Glasgow Airport
FASI-N Airspace Change Proposal
Step 2B
Initial Options Appraisal

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Figures and Tables

1. Introduction

Airspace Modernisation Strategy

Following the publication of the strategic rationale for airspace modernisation[1], the Government directed the Civil Aviation Authority (CAA) to "prepare and maintain a coordinated strategy and plan for the use of UK airspace up to 2040, including its modernisation". As a result, in 2018 the CAA published the Airspace Modernisation Strategy (AMS)[2], which replaced the earlier 2011 Future Airspace Strategy. The AMS sets out the initiatives required to modernise the existing Airspace System by upgrading the airspace design, technology, and operations. The CAA is in the process of reviewing the AMS and expects to publish an updated version of the strategy in early 2022.

One of the most important initiatives required to achieve the AMS objective is known as FASI (Future Airspace Strategy Implementation). 21 airports in the UK comprise FASI and Glasgow Airport is one of them. This FASI initiative is considered the UK's Airspace Change National Infrastructure Programme (the Programme). The Programme encompasses the requirement to fundamentally redesign the National Airspace System at lower altitudes and in the terminal airspace that serves commercial air transport across the busiest regions of the UK, making the most of the capabilities of modern aircraft and satellite-based navigation technology. These airspace design projects are sponsored by the 21 airports (for the local arrival and departure routes below 7000ft) and by NERL (for the airspace structures and route network above 7000ft).

Performance Based Navigation (PBN)

Today's national route network is designed with reference to a grid of ground navigation beacons distributed across the UK. Some of these beacons are outdated and reaching their end of life. Meanwhile, 99% of the current commercial air transport fleet operates almost exclusively using avionics that rely on satellite navigation. Aircraft are able to follow routes designed to satellite navigation standards (known as Performance-based Navigation or PBN) with greater precision than conventional ground navigation. The widespread deployment of routes designed to satellite navigation standards is a cornerstone of airspace modernisation. The opportunity to design a new network of PBN routes with far greater accuracy and flexibility offers the potential to address many of the issues set out in the Government's strategic rationale. Significant improvements in airspace capacity and efficiency can be achieved by positioning routes so that they are safely separated and optimised by design.

Whilst more precise routes can be used to avoid noise sensitive areas, they may also concentrate the impacts of overflight. For this reason, the use of multiple route options that can distribute the impacts more equitably, or be configured to offer predictable relief from noise, must be considered in consultation with local stakeholders when routes are being developed for deployment at lower altitudes.

Airspace Change Organising Group (ACOG) and the Masterplan

The number, complexity and overlapping scope of the individual Airspace Change Proposals (ACPs) needed to deliver the Programme requires a strategic coordination mechanism in the form of a single joined up implementation plan or Masterplan.

Given the large number of organisations involved (21 airports and NATS EnRoute Limited (NERL)), the CAA and Department for Transport (DfT) also required NERL to set up an impartial body, The Airspace Change Organising Group (ACOG) to develop a Masterplan, coordinate the Programme and lead the necessary engagement with external stakeholders. In this context, ACOG was established in 2019 as a unit within NERL, separate and impartial from the organisation's other functions.

Masterplan Iteration 2[3] was accepted by CAA on 27th January 2022. The purpose of Iteration 2 is to provide a system-wide view of the scope of the constituent ACPs and identify the potential interdependencies between the proposals. Collectively, the ACPs that are included in the Masterplan are referred to as the 'constituent airspace change proposals'. Each individual ACP is developed following the same detailed process steps laid out in the CAA's guidance for changing the airspace design – known as CAP1616[4]. The CAA evaluates the progress of every ACP through each stage of the process, via a series of (seven) regulatory gateways and make decisions on whether to approve further development and ultimately the implementation of the proposed changes. A summary of the CAP1616 process is available in the next section.

Iteration 2 places Glasgow Airport in the 'STMA regional cluster' alongside Edinburgh and Aberdeen Airports and the NATS Scottish TMA.

Our Airspace Change

Glasgow Airport Limited (GAL) began their ACP to modernise their airspace in June 2019 and passed through Stage 1 of CAP1616 in December 2019. Shortly after this, the project and much of the wider Programme was paused due to COVID-19 pandemic whilst the aviation industry focussed on managing the pandemic and its recovery from it. The Programme was remobilised in March 2021 following the provision of DfT grant funding, allowing GAL to recommence their ACP in May 2021.

This document forms part of the GAL Stage 2 submission to the CAA. It takes the options that progressed from the Design Principle Evaluation at Step2A and undertakes a more rigorous qualitative appraisal of their benefits and impacts as part of what's called an Initial Options Appraisal (IOA). The IOA is the first of three appraisals that will take place as part of the Airspace Change Process with each appraisal increasing in quantitative analysis.

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, our design principles, our appraisals and stakeholder engagement and consultation with all our stakeholders.

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1.1. CAP1616

In December 2017 the Civil Aviation Authority (CAA) published CAP1616[5] Airspace Design: Guidance on the regulatory process for changing airspace design, including community engagement requirements. The guidance sets out the process for the airspace change process, which a change sponsor of any permanent change to the published airspace design must follow. The airspace change process is split into 7 Stages;

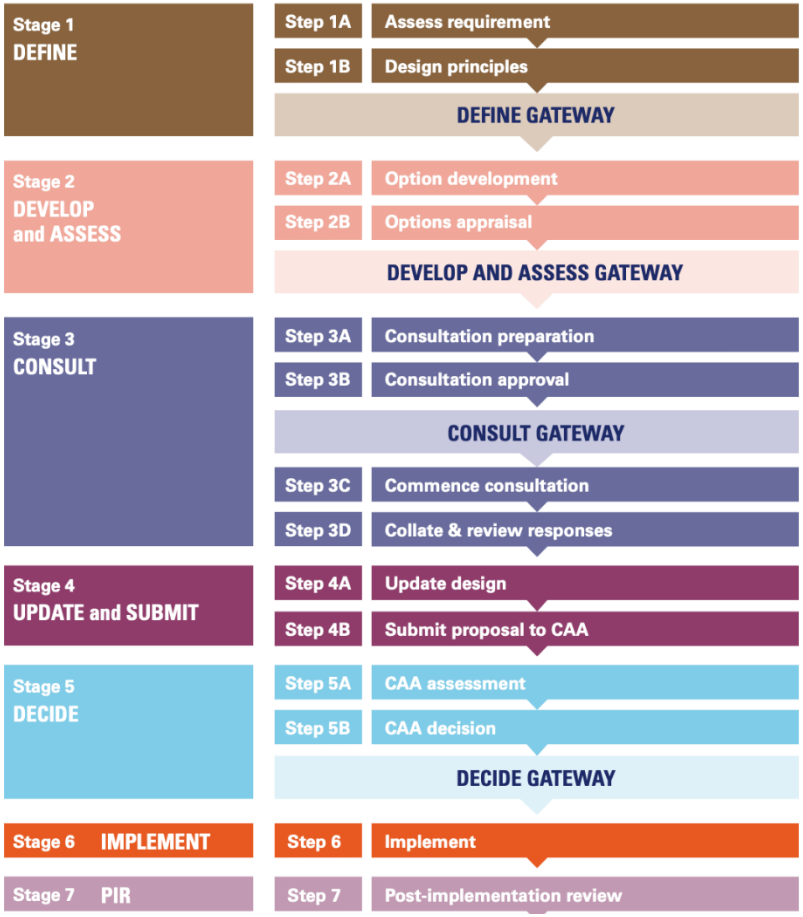


Figure 1 CAP1616 7 Stages

1.2. Glasgow Airspace Change Proposal

This Airspace Change Proposal is required to follow the CAP1616 process detailed in the section above. Table 1 below summarises the CAP1616 stages already undertaken for this ACP and the stage where we are at now, providing links to previous submission documents with further information.

Table 1 ACP progress to date

Airspace Change Stage	Summary	Link to Documents (Also available on the ACP portal)
Stage 1A	In June 2019, Glasgow Airport submitted their following statement of need (SoN) to the CAA	Statement of Need on CAA's Airspace Change Portal
	Glasgow Airport participated in an assessment meeting with the CAA on the 18th June 2019 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.	Assessment meeting minutes
Stage 1B	At Stage 1B Glasgow developed a set of design principles with identified Stakeholders. The aim of the design principles is to provide high-level criteria that the proposed airspace design options should meet. They also provide a means of analysing the impact of different design options and a framework for choosing between or prioritising options. The final design principles outlined within the Stage 1B submission.	Stage 1B Design Principle Submission Report
Stage 2A	Stage 2A requires change sponsors to develop and assess options for the airspace change. In Stage 2A, the change sponsor develops a comprehensive list of options that address the Statement of Need and that align with the design principles from Stage 1. We then share those options with our Stakeholder representatives (the same ones engaged with on the Design Principles). Feedback from the engagement may then be used to refine and/or generate further options where feasible at this stage or later in the process. Finally, we qualitatively assess all options developed against the Design Principles and produce a Design Principle Evaluation (DPE). Our comprehensive list of options is then shortlisted before progressing to Stage 2B. Our Stage 2A document provides details of this process, and our shortlisted options following the DPE. Our shortlist is also shown in the 'Overview of options under assessment' part of this document.	Stage 2A DPE Submission Document
Stage 2B	At Stage 2B an Airspace Change Sponsor is required to undertake an Initial Options Appraisal (IOA) of the airspace change options which proceed from Stage 2A. This is where we are now. The following sections of the document initially describe the options under assessment and the baseline option, followed by explaining the methodology used to assess each option, and then the IOA outcome. At the end of the document we explain, based on the IOA, the options which we intend to take forward to Stage 3 and our preferred option(s).	This document

2. Overview of options under assessment

Our comprehensive list of options included 32 options. These are split into easterlies and westerlies, arrivals, and departures.

As part of Stage 2A, we undertook a Design Principle Evaluation where we evaluated each option against each Design Principle. This was the first opportunity to shortlist options before we progress to this IOA. The outcome of our Stage 2A Design Principle Evaluation was that some options were discontinued including the baseline 'Do Nothing' options.

Although the 4 baseline 'do nothing' scenarios (easterly departures, easterly arrivals, westerly departures, and westerly arrivals) did not progress as options, CAP1616 requires the baseline scenario to be appraised in this IOA as it provides a means of testing the options against the current day operations to better understand and highlight the benefits and impacts of each new option. The baseline will also continue to be appraised as part of the Full Options Appraisal and Final Options Appraisal at Stage 3 and Stage 4.

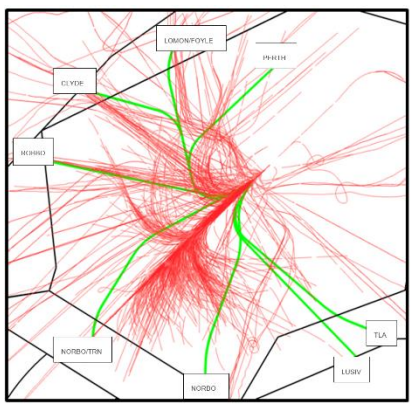
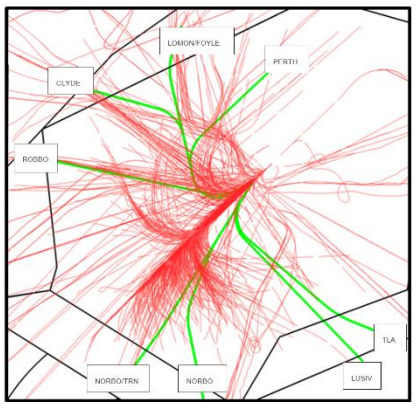
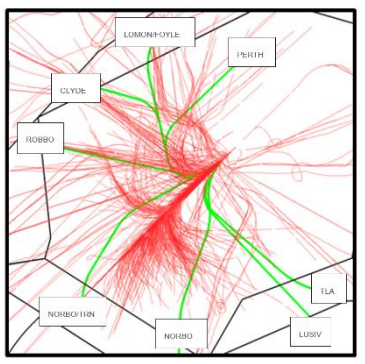
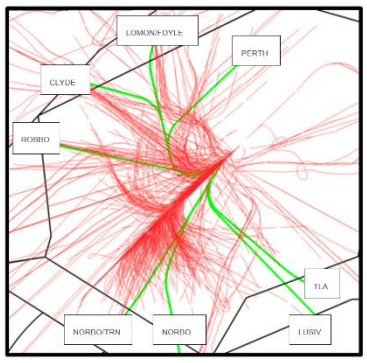
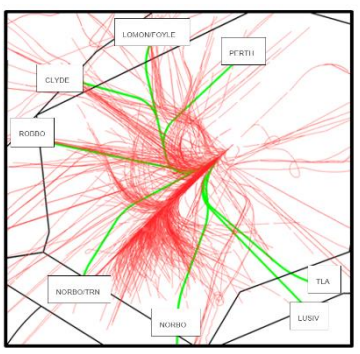
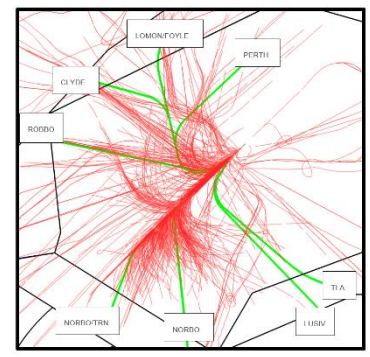
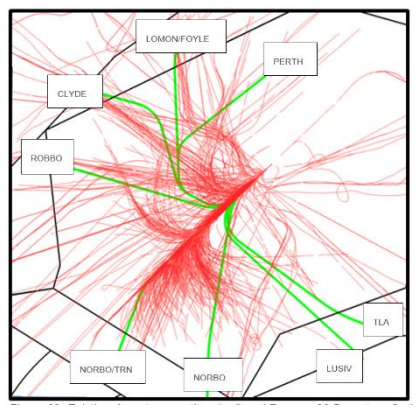
Use of pure PBN for arrivals into Glasgow did not perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. However, the option of a mix of PBN and vectoring does come through very favourable. In this scenario, we would want to use the best performing PBN routes, so we have taken the remaining PBN arrival options into the Initial Options Appraisal for further assessment.

The following sections summarise the airspace change options we have taken through to this IOA. More information about how we have developed and evaluated these options is available in our Stage 2A submission document on the CAA Airspace Change Portal. The Initial Options Appraisal section of this document and technical appendix A also contain larger images and a more details of each option.

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, our design principles, our appraisals and stakeholder engagement and consultation.

2.1. Runway 23 Westerly Departures

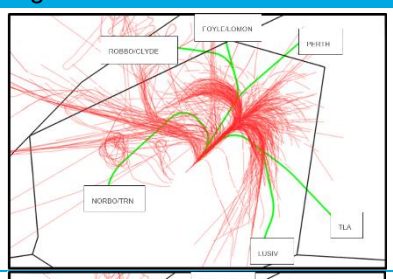
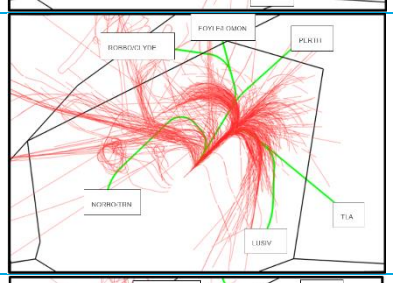
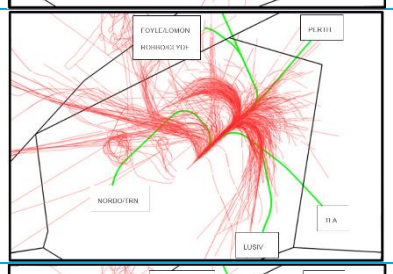
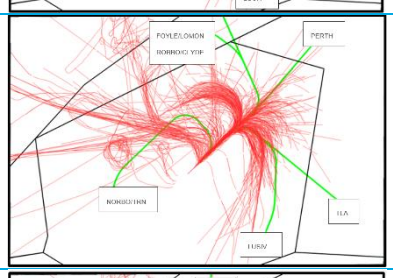
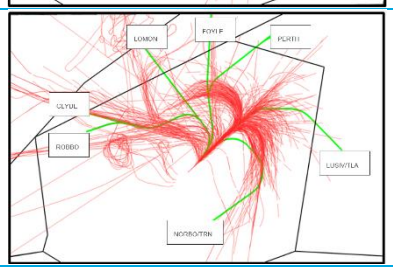
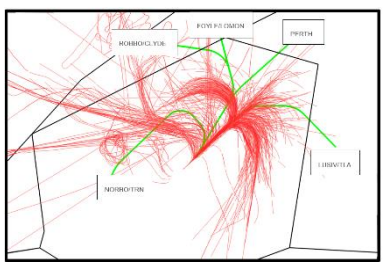
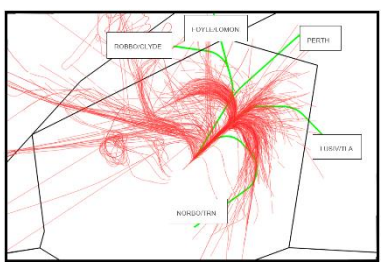
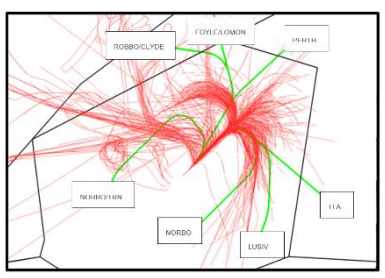
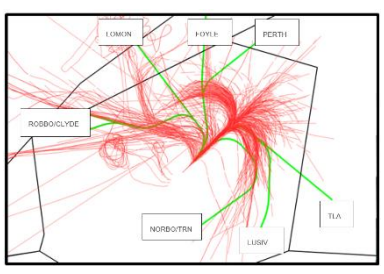
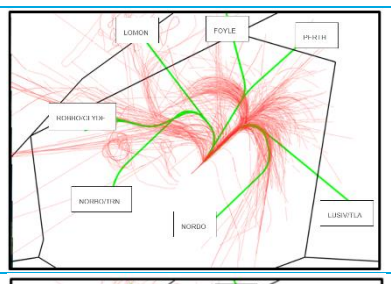
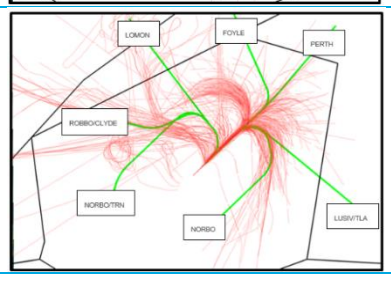
Table 2 Runway 23 Westerly Departure Options

Option name	Summary	Image
RWY 23 Dep Option A	Offset right departures with turns at 2nm and 7nm from the runway. Offset left departures with turns at 1nm from the runway. NORBO traffic is shared between a left turn departure route and the departure route that offsets right and then turns left at 7nm with both routes available at the same time.	
RWY 23 Dep Option B	Offset right departures with turns at 2nm from the runway. Offset left departures with turns at 1nm and 5nm from the runway. NORBO traffic is shared between two departure routes however they are the same route until 5nm from the runway.	
RWY 23 Dep Option C	This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use different flight path which offsets to the left, with the rest of the routes remaining the same.	 
RWY 23 Dep Option D	This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure periods. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a different flight path which follows a straight line from the runway until splitting at 5nm, with the rest of the routes remaining the same. This option is similar to Option C except that the non-peak NORBO route is different.	 
RWY 23 Dep Option E	Straight ahead departures only (no offsets) with turns at 1nm and 9nm from the runway NORBO is traffic is shared between a route that turns left at 1nm and one that doesn't turn until 9nm from the runway.	

Further information around our Options can be found in our Stage 2A submission document on the CAA Airspace Change Portal

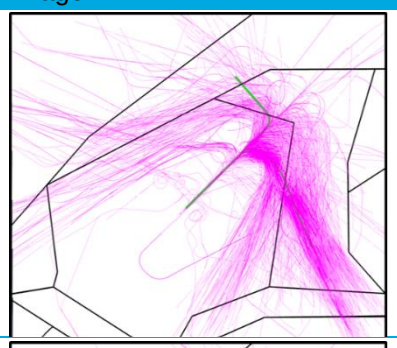
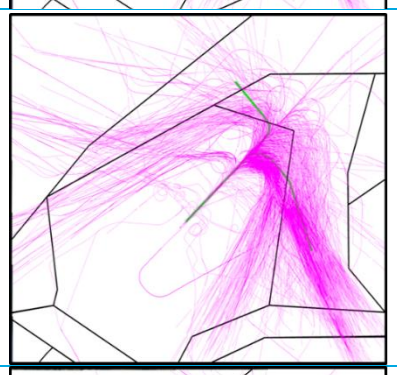
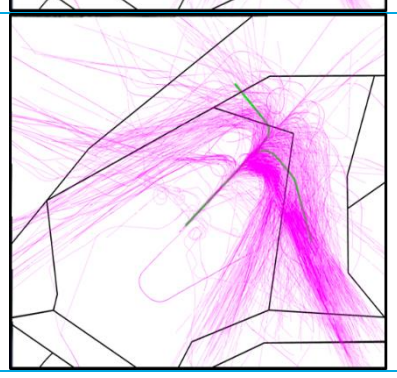
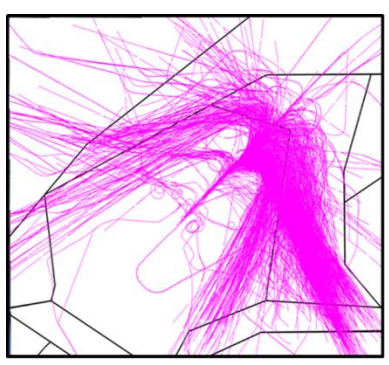
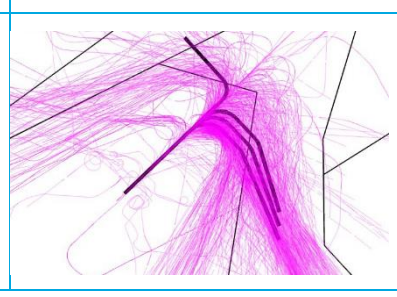
2.2. Runway 05 Easterly Departures

Table 3 Runway 05 Easterly Departure Options

Option name	Summary	Image
RWY 05 Dep Option A	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 3nm from the runway. NORBO is offset left with turn at 1nm	
RWY 05 Dep Option B	Offset right departures with turns at 2nm from the runway. Offset left departures with turns at 1nm and 5nm from the runway. NORBO traffic is shared between two departure routes however they are the same route until 5nm from the runway.	
RWY 05 Dep Option C	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 4nm from the runway.	
RWY 05 Dep Option D	Straight ahead departures only (no offsets) with turns at 1nm, 4nm and 6nm from the runway.	
RWY 05 Dep Option E	Offset left departures with turns at 1nm from the runway. Straight ahead departures with turns at 2nm and 6.5nm from the runway. NORBO is straight ahead to 2nm with a right turn.	
RWY 05 Dep Option F	This option shares NORBO traffic between a left and right turn with only one of those routes in use at a time. The rest of the routes remain in the same configuration. When turning left, the NORBO would offset left then turn further left at 1nm When turning right, the NORBO would go straight ahead to 2nm then a right turn	 
RWY 05 Dep Option G	This option has two, quite different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between a left turn departure and a right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a single flight path turning right, but that path could be different to the one used for the peak periods.	 
RWY 05 Dep Option H	This option was generated as a result of Community and ATC feedback in our engagement. They proposed that ROBBO/CLYDE/LOMON SIDs could also turn left immediately, together with the left turn NORBO SID. Predictable respite is not a feature.	
RWY 05 Dep Option I	This option is the same as Option H except that track adjustments do not feature. This is due to a concern that a track adjustment followed by an immediate left 180˚ turn for the NORBO/ROBBO/CLYDE/LOMON departure could be too technically challenging. This has a knock-on impact in that the PERTH/FOYLE would also not feature a track adjustment.	

2.3. Runway 23 Westerly Arrivals

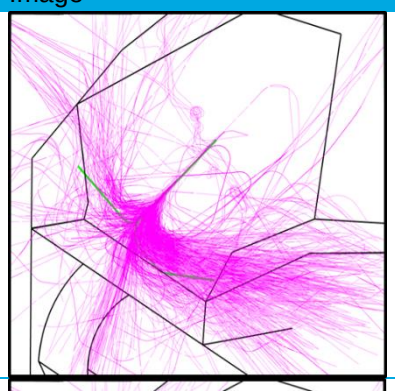
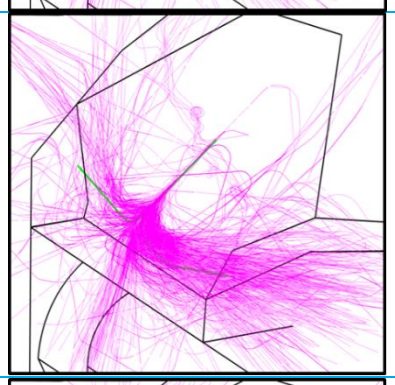
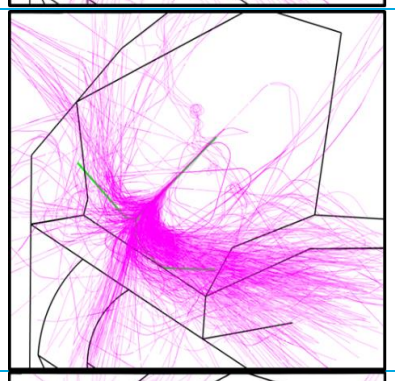
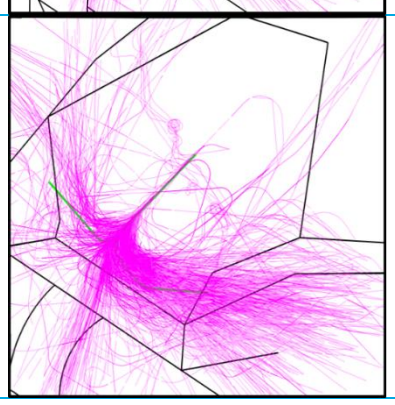
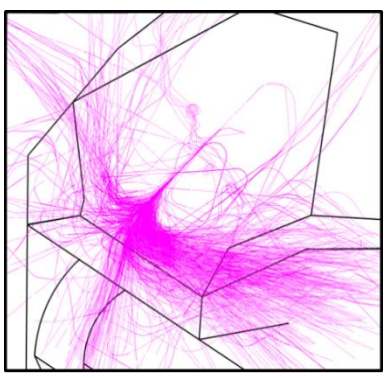
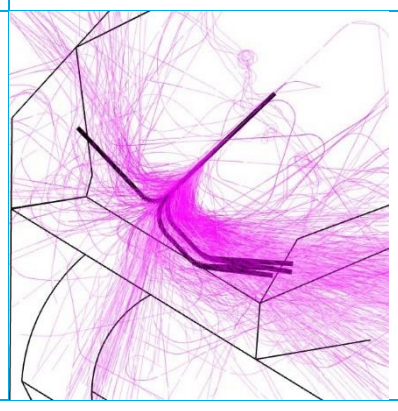
Table 4 Runway 23 Westerly Arrival Options

Option name	Summary	Image
RWY 23 Arrival Option C	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 8nm.	
RWY 23 Arrival Option D	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 9nm.	
RWY 23 Arrival Option E	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 10nm.	
RWY 23 Arrival Vectors only	This option would see all arrivals continuing to be vectored with no PBN paths available for routine use. Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet, so there is not an illustration for this option. For the Design Principle Evaluation and this Initial Options Appraisal, we will assume similar impacts as the baseline however for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft.	 Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known, alongside more information about departures and CAS arrangements.
RWY 23 Arrival Vectors and PBN hybrid	This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival(s) would likely be the 'best performing' of Options C-E above which are then optimised in Stage 3 to balance CO2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation.	 Note: Image shows existing vectoring swathe alongside the centrelines for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there is further information around vectoring arrangements.

Further information around our Options can be found in our Stage 2A submission document on the CAA Airspace Change Portal

2.4. Runway 05 Easterly Arrivals

Table 5 Runway 05 Easterly Arrival Options

Option name	Summary	Image
RWY 05 Arrival Option A	PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway.	
RWY 05 Arrival Option B	PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm.	
RWY 05 Arrival Option C	PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway. Slightly different track to Option A above 5000ft.	
RWY 05 Arrival Option D	PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm. Slightly different track to Option B above 5000ft	
RWY 05 Arrival Vectors only	This option would see all arrivals continuing to be vectored with no PBN paths available for routine use. Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet so there is not an illustration for this option. For the Design Principle Evaluation and Initial Options Appraisal we will assume similar impacts as the baseline however, for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft.	 Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known, alongside more information about departures and CAS arrangements.
RWY 05 Arrival Vectors and PBN hybrid	This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival(s) would likely be the 'best performing' of Options A-D above which are then optimised in Stage 3 to balance CO2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation.	 Note: Image shows existing vectoring swathe alongside the overflight contours for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there is further information around vectoring arrangements.

Further information around our Options can be found in our Stage 2A submission document on the CAA Airspace Change Portal

3. Initial Options Appraisal Methodology

The Initial Options Appraisal (IOA) is the first stage in a three-phase appraisal of airspace change options. It involves the mainly qualitative appraisal of the airspace change options that have proceeded from Stage 2A (outlined in Section 2 of this document). 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 quantitively evaluate options in further detail. The following sections outline the methodology we have followed whilst appraising our airspace change options as part of this IOA.

3.1. Baseline and Year of Implementation

As part of this IOA, CAP1616 requires airspace change sponsors to set a baseline which is used for environmental evaluation of the options. CAP1616 explains that this will be a 'do nothing' scenario and will largely reflect the current-day scenario, 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. Therefore, all environmental assessments must illustrate the difference between a pre-implementation ('do nothing') scenario and a post-implementation scenario, ensuring that the periods are comparable.

Owing to the impact of COVID-19 on the aviation industry throughout 2020 and 2021, we have selected to use 2019 movement data as the baseline data that we will use as the basis for the environmental assessment as part of this initial appraisal, as this is most representative of a recovered COVID-19 scenario. We will qualitatively describe the growth of this baseline to the year of implementation (see below).

Year of Implementation

At present the exact implementation date for the FASI-S airspace changes is unknown as the timeline for implementation will be dependent on a number of factors, including the airspace changes above 7000ft which form part of a separate ACP sponsored by NATS NERL. Current deployments of the Scottish-TMA within Masterplan Iteration 2 suggest to expect an implementation date of around 2025, however this will be subject to alignment with masterplan iteration 3. For the purpose of this IOA, we will qualitatively describe the anticipated factors that are expected to impact the baseline, such as any forecast growth, fleet mix changes and planned developments based on implementation in 2025.

Traffic Forecast: Movement numbers and schedule

For the purposes of environmental assessment, Airspace Change sponsors are required to use a 92-day summer period between 16 June to 15 September inclusive. In 2019, there were 25,275 movements during this 92-day period to/from Glasgow Airport. A movement is considered either an arrival or a departure.

Table 6 GLA 2019 92-day summer movements

Runway	Number of operations	Percentage
23 (Westerly Operations)	20,658	81.7
05 (Easterly Operations)	4,617	18.3
Total	25,275	

When reviewing the movement data in table 6, in 2019 82% of flights operated on runway 23 (westerly operations when aircraft take off and land towards the south-west), and 18% of flights operated on runway 05 (easterly operations when aircraft take off and land towards the north-east). This modal split will be used for this IOA. We have also analysed the 92-day 2019 data to find out information about SID usage and existing departure directions.

Traffic Forecast

2019 is considered the year that most reflects a scenario where Glasgow airport has recovered from the impacts of COVID-19. We expect this recovery to have occurred by 2025 and therefore, as part of this IOA, we do not currently expect any fundamental changes to the movement numbers outlined above at the year of implementation. Owing to the uncertain nature of the aviation sector as a result of COVID-19, this approach to forecasting is considered proportionate at this stage of the CAP1616 process. When considering the future forecast (10 years after the year of implementation), given the number of options that form part of this appraisal, the qualitative nature of large parts of the appraisal, and the methodology applied where quantified information has been used, it is not considered proportionate to also appraise all options against this future traffic scenario in Stage 2; as part of our Stage 3 Full Options Appraisal, we will fully quantitatively appraise the pre-implementation baseline and options for the year of implementation and future scenarios (plus 10 years).

The methodology applied to appraise each option as part of this Initial Options Appraisal focuses on the % split of movements distributed across Glasgow's arrival and departure routes. These % are derived from the actual flight track data and known factors which will influence the baseline in 2025 (see sections below). We expect the southerly directional bias will continue for any future forecast given the geographic location of Glasgow compared to London and Europe. Specific numbers of movements have not been applied to the assessments; this will form part of the detailed quantitative noise and environmental modelling that will be undertaken as part of the Stage 3 Full Options Appraisal.

Fleet Mix

In 2019 Turbo prop aircraft made up around 25% of traffic arriving and departing from Glasgow Airport. Due to factors such as the change in aircraft operators and passenger habits, Glasgow Airport expect to see a shift towards more jet aircraft going forward than was the norm in 2019 and preceding years. This will be considered as part of our qualitative appraisal of the options. In Stage 3 we will quantify the changes to the baseline as a result of the expected fleet mix at the year of implementation.

