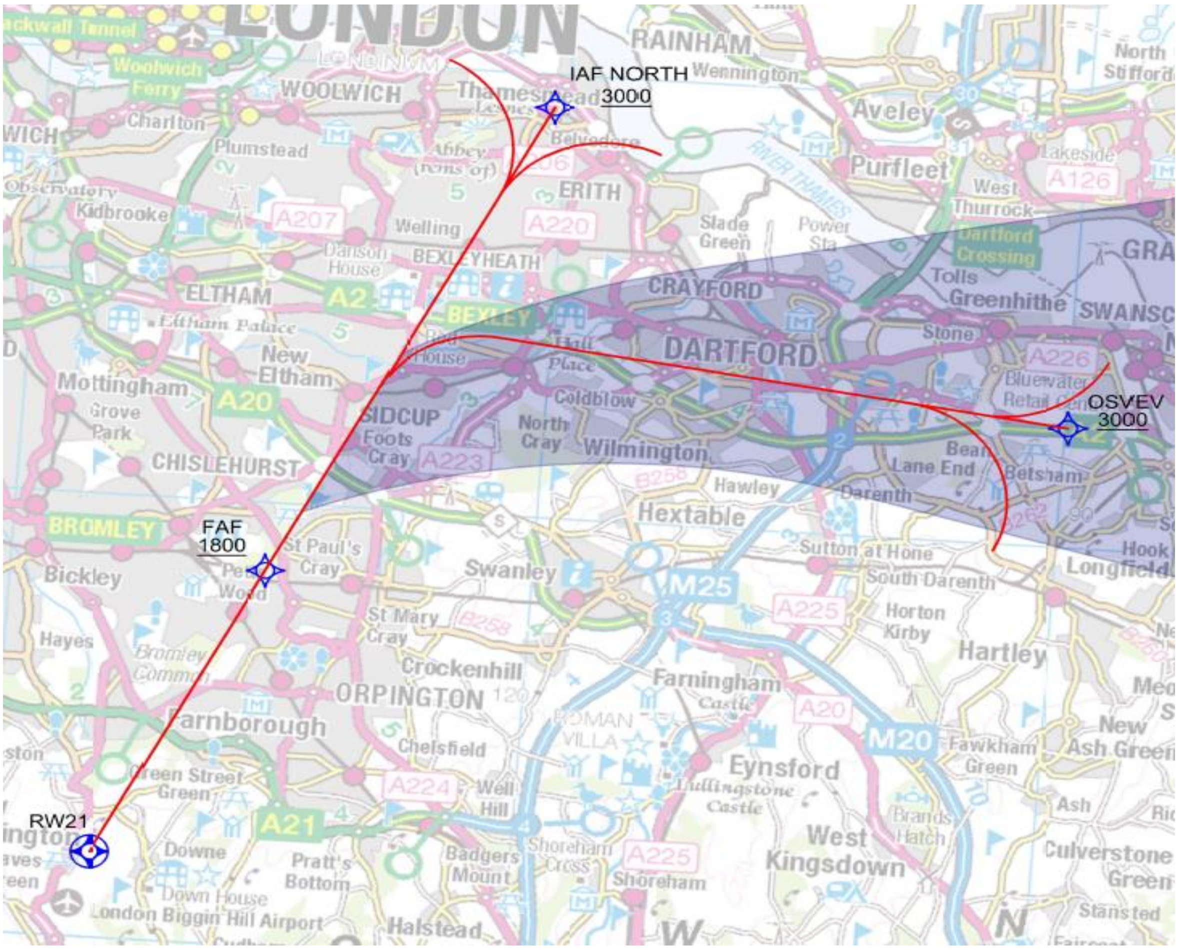

Figure 17 Option 6AT

A1.15 Option 7A/B/C

From OSVEV and ignoring ALKIN, to enable inbounds to exit the network, routing down the right of the current ILS vectoring swathe, final approach at various angles.

The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors.

Unable to route further right (which means this is the furthest north possible) due to the design criteria.

Discontinued as it proved impossible to design within the constraints and criteria; it would introduce operational complexity and necessitate additional safety work to:

- understand the impact on London City operations due to the increased probability of dependent operations and increased controller workload.
- assess whether extant or new procedures could be utilised to exit the network at OSVEV.