Planned developments

As part of our preparation of the baseline, we have identified planned developments in the area surrounding Glasgow airport so that these can be considered as part of appraisal of the benefits and impacts of each option:

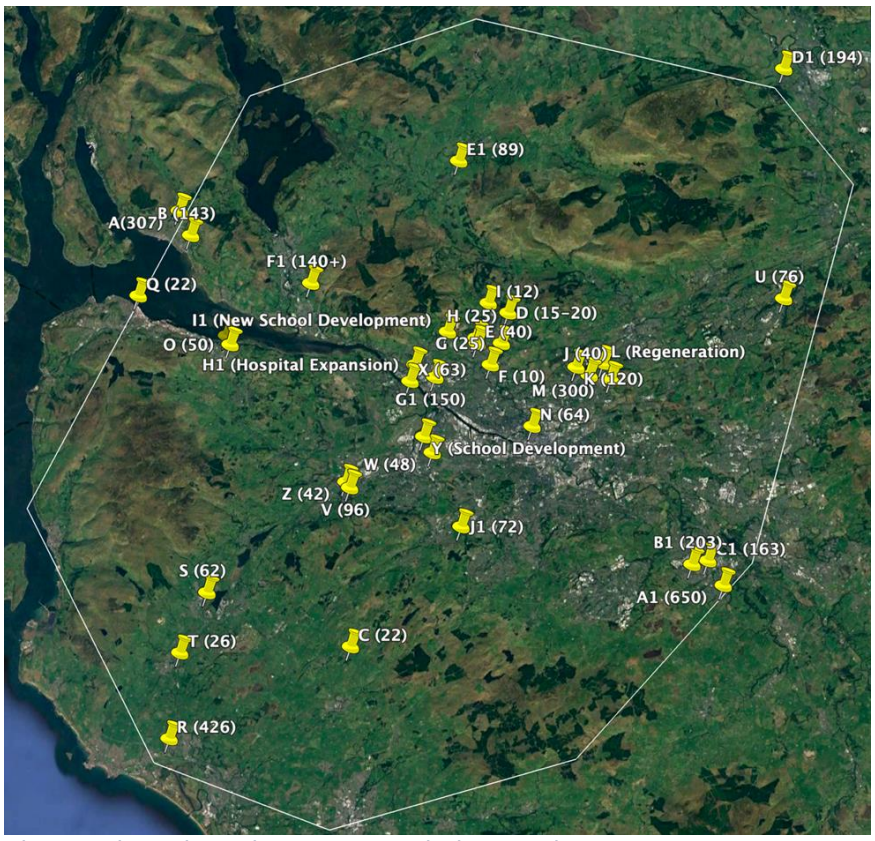


Table 7 Planned Developments around GlasgowFigure 2 Planned Developments around Glasgow Airport

Ref	Local Authority	Location	Type of Development	Size of Development	Status (if known)	Further information
A	Argyll & Bute	Helensburgh Golf Course	Housing	307	Approved (Feb 21)	Planning Page
B	Argyll & Bute	Hermitage Academy, Helensburgh	Housing	143	Nearly complete	Developer
C	East Ayrshire	KA3 4BD	Housing	23	Registered (Mar 22)	Planning Page
D	East Dunbartonshire	G62 8BY	Housing	15-20	Awaiting decision (Mar 22)	Planning Page
E	East Dunbartonshire	Bearsden Golf Course	Housing	40	Unknown	Planning Page
F	East Dunbartonshire	Crarae Avenue, Bearsden	Housing	10	Decided	Planning Page
G	East Dunbartonshire	Milngavie Road, Bearsden	Housing	25	Awaiting decision (Mar 22)	Planning Page
H	East Dunbartonshire	Nithsdale Crescent, Bearsden	Housing	26	Awaiting decision (Mar 2020)	Planning Page
I	East Dunbartonshire	Craigton Road, Milngavie	Housing	120	Unknown	-[1]
J	East Dunbartonshire	Auchinairn, Bishopbriggs	Housing	40	Unknown	-[1]
K	East Dunbartonshire	Bishopbriggs Town Centre	Housing	220	Public Consultation (2021)	Article
L	East Dunbartonshire	Westerhill, Bishopbriggs	Regeneration	TBC	Public Consultation (2021)	Article
M	Glasgow City	G33 1TG	Housing	300	Awaiting Approval (Feb 22)	Developer
N	Glasgow City	Finnieston	Flats	64	Submitted (Nov 21)	Planning Page
O	Inverclyde	PA14 6PP	Housing/Flats	50	Nearly complete (Apr 22)	Planning Page
P	Inverclyde	PA14 6PR	Housing/Flats	40	Nearly complete (Apr 22)	Planning Portal
Q	Inverclyde	PA16 8DA	Flats	22	Pending consideration (Mar 22)	Planning Page
R	North Ayrshire	Byrehill Place, Kilwinning	Housing	426	Pending consideration (Feb 22)	Planning Page
S	North Ayrshire	Knoxville Road, Kilbirnie	Housing	62	Pending consideration (Feb 22)	Planning Page
T	North Ayrshire	Bridgene Mill, Dalry	Housing	26	Approved (Dec 21)	Planning Page
U	North Lanarkshire	Kildrum, Cumbernauld	Flats	76	Unknown	Planning Page
V	Renfrewshire	PA5 0SP	Housing	96	Awaiting Decision (Mar 22)	Planning Page
W	Renfrewshire	East Lane, Paisley	Flats	48	Awaiting Decision (Mar 22) Awaiting Decision (Mar 22)	Planning Page
X	Renfrewshire	Erskine	Housing/Flats	59/24	Awaiting Decision (Mar 22)	Planning Page
Y	Renfrewshire	Renfrew Road, Paisley	New School	-	Approved	Article
Z	Renfrewshire	Elm Drive, Johnstone	Housing/Flats	36/6	Awaiting Decision (Mar 22)	Planning Page
A1	South Lanarkshire	Strathaven Road, Hamilton	Housing	650	Registered (Oct 21)	Planning Page
B1	South Lanarkshire	Earnock Road, Hamilton	Housing	203	Awaiting Decision (Jul 21)	Planning Page
C1	South Lanarkshire	ML3 9BZ	Housing	163	Approved (Sep 21)	Planning Page
D1	Stirling	Cambusbarron	Housing	194	Under construction	Website
E1	Stirling	Killearn	Housing	89	Under construction	Website
F1	West Dunbartonshire	Bellsmyre	Housing	140+	Under construction	Regeneration Plan
G1	West Dunbartonshire	Queens Quay	Housing/Flats	150	Under construction	Website
H1	West Dunbartonshire	Clydebank	Golden Jubilee Hospital Expansion	-	Permission issued	
I1	West Dunbartonshire	Faifley	New School	-	Post consultation (Sep 21) period	Article
J1	East Renfrewshire	Lyoncross Farm, Barrhead	Housing	72	Registered (Jan 22)	Planning Page

[1] Information provided by email from East Dunbartonshire council – no information available online

3.2. Initial Options Appraisal Categories and Criteria

At Stage 2B CAP1616 requires sponsors to carry out an initial qualitative assessment of the benefits and impacts of each option, tested against the 'do nothing' baseline scenario. The purpose of this initial appraisal is to highlight the change to sponsors, stakeholders and the CAA and the relative differences between the impacts, both positive and negative, of each option.

Our assessment criteria shown in table 8 below have been categorised based on the example in CAP1616 Appendix E, however we have added an additional category called 'Interdependencies, conflicts and trade-offs' to satisfy the requirements to outline potential interdependencies with other FASI-N ACPs, and 'Airspace Modernisation Strategy' to satisfy the 7 confirmed indicators that the CAA will use to assess whether this Stage 2 submission accords with the AMS including iteration 2 of the Masterplan. We will follow this table structure across the appraisal of all of our options.

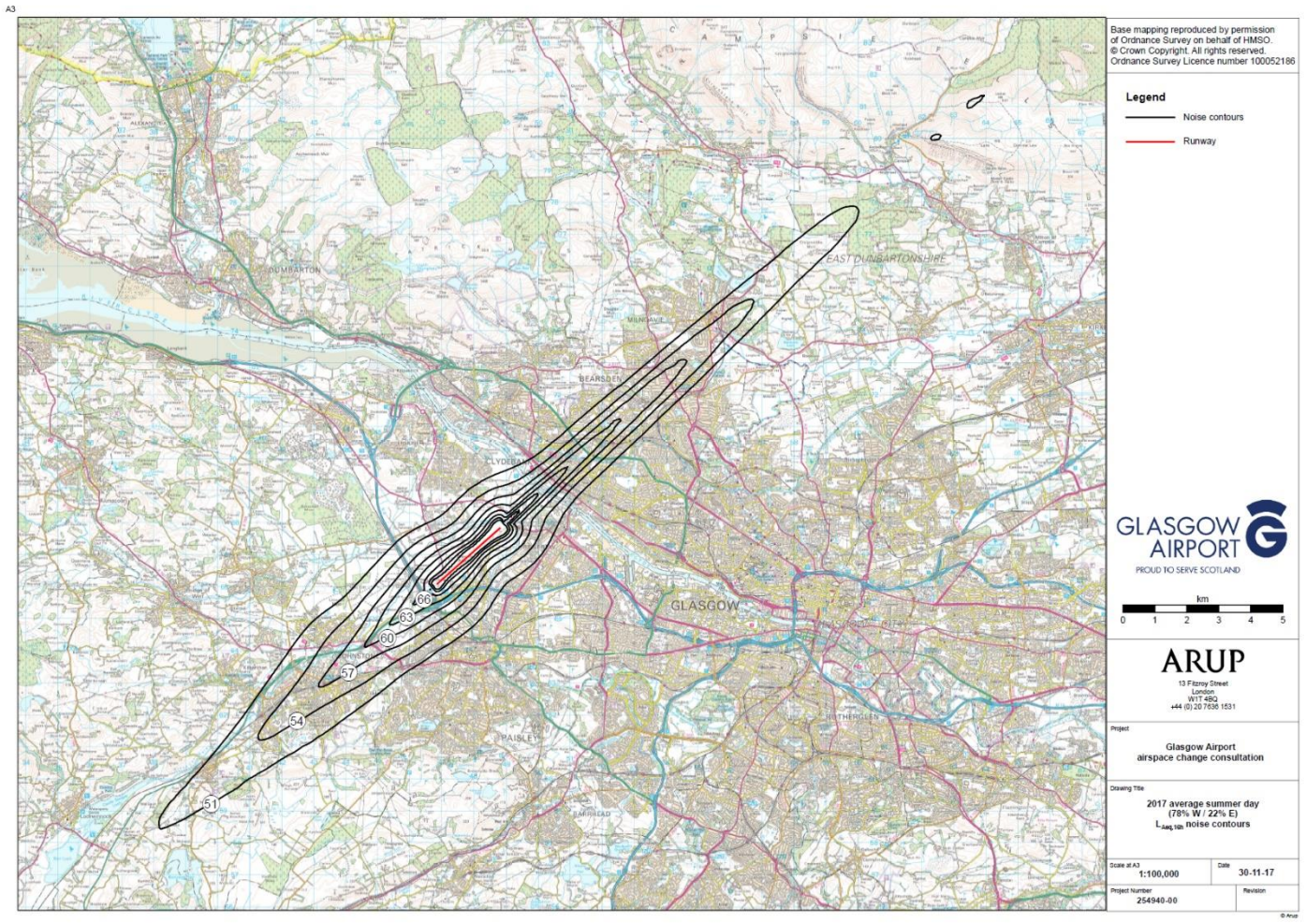
Table 8 Initial Options Appraisal Assessment Criteria (Based on CAP1616 Appendix E)

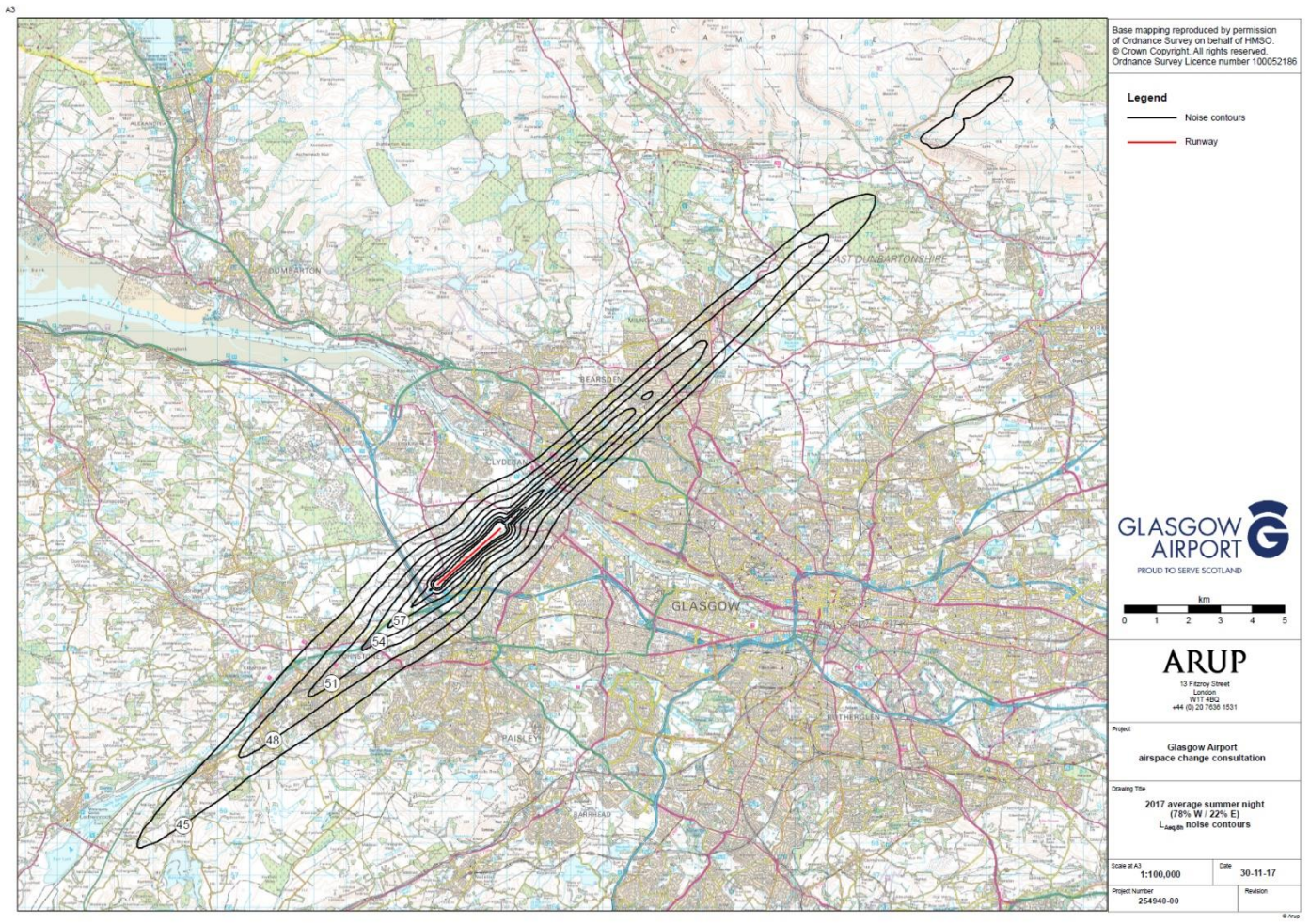
Group	Impact
Communities	Noise impact on health and quality of life
	Air Quality
Wider Society	Greenhouse gas impact
	Capacity / resilience
	Tranquillity
	Biodiversity
General Aviation	Access
General Aviation / Commercial airlines	Economic impact from increased effective capacity
	Fuel burn
Commercial airlines	Training costs
	Other costs
Airport / Air navigation service provider	Infrastructure costs
	Operational costs
	Deployment costs
All	Safety
All	Interdependencies, conflicts, and trade-offs
All	Airspace Modernisation Strategy (AMS) (CAP1711)

3.3. Initial Options Appraisal: Methodology

Table 9 below presents the IOA methodology that will be followed. This methodology will be used to compare the airspace change options against the baseline.

Table 9 IOA Methodology

IOA Methodology		
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Our noise assessment for each airspace change option includes a qualitative description of the expected benefits and impacts of noise on health and quality of life, supported by some proportionate quantitative analysis: **L_{Aeq} Contours** 51dB $L_{Aeq,16hr}$ (daytime noise) and 45dB $L_{Aeq,8hr}$ (night time noise) contours form part of the primary CAP1616 metrics used to evaluate the benefits and impacts of airspace changes. These contours represent the daytime and night time lowest observable adverse effect level (LOAEL) contour defined in UK airspace policy. L_{Aeq} contours, are the equivalent sound level of aircraft noise in dBA. This is based on the daily average movements that take place in the 16-hour period (07:00-23:00 local time) or 8-hour period (23:00-07:00) during the 92-day period 16 June to 15 September inclusive. This metric is the measure of noise exposure adopted by Government for the purposes of considering adverse effects from aircraft noise. It forms the basis of the Government's policies in relation to aircraft noise. To determine the size of the forecast contours based on the new airspace design options, requires noise modelling at a system level. This requires a complete system design of arrivals and departures modelled with a forecast schedule and fleet mix which is very detailed and complex work. At this stage in the process, given the number of arrival and departure options and the subsequent permutations when combining these, it is not proportionate to quantify the L_{Aeq} metrics. We will however make a qualitative assessment of the anticipated benefits or impacts to the daytime L_{Aeq} as a result of each option. Full quantitative analysis will be undertaken in the Full Options Appraisal in Stage 3 on Glasgow's shortlisted options. Glasgow Airport do not currently publish L_{Aeq} contours on an annual basis, however they are published as part of the 5-year Noise Action Plan. The last noise action plan was published in 2017 and therefore we've used the overall contours from 2017, as an indicative contour for the year of implementation as it is expected that contours will be a similar size with some small adjustments. The contours are shown below: 



WebTAG

The data from $L_{Aeq,16hr}$ (daytime noise) and $L_{Aeq,8hr}$ (night time noise) contours form part of a key input into WebTAG. WebTAG is the Department for Transport's suite of guidance on how to assess the expected impacts of transport policy proposals and projects. These workbooks can be used to monetise certain aspects of the noise impact, given the correct inputs are available.

As explained above, owing to the number of permutations and the complexity of the noise modelling, we will qualitatively describe the expected changes to the L_{Aeq} contours as part of this IOA. As we do not have the quantitative information, we are unable to use the WebTAG workbook at this stage, however this analysis will be undertaken as part of our Stage 3 Full Options Appraisal.

Overflight Contours

Technical Appendix A includes images and data tables of overflight information which we have used to inform our qualitative assessment of each option. There are two types of overflight information that we have termed 'centreline' and 'vectoring'.

Centreline Overflight Data

The centreline overflight contours are based on a single event, i.e. one departure or one arrival using the CAA's 48.5 degree definition of overflight as defined in CAP1498. This departure is assumed to follow the SID route from 0-7000ft therefore this data does not take into account any vectoring. This is particularly important to note when considering the baseline data, as we know that the majority of aircraft today are typically vectored rather than following the full SID centreline.

The contours are generated using a standard AEDT (Aviation Environmental Design tool) profile of an 737-800 aircraft and we have added qualitative statements as part of this IOA assessment (particularly for departures) about how the overflight contours may change when considering Glasgow's fleet mix. We chose the B738 as it is one of the largest and noisier aircraft that regularly flies at GLA and therefore tends towards the worst case.

The contour images shown in this IOA and in Technical Appendix A include an indication of the anticipated use of each route which has been based on actual 2019 data, with adjustments made on an option-by-option basis (for example where the option introduces a respite route).

The data-tables use the latest available CACI population data for 2021, PointX data to identify noise sensitive buildings (schools, hospitals, and places of worship). National Parks, National Scenic Areas, Special Areas of Conservation, Special Protection Areas and Sites of Special Scientific Interest have been collected from the Scottish Government's catalogue of spatial data (https://www.spatialdata.gov.scot/geonetwork/srv/eng/catalog.search#/home). In addition, designated quiet areas in Glasgow City were mapped using information taken from the Glasgow City Development Plan (http://www.glasgow.gov.uk/CHttpHandler.ashx?id=35882&p=0)

It's important to note that the overflight contours only look at a single overflight along the PBN centreline, and therefore at this stage the data does not take into account frequency of overflight. This will be qualitatively described as part of this IOA and then fully quantified at Stage 3 Full Options Appraisal.

Data includes overflight counts and areas (km^2) of: Population, National Scenic Areas (NSA), Parks and gardens, special areas of conservation (SAC), sites of special scientific interest (SSSI), special protection areas (SPA), national parks, designated quiet areas (DQA), schools, hospitals, and places of worship.

At this stage, owing to the complexity of modelling vectoring, we have modelled each option based on aircraft flying the PBN centreline however vectoring below 7000ft may still occur. We have noted throughout the IOA where this applies and added a qualitative assessment alongside the data. As part of our Stage 3 Full Options Appraisal noise modelling of the vectoring will be investigated.

When considering the centreline data for the arrivals baseline, it's important to note that a centreline for the existing arrivals does not actually exist in reality; we created one based on the area's most frequently overflown by arrivals in today's airspace arrangement for comparative purposes.

Vectoring (Baseline) Overflight data
As described above, owing to the nature of vectoring, it is very complex to model and at this stage of the process, given the number of options, it is not proportionate to undertake full modelling.

In order to illustrate the difference between the today's baseline flight tracks over the ground (also known as a vectoring swathe) and the PBN options, we have included some information about the baseline vectoring scenario. This has been generated using noise track keeping (NTK) data for the 92-day period, and therefore is not generated in the same way as the overflight contours which use a standard vertical profile of one aircraft. We have however applied the CAA's 48.5 degree overflight cone to the NTK data. The outcome are the baseline heatmaps, which are shown in Technical Appendix A, which help us to articulate the current vectoring swathe and any areas of concentration which occur today. Alongside the images, we have included overflight data as part of our Technical Appendix and IOA. This data does not consider frequency of overflight but instead takes account of any areas that are overflown at least once, based on the NTK data; this allows some preliminary comparison to be drawn between the option's overflight contours and what happens today.

60dB and 65dB LAMax
As part of this IOA, we have calculated 65dB L_{Amax} (day) and 60dB L_{Amax} (night) contours and data using an Airspace Optioneering Tool. The indicative noise calculations in the tool are based on the methods set out in ECAC Doc 29 (https://www.ecac-ceac.org/images/documents/ECAC-Doc_29_4th_edition_Dec_2016_Volume_1.pdf) and have been verified against calculations using the FAA's Aviation Environmental Design Tool (AEDT) (https://aedt.faa.gov/). The optioneering tool is not a full noise model complying to the standards required by CAP2091, but we have agreed with the CAA that it is a proportional method to use at this stage of the analysis. The optioneering tool does not take airport specific atmospheric conditions into account and assumes standard atmospheric attenuation rates set out in SAE-AIR-1845. The source of the acoustic data used in the tool is the international Aircraft Noise and Performance (ANP) database (https://www.aircraftnoisemodel.org/). Arrival and departure flight profiles for a Boeing 737-800 have been calculated as a function of track distance using the default departure / arrival procedural steps for Aircraft ID 737800 in the ANP database. The procedure for maximum take-off weight has been used as this is the most conservative profile in noise terms due to the low climb rate. The departure and arrival profiles are shown as a function of track distance in the figures below.

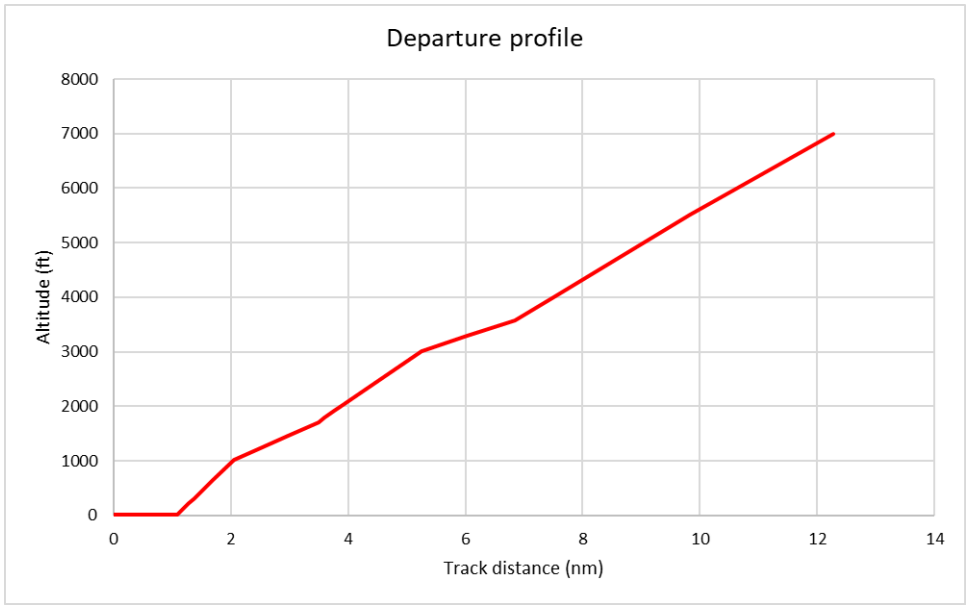


Figure 3 737-800 departure profile.

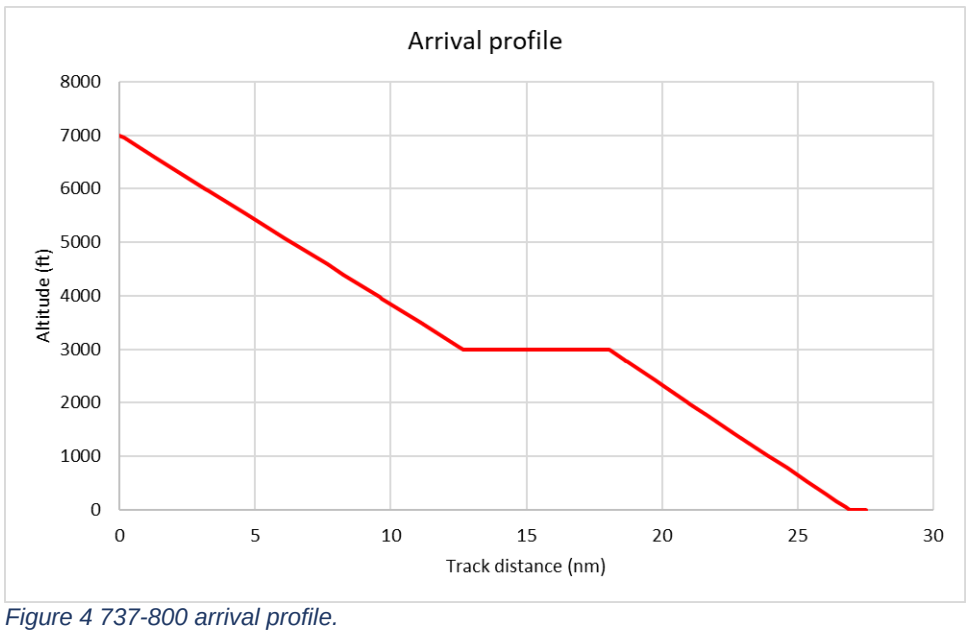
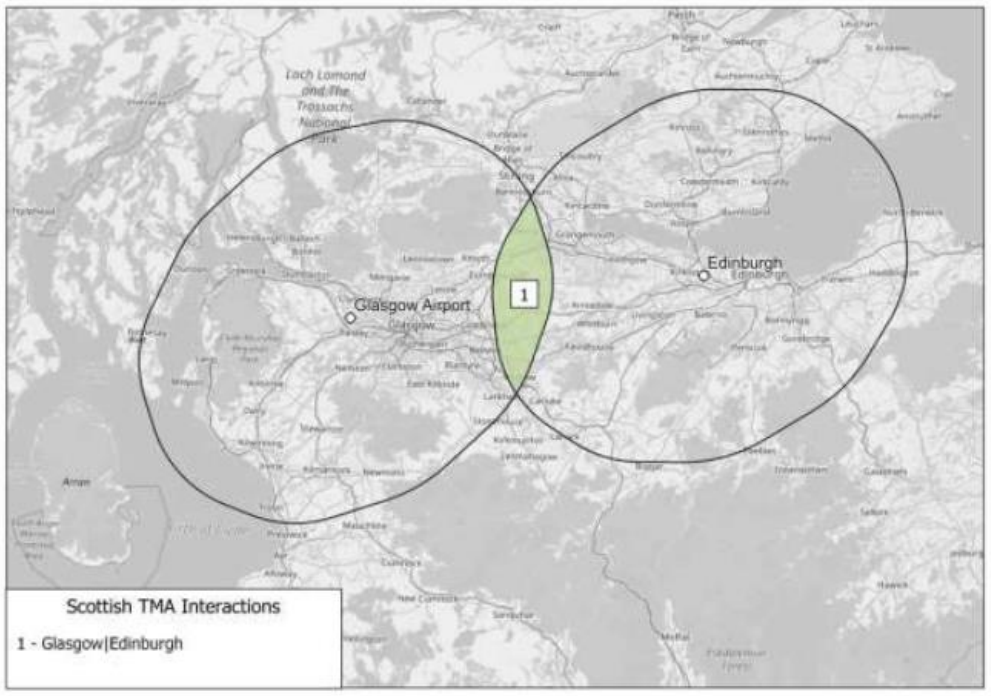


Figure 4 737-800 arrival profile.

Similar to the overflight contours, these are based on a single noise event i.e. based on one departure or one arrival. 60dB and 65dB L_{Amax} contours are an indication of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. These are required by the CAA to help with engagement on noise and airspace change, and to further differentiate between airspace options which have a similar impact with respect to the L_{Aeq} metrics.

The 60dB and 65dB L_{AMax} data contained within the Technical Appendix is based only on centreline data and assumes no dispersion around the centreline; this means that for the baseline, it does not reflect the vectoring that occurs today. As explained above, to model vectoring is complex and something that we will do as part of our Stage 3 Full Options Appraisal. As part of this IOA, we will use the data as a starting point for comparison between the baseline and the options and we will also provide some additional qualitative analysis.

		CAP2091 At this stage in the airspace change process, we have not calculated L_{Aeq} contours (see section above) and instead we will qualitatively describe anticipated changes based on the most recent contours generated for Glasgow's 2017 noise action plan. The contours in the noise action plan were generated to CAP2091 category D/E standards however the output shows that the airport should move to category C for future noise modelling as there were 83,200 people within the 51dB$_{LAeq,16h}$ contour which is above the mandated minimum threshold of 25,000 (and below the maximum threshold of 200,000) for category C. In Stage 3, when the L_{Aeq} contours are fully quantified, all noise modelling will therefore be undertaken to category C standards. When considering future forecast 10 years from implementation, although a full quantified 10 year forecast is not available at this stage, given the current population levels are 116,800 below the maximum daytime category C threshold (76,800 below the recommended minimum daytime threshold for category B) and also given the low density of conurbations outside of the 51dB contour, it is expected that the daytime contours will remain within the category C threshold as it would require at least a doubling of population within the 51dBLAeq,16h contour to be required to move up a category. The night-time contour differences are a similar magnitude. The CAP2091 category will be confirmed at Stage 3 when full quantified noise modelling takes place and a 10 year forecast will be available. **Continuous Climb** As part of some of the departure options, we describe how they are anticipated to continuously climb to above 6000ft. The scope of this Level 1 ACP is up to 7000ft and therefore typically we would seek continuous climb to 7000ft. As discussed in our Stage 2A document, even with a redesign and modernisation of the airspace there is another significant and fixed constraint that requires consideration when looking at continuous climb up to 7000ft. This is the Transition Altitude (TA), which is 6000ft in the Scottish TMA. In summary, any SIDs that climb above 6,000ft need to climb continuously from the runway, to at least FL90 in order to guarantee continuous climb above 7000ft. As the NATS NERL ACP, which looks at the airspace above 7000ft, is not yet at the stage to be able to inform whether climb to FL90 is achievable, for the basis of this IOA we have assumed that aircraft will be able to continuously climb to 7000ft for the purposes of the noise modelling at this stage. We will revisit this as part of our Full Options Appraisal when we have further information from NERL around the upper airspace network.
	Air Quality	Due to the effects of mixing and dispersion, emissions of NOx, PM10 and PM2.5 from aircraft travelling from aircraft above 1,000 feet are unlikely to have a significant impact on local air quality. The DfT's Air Navigation Guidance (2017) 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. ICAO, Canada.) similarly states that 1,000ft is the typical limiting altitude for ground-level NO2 impacts from aircraft emissions. **Assessment of Arrival Options** As part of this IOA we will qualitatively describe any expected changes below 1000ft. Aircraft arriving at Glasgow fly a standard 3-degree angle of approach and descend through 1000ft whilst aligned with the extended runway centreline. This is in the last stages of the final approach. It's therefore very unlikely that any arrivals options will offer any significant impact air quality however we will review each option for changes below 1000ft. **Assessment of Departure Options** Aircraft departing Glasgow have varying climb performance depending on aircraft type and therefore different aircraft reach 1000ft at different locations. Today, virtually all Glasgow departures climb straight ahead for 5nm and during this they climb above 1000ft. Our IOA will qualitatively describe any changes to the lateral locations of flight paths which could occur below 1000ft; whilst a change in route will not impact the totality of emissions, it may result in a change in location of the emissions which we will qualitatively describe.
Wider Society	Greenhouse gas impact	As emissions of greenhouse gases arise from the combustion of aviation fuel and fuel burn is linked to track mileage, for this IOA we have estimated the differences in track miles between the baseline and each route which forms part of the options. We have then applied a percentage weighting, based on the anticipated usage of the routes, to understand the overall performance of the option. This weighting is based on 2019 movement data. A table with full details is shown in Technical Appendix A. As part of the Full Options Appraisal (Stage 3A), we appraise track mileage, fuel burn and the associated greenhouse gas impact in further detail.
	Capacity / resilience	Subject matter experts will qualitatively assess any impacts to capacity and/or resilience against the baseline scenario.
	Tranquillity	CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB), plus any locally identified 'tranquil' areas that are identified through community engagement and are subsequently reflected within an airspace change proposal's design principles. In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks, and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP, we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB.
	Biodiversity	The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance 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." 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 500m (~1,640ft). [Drewitt, A. (1999) Disturbance effects of aircraft on birds. English Nature Birds Network Information Note]. Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft.
General Aviation	Access	As part of this IOA, we will qualitatively describe the potential impacts and benefits to general aviation access as a result of each option. This will be partially informed by the engagement undertaken with GA users during Stage 2. At the full options appraisal stage, we will have detailed plans for CAS and will quantify any increase or decreases in CAS volume.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	The IOA will qualitatively estimate the differences between the option and the baseline. As part of the FOA at Stage 3 we will quantitively appraise any economic benefits or impacts in further detail.

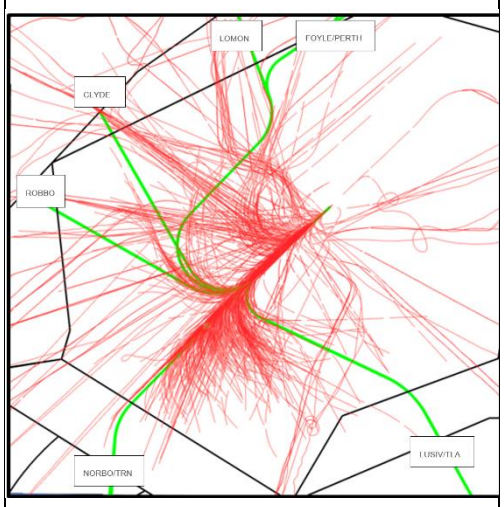
	Fuel burn	As the combustion of aviation fuel is linked to track mileage, for this IOA we have estimated the differences in track miles between the baseline and each route which forms part of the options. We have then applied a percentage weighting, based on the anticipated usage of the routes, to understand the overall performance of the option. This weighting is based on 2019 movement data. Tables with full details are shown in Technical Appendix A. Alongside the estimated quantitative information, we will provide a qualitative statement around continuous climb and continuous descent operations which also have the potential to impact fuel burn.
Commercial airlines	Training costs	The IOA will qualitatively estimate whether any training costs would be incurred by Commercial airlines in order to implement the option.
	Other costs	The IOA will qualitatively estimate whether any other costs would be incurred by Commercial airlines in order to implement the option.
Airport / Air navigation service provider	Infrastructure costs	The IOA will qualitatively estimate whether any infrastructure costs would be incurred by the airport or ANSP in order to implement the option.
	Operational costs	The IOA will qualitatively estimate whether any operational costs would be incurred by the airport or ANSP in order to implement the option.
	Deployment costs	The IOA will qualitatively estimate whether any deployment costs would be incurred by the airport or ANSP in order to implement the option.
All	Safety	A qualitative safety assessment of each option will be undertaken which compares against the baseline.
All	Interdependencies, conflicts, and trade-offs	An airspace change proposal at a Stage 2 gateway in the CAP 1616 process should specify any interdependencies with other airspace changes identified in Iteration 2 of ACOG's Airspace Change Masterplan. This IOA will take the information contained within the masterplan document around potential areas of conflict / interdependencies and identify if the option falls within these areas. This will give an indication of whether there is the potential for trade-offs with other airspace change sponsors required during Stage 3. The figure below shows the illustration provided within the masterplan that outlines Glasgow's potential interdependencies. *Figure 5 Potential Scottish TMA GLA EDI Interactions (From ACOG Masterplan)*  Although not part of the FASI-N programme, Glasgow airport also share interdependencies with Prestwick Airport (located to the south-west of Glasgow). We will consider this and qualitatively describe potential interdependencies as part of our IOA.
All	Airspace Modernisation Strategy	Our IOA will include a qualitative, high level, assessment of how the design options perform against the vision and parameters/strategic objectives of the Airspace Modernisation Strategy. CAP1711 describes the objective as: *Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* And the parameters as: • *create sufficient airspace capacity to deliver safe and efficient growth of commercial aviation* • *progressively reduce the noise of individual flights, through quieter operating procedures and, in situations where planning decisions have enabled growth which may adversely affect noise, require that noise impacts are considered through the airspace design process and clearly communicated* • *use the minimum volume of controlled airspace consistent with safe and efficient air traffic operations* • *in aiming for a shared and integrated airspace, facilitate safe and ready access to airspace for all legitimate classes of airspace users, including commercial traffic, General Aviation, and the military, and new entrants such as drones and spacecraft* • *not conflict with national security requirements (temporary or permanent) specified by the Secretary of State for Defence.*

4. Initial Options Appraisal

The following tables outline our Initial Options Appraisal for each option and provide an assessment of the four baseline scenarios.

4.1. Runway 23 Westerly Departures Baseline

Runway 23 Westerly Departures Baseline



This option represents the do-nothing scenario for Glasgow Westerly SIDs. Today, all Glasgow SIDs climb straight ahead to 5nm before turning. This means that the minimum departure interval between successive departing aircraft is at least 2 minutes. The result is that during peak departure times, aircraft are held on the runway and at the runway holding points, leading to increased emissions and delay. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC, resulting in broad swathes.

Some aircraft less than 5700kg MTWA do not have to depart via the SIDs. These are usually non-jet aircraft and therefore slower than jet aircraft. These aircraft are vectored by ATC which helps them turn towards their destination early, reduces track miles and reduces departure delays.

Glasgow Airport's current SIDs are dependent on conventional ground-based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is an interim measure that only can only be used to bridge the gap ahead of FASI implementation. The AMS mandates airports implement IFPs based on PBN and doing nothing does not meet that national requirement.

For more information on our do-nothing scenario, which was discontinued as part of the Design Principle Evaluation, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Aircraft above 5700kg departing from Glasgow climb straight ahead to 5nm before turning. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC resulting in dispersion. These swathes can be seen in the vectoring heatmaps below which have been generated using NTK data:

Figure 6 Runway 23 Departure Vectoring Swathe 2019

The Technical Appendix to this document includes a larger version of this map along with overflight data. It's important to note that this vectoring data is not modelled in the same way as the centreline overflight contours, however it does provide a preliminary means of comparison between this baseline and the airspace change options. Table 10 below includes data based on this NTK vectoring map and data output from the optioneering tool for if aircraft were to follow the centreline of the current published SID:

Table 10 Westerly departures baseline overflight data

System	Area (km^2)	Population
RWY 23 Baseline – Vectoring (NTK data)	547.32	163216
RWY23 Baseline (Centreline – optioneering tool)	141.18	29838

The data from these tables will be used to compare the westerly departure options against the 'do nothing' baseline.

In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals, and places of worship; the full data around these is shown in Technical Appendix A, and as part of this IOA we will provide a qualitative statement around this data.

60dB and 65dB L_{Amax}

Technical Appendix A includes 60dB and 65dB L_{Amax} contours and data for the centreline baseline, to aid comparison between the baseline and the options. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal.

Table 11 Runway 23 Departures Baseline LAMax Data

	60dB L_{Amax}		65dB L_{Amax}	
System	Area (km^2)	Population	Area (km^2)	Population

		RWY23 Baseline (Centreline – optioneering tool) | 285.37 | 99120 | 95.69 | 53704 The data from these tables will be used to compare the westerly departure options against the 'do nothing' baseline. **L_{Aeq}** The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025 as it is expected that contours will be a similar shape and size. **Noise Abatement Procedures** As this baseline reflects current day, there would be no changes to NAPs as a result of this option. **Noise Mitigation** The existing SIDs configuration does not offer any opportunities for predictable respite. Furthermore, communities underneath final approach within 5nm of the airport currently experience all departures and arrivals from/to the airport.
	Air Quality	Impacts to air quality are considered for changes below around 1000ft (200m). Aircraft flying above this are unlikely to have a significant impact on local ground air quality. Aircraft departing Glasgow have varying climb performance depending on aircraft type and therefore different aircraft reach 1000ft at different locations. Today, virtually all Glasgow departures climb straight ahead for 5nm and during this they climb above 1000ft. Our IOA will qualitatively describe any changes to the lateral locations of flight paths which could occur below 1000ft.
Wider Society	Greenhouse gas impact	Emissions of greenhouse gases arise from the combustion of aviation fuel, and as the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly departures. The greenhouse gas assessment is therefore linked to the fuel burn assessment detailed in the section below. *Table 12 Westerly departure baseline – Indicative track miles*

RWY 23		Baseline (Centreline)		
		nm	% Weighting	Score
DEPS	TRN	38.50	3.69	142.065
	NORBO – SUBUK	93.40	26.2	2447.08
	NORBO – LAKEY	93.40	32	2988.8
	LUSIV-DCS	84.80	10.66	903.968
	TLA	54.70	0.41	22.427
	PERTH	69.80	1.23	85.854
	FOYLE	33.00	0.82	27.06
	LOMON	26.70	2.05	54.735
	CLYDE	19.50	2.87	55.965
	ROBBO	19.60	2.05	40.18
		Total	82%	6768.134

		We will estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today. As CO_2 emissions are linked to the difference in aviation fuel burnt, this will allow us to qualitatively describe anticipated greenhouse gas impacts as a result of the option. Full data tables are shown in Technical Appendix A.
	Capacity / resilience	Glasgow's current SID configuration, with the majority of departures flying straight ahead to 5nm before turning, results in a capacity constraint on the airport, as aircraft are only able to depart with at least 2-minute intervals. This leads to holding on the ground which results in increased emissions and delays. Any future increases in movement numbers at the airport will result in increases in ground holding and delay and therefore the SIDs in the existing configuration are not fit for purpose for future growth at the airport. In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. As traffic increases, flow restrictions are likely to be put in place in order for ATC and pilots to manage the additional complexity and workload. Flow regulations stabilise the number of movements until the peak in traffic subsides, however in doing so they generate ground delay for Glasgow. It is therefore possible that, with future traffic levels, this baseline scenario would result in increases in departure delay at Glasgow airport. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme. This baseline is dependent on conventional ground-based navigation aids called VORs. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[2] resilience for Glasgow's SIDs when NERL decommissions the VORs, which will result in critical operational issues and significant loss of revenue.
	Tranquillity	CAP1616 outlines the consideration of impacts upon tranquillity with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks, and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP, we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB. Table 13 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines. The data from this table will be used to compare the westerly departure baseline. *Table 13 Westerly departure baseline – Tranquillity overflown*

System	NSA area	NSA count	National Parks area	National Parks count	DQA area	DQA count
RWY 23 Baseline – Vectoring (NTK data)	0.02	1	1.68	1	0	0

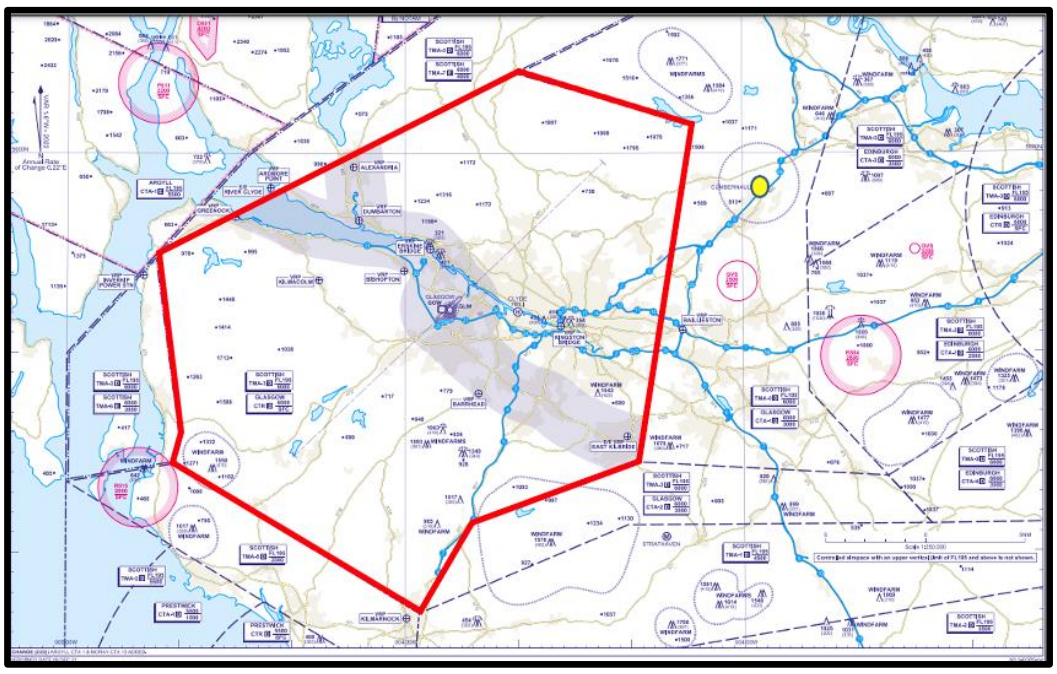
[2] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		RWY23 Baseline (Centreline – Optioneering tool) 0 0 0 0 0 0 In addition to the data tables, Technical Appendix A contains maps which show NSAs, National Parks and DQAs alongside the departure options overflight contours.
	Biodiversity	The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance 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." 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 500m (~1,640ft). Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft. Table 14 shows data on the overflight of these areas, based on the NTK vectoring heatmap and if aircraft were to follow Glasgow's existing SID centrelines. The data from this table will be used to compare options against the westerly departure baseline.

Table 14 Biodiversity – baseline areas overflown

System	SAC count	SAC area	SSSI count	SSSI area	SPA count	SPA area	National Park count	National park area	NSA count	NSA area
RWY 23 Baseline – Vectoring (NTK data)	3	1.42	32	65.82	12	58.95	1	1.68	1.00	0.02
RWY 23 Baseline (Centreline – Optioneering tool)	0	0	3	23.69	1	21.89	0	0	0	0

Below 2000ft based on the centreline baseline there is no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interest for the vast majority of aircraft. Lower and slower aircraft, climbing at below a 6% climb gradient, may overfly the Castle Semple and Barr Lochs SSSI, however this is likely to be infrequently as lower and slower aircraft will typically not be required to follow the NAP and will therefore be tactically turned before reaching the site.

General Aviation	Access	This baseline scenario would not offer any change from the existing Controlled Airspace (CAS) arrangements in place today. The options will be qualitatively compared against this existing scenario.  *Figure 7 Glasgow Airport Control Zone and Control Area Chart (See eAIP for full details)* Within c.35nm of Glasgow airports are Edinburgh and Glasgow Prestwick Airport each with their own Controlled Airspace (CAS) volumes. In addition to this, the Scottish TMA airspace sits above and around the airports' airspace which generates the volumes shown in Figure 5. The controlled airspace at Glasgow has varying lower and upper limits with the volume closest to the airport going down to ground level. This is the Glasgow CTR shown in red outline. Also, in this figure can be seen Cumbernauld Airport approximately 15nm to the east of Glasgow airport which sits outside CAS where the base of the CTA is 3000ft. This is indicated with a yellow dot. It is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size. Whilst the existing baseline scenario will not result in the requirement for more airspace, this option offers no opportunity to simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to achieve.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	There will be no change from today as a result of this option; later in this IOA we will qualitatively estimate the differences between this, and the airspace change options.
	Fuel burn	As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly departures. When departing from Glasgow, the majority of aircraft fly straight ahead until 5nm and then are vectored by air traffic control, this means that track length is varied from flight to flight. For the purposes of comparing our westerly SID options against the baseline scenario, we have taken the track length of the SID centerlines as an initial indication of 'do nothing' track length. We have then applied a weighting based on SID usage to provide an overall total track mileage for the system. At the Stage 3 full options appraisal track length and fuel burn will be modelled

in further detail.

Table 15 Westerly SID Track Mileage

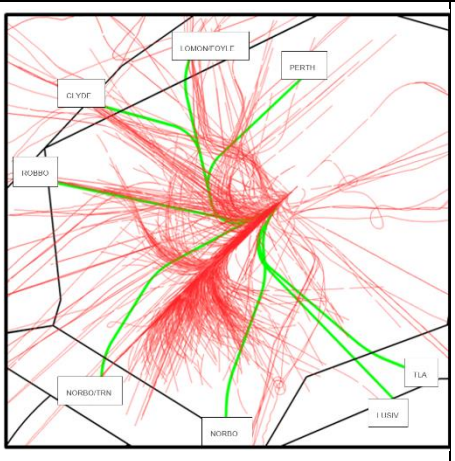
RWY 23		Baseline (Centreline)		
		nm	% Weighting	Score
DEPS	TRN	38.50	3.69	142.065
	NORBO – SUBUK	93.40	26.2	2447.08
	NORBO – LAKEY	93.40	32	2988.8
	LUSIV-DCS	84.80	10.66	903.968
	TLA	54.70	0.41	22.427
	PERTH	69.80	1.23	85.854
	FOYLE	33.00	0.82	27.06
	LOMON	26.70	2.05	54.735
	CLYDE	19.50	2.87	55.965
	ROBBO	19.60	2.05	40.18
Total				6768.134

Aircraft departing from Glasgow are sometimes prevented from continuously climbing due to the tactical coordination with other traffic in the airspace.

We will qualitatively estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option against current day. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today and will also consider the opportunity for continuous climb.

Commercial airlines	Training costs	As this option is already in operation, there are no training costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
	Other costs	As this option is already in operation, there are no other costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
Airport / Air navigation service provider	Infrastructure costs	As this option is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
	Operational costs	As this option is already in operation, there are no operational costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline. Glasgow Airport's current SIDs are dependent on conventional ground-based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is an interim measure that only can only be used to bridge the gap ahead of FASI implementation. Failure to mitigate the impacts of VOR rationalisation in the long term will result in critical operational issues and significant loss of revenue, as well as not meeting the requirements of the AMS
	Deployment costs	As this option is already in operation, there are no deployment costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
All	Safety	At current traffic levels, there are no safety concerns with the current arrangements at Glasgow. Future traffic growth could however result in increased complexity and workload for Air Traffic Controllers and pilots, which may lead to traffic levels within the Scottish TMA being capped, on increased aircraft holding on the ground, in order to maintain safety.
All	Interdependencies, conflicts, and trade-offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with Westerly departures which are separated from Prestwick's airspace and do not conflict with Edinburgh's traffic below 7000ft. The existing ScTMA route structure shares airways for use by both Edinburgh and Glasgow results in higher ATC workload and less efficient profiles in the airspace above 7000ft.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* Doing nothing with Westerly departures will not align with the AMS. It will not enable any environmental benefits or maximise benefits from NERL's re-design of the ScTMA. No change and therefore no ACP submission will not enable any reduction in the volume of controlled airspace.

4.2. Runway 23 Westerly Departure Option A

Runway 23 Westerly Departures (Do Nothing Baseline)		
	Offset right departures with turns at c.2nm and c.7nm from the runway. Offset left departures with turns at c.1nm from the runway. NORBO traffic is shared between a left turn departure route and the departure route that offsets right and then turns left at c.7nm with both routes available at the same time. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.	
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. **Overflight** This option would see the NORBO route which accounts for 58% of Glasgow's overall movements, split into two with offset left and right departures. This would mean that westerly departures would not overfly the same areas as easterly approaches, providing some noise relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas not currently overflown frequently by departures will now be overflown on a more frequent basis.

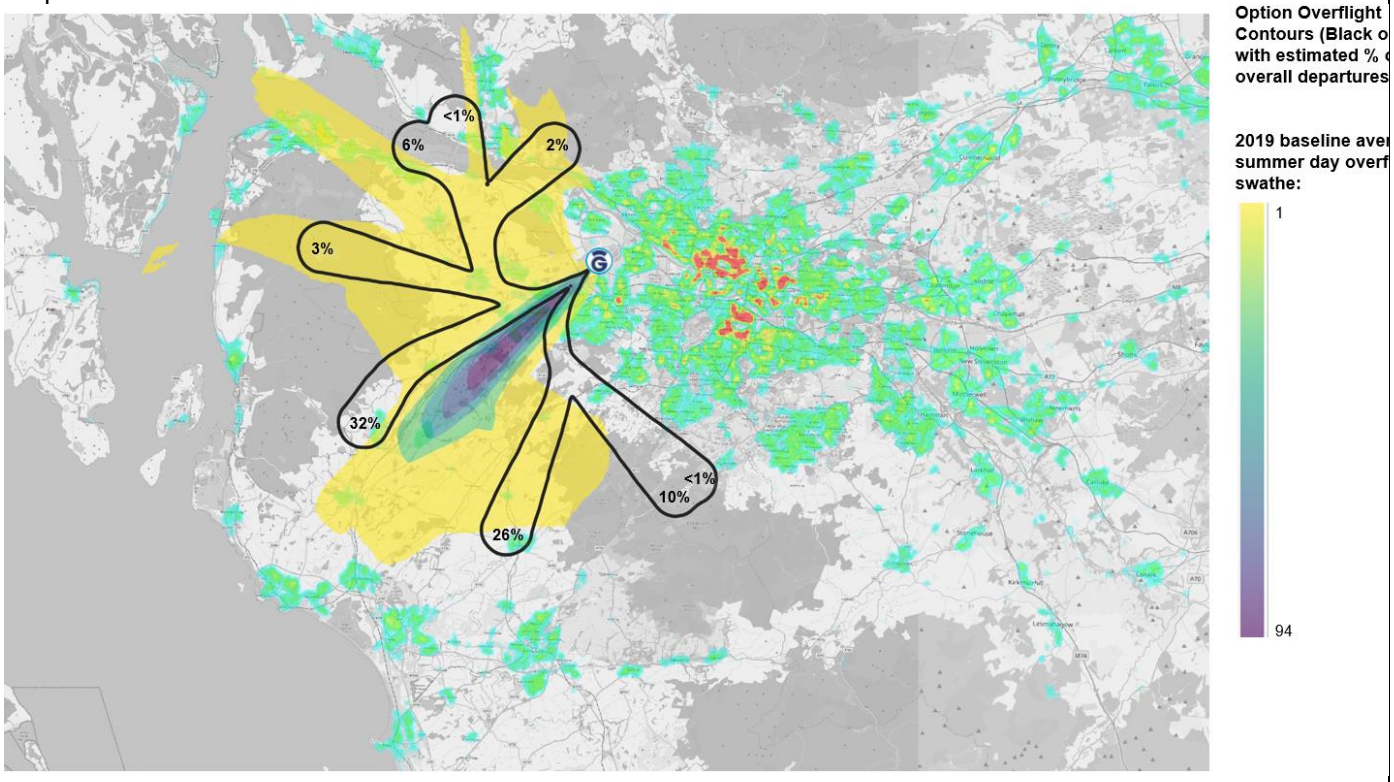


Figure 8 Westerly Option A Overflight and 2019 baseline NTK data

The NTK vectoring baseline data and population data shows that the offset to the left removes overflight of some areas of Johnstone and Elderslie, however this is shifted to parts of east Elderslie and also captures some westerly parts of Foxbar. Beyond this point the route, which would account for around 26% of overall departures, overflies the populated areas of Uplawmoor, Dunlop and Stewarton. The offset to the right NORBO route accounts for around 32% of overall departures, and results in overflight of Linwood and Kilbarchan at lower levels, and overflight of parts of Lochwinnoch and Kilbirine at higher levels. From the NTK vectoring data shown in Figure 8, we can see that these two offset routes would result in some areas not overflown by westerly departures today, or overflown at a relatively low rates, to be overflown at a higher frequency in future albeit splitting the NORBO departures into two will help to mitigate this through a reduction of frequency of overflight should there be just one NORBO route.

The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow, Dumbarton and Alexandria. The vectoring baseline data demonstrates that these SIDs mainly route over areas already overflown today, however there is currently broad dispersion, whereas PBN routes in future would be expected to concentrate traffic, albeit at comparatively low percentages compared to other routes such as NORBO. At higher altitudes the CLYDE/LOMON/FOYLE SIDs overfly areas not currently overflown by westerly departures and this occurs over areas with lower population density.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the Highlands and Islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, it is not expected that the contours would increase in size to overfly any additional dense areas of population with the exception of the CLYDE/LOMON/FOYLE routes, which may overfly Cardross although they are currently positioned over the River Clyde where possible.

The Technical Appendix to this document includes images and data which illustrate the NTK vectoring baseline data, the baseline centreline overflight contour data and the option's centreline overflight contour data. It's important to note that the vectoring baseline data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between the baseline, and the airspace change option.

Overflight data
Table 16 gives an overview of the Option A overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown

more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is an increase in the area of the overflight contours and the number of population overflown which can be attributed to introducing an additional NORBO SID to split the traffic; the benefits and impacts of this will be quantified at Stage 3 should this option progress.

Table 16 Westerly departures option A overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option A	262.55	58671

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number overflown compared to the baseline centreline data. Compared to the vectoring data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage the data does not consider the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option A against the baseline. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 17 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. This is due to the earlier divergence of SIDs compared to the baseline, however the baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 17 60dB and 65dB LAMax Data – Rwy23 Dep Option A

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km²)**	**Population**	**Area (km²)**	**Population**
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option A	493.41	143425	178.62	77760

L_{Aeq}
The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall shape of the L_{Aeq} contours. The offset departures deviate from current day, and it is expected that this change will result in the daytime L_{Aeq} contours shortening compared to current day, however also extending further north-west and south-east to reflect the offset tracks. Review of the population density suggests that this may reduce the shape/size over Howwood, however it may result in population within Linwood and Elderslie being in a higher dB contour than today. Some areas of Linwood, and Foxbar, not currently within the L_{Aeq} contours may now fall into the lower dB contours.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise mitigations
The option offers noise relief for those communities currently located under immediate climb out and final approach, as the offset departures route aircraft away from the final approach track. It also aims to share the impacts of noise by splitting the NORBO departures (which make up 58% of Glasgow's overall movements). Unlike other options, it does not offer respite configurations that would be alternated and achieve predictable respite.

	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option A will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. In addition to this, this option splits the NORBO departures across two routes which will enhance operational performance throughout the day and reduce ground delays and CO_2 contributions. In order to gain the full benefits of this, future investment may be required in additional taxiway infrastructure to enable aircraft to be 'lined up' in the correct order before take-off however this is not within scope of an Airspace Change project. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[3] resilience for Glasgow's SIDs when NERL

[3] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.
	Tranquillity	Table 18 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines. *Table 18 RWY 23 Westerly Departures Option A – Tranquillity overflown* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 23 Baseline – Vectoring (NTK data)**: 0.02 / 1 / 1.68 / 1 / 0 / 0 **RWY23 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 0 / 0 **RWY 23 Option A**: 0 / 0 / 0 / 0 / 0 / 0 The data shows that there is no change in overflight of DQA's and there is a reduction in overflight of NSAs and National parks compared to the vectoring baseline. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 19 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 19 Runway 23 Departure Option A – Biodiversity – areas overflown between 0-7000ft* **System** / **SAC count** / **SAC area** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 23 Baseline – Vectoring (NTK data)**: 3 / 1.42 / 32 / 65.82 / 12 / 58.95 / 1 / 1.68 / 1.00 / 0.02 **RWY 23 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 3 / 23.69 / 1 / 21.89 / 0 / 0 / 0 / 0 **RWY 23 Dep Option A**: 0 / 0 / 26 / 34.66 / 13 / 33.33 / 0 / 0 / 0 / 0 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline, Castle Semple and Barr Lochs SSSI would be avoided. Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston, Barmufflock Dam and Chlochodrick Stone SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal. We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.
General Aviation	Access	Option A is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR is c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline.
	Fuel burn	We estimate that Option A, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This is mainly driven by the reduction in track mileage of the NORBO LAKEY route. There are also reductions in the LUSIV, TALLA, PERTH, LOMON, CLYDE and ROBBO routes although these are operated less frequently than the NORBO. **RWY 23** / **Baseline (Centreline)** / **A** **nm** / **% Weighting** / **Score** / **nm** / **Score** DEPS / TRN: 38.50 / 3.69 / 142.065 / 39.4 / 145.386 NORBO – SUBUK: 93.40 / 26.2 / 2447.08 / 94.3 / 2470.66 NORBO – LAKEY: 93.40 / 32 / 2988.8 / 84.4 / 2700.8 LUSIV-DCS: 84.80 / 10.66 / 903.968 / 81.3 / 866.658 TLA: 54.70 / 0.41 / 22.427 / 47.9 / 19.639 PERTH: 69.80 / 1.23 / 85.854 / 60.2 / 74.046 FOYLE: 33.00 / 0.82 / 27.06 / 26.3 / 21.566 LOMON: 26.70 / 2.05 / 54.735 / 18.1 / 37.105 CLYDE: 19.50 / 2.87 / 55.965 / 16.7 / 47.929 ROBBO: 19.60 / 2.05 / 40.18 / 17.1 / 35.055 Total: 6768.134 / 6418.844 Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.

	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow, with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport nor ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[4];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick Centre and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal, when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. Other than the use of track adjustments on departure no safety issues are expected. The early right turn on ROBBO/FOYLE/LOMON/CLYDE/PERTH departures replicated what is tactically achieved today for most of those departures (excluding PERTH).
All	Interdependencies, conflicts, and trade-offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departure is separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options on their proposed shortlist which would cater for a duel NORBO southbound track structure. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO2 reductions, provide relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure). However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise. This option could be expected to result in reductions in the volume of Glasgow's CAS.

[4] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.3. Runway 23 Westerly Departure Option B

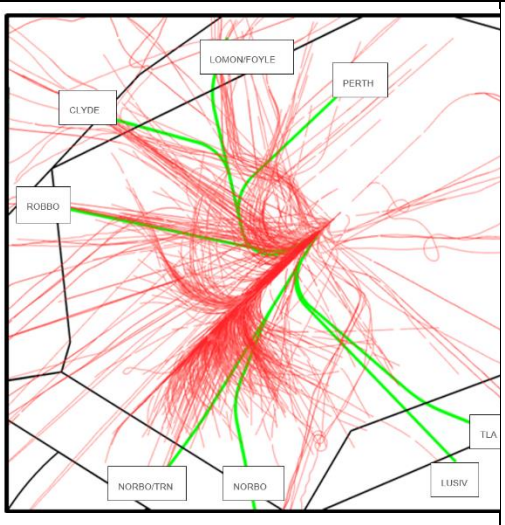
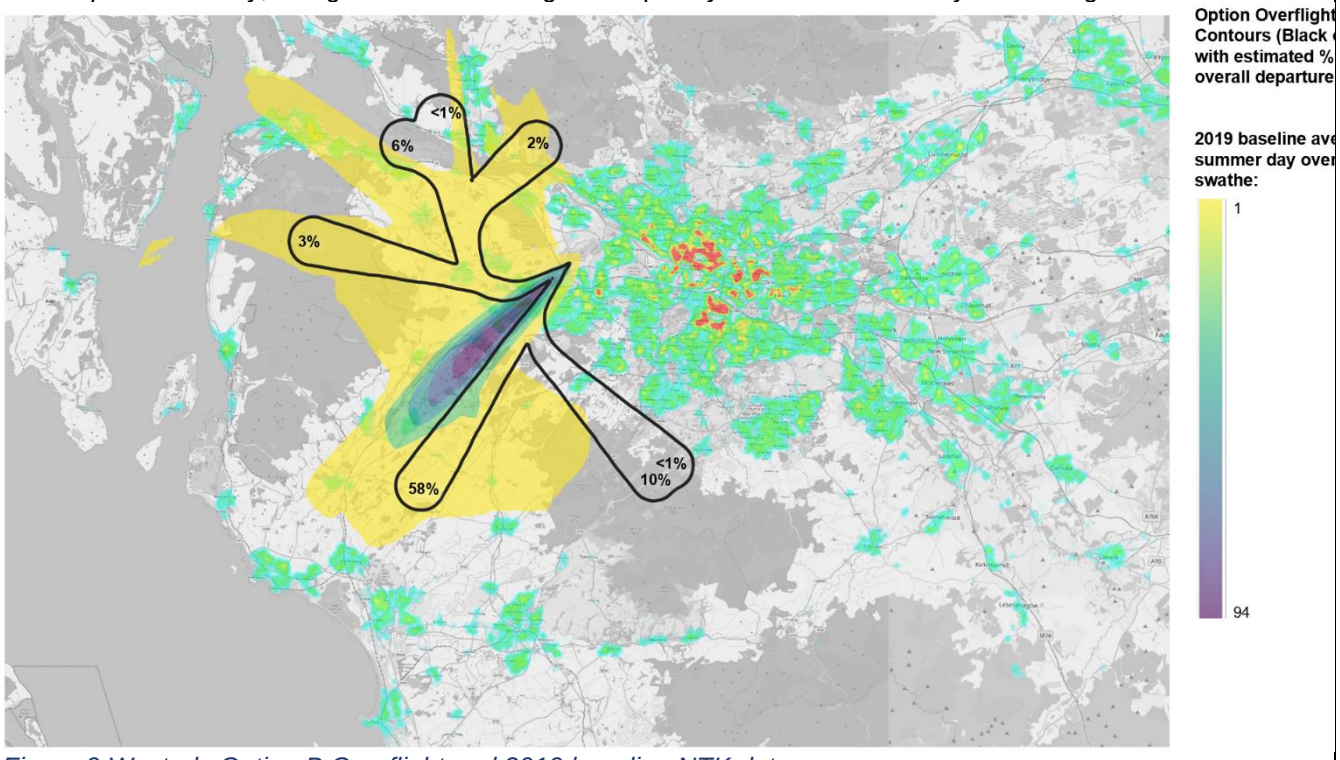
Runway 23 Westerly Departures – Option B		
	Offset right departures with turns at c.2nm from the runway. Offset left departures with turns at c.1nm and c.5nm from the runway. NORBO traffic is shared between two departure routes however they are the same route until c.5nm from the runway. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.	
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. **Overflight** This option would see offset left and right departures. This would mean that westerly departures would not overfly the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis. The heatmap (Figure 9) shows that the offset left departure, which equates for the largest % of departures, deviates away from the area's most frequently overflown today. The NORBO route, which accounts for approximately 58% of overall traffic, offsets to the left which results in the overflight contour picking up some areas not currently overflown today. The NORBO route initially follows the same track and then splits into two however based on the 737-800 climb profile, the benefits of this split mostly occur beyond 7000ft. The route initially flies over Elderslie however then endeavours to avoid areas of dense population with the exception of Barrmill which is overflown at higher altitudes. Unlike other options, this option does not share the impacts of the NORBO route, and therefore this option will result in populations overflown at low frequencies today, being overflown at a higher frequency in future without any other mitigations.  *Figure 9 Westerly Option B Overflight and 2019 baseline NTK data* The LUSIV and TALLA SIDs also offset left and routes over Neilston. The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow, Dumbarton, and Alexandria. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would be expected to concentrate traffic, albeit at comparatively low percentages compared to other routes such as NORBO. **Overflight data** The Technical Appendix to this document includes images and data which illustrate the NTK vectoring baseline data, the baseline centreline overflight contour data and the option's centreline overflight contour data. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID. Table 20 gives an overview of the Option B overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is an increase in the area of the overflight contours and the number of population overflown.

Table 20 Westerly departures option B overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option B	225.76	37664

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows a decrease in the number of care homes and places of worship overflown compared to the centreline baseline and an increase in the number of schools overflown. Number of hospitals remains the same. Compared to the vectoring data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage the data does not consider the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis, should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option B against the baseline. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in Table 21 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. This is due to the earlier divergence of SIDs compared to the baseline however the baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today. We'd expect to see a decrease in population compared to the 2019 vectored L_{Amax} contours.

Table 21 60dB and 65dB LAMax Data – Rwy23 Dep Option A

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km²)**	**Population**	**Area (km²)**	**Population**
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option B	433.35	121890	160.28	70853

L_{Aeq}

The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the offset departures that form part of this option deviate from current day. It is expected that this change will result in the L_{Aeq} contours shortening compared to current day. The offset departure to the left, which would operate around 68% of departure movements, is expected to result in the L_{aeq} contour extending further to the south-west to reflect the offset track. When reviewing population density, this suggests there may be some benefit to Howwood and Johnstone, however the lobe would now potentially extend over Foxbar and parts of Ferguslie. The equivalent ROBBO/CLYDE/LOMON/FOYLE/ PERTH SIDs operate a far lower percentage of flights and so are likely to have less influence on the overall shape of L_{Aeq} contours however the offset route may result in some areas of Linwood, which currently sit in the lower dB L_{Aeq} contours, to move into a higher dB contour.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation

The option offers relief for those communities currently located under immediate climb out and final approach as the offset departures route aircraft away from the final approach track. Unlike other options, it does not offer respite configurations that would be alternated and achieve predictable respite. This option would not mitigate the effects for those newly overflown by a NORBO departure by splitting the NORBO departures across 2 tracks.

	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option B will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience[5]	This option sees the SIDs splitting before 5nm which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. Splitting the NORBO departures across two routes would enhance operational performance and reduce ground delays and CO_2 contributions, particularly at peak periods. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide

[5] Summary colour corrected

<table>
<tr><td></td><td></td><td>programme under the Airspace Modernisation programme. There is currently no long term[6] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.</td></tr>
<tr><td></td><td>Tranquillity</td><td>Table 22 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines.

Table 22 RWY 23 Westerly Departures Option B – Tranquillity overflown

<table>
<tr><th>System</th><th>NSA area</th><th>NSA count</th><th>National Parks area</th><th>National Parks count</th><th>DQA area</th><th>DQA count</th></tr>
<tr><td>RWY 23 Baseline – Vectoring (NTK data)</td><td>0.02</td><td>1</td><td>1.68</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>RWY23 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 23 Option B</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

The data shows that there is no change in overflight of DQA's and there is a reduction in overflight of NSAs and National parks compared to the vectoring baseline. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td></td><td>Biodiversity</td><td>Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline Castle Semple and Barr Lochs SSSI would be avoided.

Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal.

We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Option B is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS.

We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.</td></tr>
<tr><td>General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>We expect the small increased effective capacity detailed in the section above will result in a small positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline however the continuation of NORBO departures in a single track would not deliver the biggest economic benefits.</td></tr>
<tr><td></td><td>Fuel burn</td><td>We estimate that Option B, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This is mainly driven by the reduction in track mileage of the NORBO LAKEY route. There are also small reductions in the TRN, NORBO SUBUK, LUSIV, TALLA, PERTH, LOMON, CLYDE and ROBBO routes.