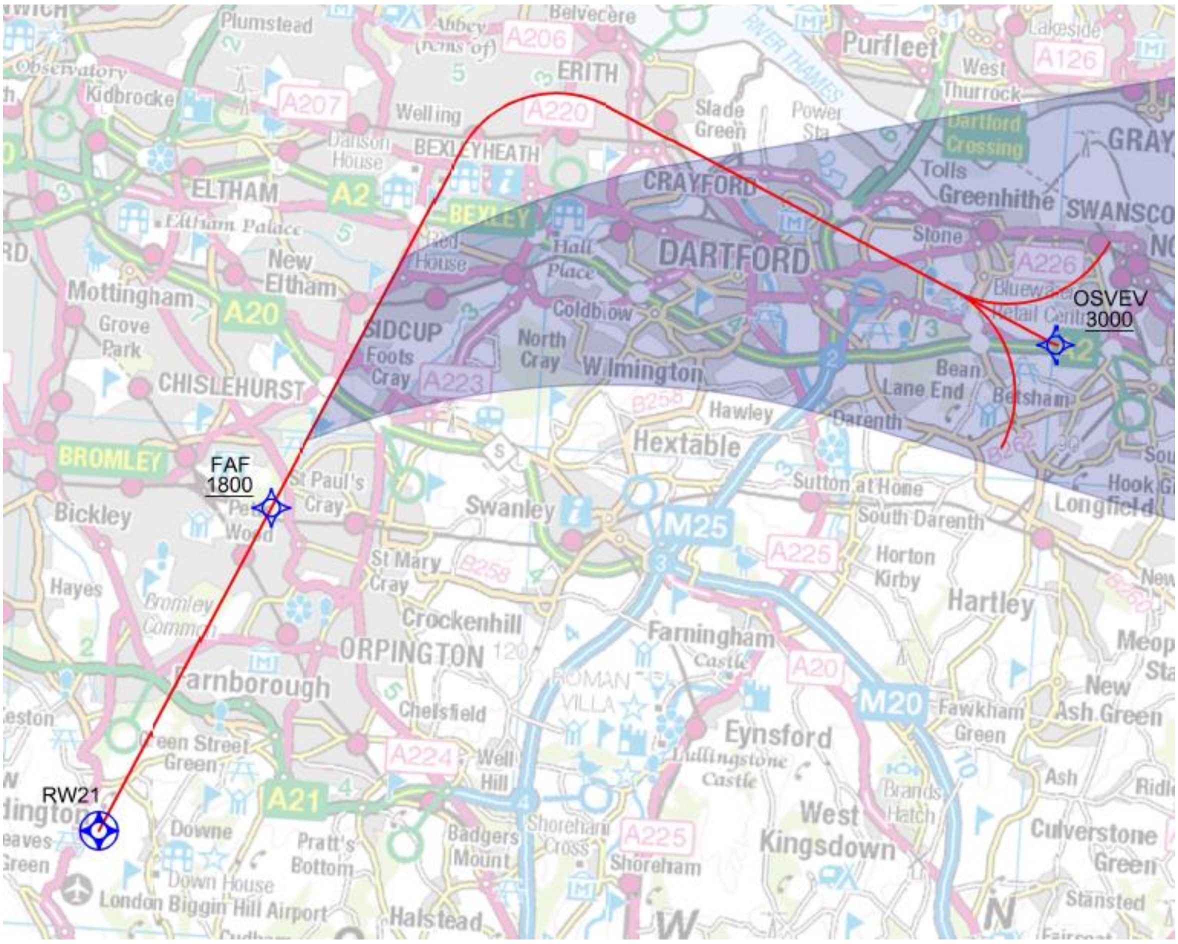

Figure 18 Option 7A

A1.16 Option 7AT/BT/CT

From OSVEV and ignoring ALKIN, to enable inbounds to exit the network routing down the right of the current ILS vectoring swathe, with the addition of a new route positioned from the north/northeast. Final approach at various angles. The shaded area shows the position of the vast majority of the current arrivals of all types receiving radar vectors. The use of this option would require the ILS glideslope to also be increased. This would not change the lateral positioning. Unable to route further right (which means this is the furthest north possible) due to the design criteria.