Table 23 Track Length Calculations – Fuel Burn Option B

<table>
<tr><th colspan="2" rowspan="2">RWY 23</th><th colspan="3">Baseline (Centreline)</th><th colspan="2">B</th></tr>
<tr><th>nm</th><th>% Weighting</th><th>Score</th><th>nm</th><th>Score</th></tr>
<tr><td rowspan="9">DEPS</td><td>TRN</td><td>38.50</td><td>3.69</td><td>142.065</td><td>37.5</td><td>138.375</td></tr>
<tr><td>NORBO – SUBUK</td><td>93.40</td><td>26.2</td><td>2447.08</td><td>91.6</td><td>2399.92</td></tr>
<tr><td>NORBO – LAKEY</td><td>93.40</td><td>32</td><td>2988.8</td><td>85.1</td><td>2723.2</td></tr>
<tr><td>LUSIV-DCS</td><td>84.80</td><td>10.66</td><td>903.968</td><td>81.3</td><td>866.658</td></tr>
<tr><td>TLA</td><td>54.70</td><td>0.41</td><td>22.427</td><td>47.9</td><td>19.639</td></tr>
<tr><td>PERTH</td><td>69.80</td><td>1.23</td><td>85.854</td><td>60.2</td><td>74.046</td></tr>
<tr><td>FOYLE</td><td>33.00</td><td>0.82</td><td>27.06</td><td>26.3</td><td>21.566</td></tr>
<tr><td>LOMON</td><td>26.70</td><td>2.05</td><td>54.735</td><td>18.1</td><td>37.105</td></tr>
<tr><td>CLYDE</td><td>19.50</td><td>2.87</td><td>55.965</td><td>16.7</td><td>47.929</td></tr>
<tr><td>ROBBO</td><td>19.60</td><td>2.05</td><td>40.18</td><td>17.1</td><td>35.055</td></tr>
<tr><td colspan="5">Total</td><td>6768.134</td><td></td><td>6363.493</td></tr>
</table>

Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn.</td></tr>
<tr><td>Commercial airlines</td><td>Training costs</td><td>Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.</td></tr>
<tr><td></td><td>Other costs</td><td>No other airline costs are foreseen.</td></tr>
<tr><td>Airport / Air navigation service provider</td><td>Infrastructure costs</td><td>Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are</td></tr>
</table>

[6] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[7];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick Centre and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. Other than the use of track adjustments on departure no safety issues are expected. The early right turn on ROBBO/FOYLE/LOMON/CLYDE/PERTH departures replicated what is tactically achieved today for most of those departures (excluding PERTH)
All	Interdependencies, conflicts, and trade-offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departure is separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options ion their proposed shortlist which would cater for a duel NORBO southbound track structure, noting that the split of NORBO traffic takes place above 7000ft in this option. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would be expected to generate significant CO_2 reductions, provide relief from noise to those most frequently overflown by Glasgow arrivals and departures. However, this option would not accommodate future demand in the most effective manner as a single initial NORBO departure would likely generate future ground delay. In addition, positioning all NORBO departures over the same newly overflown communities would not mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to sharing across a dual NORBO SID structure). However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise. This option could be expected to result in reductions in the volume of Glasgow's CAS

[7] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.4. Runway 23 Westerly Departure Option C

Runway 23 Westerly Departures – Option C

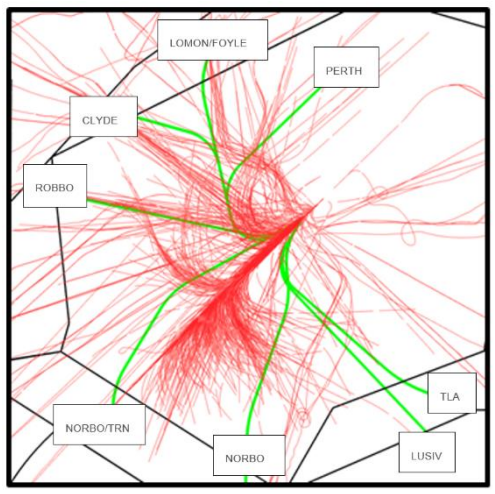


Figure 11 Option C Peak Hours

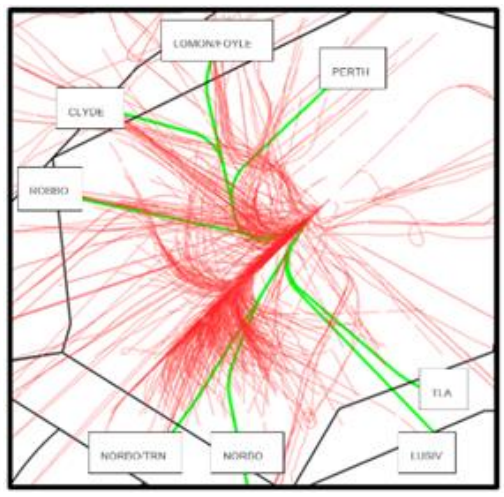
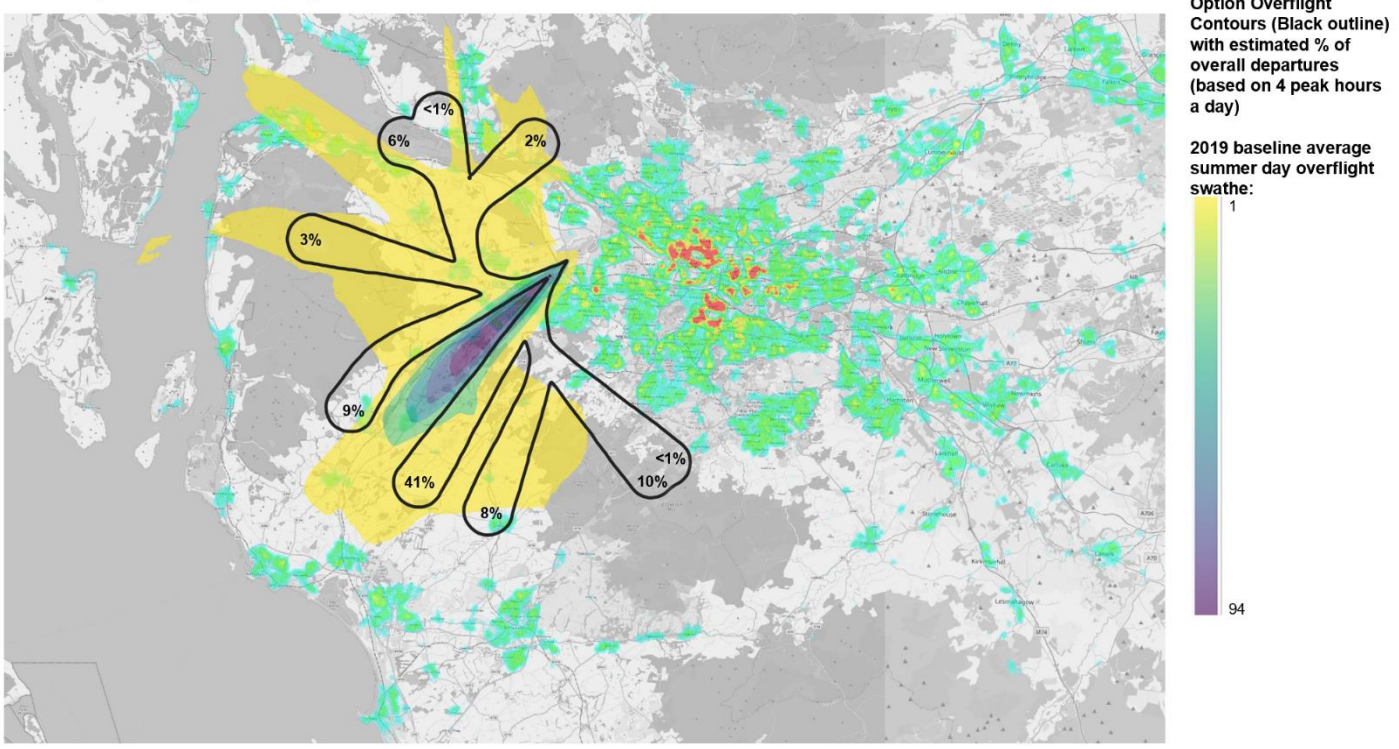


Figure 10 Option C Rest of the day

This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure periods. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a different NORBO flight path which offsets to the left, with the rest of the routes remaining the same. The reason for this would be to mitigate the small increase in mileage of a NORBO route which offsets to the right, compared to the baseline SID.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see offset left and right departures. This would mean that westerly departures would not overfly the same areas as easterly approaches, providing some noise relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis.  *Figure 12 Westerly Option C Overflight and 2019 baseline NTK data* In this appraisal we have assumed the dual NORBO SID structure is used for the first rotation only. **Period 1 (Peak departure Hours) overflight (NORBO Route changing)** During peak hours, particularly in the morning period, the majority of aircraft are flying to destinations routing south from Glasgow, and therefore the NORBO direction becomes the predominantly used SID. In this option, during peak hours the NORBO route is split into two which would share the noise. Both of these NORBO routes are offset, one left and one right, which would mean that westerly departures would not overfly the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that areas not currently overflown frequently by departures will now be overflown on a more frequent basis. The heatmap (Figure 12) shows that the offset to the left removes overflight of some areas of Johnstone and Elderslie, however this is shifted to parts of east Elderslie and also captures some westerly parts of Foxbar. Beyond this point the route, which would account for around 8% of overall departures, overflies the populated areas of Uplawmoor, Dunlop and Stewarton. Some overflight of these areas is required in order to achieve respite for communities living under the NORBO SID during the off-peak hours which account for around 41% of overall departures from Glasgow. The offset to the right NORBO route accounts for around 9% of overall departures, and results in overflight of Linwood and Kilbarchan at lower levels, and overflight of parts of Lochwinnoch and Kilbirine at higher levels. **Period 2 overflight** During the off-peak periods the NORBO departure, which accounts for approximately 41% of overall traffic (assuming this route is used all day after the first rotation), offsets to the left but follows a different path than the peak hours offset-left SID. The initial section of the NORBO route follows the same path as the peak period configuration, and therefore there is very limited respite for communities living under the early parts of these routes who will experience around 49% of departures overall. From the heatmap, this level of overflight would be a significant change from current day, where those areas are typically experiencing somewhere between 1 – 10 flights per day on average. The route initially flies over Elderslie however then endeavours to avoid areas of dense population with the exception of Barrmill which is overflown at higher altitudes. The LUSIV and TALLA SIDs also offset left and route over Neilston; beyond this they largely avoid dense areas of population. The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow, Dumbarton, and Alexandria. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would concentrate traffic albeit at comparatively low percentages compared to other routes such as NORBO.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, it is not expected that the contours would increase in size to overfly any additional dense areas of population.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option C. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Overflight data
Table 24 gives an overview of the Option C overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is a significant increase in the area of the contours and the number of population and noise sensitive sites overflown; this is due to the nature of having multiple NORBO routes, an additional NORBO respite route and also avoiding the easterly final approach track whereby more people are overflown. However, the noise is shared and therefore it is overflight on a less frequent basis than for those who live under easterly final approach currently experience.

Table 24 Westerly departures option C overflight data

System	Area (km^2)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option C	305.53	60931

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools, care homes and places of worship overflown compared to the centreline baseline. Number of hospitals remains the same. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option C against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in Table 25 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour however the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 25 60dB and 65dB L_{AMax} Data – Rwy23 Dep Option C

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option C	563.66	146232	206.59	80377

L_{Aeq}
The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the offset departures that form part of this option deviate from current day. It is expected that this change will result in the L_{Aeq} contours shortening compared to current day. The offset departure to the left, which would operate around 60% of departure movements, is expected to result in the L_{Aeq} contour extending further to the south-west to reflect the offset track. When reviewing population density, this suggests there may be some benefit to Howwood and Johnstone, however the lobe would now potentially extend over Foxbar and parts of Ferguslie. The equivalent ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs operate a far lower percentage of flights and so are likely to have less influence on the overall shape of L_{Aeq} contours however the offset route may result in some areas of Linwood, which currently sit in the lower dB L_{Aeq} bands, to move into a higher dB contour.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option offers relief for those communities currently located under immediate climb out and final approach as the offset departures route aircraft away from the final approach track. Having 2 NORBO SIDs also reduces the frequency of overflight for communities situated under just one NORBO SID, but only for the first rotation. It also offers an alternative respite configuration during peak departure periods for communities who live under the NORBO departure which accounts for the majority of departures from Glasgow airport however the benefits of this are minor as the respite configuration mainly benefits communities to the north-west (See overflight section above).

The introduction of alternative predictable respite arrangements also increases population overflown and the 60dB and 65dB L_{Amax} outcomes compared to other options; the benefits and impacts of this will be further analysed as part of the Full Options Appraisal at Stage 3 when we have quantitative information about the frequency of overflight should this option progress.

<table>
<tr><td></td><td>Air Quality</td><td>This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard ‘straight ahead’ departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as ‘offset departures’) there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that Option C will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience[8]</td><td>This option sees the SIDs splitting before 5nm which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.

However, this option only splits the NORBO departures across two routes during peak departure periods. In order to gain the full benefits of this, future investment may be required in additional taxiway infrastructure to enable aircraft to be ‘lined up’ in the correct order before take-off however this is not within scope of an Airspace Change project. The availability of the dual NORBO structure during the existing peak departure hours only would not accommodate future daily peaks in demand outside of these peak times.

The introduction of PBN SIDs also removes Glasgow’s dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[9] resilience for Glasgow’s SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL’s VOR withdrawal programme.</td></tr>
<tr><td>Tranquillity</td><td>Table 26 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow’s existing SID centrelines.

Table 26 RWY 23 Westerly Departures Option C – Tranquillity overflown
<table>
<tr><th>System</th><th>NSA area</th><th>NSA count</th><th>National Parks area</th><th>National Parks count</th><th>DQA area</th><th>DQA count</th></tr>
<tr><td>RWY 23 Baseline – Vectoring (NTK data)</td><td>0.02</td><td>1</td><td>1.68</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>RWY23 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 23 Option C</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
The data shows that there is no change in overflight of DQA’s and there is a reduction in overflight of NSAs and National parks compared to the vectoring baseline. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td>Biodiversity</td><td>Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline Castle Semple and Barr Lochs SSSI would be avoided.

Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal.

We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Option C is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS.

We created an “illustrative CAS volume” which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the “illustrative” airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, the merging of NORBO departures in a single track for the majority of the day would not deliver the biggest economic benefits.</td></tr>
<tr><td>Fuel burn</td><td>We estimate that Option C, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This is mainly driven by the reduction in track mileage of the NORBO LAKEY route however there are overall reductions in all routes.

Table 27 Track Length Calculations – Fuel Burn Option C
<table>
<tr><th colspan="2" rowspan="2">RWY 23</th><th colspan="3">Baseline (Centreline)</th><th colspan="4">C</th></tr>
<tr><th>nm</th><th>% Weighting</th><th>Score</th><th>nm P1</th><th>nm P2</th><th>Average</th><th>Score</th></tr>
<tr><td rowspan="8">DEPS</td><td>TRN</td><td>38.50</td><td>3.69</td><td>142.065</td><td>39.4</td><td>37.5</td><td>38.45</td><td>141.8805</td></tr>
<tr><td>NORBO – SUBUK</td><td>93.40</td><td>26.2</td><td>2447.08</td><td>94.3</td><td>91.6</td><td>92.95</td><td>2435.29</td></tr>
<tr><td>NORBO – LAKEY</td><td>93.40</td><td>32</td><td>2988.8</td><td>84.4</td><td>85.1</td><td>84.75</td><td>2712</td></tr>
<tr><td>LUSIV-DCS</td><td>84.80</td><td>10.66</td><td>903.968</td><td>81.3</td><td>81.3</td><td>81.3</td><td>866.658</td></tr>
<tr><td>TLA</td><td>54.70</td><td>0.41</td><td>22.427</td><td>47.9</td><td>47.9</td><td>47.9</td><td>19.639</td></tr>
<tr><td>PERTH</td><td>69.80</td><td>1.23</td><td>85.854</td><td>60.2</td><td>60.2</td><td>60.2</td><td>74.046</td></tr>
<tr><td>FOYLE</td><td>33.00</td><td>0.82</td><td>27.06</td><td>26.3</td><td>26.3</td><td>26.3</td><td>21.566</td></tr>
<tr><td>LOMON</td><td>26.70</td><td>2.05</td><td>54.735</td><td>18.1</td><td>18.1</td><td>18.1</td><td>37.105</td></tr>
</table></td></tr>
</table>

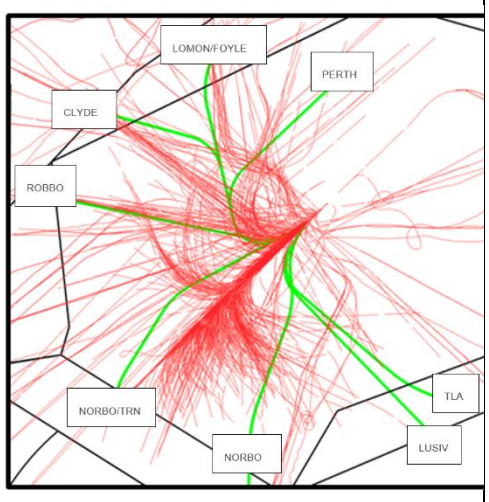
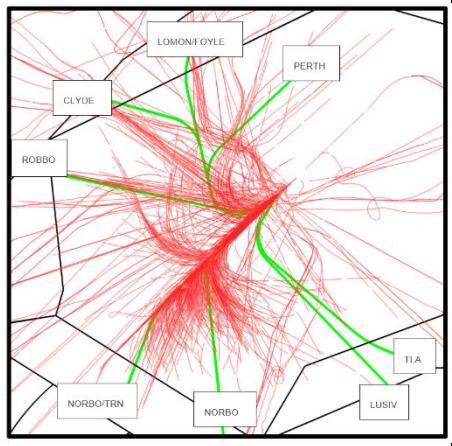
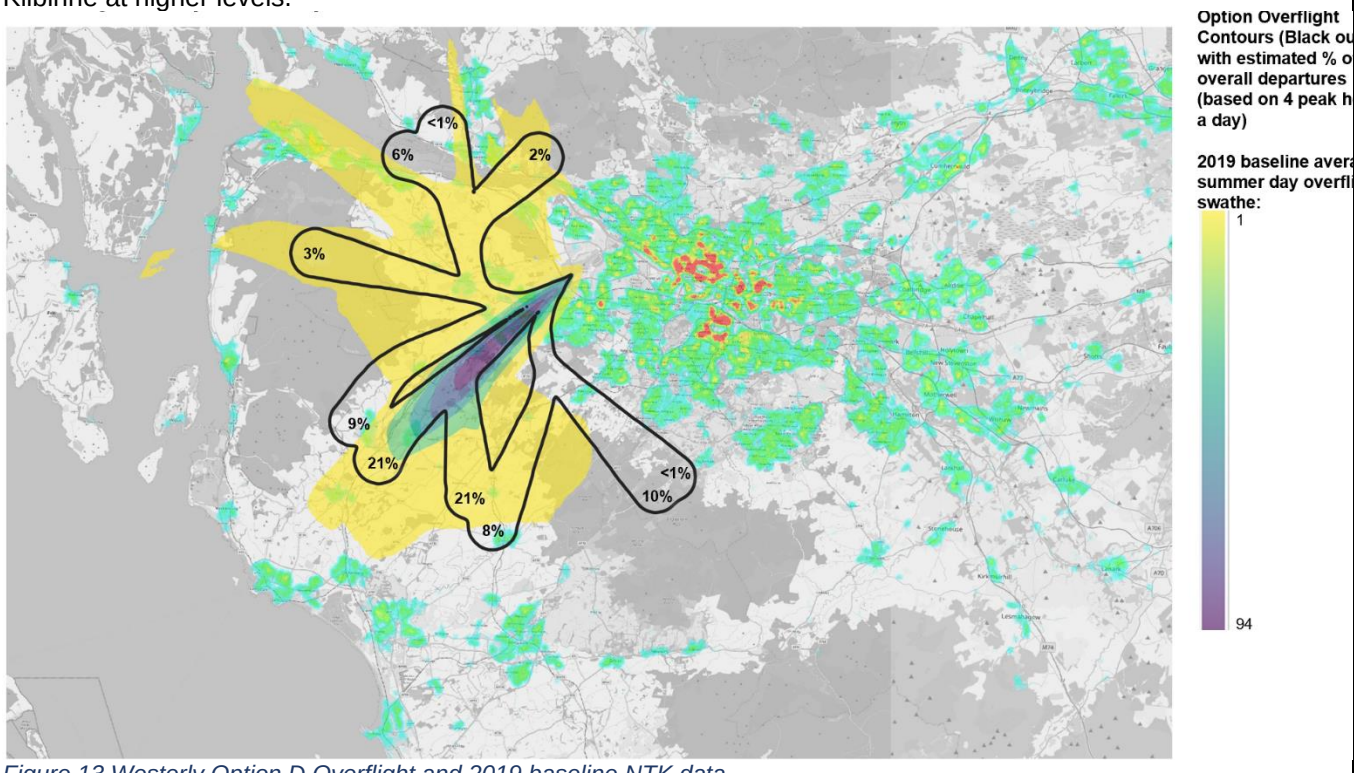
[8] Summary colour corrected

[9] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		<table><tr><td></td><td>CLYDE</td><td>19.50</td><td>2.87</td><td>55.965</td><td>16.7</td><td>16.7</td><td>16.7</td><td>47.929</td></tr><tr><td></td><td>ROBBO</td><td>19.60</td><td>2.05</td><td>40.18</td><td>17.1</td><td>17.1</td><td>17.1</td><td>35.055</td></tr><tr><td>Total</td><td></td><td></td><td></td><td>6768.134</td><td></td><td></td><td></td><td>6391.169</td></tr></table> Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[10];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh. Owing to the respite configuration, there may be more training required for this option, compared to other options that form part of this IOA.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. A SID structure from the same runway which changes during the day is unchartered territory for the UK. Whilst it is expected that perhaps a much more subtle change to a SID structure can be safely accommodated, ATC advised that an option where a SID utilisation would change significantly from a left turn to a right turn (or vice-versa) immediately after departure introduces hazards to the operation which at this stage cannot considered to be mitigated without introducing other issues*. Such hazards are not just associated with aircraft inadvertently flying (or being issued) the wrong SIDs and the wrong time of day but also Human Factor (HF) issues associated with ATC confusion. *As an example, mitigations identified for SIDs switching to fundamental different directions after departure were SIDs with completely different names. However, flight planning and ATM issues previously identified by NERL requires SIDs going to the same places in the network are required to terminate at the same point which in turn would mean similar SID names to match the SID termination point.
All	Interdependencies, conflicts, and trade-offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departures are separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options ion their proposed shortlist which would cater for a dual NORBO southbound track structure, noting these SIDs would then merge into one initial track for the rest of the day As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would be expected to generate significant CO_2 reductions, provide relief and respite from noise to those most frequently overflown by Glasgow arrivals and departures living under final approach. However, this option would not accommodate future demand in the most effective manner as a single initial NORBO departure track for the majority of the day would likely generate future ground delay. In addition, positioning that single NORBO departure over the same newly overflown communities for the rest of the day would not mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a dual NORBO SID structure). However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise. This option could be expected to result in reductions in the volume of Glasgow's CAS.

[10] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.5. Runway 23 Westerly Departure Option D

Runway 23 Westerly Departures – Option D		
		This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a different NORBO flight path which follows a straight line from the runway until splitting at 5nm, with the rest of the routes remaining the same. The reason for this would be to mitigate the small increase in mileage of a NORBO route which offsets to the right, compared to the baseline SID as well as mitigating the effects for those newly overflown by the peak NORBO SIDs. This option is similar to Option C except that the daytime (non-peak) NORBO route is different. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal. 
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see offset left and right departures. This would mean that westerly departures would not overfly the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis. In this appraisal we have assumed the dual NORBO SID structure is used for the first rotation only. **Period 1 (Peak departure Hours) overflight (NORBO Route changing)** During peak hours, particularly in the morning period, the majority of aircraft are flying to destinations routing south from Glasgow, and therefore the NORBO direction becomes the predominantly used SID. In this option, during peak hours the NORBO route is split into two, which would share the noise. Both of these NORBO routes are offset, one left and one right, which would mean that westerly departures would not overfly the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis. The heatmap Figure 13 shows that the offset to the left removes overflight of some areas of Johnstone and Elderslie, however this is shifted to parts of east Elderslie and also captures some westerly parts of Foxbar. Beyond this point the route, which would account for around 8% of overall flights, overflies the populated areas of Uplawmoor, Dunlop and Stewarton. Some overflight of these areas is required in order to achieve respite for communities living under the NORBO SID during the off-peak hours which account for around 42% of overall departures from Glasgow. The offset to the right route accounts for around 9% of overall departures, and results in overflight of Linwood and Kilbarchan at lower levels, and overflight of parts of Lochwinnoch and Kilbirine at higher levels.  *Figure 13 Westerly Option D Overflight and 2019 baseline NTK data* **Period 2 overflight** During the off-peak periods the NORBO departure, which accounts for approximately 42% of overall traffic (assuming this route is used all day after the first rotation) would fly straight ahead, similar to how aircraft fly the NORBO route today. At 5nm the route would then split into two, with 21% of departures continuing straight ahead and 21% turning south. The initial straight-ahead section between the runway and 5nm overflies Johnstone, Elderslie and Howwood as the majority of departures do today. The straight-ahead section beyond 5nm overflies Beith and parts of Kilbirnie however this will be different to current day owing to the concentration of traffic along the PBN routes. From the NTK data we can see that the route to the south route would increase the frequency of overflight compared to today however this route largely avoids areas of dense population with the exception of parts of Dunlop at around 7000ft. In both periods, the ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow, Dumbarton, and Alexandria. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would be expected to concentrate traffic albeit at comparatively low percentages compared to other routes such as NORBO.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option D. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Overflight data
Table 28 gives an overview of the Option D overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is a significant increase in the area of the contours and the number of population overflown; this is partially due to the nature of the respite routes whereby more people are overflown, however the noise is shared and therefore it is overflight on a less frequent basis.

Table 28 Westerly departures option D overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option D	332.84	82804

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools, care homes and places of worship overflown compared to the centreline baseline. Number of hospitals remains the same. Compared to the vectoring data, there is a decrease in potentially noise sensitive buildings overflown, but it's important to note that at this stage the data does not consider the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option D against the baseline. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in Table 29 shows a significant increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour however the baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 29 60dB and 65dB LAMax Data – Rwy23 Dep Option D

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km²)**	**Population**	**Area (km²)**	**Population**
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option D	583.18	153095	214.24	84120

L_{Aeq}
The westerly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the offset departures that form part of this option deviate from current day. Unlike some other options, the NORBO offset routes are only used for a small part of the day, with the majority of the NORBO departures continuing to fly straight ahead to 5nm as they do today. The introduction of the offset routes overall may result in a small change in the L_{Aeq} contours shortening compared to current day. The offset departures to the left, which would operate around 19% of departure movements, is expected to result in the L_{Aeq} contour extending slightly further to the south-west to reflect the offset track, this change is likely to occur over an area with low population however it would require further quantitative investigation at Stage 3 should this option progress. The offset departures to right, which would operate around 21% of departure movements, is expected to result in the L_{Aeq} contour extending slightly further to the north-east to reflect the offset track, this change is likely to occur over Linwood however it would require further quantitative investigation at Stage 3 should this option progress.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigations
The option offers an alternative respite configuration during peak departure periods for communities who live under the NORBO departure which accounts for the majority of departures from Glasgow airport. This means that overall, the NORBO noise is shared across three different routes although the straight-ahead off-peak route, which is similar to current day, sees the majority of the traffic.

The other routes remain the same during peak and off-peak periods however they have comparatively lower percentages of overall flights operating.

The introduction of alternative predictable respite arrangements (for those communities newly overflown by the peak NORBO) increases population overflown and the 60dB and 65dB L_{Amax} outcomes compared to other options; the benefits and impacts of this will be further analysed as part of the Full Options Appraisal at Stage 3 when we have quantitative information about the frequency of overflight (should this option progress).

	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral

<table>
<tr><td></td><td></td><td>tracks are newly overflying areas to the side of the straight-ahead departure route (known as ‘offset departures’) there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that Option D will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience[11]</td><td>This option sees the SIDs splitting before 5nm which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.

However, this option only splits the NORBO departures across two routes during peak departure periods. In order to gain the full benefits of this, future investment may be required in additional taxiway infrastructure to enable aircraft to be ‘lined up’ in the correct order before take-off however this is not within scope of an Airspace Change project. The availability of the dual NORBO structure during the existing peak departure hours only would not accommodate future daily peaks in demand outside of these peak times.

The introduction of PBN SIDs also removes Glasgow’s dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[12] resilience for Glasgow’s SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL’s VOR withdrawal programme.</td></tr>
<tr><td>Tranquillity</td><td>Table 30 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow’s existing SID centrelines.

Table 30 RWY 23 Westerly Departures Option D – Tranquillity overflown
<table>
<tr><th>System</th><th>NSA area</th><th>NSA count</th><th>National Parks area</th><th>National Parks count</th><th>DQA area</th><th>DQA count</th></tr>
<tr><td>RWY 23 Baseline – Vectoring (NTK data)</td><td>0.02</td><td>1</td><td>1.68</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>RWY23 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 23 Option D</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
The data shows that there is no change in overflight of DQA’s and there is a reduction in overflight of NSAs and National parks compared to the vectoring baseline. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td>Biodiversity</td><td>Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline Castle Semple and Barr Lochs SSSI would be avoided.

Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal.

We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Option D is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS.

We created an “illustrative CAS volume” which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the “illustrative” airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, the merging of NORBO departures in a single track for the majority of the day would not deliver the biggest economic benefits.</td></tr>
<tr><td>Fuel burn</td><td>We estimate that Option D, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This is mainly driven by the reduction in track mileage of the NORBO LAKEY route however there are also some small reductions in the LUSIV, TLA, PERTH, FOYLE, LOMON, CLYDE and ROBBO departures.

Table 31 Track Length Calculations – Fuel Burn Option D
<table>
<tr><th colspan="2" rowspan="2">RWY 23</th><th colspan="3">Baseline (Centreline)</th><th colspan="4">D</th></tr>
<tr><th>nm</th><th>% Weighting</th><th>Score</th><th>nm P1</th><th>nm P2</th><th>Average</th><th>Score</th></tr>
<tr><td rowspan="9">DEPS</td><td>TRN</td><td>38.50</td><td>3.69</td><td>142.065</td><td>39.4</td><td>37.8</td><td>38.6</td><td>142.434</td></tr>
<tr><td>NORBO – SUBUK</td><td>93.40</td><td>26.2</td><td>2447.08</td><td>94.3</td><td>92.5</td><td>93.4</td><td>2447.08</td></tr>
<tr><td>NORBO – LAKEY</td><td>93.40</td><td>32</td><td>2988.8</td><td>84.4</td><td>85.6</td><td>85</td><td>2720</td></tr>
<tr><td>LUSIV-DCS</td><td>84.80</td><td>10.66</td><td>903.968</td><td>81.3</td><td>81.3</td><td>81.3</td><td>866.658</td></tr>
<tr><td>TLA</td><td>54.70</td><td>0.41</td><td>22.427</td><td>47.9</td><td>47.9</td><td>47.9</td><td>19.639</td></tr>
<tr><td>PERTH</td><td>69.80</td><td>1.23</td><td>85.854</td><td>60.2</td><td>60.2</td><td>60.2</td><td>74.046</td></tr>
<tr><td>FOYLE</td><td>33.00</td><td>0.82</td><td>27.06</td><td>26.3</td><td>26.3</td><td>26.3</td><td>21.566</td></tr>
<tr><td>LOMON</td><td>26.70</td><td>2.05</td><td>54.735</td><td>18.1</td><td>18.1</td><td>18.1</td><td>37.105</td></tr>
<tr><td>CLYDE</td><td>19.50</td><td>2.87</td><td>55.965</td><td>16.7</td><td>16.7</td><td>16.7</td><td>47.929</td></tr>
</table></td></tr>
</table>

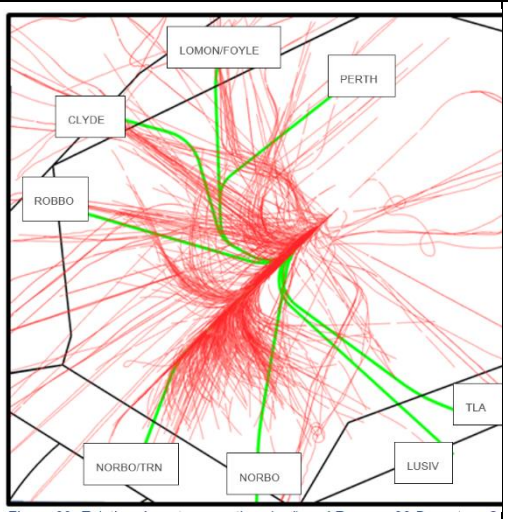
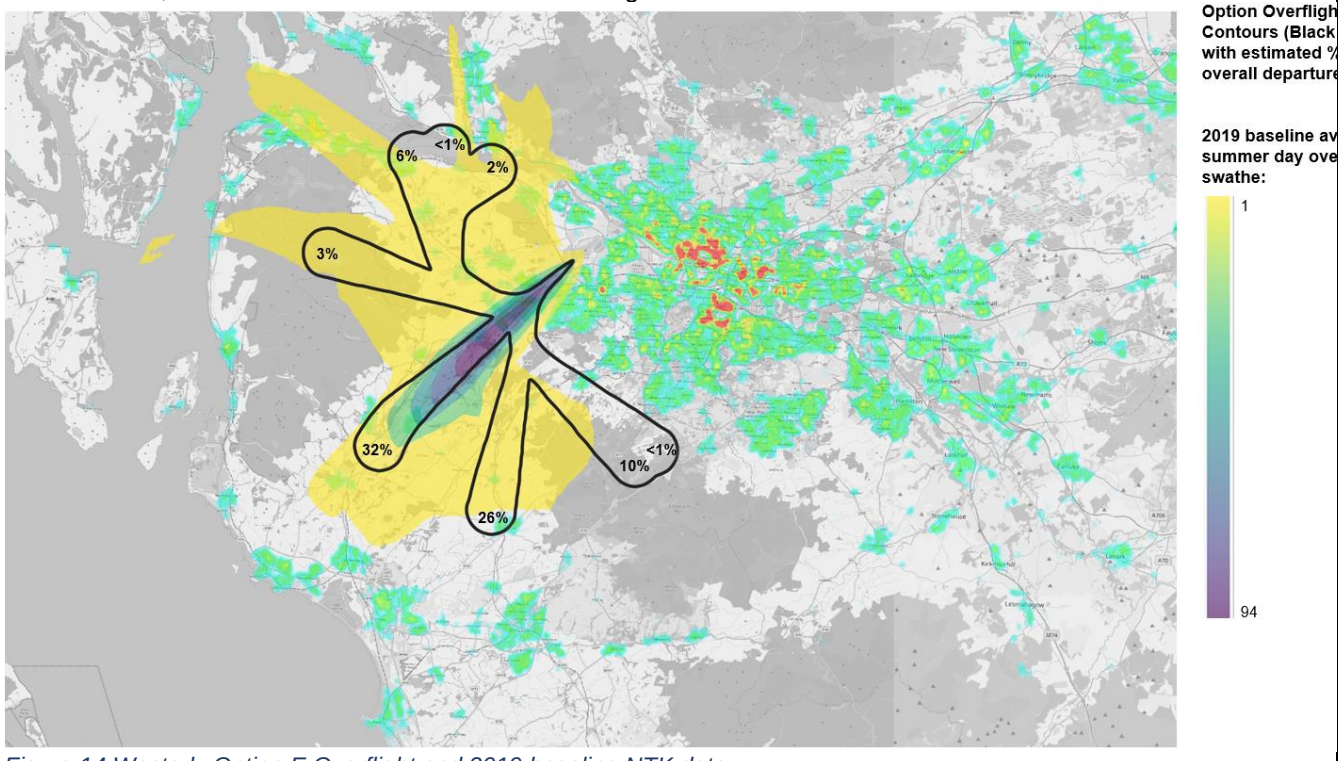
[11] Summary colour corrected

[12] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		ROBBO 19.60 2.05 40.18 17.1 17.1 17.1 35.055 Total 6768.134 6411.512 Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[13].
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh. Owing to the respite configuration, there may be more training required for this option compared to other options that form part of this IOA.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. A SID structure from the same runway which changes during the day is unchartered territory for the UK. Whilst it is expected that perhaps a much more subtle change to a SID structure can be safely accommodated, ATC advised that an option where a SID utilisation would change significantly from a left turn to a straight ahead (or vice-versa) immediately after departure introduces hazards to the operation which at this stage cannot considered to be mitigated without introducing other issues*. Such hazards are not just associated with aircraft inadvertently flying (or being issued) the wrong SIDs and the wrong time of day but also HF issues associated with ATC confusion. *As an example, mitigations identified for SIDs switching to fundamental different directions after departure were SIDs with completely different names. However, flight planning and ATM issues previously identified by NERL requires SIDs going to the same places in the network are required to terminate at the same point which in turn would mean similar SID names to match the SID termination point.
All	Interdependencies, conflicts, and trade-offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departures are separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options on their proposed shortlist which would cater for a dual NORBO southbound track structure, noting these SIDs would then merge into one initial track for the rest of the day. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would be expected to generate significant CO_2 reductions and provide relief and respite from noise to those communities that would be newly overflown by the peak NORBO Routes. However, that would come at the expense of then overflying the communities most frequently overflown by Glasgow arrivals and departures living under final approach the rest of the day. This option would not accommodate future demand in the most effective manner as a single initial NORBO departure track for the majority of the day would likely generate future ground delay. However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise. This option could be expected to result in reductions in the volume of Glasgow's CAS

[13] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.6. Runway 23 Westerly Departure Option E

Runway 23 Westerly Departures – Option E		
		Straight ahead departures only (no offsets) with turns at c.1nm and c.9nm from the runway NORBO is traffic is shared between a route that turns left at c.1nm and one that doesn't turn until c.9nm from the runway. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see all departures going straight ahead, however compared to today, some departures would turn at c.1nm, c.2nm and c.9nm rather than all turning at 5nm.  *Figure 14 Westerly Option E Overflight and 2019 baseline NTK data* The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that routes straight ahead until turning at c.9nm and one that initially flies straight ahead and then turns at c.2nm. Unlike other options, these routes are not offset and so the straight-ahead sections overfly similar areas to today such as Johnstone and Elderslie, which are the same populations as under final approach. Around 32% of overall departure movements would fly the route that climbs straight ahead before turning at 9nm although this is a significantly lower % than experiences today. The NTK heatmap shown in figure 14 shows that this largely follows the areas where departures fly today. This includes overflight of Johnstone, Elderslie and Howwood, and at higher altitudes, Beith and the south of Kilbirnie. The other 26% of NORBO departures will fly the route that turns at c.2nm. Beyond the 2nm, the turn to the south introduces overflight over some new areas although figure 14 shows these are not densely populated. Aircraft would then route over areas that are currently overflown today including the populated areas of Lugton, Dunlop, western parts of Uplawmoor, and the northwestern parts of Stewarton at 7000ft. From the heatmap, this level of overflight would be a change from current day, where those areas are typically experiencing somewhere between around 1–10 flights per day, on average. The LUSIV and TALLA SIDs, which account for 10% and <1% of traffic respectively, also turn earlier today resulting in some new areas of overflight. Figure 14 shows that this largely avoids dense areas of population with the exception of western Neilston which will mainly be overflown by the TALLA departures. The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs fly straight ahead before turning right. This initial part of the right turn routes over parts of Johnston and Kilbarchan. Beyond this point, the ROBBO SID which is estimated to be operated by 3% of overall Glasgow departures, routes over areas overflown today, and avoids dense areas of populations. The CLYDE, LOMON and PERTH SIDS turn north and overfly parts of the Bridge of Weir and Quarriers village – these areas will see the cumulative impact of all three SIDs. Beyond this point, the CLYDE SID, which accounts for around 6% of overall Glasgow departures, routes over Kilmacolm before reaching the eastern parts of Port Glasgow. The LOMON SID overflies eastern areas of Kilmacolm, before reaching Langbank and the western parts of Dumbarton at higher altitudes. Finally, the PERTH SID largely avoids areas of dense population with the exception of the easter parts of Dumbarton which are overflown around 7000ft. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would be expected to concentrate traffic albeit at comparatively low percentages compared to other routes such as NORBO. It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LOMON and PERTH SIDs may increase in size and overfly additional parts of Dumbarton and

may extend as far as Alexandria.