Discontinued as it proved impossible to design within the constraints and criteria; it would introduce operational complexity and necessitate additional safety work to:

- understand the impact on London City operations due to the increased probability of dependent operations and increased controller workload.
- assess whether extant or new procedures could be utilised to exit the network at OSVEV.
- Understand the limited availability of the IAF North and associated complex operational scenarios.

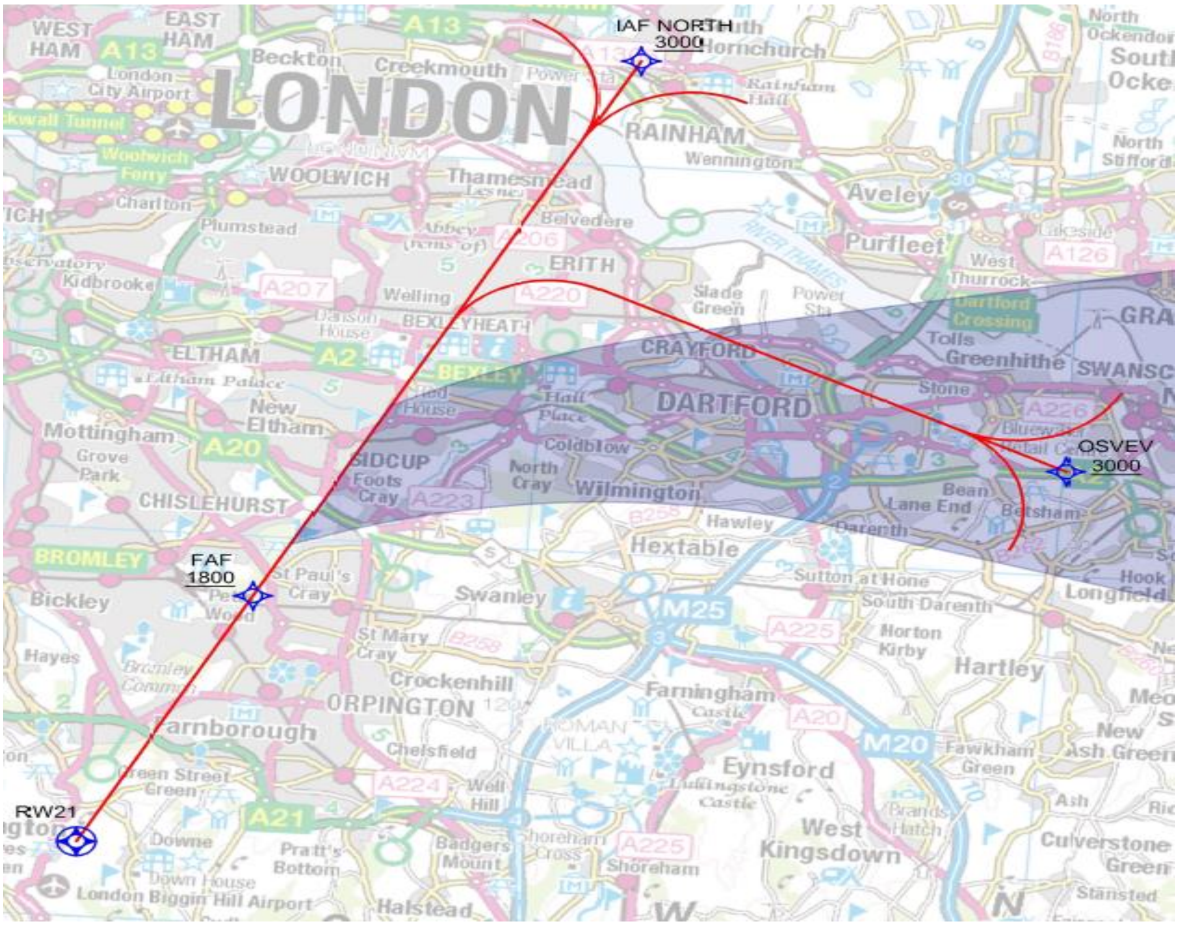

Figure 19 Option 7AT

A1.17 Option 8 MAP Do Nothing

This is only possible with Option 1. The removal of the VOR will necessitate a different MAP. Therefore this is not an option to progress.

A1.18 Option 9 MAP

Mimic the current right turn MAP to ALKIN (via the LBHA overhead), although with different protection areas due to the PBN design criteria, and then radar vectors from NATS/ or follow the procedural approach from ALKIN.

This MAP would also become the ILS MAP.

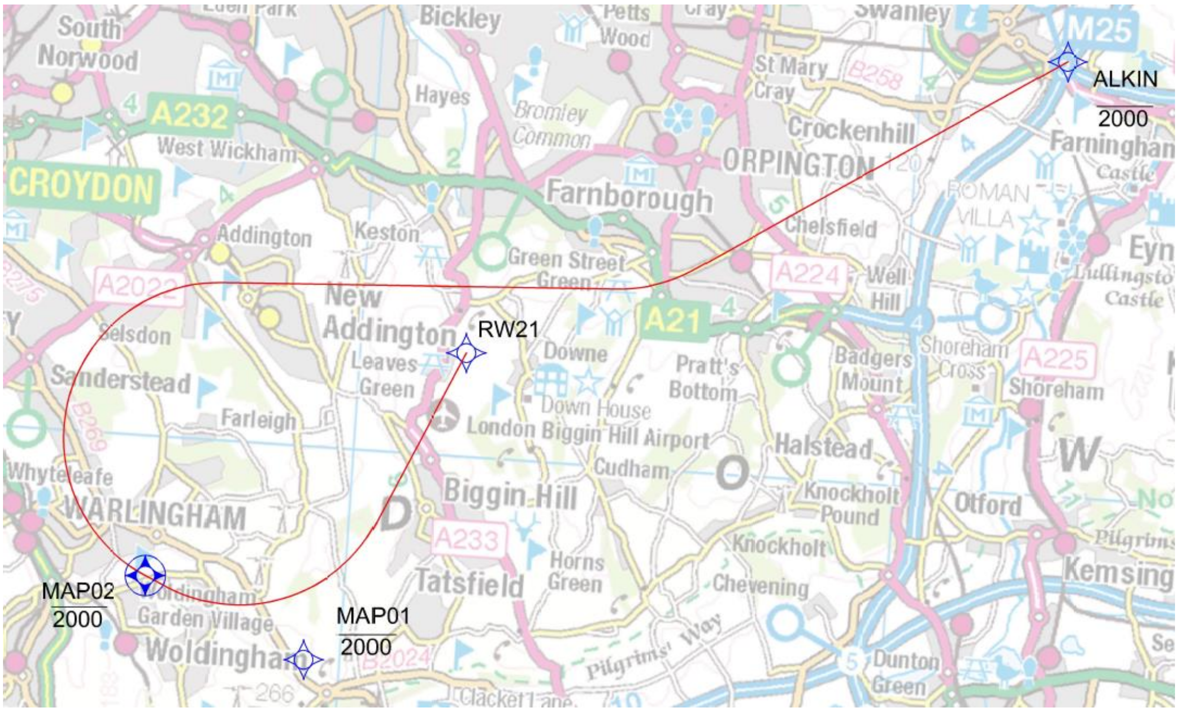

Figure 20 Option 9

A1.19 Option 10

Most efficient left turn out back to ALKIN.

This MAP would also become the ILS MAP.

Discontinued as it proved impossible to design within the constraints and criteria; it would introduce operational complexity and necessitate additional safety work to understand the impact on Gatwick operations as it penetrates the Gatwick control zone and is likely to adversely impact runway 08 departures and runway 26 arrivals.