Overflight data
The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option E. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

As shown in Table 32, against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is a significant increase in the area of the contours and the number of population overflow; this is due to the routes turning earlier than they do today alongside splitting the NORBO route into two. This does however mean that the noise from the busiest departure route is shared.

Table 32 Westerly departures option E overflight data

System	Area (km^2)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option E	248.01	69308

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools, care homes and places of worship overflown compared to the centreline baseline. Number of hospitals remains the same. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option E against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 33 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour however the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 33 60dB and 65dB L_{AMax} Data – Rwy23 Dep Option E

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option E	458.27	139426	161.26	64472

L_{Aeq}
The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the departures which turn before 5nm will influence the shape of the L_{Aeq} contour. It is expected that this change will result in the L_{Aeq} contours shortening compared to current day although 32% of NORBO traffic will continue straight ahead and so this reduction is expected to be less than some other options. This may benefit some parts of Howwodd. The NORBO, LUSIV and TALLA turns to the left, which overall account for around 37% of Glasgow departures are expected to result in the L_{Aeq} contour extending further to the south; the heatmap data suggests that this will occur over areas where there are not high levels of population density. The equivalent ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs operate a far lower percentage of flights and so are likely to have less influence on the overall shape of L_{Aeq} contours however the turns may result in some areas of Johnstone, which currently sit in the lower dB L_{Aeq} bands, to move into a higher dB contour.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option shares the noise from the existing most heavily used NORBO route into two routes. This offers some noise relief for those communities currently located under immediate climb out and final approach however this would not be predictable respite; having 2 NORBO SIDs reduces the frequency of overflight for communities situated under just one NORBO SID. This option helps to reduce the numbers of newly overflown by having approximately half of the NORBO departures flying straight ahead, as today.

	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft; the majority of departures will climb above 1000ft whilst flying straight ahead as today. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option E will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.

<table>
<tr><td></td><td>Capacity / resilience</td><td>This option sees the SIDs splitting before 5nm which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. This option relies on achieving at least a 45˚ split between the two NORBO SIDs.

In addition to this, this option splits the NORBO departures across two routes which will enhance operational performance throughout the day and reduce ground delays and CO_2 contributions. In order to gain the full benefits of this, future investment may be required in additional taxiway infrastructure to enable aircraft to be ‘lined up’ in the correct order before take-off however this is not within scope of an Airspace Change project.

The introduction of PBN SIDs also removes Glasgow’s dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[14] resilience for Glasgow’s SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL’s VOR withdrawal programme.</td></tr>
<tr><td></td><td>Tranquillity</td><td>Table 34 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow’s existing SID centrelines.

Table 34 RWY 23 Westerly Departures Option E – Tranquillity overflown

<table>
<tr><th>System</th><th>NSA area</th><th>NSA count</th><th>National Parks area</th><th>National Parks count</th><th>DQA area</th><th>DQA count</th></tr>
<tr><td>RWY 23 Baseline – Vectoring (NTK data)</td><td>0.02</td><td>1</td><td>1.68</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>RWY23 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 23 Option E</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

The data shows that there is no change in overflight of DQA’s and there is a reduction in overflight of NSAs and National parks compared to the vectoring baseline. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td></td><td>Biodiversity</td><td>Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline Castle Semple and Barr Lochs SSSI would be avoided.

Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal.

We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Option E is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS.

We created an “illustrative CAS volume” which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the “illustrative” airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.</td></tr>
<tr><td>General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline.</td></tr>
<tr><td></td><td>Fuel burn</td><td>We estimate that Option E, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This is mainly driven by the reduction in track mileage of the NORBO LAKEY route however there are also some reductions all other departure routes.

Table 35 Track Length Calculations – Fuel Burn Option E

<table>
<tr><th colspan="2" rowspan="2">RWY 23</th><th colspan="3">Baseline (Centreline)</th><th colspan="2"></th></tr>
<tr><th>nm</th><th>% Weighting</th><th>Score</th><th>nm P1</th><th>Score</th></tr>
<tr><td rowspan="10">DEPS</td><td>TRN</td><td>38.50</td><td>3.69</td><td>142.065</td><td>37.8</td><td>139.482</td></tr>
<tr><td>NORBO – SUBUK</td><td>93.40</td><td>26.2</td><td>2447.08</td><td>92.5</td><td>2423.5</td></tr>
<tr><td>NORBO – LAKEY</td><td>93.40</td><td>32</td><td>2988.8</td><td>83</td><td>2656</td></tr>
<tr><td>LUSIV-DCS</td><td>84.80</td><td>10.66</td><td>903.968</td><td>81.7</td><td>870.922</td></tr>
<tr><td>TLA</td><td>54.70</td><td>0.41</td><td>22.427</td><td>49</td><td>20.09</td></tr>
<tr><td>PERTH</td><td>69.80</td><td>1.23</td><td>85.854</td><td>62.6</td><td>76.998</td></tr>
<tr><td>FOYLE</td><td>33.00</td><td>0.82</td><td>27.06</td><td>27.7</td><td>22.714</td></tr>
<tr><td>LOMON</td><td>26.70</td><td>2.05</td><td>54.735</td><td>19.5</td><td>39.975</td></tr>
<tr><td>CLYDE</td><td>19.50</td><td>2.87</td><td>55.965</td><td>17.6</td><td>50.512</td></tr>
<tr><td>ROBBO</td><td>19.60</td><td>2.05</td><td>40.18</td><td>17.4</td><td>35.67</td></tr>
<tr><td colspan="5">Total</td><td>6768.134</td><td></td><td>6335.863</td></tr>
</table>

Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.</td></tr>
</table>

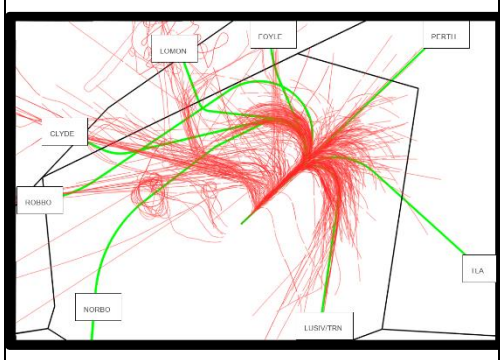
[14] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP. Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB $L_{Aeq,16h}$ noise contour and therefore not affect Glasgow's noise insultation scheme costs.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[15];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	No safety issues have been identified.
All	Interdependencies, conflicts, and trade-offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departure is separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options ion their proposed shortlist which would cater for a duel NORBO southbound track structure. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure). This option could be expected to result in reductions in the volume of Glasgow's CAS

[15] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.7. Runway 05 Easterly Departures Baseline

Runway 05 Easterly Departures Baseline



This option represents the do-nothing scenario for Glasgow Easterly SIDs. Today, all Glasgow SIDs climb straight ahead to 5nm before turning. This means that the minimum departure interval between successive departing aircraft is at least 2 minutes. The result is that during peak departure times, aircraft are held on the runway and at the runway holding points, leading to increased emissions and delay. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC, resulting in broad swathes.

Some aircraft less than 5700kg MTWA do not have to depart via the SIDs. These are usually non-jet aircraft and therefore slower than jet aircraft. These aircraft are vectored by ATC which helps them turn towards their destination early, reduces track miles and reduces departure delays.

Glasgow Airport's current SIDs are dependent on conventional ground-based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is an interim measure that only can only be used to bridge the gap ahead of FASI implementation. The AMS mandates airports implement IFPs based on PBN and doing nothing does not meet that national requirement.

For more information on our do-nothing scenario, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Aircraft above 5700kg departing from Glasgow climb straight ahead to 5nm before turning. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC resulting in dispersion. These swathes can be seen in the vectoring heatmaps below which have been generated using NTK data:  *Figure 15 Runway 05 Departure Vectoring Swathe 2019* The Technical Appendix to this document includes a larger version of this map along with overflight data. It's important to note that this data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline and the airspace change options. Table 36 below includes data based on this NTK heat map and data output from the optioneering tool for if aircraft were to follow the centreline of the current published SID: *Table 36 Easterly departures baseline overflight data* System / Area (km^2) / Population RWY 05 Baseline – Vectoring (NTK data) / 246.99 / 364763 RWY 05 Baseline (Centreline – Optioneering tool) / 186.52 / 173213 The data from these tables will be used to compare the westerly departure options against the 'do nothing' baseline. In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals, and places of worship; the full data around these is shown in technical appendix A, and as part of this IOA we will provide a qualitative statement around this data. **60dB and 65dB L_{Amax}** Technical Appendix A includes 60dB and 65dB L_{Amax} contours and data for the baseline, to aid comparison between the baseline and the options. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal.

		<table><tr><th></th><th colspan="2">60dB L_{Amax}</th><th colspan="2">65dB L_{Amax}</th></tr><tr><th>System</th><th>Area (km²)</th><th>Population</th><th>Area (km²)</th><th>Population</th></tr><tr><td>**RWY 05 Baseline (Centreline – Optioneering tool)**</td><td>356.82</td><td>382113</td><td>114</td><td>120793</td></tr></table> The data from these tables will be used to compare the easterly departure options against the 'do nothing' baseline. **L_{Aeq}** The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025 as it is expected that contours will be a similar shape and size. **Noise Abatement Procedures** As this baseline reflects current day, there would be no changes to NAPs as a result of this option. **Noise Mitigation** The existing SIDs configuration does not offer any opportunities for predictable respite. Furthermore, communities underneath final approach within 5nm of the airport currently experience all departures and arrivals from/to the airport.
	Air Quality	Impacts to air quality are considered for changes below around 1000ft (200m). Aircraft flying above this are unlikely to have a significant impact on local ground air quality. Aircraft departing Glasgow have varying climb performance depending on aircraft type and therefore different aircraft reach 1000ft at different locations. Today, virtually all Glasgow departures climb straight ahead for 5nm and during this they climb above 1000ft. Our IOA will therefore qualitatively describe any changes to the lateral locations of flight paths which could occur below 1000ft.
Wider Society	Greenhouse gas impact	Emissions of greenhouse gases arise from the combustion of aviation fuel, and as the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly departures. The greenhouse gas assessment is therefore linked to the fuel burn assessment detailed in the section below. *Table 37 Easterly departure baseline – Indicative track miles* <table><tr><th colspan="2" rowspan="2">RWY 05</th><th colspan="3">Baseline (Centreline)</th></tr><tr><th>nm</th><th>% Weighting</th><th>Score</th></tr><tr><td rowspan="10">DEPS</td><td>TRN</td><td>50.00</td><td>0.81</td><td>40.50</td></tr><tr><td>NORBO – SUBUK</td><td>112.00</td><td>5.75</td><td>644.00</td></tr><tr><td>NORBO – LAKEY</td><td>112.00</td><td>7.03</td><td>787.36</td></tr><tr><td>LUSIV-DCS</td><td>88.80</td><td>2.34</td><td>207.79</td></tr><tr><td>TLA</td><td>49.20</td><td>0.09</td><td>4.43</td></tr><tr><td>PERTH</td><td>50.30</td><td>0.27</td><td>13.58</td></tr><tr><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td></tr><tr><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td></tr><tr><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td></tr><tr><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td></tr><tr><td colspan="4">Total</td><td>1740.92</td></tr></table> We will estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today. As CO_2 emissions are linked to the difference in aviation fuel burnt, this will allow us to qualitatively describe anticipated greenhouse gas impacts as a result of the option. Full data tables are shown in Technical Appendix A.
	Capacity / resilience	Glasgow's current SID configuration, with the majority of departures flying straight ahead to 5nm before turning, results in a capacity constraint on the airport, as aircraft are only able to depart with at least 2-minute intervals. This leads to holding on the ground which results in increased emissions and delays. Any future increases in movement numbers at the airport will result in increases in ground holding and delay and therefore the SIDs in the existing configuration are not fit for purpose for future growth at the airport. In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. As traffic increases, flow restrictions are likely to be put in place in order for ATC and pilots to manage the additional complexity and workload. Flow regulations stabilise the number of movements until the peak in traffic subsides, however in doing so they generate ground delay for Glasgow. It is therefore possible that, with future traffic levels, this baseline scenario would result in increases in departure delay at Glasgow airport. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme. This baseline is dependent on conventional ground-based navigation aids called VORs. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[16] resilience for Glasgow's SIDs when NERL decommissions the VORs which will result in critical operational issues and significant loss of revenue.
	Tranquillity	CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks, and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB. Table 38 shows data on the overflight of these areas, based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. The data from this table will be used to compare options against the easterly departure baseline.

[16] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

Table 38 Easterly departure baseline – Tranquil areas overflown

System	NSA area	NSA count	National Parks count	National Parks area	DQA count	DQA area
RWY 05 Baseline – Vectoring (NTK data)	0	0	0	0	4	0.66
RWY 05 Baseline (Centreline – Optioneering tool)	0	0	0	0	2	0.38

Biodiversity

The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance 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." 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 500m (~1,640ft). Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interest, particularly at altitudes below 2000ft.

Table 39 shows data on the overflight of these areas, based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. The data from this table will be used to compare options against the easterly departure baseline.

Table 39 Biodiversity – areas overflown

System	SAC area	SAC count	SSSI count	SSSI area	SPA count	SPA area	National Park count	National park area	NSA count	NSA area
RWY 05 Baseline – Vectoring (NTK data)	0	0	24	10.46	11	6.37	0	0	0	0
RWY 05 Baseline (Centreline – Optioneering tool)	0	0	10	3.31	0	0	0	0	0	0

Below 2000ft there is no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interest for the vast majority of aircraft. Lower and slower aircraft, climbing at below a 6% climb gradient, may overfly the Manse Burn and Mugdock Wood SSSIs however this is likely to be infrequently, as lower and slower aircraft will typically not be required to follow the NAP and will therefore be tactically turned left before reaching the sites.

General Aviation

Access

This baseline scenario would not offer any change from the existing Controlled Airspace (CAS) arrangements in place today. The options will be qualitatively compared against this existing scenario.

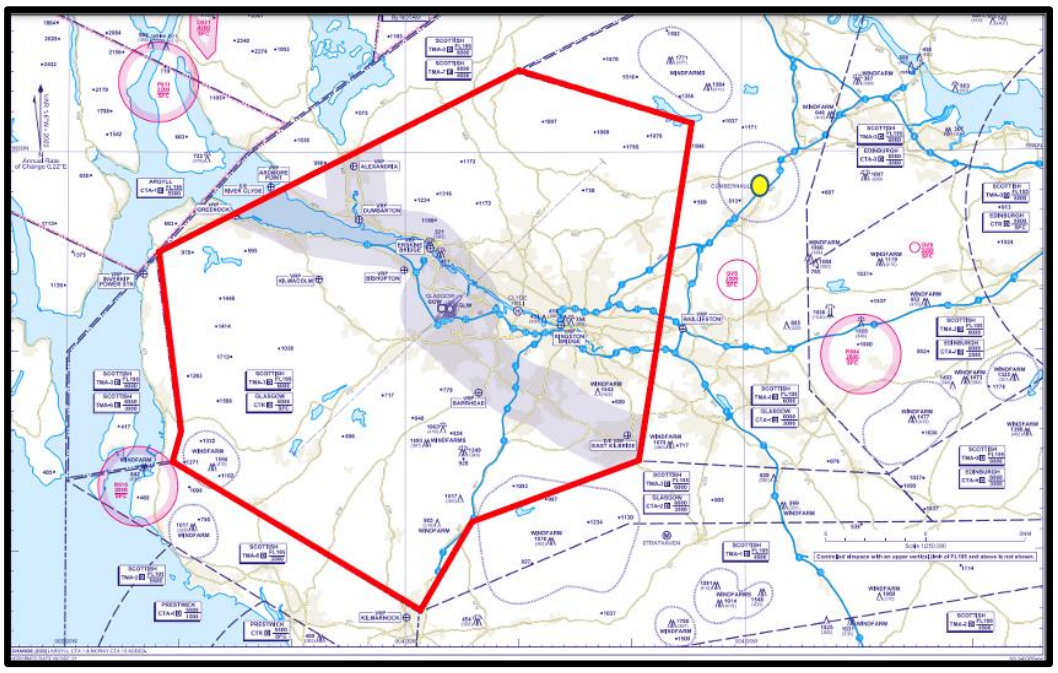


Figure 16 Glasgow Airport Control Zone and Control Area Chart (See eAIP for full details)

Within c.35nm of Glasgow airports are Edinburgh and Glasgow Prestwick Airport each with their own Controlled Airspace (CAS) volumes. In addition to this, the Scottish TMA airspace sits above and around the airports' airspace which generates the volumes shown in Figure 16. The controlled airspace at Glasgow has varying lower and upper limits with the volume closest to the airport going down to ground level. This is the Glasgow CTR shown in red outline. Also, in this figure can be seen Cumbernauld Airport approximately 15nm to the east of Glasgow airport which sits outside CAS where the base of the CTA is 3000ft. This is indicated with a yellow dot.

It is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size.

Whilst the existing baseline scenario will not result in the requirement for more airspace, this option offers no opportunity to simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to achieve.

General Aviation / Commercial airlines

Economic impact from increased effective capacity

There will be no increase to capacity from today as a result of this option; later in this IOA we will qualitatively estimate the differences between this baseline and the airspace change options.

Fuel burn

As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline easterly departures.

When departing from Glasgow, the majority of aircraft fly straight ahead until 5nm and then are vectored by air traffic control, this means that track length is varied from flight to flight. For the purposes of comparing our easterly SID options against the baseline scenario, we have taken the track length of the SID centerlines as an initial indication of 'do nothing' track length. We have then applied a weighting based on SID usage to provide an overall

<table>
<tr><td></td><td></td><td>total track mileage for the system. At the Stage 3 Full Options Appraisal, track length and fuel burn will be modelled in further detail.

Table 40 Easterly SID Track Mileage

<table>
<tr><th colspan="2" rowspan="2">RWY 05</th><th colspan="3">Baseline (Centreline)</th></tr>
<tr><th>nm</th><th>% Weighting</th><th>Score</th></tr>
<tr><td rowspan="10">DEPS</td><td>TRN</td><td>50.00</td><td>0.81</td><td>40.50</td></tr>
<tr><td>NORBO – SUBUK</td><td>112.00</td><td>5.75</td><td>644.00</td></tr>
<tr><td>NORBO – LAKEY</td><td>112.00</td><td>7.03</td><td>787.36</td></tr>
<tr><td>LUSIV-DCS</td><td>88.80</td><td>2.34</td><td>207.79</td></tr>
<tr><td>TLA</td><td>49.20</td><td>0.09</td><td>4.43</td></tr>
<tr><td>PERTH</td><td>50.30</td><td>0.27</td><td>13.58</td></tr>
<tr><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td></tr>
<tr><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td></tr>
<tr><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td></tr>
<tr><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td></tr>
<tr><td colspan="3">Total</td><td>18%</td><td>1740.92</td></tr>
</table>

Aircraft departing from Glasgow are sometimes prevented from continuously climbing due to the tactical coordination with other traffic in the airspace.

We will qualitatively estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option against current day. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today and will also consider the opportunity for continuous climb.</td></tr>
<tr><td rowspan="2">Commercial airlines</td><td>Training costs</td><td>As this option is already in operation, there are no training costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.</td></tr>
<tr><td>Other costs</td><td>As this option is already in operation, there are no other costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.</td></tr>
<tr><td rowspan="3">Airport / Air navigation service provider</td><td>Infrastructure costs</td><td>As this option is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.</td></tr>
<tr><td>Operational costs</td><td>As this option is already in operation, there are no operational costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.

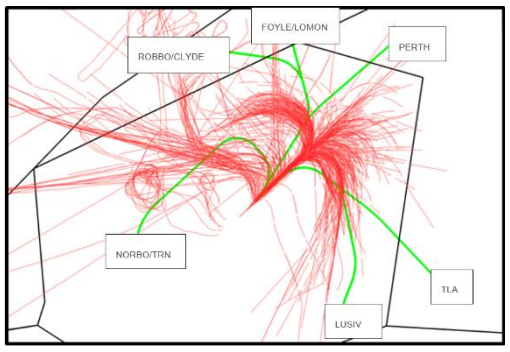
Glasgow Airport’s current SIDs are dependent on conventional ground-based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is an interim measure that only can only be used to bridge the gap ahead of FASI implementation. Failure to mitigate the impacts of VOR rationalisation in the long term will result in critical operational issues and significant loss of revenue, as well as not meeting the requirements of the AMS.</td></tr>
<tr><td>Deployment costs</td><td>As this option is already in operation, there are no deployment costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.</td></tr>
<tr><td>All</td><td>Safety</td><td>At current traffic levels, there are no safety concerns with the current arrangements at Glasgow. Future traffic growth could however result in increased complexity and workload for Air Traffic Controllers and pilots, which may lead to traffic levels within the Scottish TMA being capped, on increased aircraft holding on the ground, in order to maintain safety.</td></tr>
<tr><td>All</td><td>Interdependencies, conflicts, and trade-offs</td><td>There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures however Easterly departures are sometimes required to be ‘stepped up’ underneath Edinburgh’s GOSAM departures. Laterally deconflicting these would be optimal.

The existing ScTMA route structure shares airways for use by both Edinburgh and Glasgow results in higher ATC workload and less efficient profiles in the airspace above 7000ft.</td></tr>
<tr><td>All</td><td>AMS</td><td>CAP1711 describes the objective as:
Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.

Doing nothing with Easterly departures will not align with the AMS. It will not enable any environmental benefits or maximise benefits from NERL’s re-design of the ScTMA. No change and therefore no ACP submission will not enable any reduction in the volume of controlled airspace.</td></tr>
</table>

4.8. Runway 05 Easterly Departure Option A

Runway 05 Easterly Departures – Option A



Offset left departures with turns at 1nm and 6nm from the runway.
Straight ahead departures with turns at 3nm from the runway.
NORBO is offset left with turn at 1nm

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see some departures offset to the left with turns at c.1nm and c.6nm, and some departures flying straight ahead before turning at c.3nm. This would mean that all easterly departures would no longer overfly the same areas as westerly approaches, providing some noise sharing for communities under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis.

Figure 17 Easterly Option A Overflight and 2019 baseline NTK data

The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route offsets left and turns at c.1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 17 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 13% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. This option does not involve any noise sharing/mitigation therefore these communities will be overflown on a more frequent basis than today.

The ROBBO/CLYDE/LOMON/FOYLE/PERTH departures also offset to the left however these departures turn at c.6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other populated areas. The route initially flies over Dumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. The equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 7000ft. Figure 17 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population.

Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for c.3nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning at c.3nm rather than 5nm. This results in overflight of some areas that are already overflown today however this would be at a higher frequency in future. Review of the population data shows that this route would overfly large areas of the city of Glasgow where there is a high density of population. Although this is not dissimilar to what happens today (the heatmap shows a large swathe across parts of the city), in future concentration of overflight would be expected to occur. The latter parts of the routes will overfly dense areas of population not typically overflown by easterly departures today.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE contour may also extend further over Killearn.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option A. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 41 gives an overview of the Option A overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing

SID centreline data, the area of the contours remains similar however there is a significant increase in the number of population and noise sensitive sites overflown which can be attributed to the offset routes, early turns than today, and the overflight of Glasgow city centre by the LUSIV/TALLA SID. At present, the baseline and option overflight contours do not take into account frequency of overflight which will be important when considering total population overflown; this will be further explored at Stage 3 should this option progress.

Table 41 Easterly departures option A overflight data

System	Area (km^2)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option A	184.58	254041

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of hospitals, care homes and places of worship overflown compared to the centreline baseline. The number of schools overflown reduces. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

In our Stage 2A engagement, the Mains Estate Residents' Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward, we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option A against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 42 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. This is due to the earlier divergence of SIDs compared to the baseline however the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 42 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option A

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option A	363.53	458336	129.97	179689

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces offset departures and turns at 3nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the contour may shorten compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal, if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option does not offer an alternative, predictable respite configuration however it does aim to share the noise by relocating the majority of easterly departures to an offset track, rather than climbing straight ahead over the same areas as final approach, as they do today. This option would put all NORBO departures over newly overflown communities as well as the right turn LUSIV/TLA. The L_{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.

	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option A will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.

	Capacity / resilience[17]	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[18] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.
	Tranquillity	Table 43 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 43 Easterly departure – Tranquil areas overflown* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline – Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 4 / 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 2 / 0.38 **Runway 05 Option A**: 0 / 0 / 0 / 0 / 3 / 0.94 The data shows that there is no change in National Scenic Areas and National Parks overflown. There is a decrease in the number of DQAs overflown compared to the vectoring baseline however there is an increase in the overall area. At this stage, the frequency of overflight has not been articulated in the data and this will be important to understand the full benefits and impacts of this option; we will explore this further at Stage 3 should this option progress. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 44 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 44 Biodiversity – areas overflown* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline – Vectoring (NTK data)**: 0 / 0 / 24 / 10.46 / 11 / 6.37 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 10 / 3.31 / 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Option A**: 0 / 0 / 16 / 5.84 / 4 / 3.25 / 0 / 0 / 0 / 0 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Lower slower aircraft, climbing at below a 6% climb gradient on the CLYDE/LOMON/FOYLE/PERTH SIDs, may overfly the Marise Burn and Mugdock Wood SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SIDs, and the vast majority of aircraft will climb above 2000ft before overflying the sites, it is expected that any impacts will be very minimal. We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.
General Aviation	Access	Option A is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, having a single NORBO departure track would not deliver the biggest economic benefits.
	Fuel burn	We estimate that Option A, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows small reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, LUSIV, TLA and FOYLE routes. There are also small increases to the PERTH, LOMON, CLYDE and ROBBO routes however when considered against the overall % movements at GLA, any increase in track miles is outweighed by the decreases elsewhere. *Table 45 Track Length Calculations – Fuel Burn RWY 05 Easterly Departure Option A* **RWY 05** / **Baseline (Centreline)** / **A** **nm** / **% Weighting** / **Score** / **nm** / **Score** DEPS – TRN: 50.00 / 0.81 / 40.50 / 49.20 / 39.85 DEPS – NORBO: 112.00 / 5.75 / 644.00 / 103.60 / 595.70

[17] Summary colour corrected

[18] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

<table>
<tr><td></td><td></td><td>
<table>
<tr><td></td><td>SUBUK</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>NORBO – LAKEY</td><td>112.00</td><td>7.03</td><td>787.36</td><td>103.60</td><td>728.31</td></tr>
<tr><td></td><td>LUSIV-DCS</td><td>88.80</td><td>2.34</td><td>207.79</td><td>87.25</td><td>204.17</td></tr>
<tr><td></td><td>TLA</td><td>49.20</td><td>0.09</td><td>4.43</td><td>47.25</td><td>4.25</td></tr>
<tr><td></td><td>PERTH</td><td>50.30</td><td>0.27</td><td>13.58</td><td>50.50</td><td>13.64</td></tr>
<tr><td></td><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td><td>18.50</td><td>3.33</td></tr>
<tr><td></td><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td><td>20.30</td><td>9.14</td></tr>
<tr><td></td><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td><td>28.80</td><td>18.14</td></tr>
<tr><td></td><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td><td>34.60</td><td>15.57</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td>1740.92</td><td></td><td>1632.09</td></tr>
</table>

Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
</td></tr>
<tr><td>Commercial airlines</td><td>Training costs</td><td>Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.</td></tr>
<tr><td></td><td>Other costs</td><td>No other airline costs are foreseen.</td></tr>
<tr><td rowspan="3">Airport / Air navigation service provider</td><td>Infrastructure costs</td><td>Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government’s current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow’s ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme.

The initial deployment phase of the ACP may require some ATC system engineering amendments.</td></tr>
<tr><td>Operational costs</td><td>This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow’s dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL’s operational costs as it enables VOR rationalisation[19];</td></tr>
<tr><td>Deployment costs</td><td>This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.</td></tr>
<tr><td>All</td><td>Safety</td><td>This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a ‘not below 500ft’ flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn’t turn before the end of the runway. PANS OPS doesn’t require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER.

More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs.

There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO_2 and potentially more CAS.</td></tr>
<tr><td>All</td><td>Interdependencies, conflicts, and trade-offs</td><td>There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be ‘stepped up’ underneath Edinburgh’s GOSAM departures. Having an earlier turn to the West on NORBO departures reduces this interaction. Conversely the ROBBO/CLYDE traffic routing further to the East may increase this interaction, albeit above 7000ft.

This option is expected to be possible within the existing network and can also be accommodated within NERL’s FASI ScTMA route design but would not make the most of their proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the possibility to remove one of these SIDs in Stage 3.

The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.</td></tr>
<tr><td>All</td><td>AMS</td><td>CAP1711 describes the objective as:

Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.

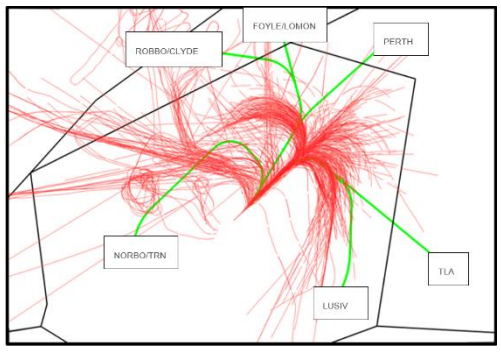
This option would support the modernisation of the airspace. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities.

This option could be expected to result in reductions in the volume of Glasgow’s CAS.</td></tr>
</table>

[19] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.9. Runway 05 Easterly Departure Option B

Runway 05 Easterly Departures – Option B



Offset left departures with turns at 1nm and 6nm from the runway.
Straight ahead departures with turns at 4nm from the runway.
NORBO is offset left with turn at 1nm

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see some departures offset to the left with turns at c.1nm and c.6nm, and some departures flying straight ahead before turning at c.4nm. This would mean that easterly departures would not overfly the same areas as westerly approaches, providing some noise sharing for communities under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis.

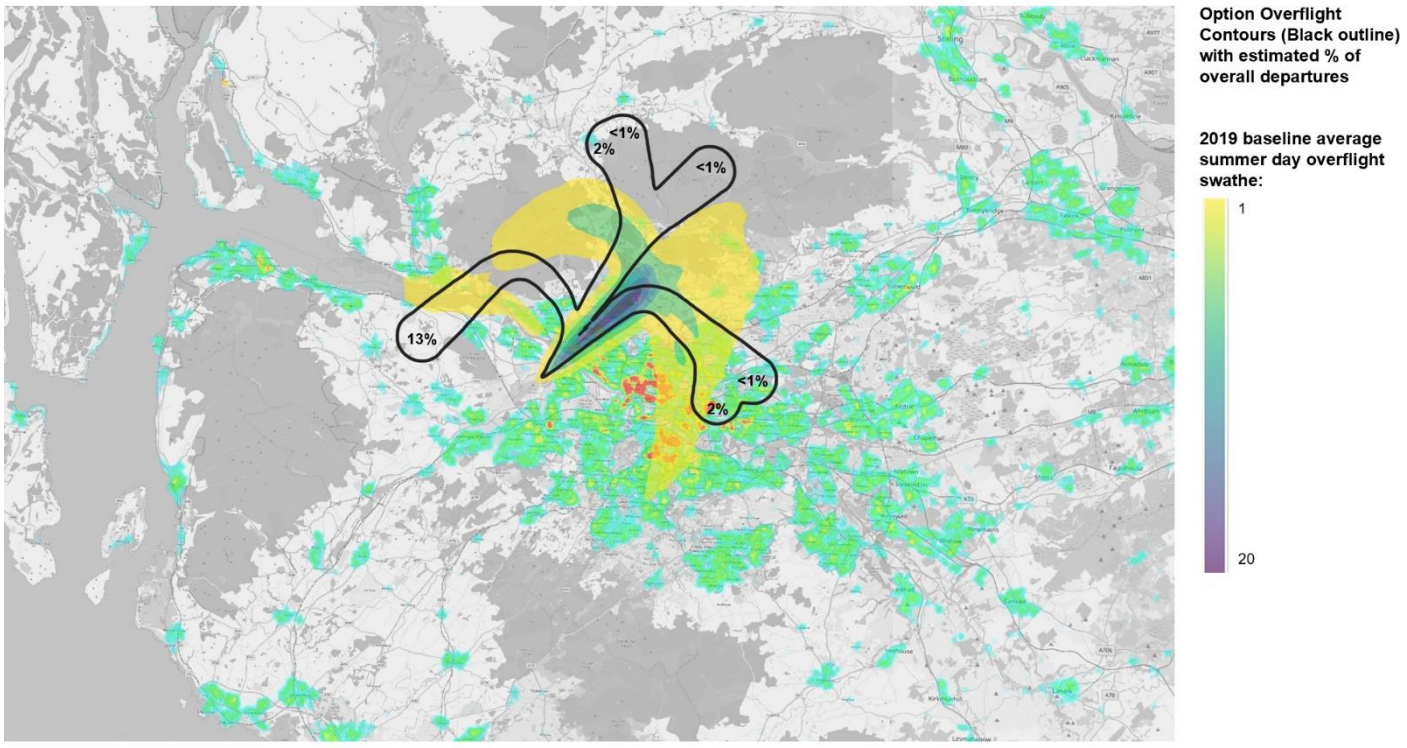


Figure 18 Easterly Option B Overflight and 2019 baseline NTK data

The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route offsets left and turns at c.1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in Figure 18 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 13% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. This option does not involve any noise sharing/mitigation therefore these communities will be overflown on a more frequent basis than today.

The ROBBO/CLYDE/LOMON/FOYLE/PERTH departures also offset to the left however these departures turn at c.6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other populated areas. The route initially flies over Drumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. The equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 7000ft. Figure 18 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population.

Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for c.4nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning at c.4nm rather than 5nm. When reviewed against the heatmap shown in Figure 16, compared to Option A, this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at c.4nm occurring north of Bearsden and routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route would overfly areas of the city of Glasgow however by turning at 4nm there is more opportunity to avoid the most dense areas of population as aircraft are slightly further north. The route also heads towards the south-east rather than turning south as it does today; this too helps to avoid some of the most dense areas of population however it should be noted that the LUSIV route will overfly the Dennistoun and Craigend areas more frequently than today.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE contour may also extend further over Killearn.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option B. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 46 gives an overview of Option B overflight data. Against the NTK baseline vectoring data, there is a decrease in

population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contours reduces and there is also a decrease in the number of population overflown compared to the centreline data. This can be attributed to the LUSIV/TALLA SID turning at 4nm and aiming to avoid areas of dense population.

Table 46 Easterly departures option B overflight data

System	Area (km^2)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option B	174.94	169398

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools overflown compared to the centreline baseline. The number of hospitals remains the same and the cares homes and places of worship reduces. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

In our Stage 2A engagement, the Mains Estate Residents' Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are any adverse effects as a result of aircraft overflight.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option B against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 47 shows an decrease in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 47 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option B

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option B	349.85	369502	125.22	141512

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces offset departures and turns at 4nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the contour may shorten compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option does not offer an alternative, predictable respite configuration however it does aim to share the noise by relocating the majority of easterly departures to an offset track, rather than climbing straight ahead over the same areas as final approach as they do today. This option would put all NORBO departures over newly overflown communities. The L_{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.

	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option B will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity /	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute

	resilience[20]	separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[21] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.
	Tranquillity	Table 48 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 48 Easterly departure – Tranquil areas overflown* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline – Vectoring (NTK data)** 0 0 0 0 4 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)** 0 0 0 0 2 0.38 **Runway 05 Option B** 0 0 0 0 3 1.01 The data shows that there is no change in National Scenic Areas and National Parks overflown. There is a decrease in the number of DQAs overflown compared to the vectoring baseline however there is an increase in the overall area. At this stage, the frequency of overflight has not been articulated in the data and this will be important to understand the full benefits and impacts of this option; we will explore this further at Stage 3 should this option progress. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 49 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 49 Biodiversity – areas overflown* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline – Vectoring (NTK data)** 0 0 24 10.46 11 6.37 0 0 0 0 **RWY 05 Baseline (Centreline – Optioneering tool)** 0 0 10 3.31 0 0 0 0 0 0 **RWY 05 Option B** 0 0 16 5.93 4 3.25 0 0 0 0 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Lower slower aircraft, climbing at below a 6% climb gradient on the CLYDE/LOMON/FOYLE/PERTH SIDs, may overfly the Marise Burn and Mugdock Wood SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SIDs, and the vast majority of aircraft will climb above 2000ft before overflying the sites, it is expected that any impacts will be very minimal. We will full quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.
General Aviation	Access	Option B is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, having a single NORBO departure track would not deliver the biggest economic benefits.
	Fuel burn	We estimate that Option B, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows small reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, TLA and FOYLE routes. There are also small increases to the LUSIV, PERTH, LOMON, CLYDE and ROBBO routes however when considered against the overall % movements at GLA, any increase in track miles is outweighed by the decreases elsewhere. *Table 50 Track Length Calculations – Fuel Burn RWY 05 Easterly Departure Option B* **RWY 05** / **Baseline (Centreline)** / B **nm** / **% Weighting** / **Score** / nm / **Score** DEPS TRN 50.00 0.81 40.50 49.20 39.85 DEPS NORBO – SUBUK 112.00 5.75 644.00 103.60 595.70 DEPS NORBO – 112.00 7.03 787.36 103.60 728.31

[20] Summary colour corrected

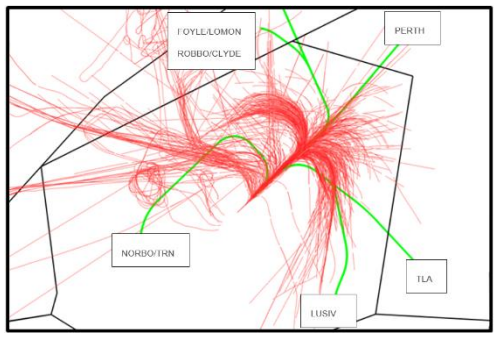
[21] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		<table><tr><td></td><td>LAKEY</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>LUSIV-DCS</td><td>88.80</td><td>2.34</td><td>207.79</td><td>89.10</td><td>208.49</td></tr><tr><td></td><td>TLA</td><td>49.20</td><td>0.09</td><td>4.43</td><td>48.20</td><td>4.34</td></tr><tr><td></td><td>PERTH</td><td>50.30</td><td>0.27</td><td>13.58</td><td>50.50</td><td>13.64</td></tr><tr><td></td><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td><td>18.50</td><td>3.33</td></tr><tr><td></td><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td><td>20.30</td><td>9.14</td></tr><tr><td></td><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td><td>28.80</td><td>18.14</td></tr><tr><td></td><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td><td>34.60</td><td>15.57</td></tr><tr><td>Total</td><td></td><td></td><td></td><td>1740.92</td><td></td><td>1636.51</td></tr></table> Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[22].
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft; flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs. There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO_2 and potentially more CAS.
All	Interdependencies, conflicts, and trade-offs	There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having an earlier turn to the West on NORBO departures reduces this interaction. Conversely the ROBBO/CLYDE traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is expected to be possible within the existing network but can also be accommodated within NERL's FASI ScTMA route design, but would not make the most of their proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

[22] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.10. Runway 05 Easterly Departure Option C

Runway 05 Easterly Departures – Option C



Offset left departures with turns at 1nm and 6nm from the runway.
Straight ahead departures with turns at 4nm from the runway.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see all departures initially fly straight ahead before turns at 1nm, 3nm and 6nm from the runway. Today, the majority of departures fly straight ahead until at least 5nm before turning and therefore turns at 1nm and 3nm are a change from current day. As aircraft will fly straight ahead, communities living under the final approach will be overflown by both arrivals and departures.

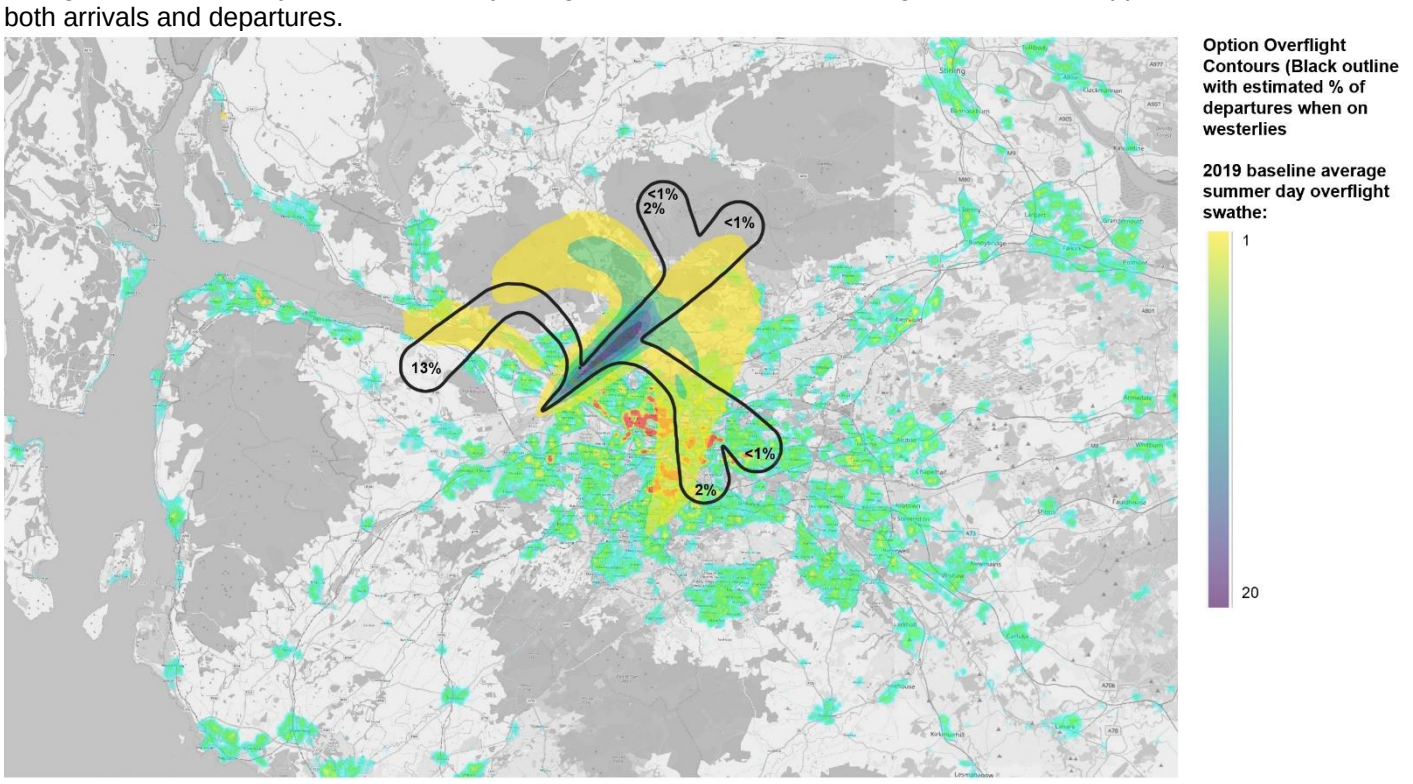


Figure 19 Easterly Option C Overflight and 2019 baseline NTK data

The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap data (Figure 19) suggests that a left turn at 1nm would overfly the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 13% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling.

The ROBBO/CLYDE/LOMON/FOYLE departures fly straight ahead before turning left at 6nm. This means that they overfly the same areas as the final approach track before turning and up to around 5nm, this reflects what happens today. Figure 19 shows today's vectoring swathe turning at around 5nm and therefore a turn at 6nm will result in some areas not currently overflown being overflown in future however the population data suggests that these areas have very low population levels. The PERTH, which accounts for less than 1% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures. The contour suggests that at 6000-7000ft it may overfly new areas however these are sparsely populated.

Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for 3nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning at 3nm rather than 5nm. This results in overflight of some areas that are already overflown today however this would be at a higher frequency in future. Review of the population data shows that this route would overfly large areas of the city of Glasgow where there is a high density of population. Although this is not dissimilar to what happens today (the heatmap shows a large swathe across parts of the city), in future concentration of overflight would occur. The latter parts of the routes will overfly dense areas of population not typically overflown by easterly departures today.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option C. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data 51 gives an overview of the Option C overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contours reduces however there is an increase in the number of population overflown compared to the centreline data. This can be attributed to the earlier turns than today and the LUSIV/TALLA SID turning at 3nm and routing over the centre of Glasgow.

Table 51 Easterly departures option C overflight data

System	Area (km²)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option C	172.34	251000

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows a decrease in the number of schools overflown compared to the centreline data. The number of hospitals, care homes and places of worship increases. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option C against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 52 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 52 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option C

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km²)**	**Population**	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option C	339.28	453932	121.06	175911

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces turns at 1nm, 3nm and 6nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, due to the turns, the contour may shorten compared to current day which may benefit parts of Milngavie. The NORBO departure to the left may result in the component part of the contour extending further to the northwest to reflect the earlier turn; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the turns at 1nm, 3nm.

Noise Mitigation
The option does not offer an alternative, predictable respite configuration and would continue to see all departures (except NORBO) to climb straight ahead as today. The early left turn on NORBO departures would reduce the volume of traffic that climbs straight ahead however it would be positioned over newly overflown communities as well as the right turn LUSIV/TLA. The L_{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.

	Air Quality	This option has a change to how some lower slower aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option C will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience[23]	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[24] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal

[23] Summary colour corrected
[24] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

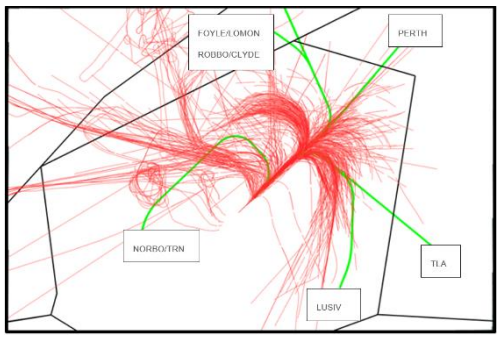
		programme.
	Tranquillity	Table 53 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 53 Easterly departure – Tranquil areas overflown* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline – Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 4 / 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 2 / 0.38 **Runway 05 Option C**: 0 / 0 / 0 / 0 / 3 / 0.94 The data shows that there is no change in National Scenic Areas and National Parks overflown. There is a decrease in the number of DQAs overflown compared to the vectoring baseline however there is an increase in the overall area. At this stage, the frequency of overflight has not been articulated in the data and this will be important to understand the full benefits and impacts of this option; we will explore this further at Stage 3 should this option progress. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 54 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 54 Biodiversity – areas overflown* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline – Vectoring (NTK data)**: 0 / 0 / 24 / 10.46 / 11 / 6.37 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 10 / 3.31 / 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Option C**: 0 / 0 / 14 / 5.57 / 4 / 3.32 / 0 / 0 / 0 / 0 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interests is expected which would offer some small benefits compared to the baseline.
General Aviation	Access	Option C is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, having a single NORBO departure track would not deliver the biggest economic benefits.
	Fuel burn	We estimate that Option C, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows small reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, LUSIV and TLA routes. There are also small increases to the FOYLE, LOMON, CLYDE and ROBBO routes. The PERTH remains the same. When considered against the overall % movements at GLA, any increase in track miles is outweighed by the decreases elsewhere. *Table 55 Track Length Calculations – Fuel Burn RWY 05 Easterly Departure Option C* **RWY 05** / **Baseline (Centreline)** / C **nm** / **% Weighting** / **Score** / **nm** / **Score** DEPS – TRN: 50.00 / 0.81 / 40.50 / 49.40 / 40.01 DEPS – NORBO – SUBUK: 112.00 / 5.75 / 644.00 / 103.90 / 597.43 DEPS – NORBO – LAKEY: 112.00 / 7.03 / 787.36 / 103.90 / 730.42 DEPS – LUSIV-DCS: 88.80 / 2.34 / 207.79 / 87.25 / 204.17 DEPS – TLA: 49.20 / 0.09 / 4.43 / 47.25 / 4.25 DEPS – PERTH: 50.30 / 0.27 / 13.58 / 50.30 / 13.58 DEPS – FOYLE: 19.10 / 0.18 / 3.44 / 20.40 / 3.67 DEPS – LOMON: 20.00 / 0.45 / 9.00 / 24.10 / 10.85 DEPS – CLYDE: 25.00 / 0.63 / 15.75 / 33.10 / 20.85 DEPS – ROBBO: 33.50 / 0.45 / 15.08 / 39.00 / 17.55 Total: 1740.92 / 1642.77 Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.

Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP. Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB $L_{Aeq,16h}$ noise contour and therefore not affect Glasgow's noise insultation scheme costs.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[25];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs. There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO_2 and potentially more CAS.
All	Interdependencies, conflicts, and trade-offs	There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having an earlier turn to the West on NORBO departures reduces this interaction. Conversely the ROBBO/CLYDE traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is expected to be possible within the existing network and can also be accommodated within NERL's FASI ScTMA route design but would not make the most of their proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

[25] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.11. Runway 05 Easterly Departure Option D

Runway 05 Easterly Departures – Option D



Straight ahead departures only (no offsets) with turns at 1nm, 4nm and 6nm from the runway.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see all departures initially fly straight ahead before turns at 1nm, 4nm and 6nm from the runway. Today, the majority of departures fly straight ahead until at least 5nm before turning and therefore turns at 1nm and 4nm are a change from current day. As aircraft will fly straight ahead, communities living under the final approach will be overflown by both arrivals and departures.

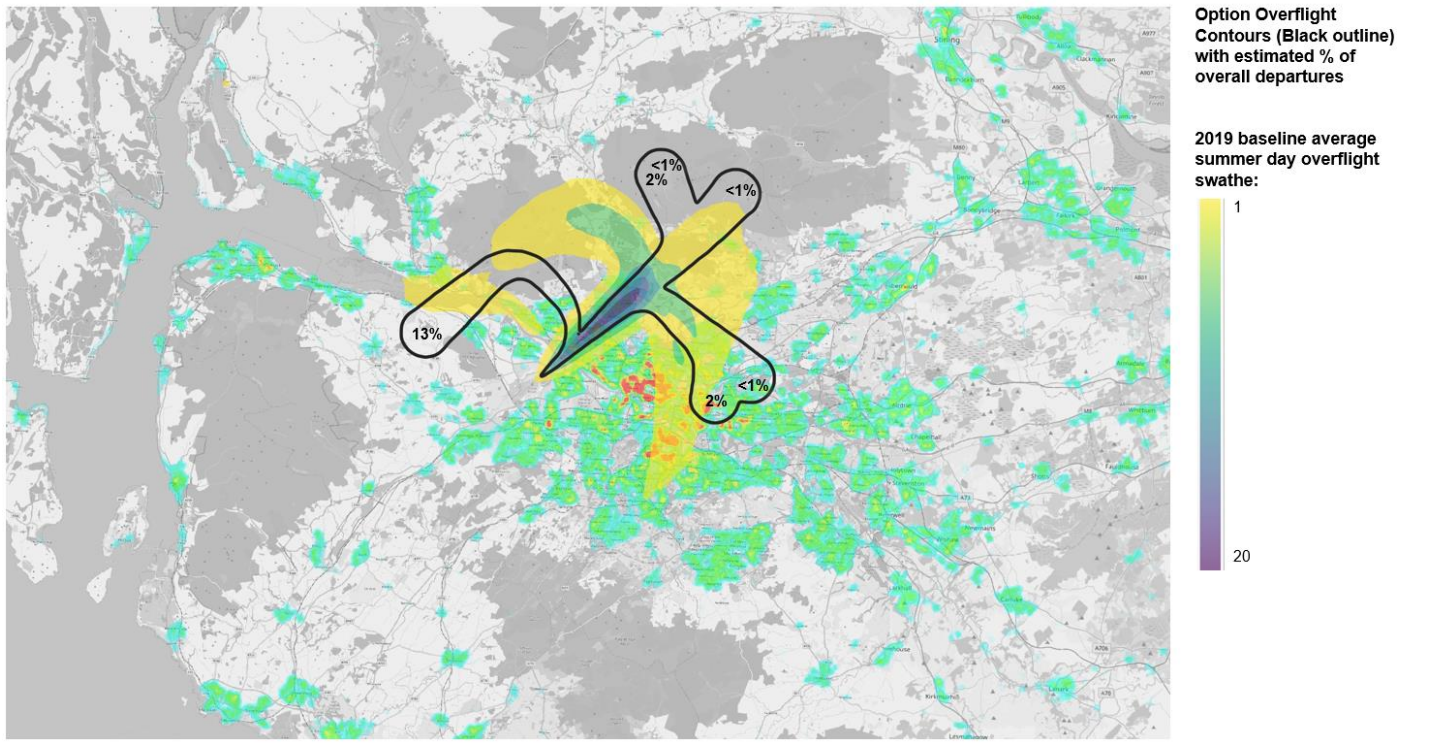


Figure 20 Easterly Option D Overflight and 2019 baseline NTK data

The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap data (Figure 20) suggests that a left turn at 1nm would overfly the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 13% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. This option does not involve any noise sharing/mitigation; therefore these communities will be overflown on a more frequent basis than today.

The ROBBO/CLYDE/LOMON/FOYLE departures fly straight ahead before turning left at 6nm. This means that they overfly the same areas as the final approach track before turning and up to around 5nm, this reflects what happens today. Figure 20 shows today's vectoring swathe turning at around 5nm and therefore a turn at 6nm will result in some areas not currently overflown being overflown in future, however the population data suggests that these areas have very low population levels. The PERTH, which accounts for less than 1% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures. The contour suggests that at 6000-7000ft it may overfly new areas however these are sparsely populated.

Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for 5nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning. When reviewed against the heatmap shown in figure 20, compared to Option C, this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 5nm occurring over an area with lower population density as aircraft do today. Beyond the turn, aircraft would fly towards the south-east, rather than turning towards the south/south-west as they do today. This results in avoidance of some of the most densely populated parts of Glasgow city centre although it results in overflight of Bishopbriggs and other densely populated areas of north-east of Glasgow city centre. The NTK heatmaps show that overflight already occurs in these areas today. The latter parts of the LUSIV/TALLA routes at higher altitudes overfly areas not currently overflown by Glasgow departures such as Dennistoun and Craigend.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option D. The vectoring data is not modelled in the same way as the overflight contours; however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 56 gives an overview of the Option D overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contours reduces and there is a decrease in the number of population overflown compared to the

centreline data.

Table 56 Easterly departures option D overflight data

System	Area (km²)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option D	158.16	158513

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows a decrease in the number of hospitals, care homes and places of worship being overflown and schools remaining the same for centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}
Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option D against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 57 shows a decrease in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 57 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option D

	60dB L_{Amax}		65dB L_{Amax}	
System	**Area (km²)**	**Population**	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option D	320.66	364573	111.91	133584

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} day ime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces turns at 1nm, 3nm and 6nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, due to the turns, the contour may shorten compared to current day which may benefit parts of Milngavie. The NORBO departure to the left may result in the component part of the contour extending further to the northwest to reflect the earlier turn; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the turns at 1nm and 3nm.

Noise Mitigation
The option does not offer an alternative, predictable respite configuration and would continue to see all departures (except NORBO) to climb straight ahead as today. The early left turn on NORBO departures would reduce the volume of traffic that climbs straight ahead, however it would be positioned over newly overflown communities. The L_{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.

	Air Quality	This option has a change to how some lower slower aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option D will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience[26]	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[27] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

[26] Summary colour corrected
[27] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

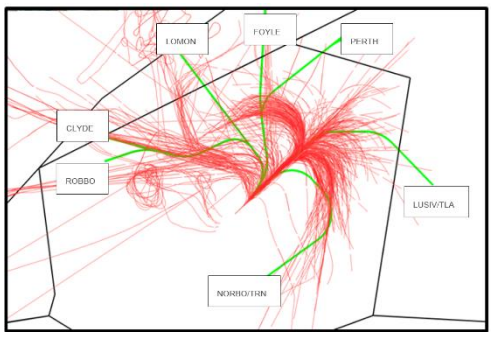
	Tranquillity	Table 58 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 58 Easterly departure – Tranquil areas overflown* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline – Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 4 / 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 2 / 0.38 **Runway 05 Option D**: 0 / 0 / 0 / 0 / 3 / 1.01 The data shows that there is no change in National Scenic Areas and National Parks overflown. There is a decrease in the number of DQAs overflown compared to the vectoring baseline however there is an increase in the overall area. At this stage, the frequency of overflight has not been articulated in the data and this will be important to understand the full benefits and impacts of this option; we will explore this further at Stage 3 should this option progress. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 59 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 59 Biodiversity – areas overflown* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline – Vectoring (NTK data)**: 0 / 0 / 24 / 10.46 / 11 / 6.37 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 10 / 3.31 / 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Option D**: 0 / 0 / 14 / 5.66 / 4 / 3.32 / 0 / 0 / 0 / 0 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected which would offer some small benefits compared to the baseline.
General Aviation	Access	Option D is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, having a single NORBO departure track would not deliver the biggest economic benefits.
	Fuel burn	We estimate that Option D, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows small reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY and TLA routes. There are also small increases to the LUSIV, FOYLE, LOMON, CLYDE and ROBBO routes. The PERTH remains the same. When considered against the overall % movements at GLA, any increase in track miles is outweighed by the decreases elsewhere. *Table 60 Track Length Calculations – Fuel Burn RWY 05 Easterly Departure Option D* **RWY 05** / **Baseline (Centreline)** / D **nm** / **% Weighting** / **Score** / **nm** / **Score** DEPS – TRN: 50.00 / 0.81 / 40.50 / 49.40 / 40.01 DEPS – NORBO – SUBUK: 112.00 / 5.75 / 644.00 / 103.90 / 597.43 DEPS – NORBO – LAKEY: 112.00 / 7.03 / 787.36 / 103.90 / 730.42 DEPS – LUSIV-DCS: 88.80 / 2.34 / 207.79 / 89.10 / 208.49 DEPS – TLA: 49.20 / 0.09 / 4.43 / 48.20 / 4.34 DEPS – PERTH: 50.30 / 0.27 / 13.58 / 50.30 / 13.58 DEPS – FOYLE: 19.10 / 0.18 / 3.44 / 20.40 / 3.67 DEPS – LOMON: 20.00 / 0.45 / 9.00 / 24.10 / 10.85 DEPS – CLYDE: 25.00 / 0.63 / 15.75 / 33.10 / 20.85 DEPS – ROBBO: 33.50 / 0.45 / 15.08 / 39.00 / 17.55 Total: 1740.92 / 1647.19 Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport /	Infrastructure	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this

Air navigation service provider	costs	there are not expected to be any changes to infrastructure for the airport or the ANSP. Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB $L_{Aeq,16h}$ noise contour and therefore not affect Glasgow's noise insultation scheme costs.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[28].
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs. There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO_2 and potentially more CAS.
All	Interdependencies, conflicts, and trade-offs	There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having an earlier turn to the West on NORBO departures reduces this interaction. Conversely the ROBBO/CLYDE traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is expected to be possible within the existing network but can also be accommodated within NERL's FASI ScTMA route design but would not make the most of their proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

[28] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.12. Runway 05 Easterly Departure Option E

Runway 05 Easterly Departures – Option E



Offset left departures with turns at 1nm from the runway.
Straight ahead departures with turns at 2nm and 6.5nm from the runway.
NORBO is straight ahead to 2nm with a right turn.
For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see some departures offset to the left with turns at 1nm, and some departures flying straight ahead before turning at 2nm and 6.5nm. Today, the majority of departures fly straight ahead until at least 5nm before turning and therefore the offset departures and turns at 2nm are a change from current day. As around 15% if aircraft will fly straight ahead, communities living under the final approach will be overflown by both arrivals and departures.

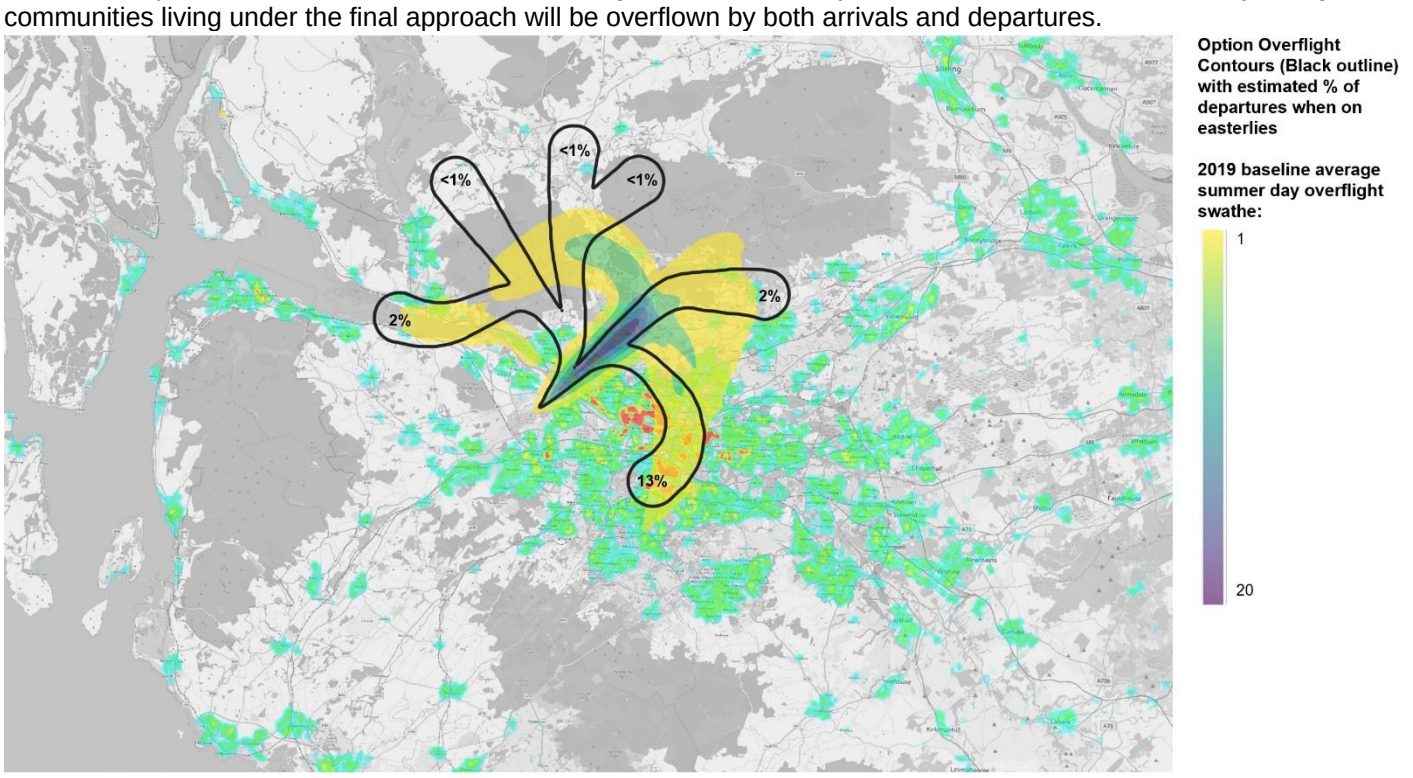


Figure 21 Easterly Option E Overflight and 2019 baseline NTK data

The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route turns right at 2nm which is a change from the left turn today at 5nm today. This means that some noise is relocated from communities under the westerly final approach such as the northern parts of Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas of high population that are not currently overflown frequently by departures will now be overflown on a more frequent basis by 13% of overall traffic. The heatmap data (figure 21) shows that this overflight would occur over large parts of the city of Glasgow.

The LUSIV route, which accounts for around 2% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures before turning at 6.5nm to head east. The contour suggests that it will route over areas already overflown today and will overfly the densely populated areas of Lennoxtown and Milton of Campsie.

The ROBBO/CLYDE/LOMON/FOYLE departures all offset left before turning at 1nm. This means that around 4-5% of departures will no longer fly along the final approach resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 21 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently frequently overflown below 7000ft.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the NORBO contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option E. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 61 gives an overview of the Option E overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour increases as does the number of population overflown compared to the centreline data. This can be attributed to the overall increase in contour area and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 61 Easterly departures option E overflight data

System	Area (km²)	Population
RWY 05 Baseline–- Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option E	232.04	249498

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{aMax}
Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option E against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 62 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 62 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option E

	60dB L_{aMax}		65dB L_{aMax}	
System	**Area (km²)**	**Population**	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option E	427.82	468436	162.05	195679

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures with a turn at 1nm and straight-ahead departures with turns at 2nm and 6.5nm and therefore the option deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, due to the offset and turns, the contour may shorten compared to current day which may benefit parts of Milngavie. The NORBO departure to the right may result in the component part of the contour extending further to the southeast to reflect the earlier turn; this may result in northern parts of Westerton moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option does not offer an alternative, predictable respite configuration. The majority of the SIDs in this option overfly new communities with the right turn, single NORBO SID potentially having the biggest effect in terms of increasing the numbers of people overflown with a relatively high frequency.

	Air Quality	This option has a change to how some lower slower aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider **Society**	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option E will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience[29]	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[30] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NER''s VOR withdrawal

[29] Summary colour corrected
[30] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

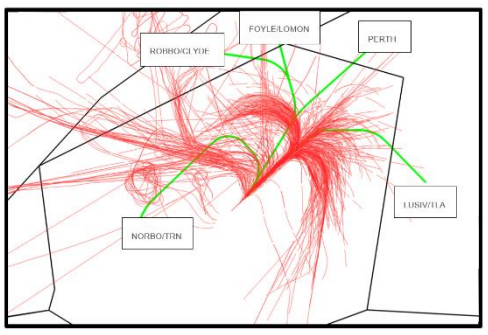
		programme.
	Tranquillity	Table 63 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 63 Easterly departure – Tranquil areas overflown Option E* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline–- Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 4 / 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 2 / 0.38 **Runway 05 Option E**: 2.91 / 1 / 1 / 14.3 / 2 / 1.27 The data shows that there is an increase in the counts and areas of NSA and National Parks overflown. DQAs decrease compared to the vectoring data however this data does not take into account frequency of overflight at this stage. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 64 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 64 Biodiversity - areas overflown Option E* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline–- Vectoring (NTK data)**: 0 / 0 / 24 / 10.46 / 11 / 6.37 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 10 / 3.31 / 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Option E**: 1 / 0.46 / 22 / 12.6 / 9 / 7.73 / 1 / 14.3 / 1 / 2.91 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected which would offer some small benefits compared to the baseline.
General Aviation	Access	The design option may require changes to the existing CAS boundaries but still offers potential to reduce the total volume of CAS. The Northbound SIDs on this option with the 7% climb gradient as illustrated would not quite be contained within ScTMA 7 in accordance with the CAA CAS containment policy. However, this assessment (together with creation of the "illustrative CAS volume") assumed the northbound SIDs terminate at 7000ft and are all wholly contained within CAS which is unlikely to happen in reality because 7000ft does not exist in Airspace Design terms and these routes are leaving CAS anyway, therefore offering more protection than today is potentially not proportionate. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the ''illustrative CAS volume'' compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However, having a single NORBO departure track would not deliver the biggest economic benefits.
	Fuel burn	We estimate that Option E, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows small reductions in track mileage for the NORBO SUNUK, NORBO LAKEY, FOYLE, CLYDE and ROBBO routes. There are small increases to the TRN, LUSIV, TLA, PERTH, and LOMON routes. When considered against the overall % movements at Glasgow, any increase in track miles is outweighed by the decreases elsewhere. *Table 65 Track Length Calculations - Fuel Burn RWY 05 Easterly Departure Option E* **RWY 05** / **Baseline (Centreline)** / E **nm** / **% Weighting** / **Score** / **nm** / **Score** DEPS / TRN / 50.00 / 0.81 / 40.50 / 50.70 / 41.07 DEPS / NORBO–- SUBUK / 112.00 / 5.75 / 644.00 / 104.20 / 599.15 DEPS / NORBO–- LAKEY / 112.00 / 7.03 / 787.36 / 104.20 / 732.53 DEPS / LUSIV-DCS / 88.80 / 2.34 / 207.79 / 104.20 / 243.83 DEPS / TLA / 49.20 / 0.09 / 4.43 / 51.10 / 4.60 DEPS / PERTH / 50.30 / 0.27 / 13.58 / 52.20 / 14.09 DEPS / FOYLE / 19.10 / 0.18 / 3.44 / 17.60 / 3.17 DEPS / LOMON / 20.00 / 0.45 / 9.00 / 20.30 / 9.14 DEPS / CLYDE / 25.00 / 0.63 / 15.75 / 19.10 / 12.03 DEPS / ROBBO / 33.50 / 0.45 / 15.08 / 23.30 / 10.49 Total / 1740.92 / 1670.09 Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.