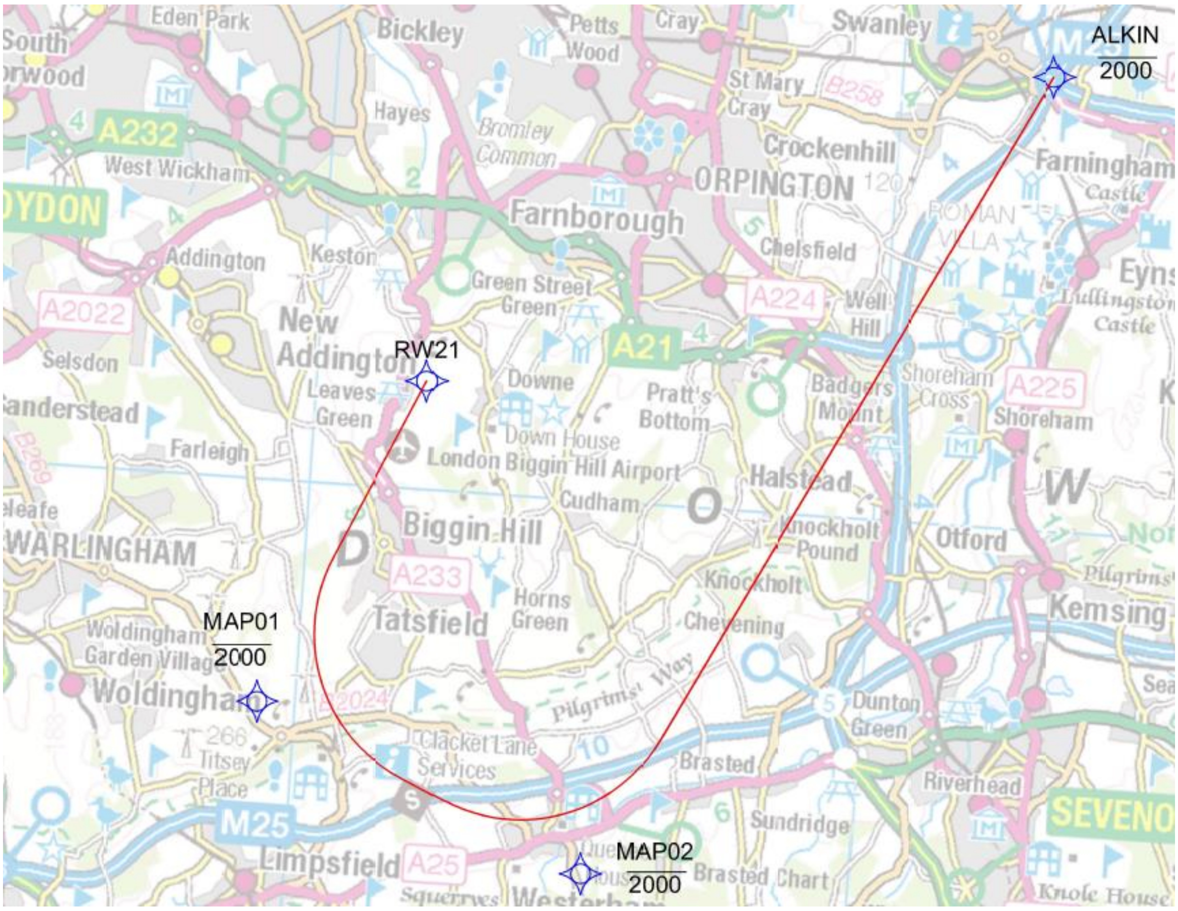

Figure 21 Option 10

A1.20 Option 11

Most efficient right turn out back to ALKIN.

This MAP would also become the ILS MAP.

Discontinued as it proved impossible to design within the constraints and criteria; it would introduce operational complexity and necessitate additional safety work to understand the impact on Gatwick operations due to the position of the first turn. Additionally this would add operational complexity due to the overflight of the arrival path, resulting in following inbound aircraft being unable to descend until the MAP aircraft provides the required lateral separation.