	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[31];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required.
All	Interdependencies, conflicts, and trade-offs	There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Conversely the LUSIV/TLA traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is not expected to be possible within the existing network as it could require a move of the LANAK hold. It would not make the most of NERL's proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

[31] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

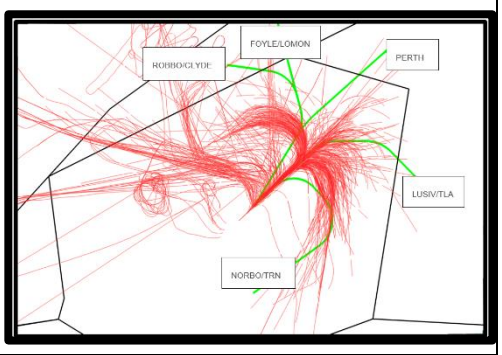
4.13. Runway 05 Easterly Departure Option F

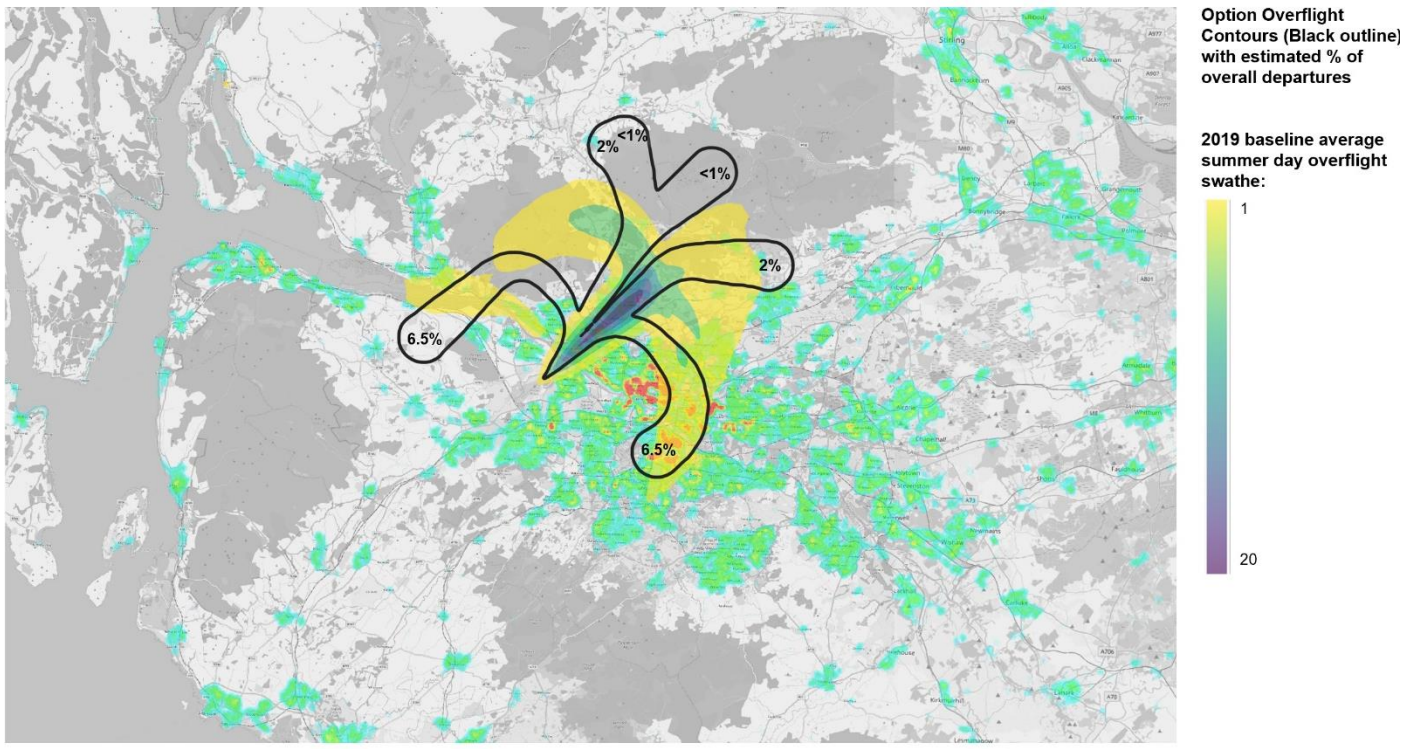
Runway 05 Easterly Departures – Option F



This option shares NORBO traffic between a left and right turn with only one of those routes in use at a time. The rest of the routes remain in the same configuration.
When turning left, the NORBO would offset left then turn further left at 1nm
When turning right, the NORBO would go straight ahead to 2nm then a right turn.
For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Period 1 (Left), Period 2 (Right)



Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option has been designed to enable the busiest NORBO departure route to switch from a left turn (with track adjustment) to a right turn to provide predictable respite to communities under both SID tracks. In both of these scenarios, the NORBO SID would overfly new communities. The other routes remain the same between period 1 and period 2. **Period 1 (NORBO to the left)** Period 1 would see the NORBO SID offset to the left and turn at 1nm. This would account for around 6.5% of overall departure movements from Glasgow airport. In this option, the NORBO route offsets left and turns at 1nm, which means that some noise is shared from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 22 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 6.5% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. **Period 2 (NORBO to the right)** Period 2 would see the NORBO route turn right at 2nm which is a change from the left turn today at 5nm today. This means that some noise is relocated from communities under the westerly final approach such as the northern parts of Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis by 6.5% of overall traffic. The heatmap data (figure 22) shows that this overflight would occur over large parts of the city of Glasgow:  *Figure 22 Easterly Option F Overflight and 2019 baseline NTK data* In both configurations, the ROBBO/CLYDE/LOMON/FOYLE/PERTH departures offset to the left however these departures turn at 6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other populated areas. The routes initially overfly Drumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. The equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 6000-7000ft. Figure 22 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population. The LUSIV route, which accounts for around 2% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures before turning at 6.5nm to head east. The contour suggests that it will route over areas already overflown today and will overfly the densely populated areas of Lennoxtown and Milton of Campsie. It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the right turn NORBO contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend over further parts of Killearn. The Technical Appendix to this document includes an image which compares the existing SID centrelines and option F. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID. Table 66 gives an overview of the Option F overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour and the population overflown increases. This can be attributed to the overall increase in contour area created

by having alternative respite configurations and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 66 Easterly departures option F overflight data

System	Area (km^2)	Population
RWY 05 Baseline–- Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option F	203.99	246626

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

In our Stage 2A engagement, the Mains Estate Resident Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB L_{aMax}
Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option F against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 67 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be partially attributed to introducing an alternative respite route and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight.
Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 67 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option F

	60dB L_{aMax}		65dB L_{aMax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option F	386.14	453065	147.12	200769

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures with a turn at 1nm and straight ahead departures with turns at 2nm and 6.5nm and therefore the option deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the contour may shorten compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigations
The option offers an alternative respite configuration via two NORBO SIDs which could be alternated. For the purposes of this IOA we have assumed that this is split 50/50 between the two SIDs on a daily basis however this can be explored in further detail with stakeholders as part of the Stage 3 consultation if this option progresses. Our overflight and L_{aMax} data has shown an increase in the overall population and noise sensitive sites overflown however the impacts of noise are now shared and so there are decreases in the frequency of overflight where the frequency of overflight is currently high. This is something that was requested by stakeholders and formed part of the design principles. The benefits and impacts of this would require further quantitative analysis as part of the Stage 3 Full Options Appraisal should this option progress.

	Air Quality	This option has a change to how some aircraft will fly laterally below 1,000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1,000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1,000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option F will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity /	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1 minute separations). This is expected to reduce ground holding which in turn will reduce ground based emissions and delays. The benefits of this will be

	resilience[32]	seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[33] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NER''s VOR withdrawal programme.
	Tranquillity	Table 68 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 68 Easterly departure – Tranquil areas overflown Option F* **System** / **NSA area** / **NSA count** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline–- Vectoring (NTK data)** 0 0 0 0 4 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)** 0 0 0 0 2 0.38 **Runway 05 Option F** 0 0 0 0 2 1.27 The data shows that there is no change in National Scenic Areas and National Parks overflown. There is a decrease in the number of DQAs overflown compared to the vectoring baseline however there is an increase in the overall area. At this stage, the frequency of overflight has not been articulated in the data and this will be important to understand the full benefits and impacts of this option; we will explore this further at Stage 3 should this option progress. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 69 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 69 Biodiversity - areas overflown Option F* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline–- Vectoring (NTK data)** 0 0 24 10.46 11 6.37 0 0 0 0 **RWY 05 Baseline (Centreline – Optioneering tool)** 0 0 10 3.31 0 0 0 0 0 0 **RWY 05 Option F** 0 0 17 6.16 4 3.25 0 0 0 0 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Lower slower aircraft, climbing at below a 6% climb gradient on the CLYDE/LOMON/FOYLE/PERTH SIDs, may overfly the Marise Burn and Mugdock Wood SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SIDs, and the vast majority of aircraft will climb above 2000ft before overflying the sites, it is expected that any impacts will be very minimal. We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.
General Aviation	Access	Option is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume'' which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative'' airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However having a single NORBO departure track would not deliver the biggest economic benefits.
	Fuel burn	We estimate that Option F, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY and FOYLE routes. There are also small increases to the LUSIV, TLA, PERTH, LOMON, CLYDE and ROBBO routes. The reduction in the NORBO SIDs means that when considered against the overall % movements at Glasgow, any increase in track miles is outweighed by the decreases elsewhere. *Table 70 Track Length Calculations–- Fuel Burn RWY 05 Easterly Departure Option F* **RWY 05** / **Baseline (Centreline)** / F **nm** / **% Weighting** / **Score** / **nm P1** / **nm P2** / **Average** / **Score** DEPS TRN 50.00 0.81 40.50 49.20 50.70 49.95 40.46 NORBO–- SUBUK 112.00 5.75 644.00 103.90 104.20 104.05 598.29 NORBO–- LAKEY 112.00 7.03 787.36 103.90 104.20 104.05 731.47 LUSIV-DCS 88.80 2.34 207.79 98.00 98.00 98.00 229.32 TLA 49.20 0.09 4.43 51.10 51.10 51.10 4.60 PERTH 50.30 0.27 13.58 50.50 50.50 50.50 13.64

[32] Summary colour corrected

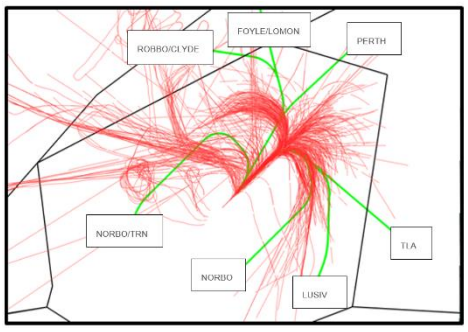
[33] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		<table><tr><td></td><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td><td>17.60</td><td>17.60</td><td>17.60</td><td>3.17</td></tr><tr><td></td><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td><td>20.30</td><td>20.30</td><td>20.30</td><td>9.14</td></tr><tr><td></td><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td><td>28.80</td><td>28.80</td><td>28.80</td><td>18.14</td></tr><tr><td></td><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td><td>34.60</td><td>34.60</td><td>34.60</td><td>15.57</td></tr><tr><td>Total</td><td></td><td></td><td></td><td>1740.92</td><td></td><td></td><td></td><td>1663.79</td></tr></table> Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operate a home owner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[34];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh. Owing to the respite configuration, there may be more training required for this option compared to other options that form part of this IOA.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a not below 500ft flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft does''t turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs. There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO_2 and potentially more CAS. A SID structure from the same runway which changes during the day is unchartered territory for the UK. Whilst it is expected that perhaps a much more subtle change to a SID structure can be safely accommodated, ATC advised that an option where a SID utilisation would change significantly from a left turn to a right turn (or vice-versa) immediately after departure introduces hazards to the operation which at this stage cannot considered to be mitigated without introducing other issues*. Such hazards are not just associated with aircraft inadvertently flying (or being issued) the wrong SIDs and the wrong time of day but also HF issues associated with ATC confusion. *As an example, mitigations identified for SIDs switching to fundamental different directions after departure were SIDs with completely different names. However flight planning and ATM issues previously identified by NERL requires SIDs going to the same places in the network are required to terminate at the same point which in turn would mean similar SID names to match the SID termination point.
All	Interdependencies, conflicts and tradeoffs	There are no interdependencies, conflicts or trade offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Conversely the CLYDE/ROBBO/LUSIV/TLA traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is not expected to be possible within the existing network as it could require a move of the LANAK hold and a SID structure which changes would not fit with the existing operation. Having a single NORBO SID would not make the most of NERL's proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate CO_2 reductions, provide some relief and respite from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

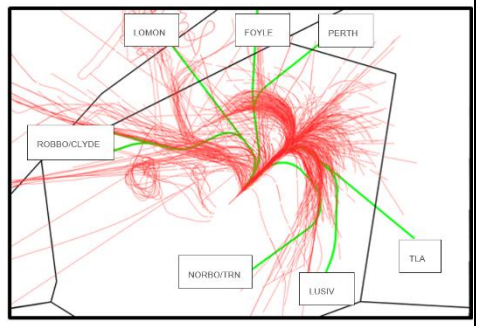
[34] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.14. Runway 05 Easterly Departure Option G

Runway 05 Easterly Departures – Option G



This option has two, quite different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day.
In the peak departure period, the NORBO traffic is shared between a left turn departure and a right turn departure with both routes available at the same time.
For the rest of the day, all the NORBO traffic would then use a single flight path turning right, but that path could be different to the one used for the peak periods.
For more information, please see our Stage 2A document on the CAA's Airspace Change Portal. **Period 1 (Left), Period 2 (Right)**



Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see 2 very different SID configurations operating at different times of day with one configuration (Period 1) for a 'peak departure period' and another for periods of lower demand (Period 2).  *Figure 23 Easterly Option F Overflight and 2019 baseline NTK data* **Period 1 (Peak departure Periods)** The period 1 configuration aims to have an optimal departure throughput configuration which shares the NORBO departures across 2 different SIDs with track adjustments for the left-hand flow. The sharing of the NORBO flow across 2 different SIDs would not only enable reduced departure delay but also reduce frequency of overflights for communities under those tracks. The offset left SID turns to the left at 1nm which is a change from today where all aircraft fly straight ahead before turning at 5nm. This would account for around 1% of overall departure movements at Glasgow Airport. The second NORBO SID flies straight ahead for 5nm before turning which is similar to current day; this is also expected to be operated by around 1% of overall Glasgow departures. The offset left NORBO SID results in some noise shared from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 23 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the route, largely avoids the overflight of populated areas with the exception of Milton, western parts of Bowling, and the northern most parts of Bishopton. The straight ahead NORBO SID largely replicates today's NORBO SID therefore impacting similar communities to current day. The only exception is at higher altitudes where the route turns further towards the south-west than the NORBO centreline does today. This results in overflight on some areas of Glasgow City centre which, according to the 2019 NTK heatmap, are not currently overflown on a frequent basis. This change does however provide some respite for those communities in Glasgow City centre that will be overflown as part of the Period 2 NORBO SID. The ROBBO/CLYDE/LOMON/FOYLE/PERTH departures offset to the left and these departures turn at 6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other populated areas. The routes initially overfly Drumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. The equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 6000-7000ft. Figure 23 shows that the latter parts of these routes fly over areas not currently overflown today however these parts largely avoid dense areas of population. Finally the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for 5nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning. When reviewed against the heatmap shown in figure 18 these routes more closely follow the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 5nm occurring over an area with lower population density as aircraft do today. Beyond the turn, aircraft would fly towards the south-east, rather than turning towards the south/south-west as they do today. This results in avoidance of some of the most densely populated parts of Glasgow city centre although it results in overflight of Bishopbriggs and other densely populated areas of north-east of Glasgow city centre. The NTK heatmaps show that overflight already occurs in these areas today. The latter parts of the LUSIV/TALLA routes at higher altitudes overfly areas not currently overflown by Glasgow departures such as Dennistoun and Craigend.

Period 2 (Rest of the day)
Period 2 would see the NORBO route fly straight ahead before turning at 1.5nm. This means that some noise is relocated from communities under the westerly final approach such as the northern parts of Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas of high population density that are not currently overflown frequently by departures will now be overflown on a more frequent basis by around 11% of overall traffic. The heatmap data (figure 23) shows that this overflight would occur over large parts of the city of Glasgow.

The LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for 4nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning at 4nm rather than 5nm. When reviewed against the heatmap shown in figure 23 this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 4nm occurring north of Bearsden and routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route would overfly areas of the city of Glasgow, including Bishopbriggs, however by turning at 4nm there is more opportunity to avoid the most dense areas of population as aircraft are slightly further north. The route also heads towards the south-east rather than turning south as it does today; this too helps to avoid some of the most dense areas of population however it should be noted that the LUSIV route will overfly the Dennistoun and Craigend areas more frequently than today.

The ROBBO/CLYDE/LOMON/FOYLE departures all offset left before turning at 1nm. This means that around 4-5% of departures will no longer fly along the final approach resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently frequently overflown below 7000ft.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the right turn NORBO, LUSIV and TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The technical appendix to this document includes an image which compares the existing SID centrelines and option G. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data and the centreline data, there is an increase in the population overflown between 0-7000ft however it's important to note that this data does not account for the frequency of overflight. This option is aiming to share the noise and therefore the increase in population can be attributed to the overall increase in contour area created by having alternative respite configurations and the right NORBO turns over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 71 Easterly departures option G overflight data

System	Area (km^2)	Population
RWY 05 Baseline–- Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option G	318.06	398460

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there are also increases in noise sensitive buildings overflown. It's important to note that at this stage none of the data considers the frequency of overflight; although the data shows largely increases, the frequency of overflight has not been articulated. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

In our Stage 2A engagement, the Mains Estate Resident's Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB L_{aMax}
Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option G against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 57 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be attributed to introducing alternative respite routes and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight. Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 72 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option G

	60dB L_{aMax}		65dB L_{aMax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option G	566.65	661368	194.89	229233

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

<table>
<tr><td></td><td></td><td>Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures and straight ahead departures with some turns earlier than today however the largest percentage of flights (11% using the NORBO right turn) follow a very similar route to today in the areas within the scope of the L_{Aeq} contours. When we consider this, and the modal split, it is expected that this option would have minimal impact on the shape and size of the overall L_{Aeq} contours.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option offers a respite configuration for peak periods vs the rest of the day. Within the peak period configuration (period 1), there is further sharing of noise by splitting the NORBO departures into two routes. Our overflight and L_{aMax} data has shown an increase in the overall population and noise sensitive sites overflown however the impacts of noise are now shared and so there are decreases in the frequency of overflight where the frequency of overflight is currently high. This is something that was requested by stakeholders and formed part of the design principles. The benefits and impacts of this would require further quantitative analysis as part of the Stage 3 Full Options Appraisal.</td></tr>
<tr><td></td><td>Air Quality</td><td>This option has a change to how some aircraft will fly laterally below 1,000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1,000ft which could affect local air quality. Where lateral tracks are moving away from the standard ‘straight ahead’ departure that aircraft follow below 1,000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight ahead departure route (known as ‘offset departures’) there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.</td></tr>
<tr><td rowspan="5">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that Option G will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience[35]</td><td>This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1 minute separations). This is expected to reduce ground holding which in turn will reduce ground based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.

The ability for 2 NORBO routes during the first rotation would further help to meet demand however it does not cater for similar demand during the off peak periods of the day.

The introduction of PBN SIDs also removes Glasgow’s dependency on conventional ground based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[36] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NER’’s VOR withdrawal programme.</td></tr>
<tr><td>Tranquillity</td><td>Table 73 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow’s existing SID centrelines:

Table 73 Easterly departure – Tranquil areas overflown Option G

<table>
<tr><th>System</th><th>NSA area</th><th>NSA count</th><th>National Parks count</th><th>National Parks area</th><th>DQA count</th><th>DQA area</th></tr>
<tr><td>RWY 05 Baseline–- Vectoring (NTK data)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>4</td><td>0.66</td></tr>
<tr><td>RWY 05 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td><td>0.38</td></tr>
<tr><td>Runway 05 Option G</td><td>2.91</td><td>1</td><td>1</td><td>14.3</td><td>5</td><td>2.28</td></tr>
</table>
The data shows that there is an increase in the number and area of NSA, National Parks and DQA’s overflown. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td>Biodiversity</td><td>Table 74 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow’s existing SID centrelines.

Table 74 Biodiversity–- areas overflown Option G

<table>
<tr><th>System</th><th>SAC area</th><th>SAC count</th><th>SSSI count</th><th>SSSI area</th><th>SPA count</th><th>SPA area</th><th>National Park count</th><th>National park area</th><th>NSA count</th><th>NSA area</th></tr>
<tr><td>RWY 05 Baseline–- Vectoring (NTK data)</td><td>0</td><td>0</td><td>24</td><td>10.46</td><td>11</td><td>6.37</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 05 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>10</td><td>3.31</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 05 Option G</td><td>0.46</td><td>1</td><td>28</td><td>15.22</td><td>9</td><td>8.14</td><td>1</td><td>14.3</td><td>1</td><td>2.91</td></tr>
</table>
Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interests is expected for the vast majority of aircraft.

Lower slower aircraft, climbing at below a 6% climb gradient on the CLYDE/LOMON/FOYLE/PERTH SIDs, may overfly the Marise Burn and Mugdock Wood SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SIDs, and the vast majority of aircraft will climb above 2000ft before overflying the sites, it is expected that any impacts will be very minimal.</td></tr>
</table>

[35] Summary colour corrected

[36] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

<table>
<tr><td></td><td></td><td>We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>The design option may require changes to the existing CAS boundaries to accommodate Period 2 SIDs to the north but still offers potential to reduce the total volume of CAS. The Northbound SIDs on this option with the 7% climb gradient as illustrated would not quite be contained within ScTMA 7 in accordance with the CAA CAS containment policy. However, this assessment (together with creation of the “illustrative CAS volume”) assumed the northbound SIDs terminate at 7000ft and are all wholly contained within CAS which is unlikely to happen in reality because 7000ft does not exist in Airspace Design terms and these routes are leaving CAS anyway, therefore offering more protection than today is potentially not proportionate.

We created an "illustrative CAS volume” which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative’’ airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline. However the merging of NORBO departures in a single track for the majority of the day would not deliver the biggest economic benefits.</td></tr>
<tr><td>Fuel burn</td><td>We estimate that Option G, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, TLA, FOYLE and CLYDE routes. There are small increases to the PERTH and LOMON routes. The LUSIV remains around the same as current day. The reduction in the NORBO SIDs means that when considered against the overall % movements at Glasgow, any increase in track miles is outweighed by the decreases elsewhere.

Table 75 Track Length Calculations–- Fuel Burn RWY 05 Easterly Departure Option G
<table>
<tr><th colspan="2" rowspan="2">RWY 05</th><th colspan="3">Baseline (Centreline)</th><th colspan="4">G</th></tr>
<tr><th>nm</th><th>% Weighting</th><th>Score</th><th>nm P1</th><th>nm P2</th><th>Average</th><th>Score</th></tr>
<tr><td rowspan="10">DEPS</td><td>TRN</td><td>50.00</td><td>0.81</td><td>40.50</td><td>49.20</td><td>49.70</td><td>49.45</td><td>40.05</td></tr>
<tr><td>NORBO–-SUBUK</td><td>112.00</td><td>5.75</td><td>644.00</td><td>97.30</td><td>103.15</td><td>100.23</td><td>576.29</td></tr>
<tr><td>NORBO–-LAKEY</td><td>112.00</td><td>7.03</td><td>787.36</td><td>96.50</td><td>96.00</td><td>96.25</td><td>676.64</td></tr>
<tr><td>LUSIV-DCS</td><td>88.80</td><td>2.34</td><td>207.79</td><td>88.80</td><td>88.80</td><td>88.80</td><td>207.79</td></tr>
<tr><td>TLA</td><td>49.20</td><td>0.09</td><td>4.43</td><td>48.20</td><td>48.20</td><td>48.20</td><td>4.34</td></tr>
<tr><td>PERTH</td><td>50.30</td><td>0.27</td><td>13.58</td><td>50.50</td><td>52.20</td><td>51.35</td><td>13.86</td></tr>
<tr><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td><td>18.50</td><td>17.60</td><td>18.05</td><td>3.25</td></tr>
<tr><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td><td>20.30</td><td>20.30</td><td>20.30</td><td>9.14</td></tr>
<tr><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td><td>28.80</td><td>19.10</td><td>23.95</td><td>15.09</td></tr>
<tr><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td><td>34.60</td><td>23.30</td><td>28.95</td><td>13.03</td></tr>
<tr><td colspan="5">Total 1740.92</td><td></td><td></td><td></td><td>1559.48</td></tr>
</table>
Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.</td></tr>
<tr><td rowspan="2">Commercial airlines</td><td>Training costs</td><td>Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.</td></tr>
<tr><td>Other costs</td><td>No other airline costs are foreseen.</td></tr>
<tr><td rowspan="3">Airport / Air navigation service provider</td><td>Infrastructure costs</td><td>Glasgow currently operate a home owner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government’s current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow’s ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme.

The initial deployment phase of the ACP may require some ATC system engineering amendments.</td></tr>
<tr><td>Operational costs</td><td>This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow’s dependency on conventional ground based navigation equipment (VORs), which contributes to a reduction in NERL’s operational costs as it enables VOR rationalisation[37];</td></tr>
<tr><td>Deployment costs</td><td>This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh. Owing to the respite configuration, there may be more training required for this option compared to other options that form part of this IOA.</td></tr>
<tr><td>All</td><td>Safety</td><td>This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a not below 500ft flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn’t turn before the end of the runway. PANS OPS doesn’t require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER.

More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required.

There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO_2 and potentially more CAS.

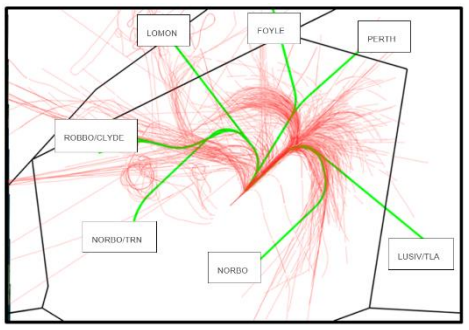
A SID structure from the same runway which changes during the day is unchartered territory for the UK. Whilst it is expected</td></tr>
</table>

[37] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		that perhaps a much more subtle change to a SID structure can be safely accommodated, ATC advised that an option where a SID utilisation would change significantly from a left turn to a right turn (or vice-versa) immediately after departure introduces hazards to the operation which at this stage cannot considered to be mitigated without introducing other issues*. Such hazards are not just associated with aircraft inadvertently flying (or being issued) the wrong SIDs and the wrong time of day but also HF issues associated with ATC confusion. *As an example, mitigations identified for SIDs switching to fundamental different directions after departure were SIDs with completely different names. However flight planning and ATM issues previously identified by NERL requires SIDs going to the same places in the network are required to terminate at the same point which in turn would mean similar SID names to match the SID termination point.
All	Interdependencies, conflicts and tradeoffs	There are no interdependencies, conflicts or trade offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Conversely the CLYDE/ROBBO traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is not expected to be possible within the existing network as it could require a move of the LANAK hold and a SID structure which changes would not fit with the existing operation. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate significant CO_2 reductions, provide some respite from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route for the majority of the day does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown and densely populated communities to the south of the airport for the majority of the day. This option could be expected to result in reductions in the volume of Glasgow's CAS.

4.15. Runway 05 Easterly Departure Option H

Runway 05 Easterly Departures – Option H



This option was generated as a result of Community and ATC feedback in our engagement. They proposed that ROBBO/CLYDE/LOMON SIDs could also turn left immediately, together with the left turn NORBO SID. Predictable respite is not a feature.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see the NORBO departures split between two routes. These would be operated throughout the day and therefore they would not be used in a respite configuration, however they would help to share the noise between communities. Unlike other options, the ROBBO/CLYDE/LOMON SIDS follow the same initial offset and turn as the left turn NORBO route. There is a mixtures of offset departures and departures that fly straight ahead, therefore there is limited relief for communities living under final approach however there are opportunities to share the noise. The NORBO route accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route is split into two. One NORBO SID offsets left and turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 24 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 6.5% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. The other NORBO SID would fly straight ahead and turn at 5nm. This would largely replicate today's NORBO departures and therefore impact similar communities to current day. The only exception is at higher altitudes where the route turns further towards the south-west than the NORBO centreline does today. This results in overflight of some areas of Glasgow City centre which, according to the 2019 NTK heatmap, are not currently overflown on a frequent basis by departures. The sharing of the route between the two SIDs means that the frequency of overflight is reduced compared to some other options that use the same NORBO right turn route. Frequency of overflight will be explored in further detail as part of Stage 3.  *Figure 24 Easterly Option H Overflight and 2019 baseline NTK data* The LUSIV/TALLA equivalent SIDs have been combined into one route, which will account for under 3% of overall departures, fly straight ahead for 4nm before turning to the southwest. Whilst flying straight ahead, the route follows the same track as today before turning at 4nm rather than 5nm. When reviewed against the heatmap shown in figure 24 this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 4nm occurring north of Bearsden and routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route would overfly areas of the city of Glasgow including Bishopbriggs and Craigend however by turning at 4nm there is more opportunity to avoid the most dense areas of population in the very centre of Glasgow as aircraft are slightly further north. The ROBBO/CLYDE/LOMON departures all offset left before turning at 1nm (The ROBBO/CLYDE has been combined into one route). This means that around 3% of these departures will no longer fly along the final approach resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently frequently overflown below 7000ft. The FOYLE/PERTH departures also offset to the left however these departures turn at 6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight of other populated areas. The route initially flies over Dumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. Figure 24 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population. It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a

737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the NORBO right turn and LUSIV/TALLA contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The technical appendix to this document includes an image which compares the existing SID centrelines and option H. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour and the population overflown increases. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 76 Easterly departures option H overflight data

System	Area (km^2)	Population
RWY 05 Baseline–- Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option H	234.43	248316

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

In our Stage 2A engagement, the Mains Estate Resident'' Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB L_{aMax}
Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option H against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 77 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight. Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 77 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option H

	60dB L_{aMax}		65dB L_{aMax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option H	433.3	442907	147.96	158079

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures with a turn at 1nm as well as straight ahead departures. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the introduction of some traffic onto the offset departures may result in the contour shortening compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Drumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigations
The option does not offer an alternative respite configuration however it does aim to share the noise by relocating half of the NORBO departures and the ROBBO/CLYDE/LOMON/FOYLE/PERTH departures onto an offset track, rather than climbing straight ahead over the same areas as final approach as they do today. Splitting the NORBO departures into two on a permanent basis also shares the noise for those communities to the south of the centreline which will be overflown by the right turn NORBO route (although they are already overflown today). The L_{aMax} and overflight data has suggested that this configuration may increase the population overflown compared to the baseline centreline data, and therefore further detailed

<table>
<tr><td></td><td></td><td>data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.</td></tr>
<tr><td></td><td>Air Quality</td><td>This option has a change to how some aircraft will fly laterally below 1,000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1,000ft which could affect local air quality. Where lateral tracks are moving away from the standard ‘straight ahead’ departure that aircraft follow below 1,000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight ahead departure route (known as ‘offset departures’) there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that Option H will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience</td><td>This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1 minute separations). This is expected to reduce ground holding which in turn will reduce ground based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.

Having 2 NORBO routes for the whole day services future demand to the greatest extent.

The introduction of PBN SIDs also removes Glasgow’s dependency on conventional ground based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[38] resilience for Glasgo’’s SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NER’’s VOR withdrawal programme.</td></tr>
<tr><td>Tranquillity</td><td>Table 78 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow’s existing SID centrelines between 0-7000ft:

Table 78 Easterly departure – Tranquil areas overflown Option H

<table>
<tr><th>System</th><th>NSA count</th><th>NSA area</th><th>National Parks count</th><th>National Parks area</th><th>DQA count</th><th>DQA area</th></tr>
<tr><td>RWY 05 Baseline–- Vectoring (NTK data)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>4</td><td>0.66</td></tr>
<tr><td>RWY 05 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td><td>0.38</td></tr>
<tr><td>Runway 05 Option H</td><td>1</td><td>2.91</td><td>1</td><td>13.93</td><td>4</td><td>1.2</td></tr>
</table>

The data shows that there is an increase in NSAs, National Parks, and DQAs compared to the vectoring and centreline data. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td>Biodiversity</td><td>Table 79 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow’s existing SID centrelines.

Table 79 Biodiversity–- areas overflown Option H

<table>
<tr><th>System</th><th>SAC area</th><th>SAC count</th><th>SSSI count</th><th>SSSI area</th><th>SPA count</th><th>SPA area</th><th>National Park count</th><th>National park area</th><th>NSA count</th><th>NSA area</th></tr>
<tr><td>RWY 05 Baseline–- Vectoring (NTK data)</td><td>0</td><td>0</td><td>24</td><td>10.46</td><td>11</td><td>6.37</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 05 Baseline (Centreline – Optioneering tool)</td><td>0</td><td>0</td><td>10</td><td>3.31</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>RWY 05 Option H</td><td>0</td><td>0</td><td>27</td><td>13.66</td><td>9</td><td>8.14</td><td>1</td><td>13.93</td><td>1</td><td>2.91</td></tr>
</table>

Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interests is expected for the vast majority of aircraft.

Lower slower aircraft, climbing at below a 6% climb gradient on the CLYDE/LOMON/FOYLE/PERTH SIDs, may overfly the Marise Burn and Mugdock Wood SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SIDs, and the vast majority of aircraft will climb above 2000ft before overflying the sites, it is expected that any impacts will be very minimal.

We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>The design option may require changes to the existing CAS boundaries to accommodate the LOMON SID but still offers potential to reduce the total volume of CAS. The Northbound SIDs on this option with the 7% climb gradient as illustrated would not quite be contained within ScTMA 7 in accordance with the CAA CAS containment policy. However, this assessment (together with creation of the “illustrative CAS volume”) assumed the northbound SIDs terminate at 7000ft and are all wholly contained within CAS which is unlikely to happen in reality because 7000ft does not exist in Airspace Design terms and these routes are leaving CAS anyway, therefore offering more protection than today is potentially not proportionate.

We created an "illustrative CAS volume’’ which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the ‘’illustrative’’ airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>We expect the increased effective capacity detailed in the section above will result in the greatest positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline.</td></tr>
<tr><td>Fuel burn</td><td>We estimate that Option H, when compared to baseline nominal centrelines, will result in an overall improvement in track</td></tr>
</table>

[38] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

mileage. This option shows reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, TLA, FOYLE, LOMON, CLYDE and ROBBO routes. There are increases to the LUSIV and PERTH routes. The reduction mainly in the NORBO SIDs but also in the other routes means that when considered against the overall % movements at Glasgow, any increase in track miles is outweighed by the decreases elsewhere.