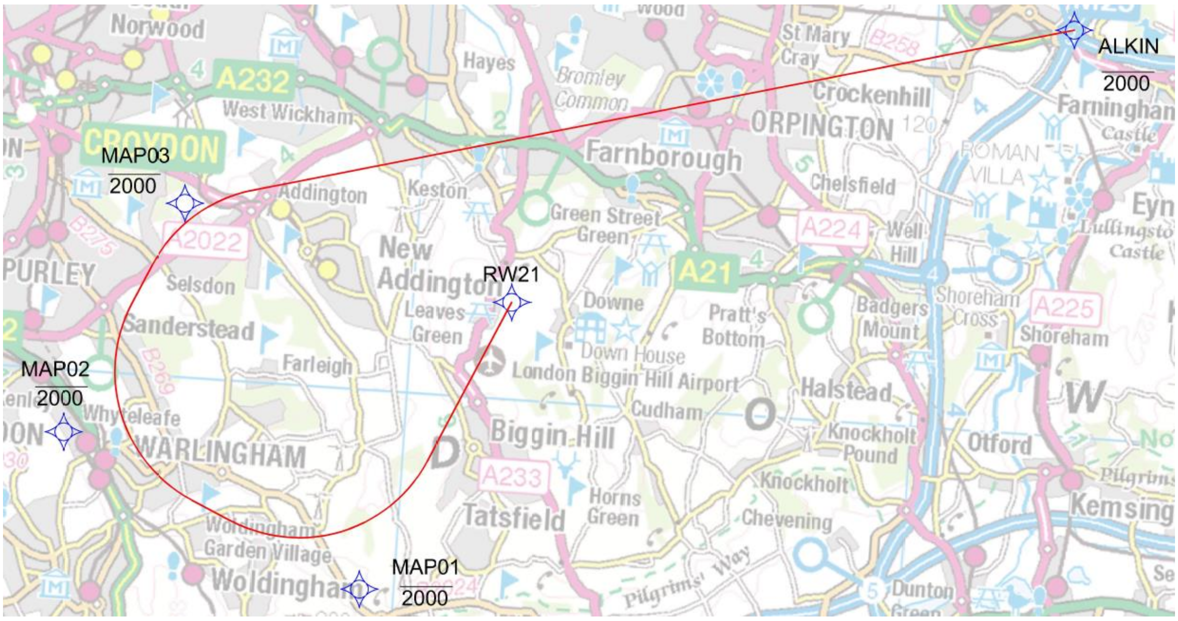

Figure 22 Option 11

A1.21 Option 12

Developed from stakeholder feedback received during the engagement period, an option to avoid RAF Kenley similar, laterally, to the same procedure for Runway 03.

This MAP would also become the ILS MAP.

Discontinued as it did not meet the criteria of avoiding the overflight of populations not previously overflown, or minimising track miles/fuel.

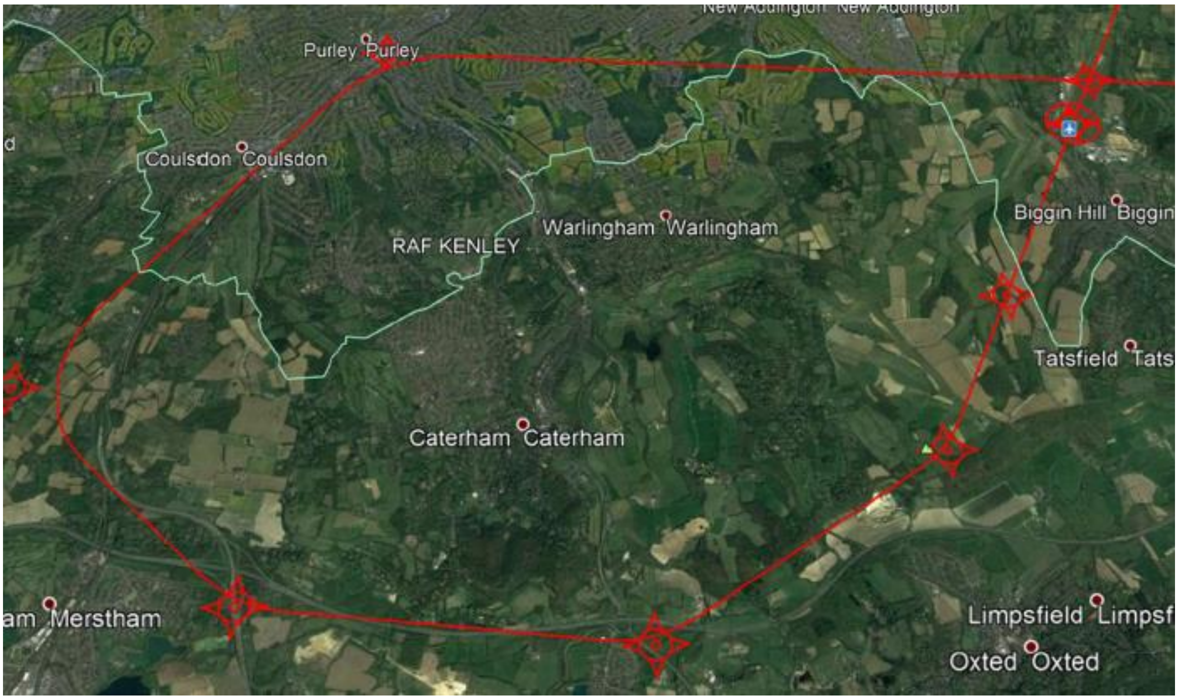

Figure 23 Option 12