Table 80 Track Length Calculations–- Fuel Burn RWY 05 Easterly Departure Option H

RWY 05		Baseline (Centreline)				
		nm	% Weighting	Score	nm	Score
DEPS	TRN	50.00	0.81	40.50	49.20	39.85
	NORBO–-SUBUK	112.00	5.75	644.00	103.60	595.70
	NORBO–-LAKEY	112.00	7.03	787.36	96.50	678.40
	LUSIV-DCS	88.80	2.34	207.79	96.50	225.81
	TLA	49.20	0.09	4.43	48.20	4.34
	PERTH	50.30	0.27	13.58	50.50	13.64
	FOYLE	19.10	0.18	3.44	18.50	3.33
	LOMON	20.00	0.45	9.00	14.60	6.57
	CLYDE	25.00	0.63	15.75	18.40	11.59
	ROBBO	33.50	0.45	15.08	22.80	10.26
Total				1740.92		1589.48

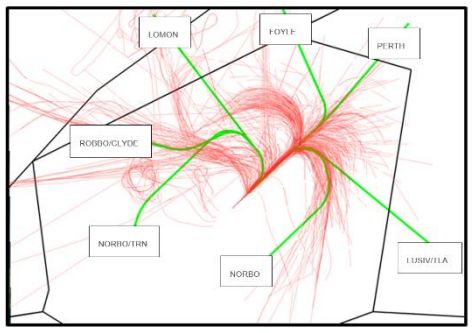
Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operate a home owner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L_{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB $L_{Aeq,16h}$ area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme. The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[39];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a not below 500ft flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required.
All	Interdependencies, conflicts and tradeoffs	There are no interdependencies, conflicts or trade offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Also keeping the CLYDE/ROBBO/LUSIV/TLA traffic more closely aligned to existing traffic patterns minimises this interaction This option is not expected to be possible within the existing network as it could require a move of the LANAK hold and having 2 NORBO SIDs maximises the benefits from NERL's proposed dual southbound route structure. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure). This option could be expected to result in reductions in the volume of Glasgow's CAS.

[39] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

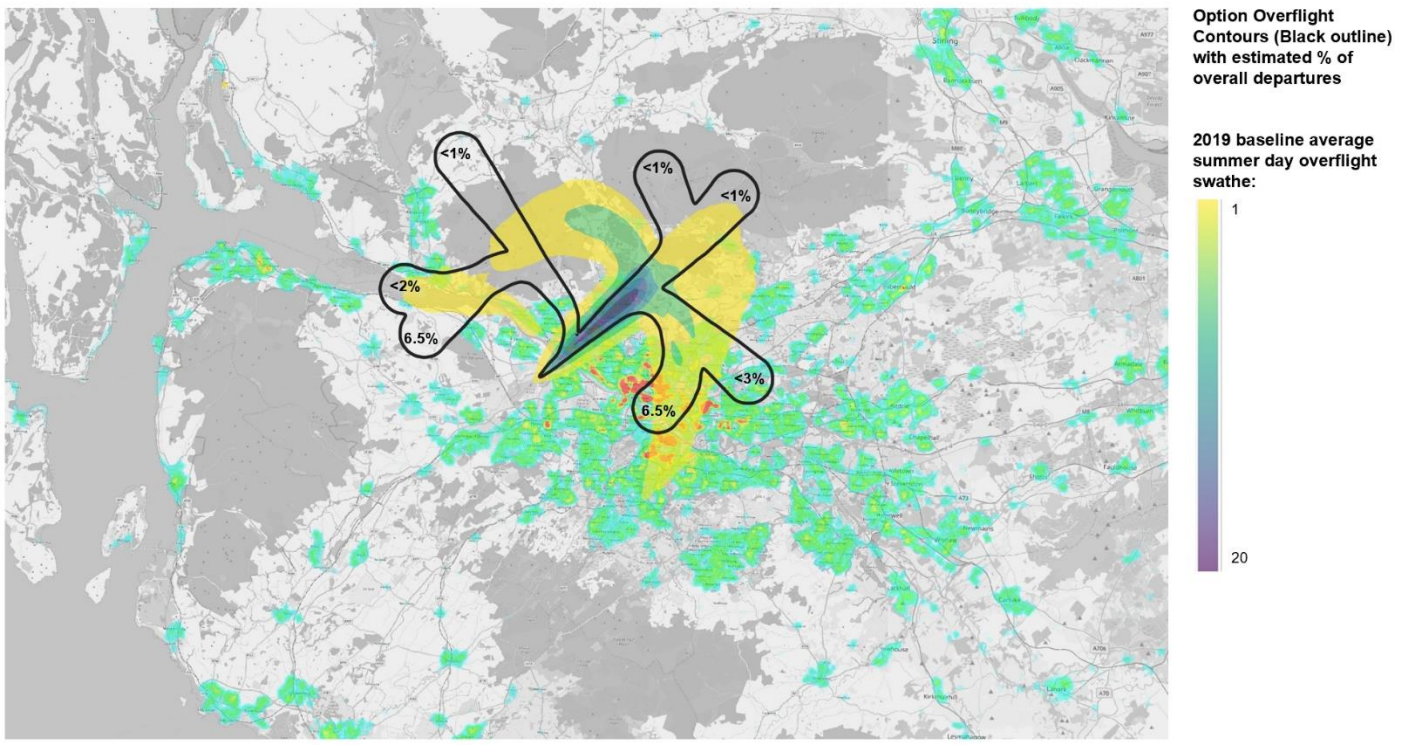
4.16. Runway 05 Easterly Departure Option I

Runway 05 Easterly Departures – Option I



This option is the same as Option H except that track adjustments do not feature. This is due to a concern that a track adjustment followed by an immediate left 180˚ turn for the NORBO/ROBBO/CLYDE/LOMON departure could be too technically challenging. This has a knock-on impact in that the PERTH/FOYLE would also not feature a track adjustment.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see the NORBO departures split between two routes. These would be operated throughout the day and therefore they would not be used in a respite configuration, however they would help to share the noise between communities. Unlike other options, the ROBBO/CLYDE/LOMON SIDS follow the same initial turn as the left turn NORBO route. All departures fly straight ahead, therefore there is no relief for communities living under immediate final approach although the NORBO Left, ROBBO/CLYDE, LOMON and FOYLE do turn shortly after departure. The NORBO route accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route is split into two. One NORBO SID turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the overflight contours and population data show that the left turn overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 6.5% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. The other NORBO SID would fly straight ahead and turn at 5nm. This would largely replicate today's NORBO departures and therefore impact similar communities to current day. The only exception is at higher altitudes where the route turns further towards the south-west than the NORBO centreline does today. This results in overflight of some areas of Glasgow City centre which, according to the 2019 NTK heatmap shown in Figure 22, are not currently overflown on a frequent basis by departures. The sharing of the route between the two SIDs means that the frequency of overflight is reduced compared to some other options that use the same NORBO right turn route. Frequency of overflight will be explored in further detail as part of Stage 3.  *Figure 25 Easterly Option I Overflight and 2019 baseline NTK data* The LUSIV/TALLA equivalent SIDs have been combined into one route, which will account for under 3% of overall departures, fly straight ahead for 4nm before turning to the southwest. Whilst flying straight ahead, the route follows the same track as today before turning at 4nm rather than 5nm. When reviewed against the heatmap shown in figure 25 this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 4nm occurring north of Bearsden and routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route would overfly areas of the city of Glasgow including Bishopbriggs and Craigend however by turning at 4nm there is more opportunity to avoid the most dense areas of population in the very centre of Glasgow as aircraft are slightly further north. The ROBBO/CLYDE/LOMON departures all turn at 1nm (The ROBBO/CLYDE has been combined into one route). This means that around 3% of these departures will no longer fly along the final approach up to 5nm resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap data shows that these departures turning left overfly the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently frequently overflown below 7000ft. The FOYLE/PERTH fly straight ahead and turn at 6nm. These routes therefore overfly the same areas as final approach and largely follow the same tracks as departures today, particularly from take off to 5nm. Beyond 6nm, at higher altitudes, the routes overfly Blanefield and Strathblane. Figure 25 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population. It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight

contours may extend further than what is shown in this IOA. In the case of this option, the NORBO right turn and LUSIV/TALLA contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The technical appendix to this document includes an image which compares the existing SID centrelines and option H. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour and the population overflown increases. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 81 Easterly departures option I overflight data

System	Area (km^2)	Population
RWY 05 Baseline–- Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option I	217.71	235019

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{aMax}
Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option I against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 82 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight. Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 82 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option I

	60dB L_{aMax}		65dB L_{aMax}	
System	**Area (km^2)**	**Population**	**Area (km^2)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option I	411.04	433493	132.97	147678

L_{Aeq}
The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces straight ahead departures with some turns earlier than today however the largest percentage of flights follow a very similar route to today in the areas within the scope of the lAeq contours. When we consider this, and the modal split, it is expected that this option would have minimal impact on the shape and size of the overall L_{Aeq} contours.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures
A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation
The option does not offer an alternative respite configuration however it does aim to share the noise by splitting the NORBO departures into two on a permanent basis. This shares the noise for those communities to the south of the centreline which will be overflown by the right turn NORBO route (although they are already overflown today). The L_{aMax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.

	Air Quality	This option has the potential to change to how a small number of aircraft will fly laterally below 1,000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1,000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1,000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option I will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.

	Capacity / resilience	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1 minute separations). This is expected to reduce ground holding which in turn will reduce ground based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. Having 2 NORBO routes for the whole day services future demand to the greatest extent. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground based navigation aids, which provides resilience. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[40] resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NER''s VOR withdrawal programme.
	Tranquillity	Table 83 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines: *Table 83 Easterly departure – Tranquil areas overflown Option I* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline–- Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 4 / 0.66 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 2 / 0.38 **Runway 05 Option I**: 1 / 1.62 / 1 / 12.7 / 4 / 1.19 The data shows that there is an increase in NSAs, National Parks, and DQAs compared to the vectoring and centreline data. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	Table 84 shows data on the overflight of biodiverse areas up to 7000ft based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. *Table 84 Biodiversity–- areas overflown Option I* **System** / **SAC area** / **SAC count** / **SSSI count** / **SSSI area** / **SPA count** / **SPA area** / **National Park count** / **National park area** / **NSA count** / **NSA area** **RWY 05 Baseline–- Vectoring (NTK data)**: 0 / 0 / 24 / 10.46 / 11 / 6.37 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 10 / 3.31 / 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Option I**: 0 / 0 / 25 / 12.99 / 9 / 7.86 / 1 / 12.7 / 1 / 1.62 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interests is expected which would offer some small benefits compared to the baseline.
General Aviation	Access	The design option may require changes to the existing CAS boundaries to accommodate the LOMON SID but still offers potential to reduce the total volume of CAS. The Northbound SIDs on this option with the 7% climb gradient as illustrated would not quite be contained within ScTMA 7 in accordance with the CAA CAS containment policy. However, this assessment (together with creation of the "illustrative CAS volume") assumed the northbound SIDs terminate at 7000ft and are all wholly contained within CAS which is unlikely to happen in reality because 7000ft does not exist in Airspace Design terms and these routes are leaving CAS anyway, therefore offering more protection than today is potentially not proportionate. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the ''illustrative'' airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. The Glasgow CTR was c.47nm^3 smaller.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in the greatest positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline.
	Fuel burn	We estimate that Option I, when compared to baseline nominal centrelines, will result in an overall improvement in track mileage. This option shows reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, TLA, PERTH, LOMON, CLYDE and ROBBO routes. There are increases to the LUSIV and FOYLE routes. The reduction mainly in the NORBO SIDs but also in the other routes means that when considered against the overall % movements at Glasgow, any increase in track miles is outweighed by the decreases elsewhere. *Table 85 Track Length Calculations–- Fuel Burn RWY 05 Easterly Departure Option I* **RWY 05** / **Baseline (Centreline)** / **nm** / **% Weighting** / **Score** / **nm** / **Score** DEPS / TRN / 50.00 / 0.81 / 40.50 / 49.10 / 39.77 DEPS / NORBO–- SUBUK / 112.00 / 5.75 / 644.00 / 103.90 / 597.43 DEPS / NORBO–- LAKEY / 112.00 / 7.03 / 787.36 / 96.50 / 678.40 DEPS / LUSIV-DCS / 88.80 / 2.34 / 207.79 / 96.50 / 225.81 DEPS / TLA / 49.20 / 0.09 / 4.43 / 48.20 / 4.34

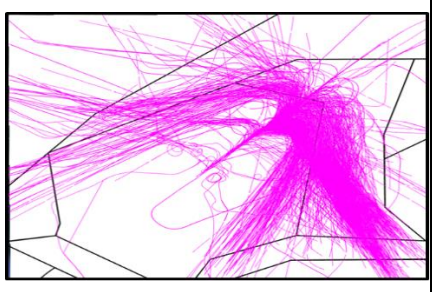
[40] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		<table><tr><td></td><td>PERTH</td><td>50.30</td><td>0.27</td><td>13.58</td><td>50.20</td><td>13.55</td></tr><tr><td></td><td>FOYLE</td><td>19.10</td><td>0.18</td><td>3.44</td><td>20.30</td><td>3.65</td></tr><tr><td></td><td>LOMON</td><td>20.00</td><td>0.45</td><td>9.00</td><td>14.80</td><td>6.66</td></tr><tr><td></td><td>CLYDE</td><td>25.00</td><td>0.63</td><td>15.75</td><td>19.00</td><td>11.97</td></tr><tr><td></td><td>ROBBO</td><td>33.50</td><td>0.45</td><td>15.08</td><td>23.00</td><td>10.35</td></tr><tr><td>Total</td><td></td><td></td><td></td><td>1740.92</td><td></td><td>1591.93</td></tr></table> Given the improvement in track mileage, and the aspiration for all aircraft to climb continuously to at least 6000ft (subject to the NATS NERL ACP for the airspace above 7000ft), it is anticipated that this option would see an improvement in fuel burn. In the Full Options Appraisal at Stage 3 we will investigate track mileage in further detail.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP. Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB $L_{Aeq,16h}$ noise contour and therefore not affect Glasgow's noise insultation scheme costs.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[41];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required. The lack of a track adjustment on this option together with a permanent SID structure and SIDs that do not wrap around each other means this option will be more straightforward to assure within established rulesets.
All	Interdependencies, conflicts and tradeoffs	There are no interdependencies, conflicts or trade offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Also keeping the CLYDE/ROBBO/LUSIV/TLA traffic more closely aligned to existing traffic patterns minimises this interaction This option is not expected to be possible within the existing network as it could require a move of the LANAK hold and having 2 NORBO SIDs maximises the benefits from NERL's proposed dual southbound route structure. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO_2 reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure). This option could be expected to result in reductions in the volume of Glasgow's CAS.

[41] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.17. Runway 23 Westerly Arrivals Baseline

Runway 23 Westerly Arrivals Baseline



The majority of aircraft are vectored to join final approach between approximately 7nm and 13nm from touchdown however they are allowed to join final approach as close as 2000ft/6nm when using the ILS. The tracks shown which join final approach inside 6nm are likely performing a visual approach.

For more information on our do nothing scenario, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Aircraft arriving at Glasgow are tactically controlled (vectored) by ATC before joining final approach which is aligned with the extended runway centreline. Aircraft typically join final approach between 7nm and 13nm before landing although when undertaking an ILS approach they can be as close as 6nm. Aircraft may also undertake visual approaches closer than 6nm. The NTK data shown in figure 26, demonstrates the large swathe of overflight created by today's vectoring. It shows that there are wide areas that are overflown between 1-10 times per day on average including Weymess Bay, Fort Glasgow, Inverkip, Helensburgh, Cardross, Boglestone, Birdgend, Greenock, Dumbarton, Bonhill, Balloch, Balfron, Cumbernauld, Kilsyth, Airdrie, Wishaw, Carluke, Udston, Blantyre, East Kilbride, Newton Mearns, Clarkstone, and eastern parts of the city centre of Glasgow. There is some concentration which occurs from a south-easterly direction, before aircraft join the final approach which overflies Larkhall, Motherwell, Belishill, Coatbridge, Gartcosh, Moddlesburn, Muirhead, eastern parts of Kirkintilloch, Milton of Campsie, and Lennoxtown:

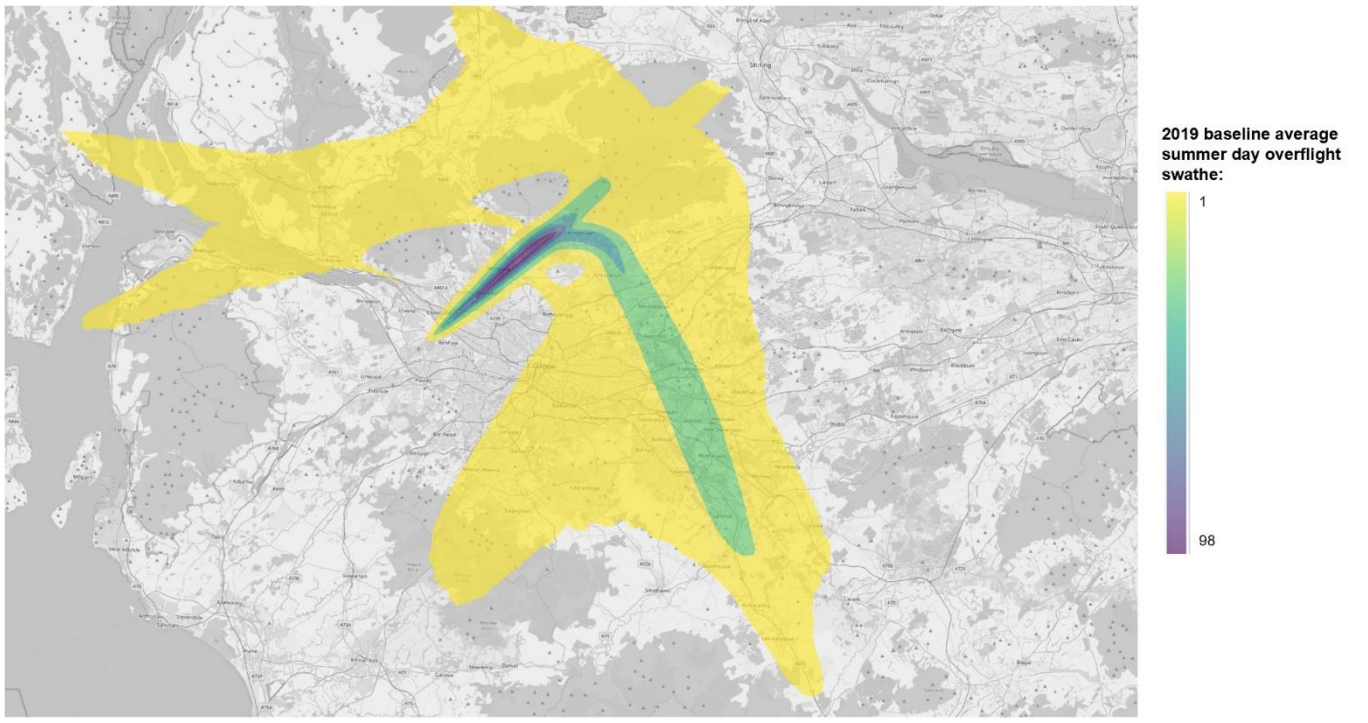


Figure 26 Runway 23 Departure Vectoring Swathe 2019

The technical appendix to this document includes a larger version of this map along with overflight data. It's important to note that this data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline and the airspace change options.

The technical appendix also includes a baseline arrivals centreline contour and associated data. Glasgow Airport does not have any published PBN arrivals and therefore this centreline has been generated by reviewing 92 day summer NTK data for 2019 and analysing the arrivals concentration which occurred across the vectored swathe. The output centreline has then been processed through the optioneering tool in order to output the data tables and contours.

Table 86 below includes data based on the NTK heat map as shown in figure 26 above, and data output from the optioneering tool for if aircraft were to follow one centreline arrival:

Table 86 Westerly arrivals baseline overflight data 0-7000ft

System	Area (km^2)	Population
RWY 23 Arrivals Baseline–- Vectoring (NTK data)	1659.74	1250066
RWY23 Arrivals Baseline (Centreline – optioneering tool)	184.13	139113

The data from these tables will be used to compare the westerly arrival options against the 'do nothing' baseline.

In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals and places of worship; the full data around these is shown in technical appendix a, and as part of this IOA we will provide a qualitative statement around this data.

60dB and 65dB L_{AMax}

Technical Appendix A includes 60dB L_{AMax} contours and data for the baseline, to aid comparison between the baseline and the options. Although we have shown a 65dB L_{AMax} contour in the appendix, this does not change between the options as the scope of the contour is only on the final approach. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal.

<table>
<tr><td></td><td></td><td>
Table 87 Westerly arrivals baseline L_{AMax} data
<table>
<tr><th></th><th colspan="2">60dB L_{AMax}</th></tr>
<tr><th>System</th><th>Area (km^2)</th><th>Population</th></tr>
<tr><td>RWY23 Arrivals Baseline (Centreline – optioneering tool)</td><td>57.86</td><td>68289</td></tr>
</table>

The data from these tables will be used to compare the westerly arrivals options against the ‘do nothing’ baseline.

L_{Aeq}
Westerly arrivals make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025 as it is expected that contours will be a similar shape and size.

Noise Abatement Procedures
As this baseline reflects current day, there would be no changes to NAPs as a result of this option.

Noise Mitigation
The option doesn't see the use of multiple routes to share noise however routine vectoring does disperse the traffic. The option doesn't contain mechanisms for predictable respite.
</td></tr>
<tr><td></td><td>Air Quality</td><td>Impacts to air quality are considered for changes below around 1000ft (200m). Aircraft flying above this are unlikely to have a significant impact on local ground air quality.

Aircraft arriving at Glasgow fly a standard 3.0 degree approach and are aligned with the runway centreline at 1000ft. This is when they are very close to landing. It’s therefore highly unlikely that any of our arrival’s options will have any lateral changes below 1000ft however we will compare this baseline against each option.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Emissions of greenhouse gases arise from the combustion of aviation fuel, and as the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly arrivals. The greenhouse gas assessment is therefore linked to the fuel burn assessment detailed in the section below.

We will estimate the differences between the baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today. As CO_2 emissions are linked to the difference in aviation fuel burnt, this will allow us to qualitatively describe anticipated greenhouse gas impacts as a result of the option. Full data tables are shown in technical appendix a.</td></tr>
<tr><td>Capacity / resilience</td><td>In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. Although vectoring of arrivals is expected to be able to meet the forecast demand, we anticipate changes to the vectoring practices may be required to facilitate the wider changes to CAS, the network and the departures. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme.

For some approaches, Glasgow Airport is dependent on conventional ground based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. Although ILS approaches will remain available, the decommissioning of VORs results in reduced resilience for Glasgow Airport in the event on an ILS outage.</td></tr>
<tr><td>Tranquillity</td><td>CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we’ve therefore included overflight data around these, National Parks and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB.

Table 88 shows data on the overflight of these areas, based on the NTK vectoring baseline and the centreline baseline. The data from this table will be used to compare the westerly arrivals to the baseline.

Table 88 Westerly arrival baseline – Tranquillity overflown 0-7000ft
<table>
<tr><th>System</th><th>NSA count</th><th>NSA area</th><th>National Parks count</th><th>National Parks area</th><th>DQA count</th><th>DQA area</th></tr>
<tr><td>RWY 23 Arrival Baseline - Vectoring (NTK data)</td><td>1</td><td>17.51</td><td>5</td><td>79.21</td><td>8</td><td>2.29</td></tr>
<tr><td>RWY23 Arrival Baseline (Centreline – optioneering tool)</td><td>1</td><td>23.63</td><td>1</td><td>34.52</td><td>0</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Biodiversity</td><td>The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance 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.” 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 500m (~1,640ft). Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft.

Aircraft arriving at Glasgow fly a standard 3.0 degree approach and are aligned with the runway centreline at 1640ft; this typically occurs at around 5nm (9-10km) from landing. The NTK vectoring baseline shows some low frequency overflight of Mugdock Wood and Manse Burn SSSIs below 2000ft (Both are located north of the extended runway centerline). It’s highly unlikely that any of our arrival’s options will have any lateral changes between 5nm and landing however we will compare this baseline against each option.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>This baseline scenario would not offer any change from the existing Controlled Airspace (CAS) arrangements in place today. The options will be qualitatively compared against this existing scenario.</td></tr>
</table>

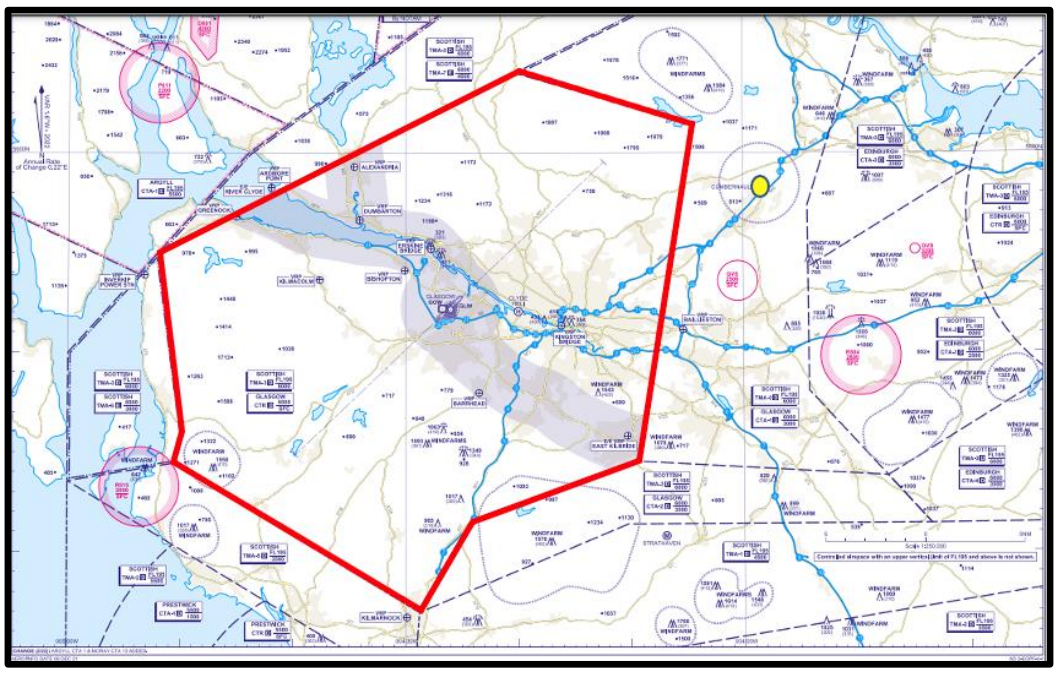


Figure 27 Glasgow Airport Control Zone and Control Area Chart (See eAIP for full details)

Within c.35nm of Glasgow airports are Edinburgh and Glasgow Prestwick Airport each with their own Controlled Airspace (CAS) volumes. In addition to this, the Scottish TMA airspace sits above and around the airports' airspace which generates the volumes shown in Figure 27. The controlled airspace at Glasgow has varying lower and upper limits with the volume closest to the airport going down to ground level. This is the Glasgow CTR shown in red outline. Also, in this figure can be seen Cumbernauld Airport approximately 15nm to the east of Glasgow airport which sits outside CAS where the base of the CTA is 3000ft. This is indicated with a yellow dot.

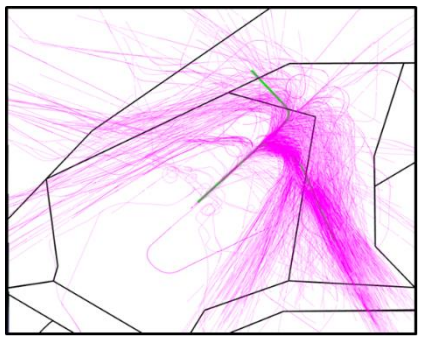
It is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size.

Whilst the existing baseline scenario will not result in the requirement for more airspace, this option offers no opportunity to simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to achieve. The most prominent feature of Westerly arrivals in relation to CAS is with regards to the Edinburgh-Glasgow Gap and the associated Gliding Corridor with a base of 3000ft. The ability to raise parts of CTA-1 would offer significant benefit to Cumbernauld and the gliding community.

General Aviation / Commercial airlines	Economic impact from increased effective capacity	There will be no increase to effective capacity by doing nothing with Westerly arrivals (in isolation to the rest of the system).
	Fuel burn	As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly arrivals. When arriving at Glasgow, aircraft are vectored by ATC before joining the final approach. This means that track length is varied from flight to flight. For the purposes of comparing our westerly arrival options against the baseline scenario, we have used the NTK vectoring baseline data and information from ATC to estimate an arrivals centreline; we have then used the track mileage from this centreline as an initial indication of 'do nothing' track length. We have then applied a weighting based on arrival direction to provide an overall total track mileage for the system. At the Stage 3 full options appraisal track length and fuel burn will be modelled in further detail. *Table 89 Westerly Arrival Track Mileage* **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)** Baseline (centreline) / 58.2 / 2380.6 Aircraft arriving at Glasgow are sometimes prevented from continuously descending due to the tactical coordination with other traffic in the airspace. We will qualitatively estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option against current day. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today and will also consider the opportunity for continuous descent from 7000ft.
Commercial airlines	Training costs	As this option is already in operation, there are no training costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
	Other costs	As this option is already in operation, there are no other costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
Airport / Air navigation service provider	Infrastructure costs	As this option is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
	Operational costs	As this option is already in operation, there are no operational costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline. For some approaches, Glasgow Airport is dependent on conventional ground based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is considered an interim measure and failure to implement a long term solution may result in additional operational costs.
	Deployment costs	As this option is already in operation, there are no deployment costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
All	Safety	At current traffic levels, there are no safety concerns with the current arrangements at Glasgow. Future traffic growth could however result in increased complexity and workload for Air Traffic Controllers and pilots, which may lead to traffic levels within the Scottish TMA being capped, on increased aircraft holding in order to maintain safety.
All	Interdependencies	As detailed in our Stage 2A documentation on the CAA airspace change portal there are currently interdependencies

	, conflicts and tradeoffs	between Westerly arrivals to Glasgow and Easterly arrivals to Edinburgh. Doing nothing will not reduce those dependencies however in all options, we expect some dependencies and airspace buffer arrangement will continue to be required based on the geography of the airports and runways.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* Whilst vectoring of arrivals is a perfectly reasonable options in a future operating environment, doing nothing with Westerly departures will not align with the AMS as it would constrain other options. Limiting our options to one which sees no change to vectoring practices could also reduce the ability to change CAS boundaries and improve CDA performance.

4.18. Runway 23 Arrival Option C

Runway 23 Westerly Arrivals Option C	
	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 8nm. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 12nm from the runway, and be used by around 13% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 8nm, and would be used by around 69% of overall arrivals.

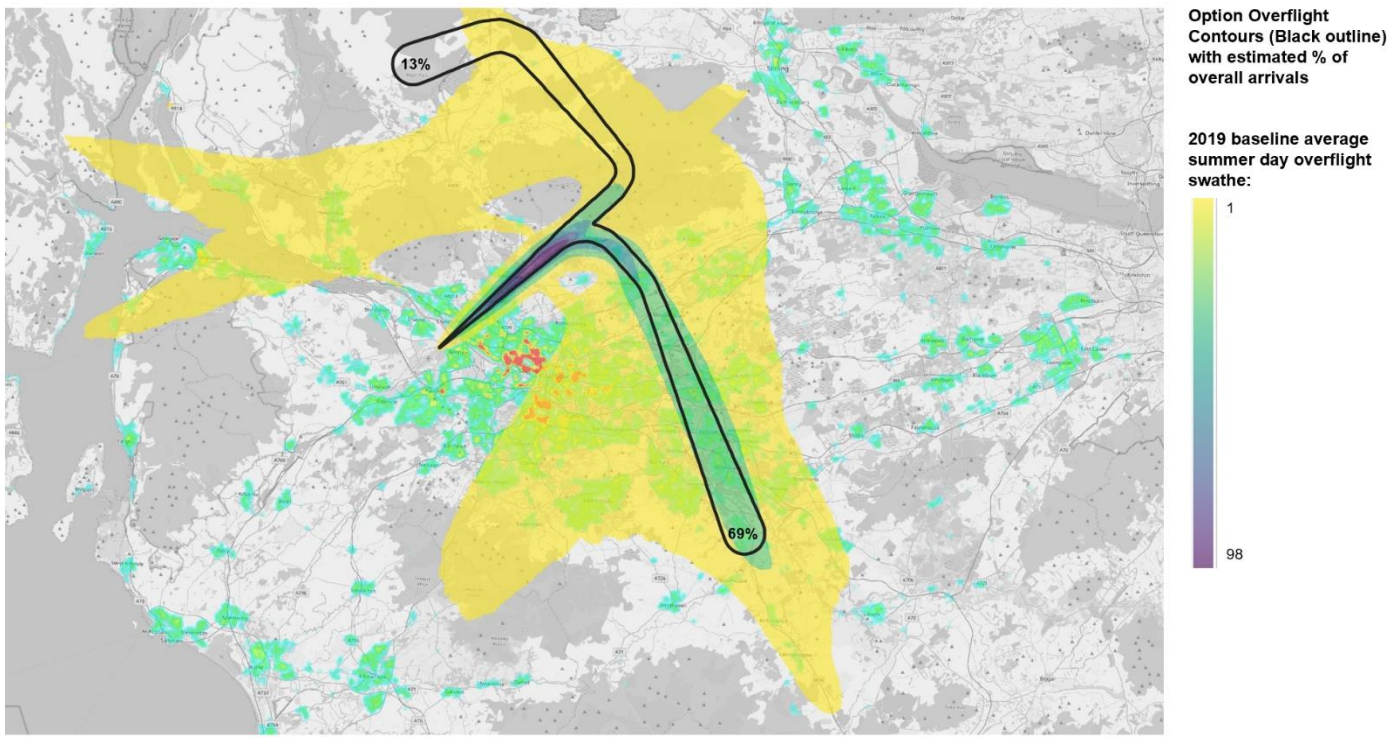


Figure 28 Westerly Arrivals Option C Overflight and 2019 baseline NTK data

Route from the North
This route would see aircraft continuously descending from 7000ft over areas of relatively low population. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map suggests these areas are not heavily populated and by relocating the arrival route to the north, populated areas such as Dryman and Balfron can be avoided. On the base-leg, (as aircraft turn to the south-east), the route continues to avoid overflight of populated areas with the exception of Buchlyvie before turning to join final approach. The NTK data shown in figure 28 suggests that this turn takes place in around the same areas as some concentration occurs today, although this could be more concentrated in future. Aircraft then join the final approach and overfly the same areas as they do today.

Route from the South
The route from the south would see aircraft start a continuous descent at 7000ft from around the Larkhall area. When reviewed against the NTK data in figure 28, the route then tracks north-west following the same areas where there is concentration in arrivals today. This occurs over the populated areas of Motherwell, Bellshill, Cuparhead, Gartcosh, and East Kirkintillock amongst others. Aircraft then turn to join the final approach at 8nm from the threshold, over Milton on Campsie and Lennoxtown. Reviewed against the NTK data shown in figure 28, this is area where concentration of arrivals traffic is also seen today. Aircraft then join the final approach and overfly the same areas as they do today.

Overflight Data
The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is a small decrease in the area of the contours and the number of population and noise sensitive sites overflown.

Note that a Centreline for the baseline does not actually exist in reality, we created one based on the areas most frequently overflown by RWY 23 arrivals in today's airspace arrangement. Compared to the other options, Option C overflies the highest number of population compared between 0-4000ft and 0-7000ft.

Table 90 Westerly arrivals option C overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	1659.74	1250066
RWY23 Baseline (Centreline)	184.13	139113
RWY23 Option C	180.49	129769

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, and places of worship overflown compared to the centreline baseline data. Hospitals

remained the same. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}

Technical Appendix A includes 60dB which compare Option C against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 85 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 91 60dB L_{AMax} Data - Rwy23 Arrival Option C

	60dB L_{AMax}	
System	**Area (km²)**	**Population**
RWY23 Baseline (Centreline – Optioneering tool)	57.86	68289
RWY 23 Dep Option C	55.49	63544

L_{Aeq}

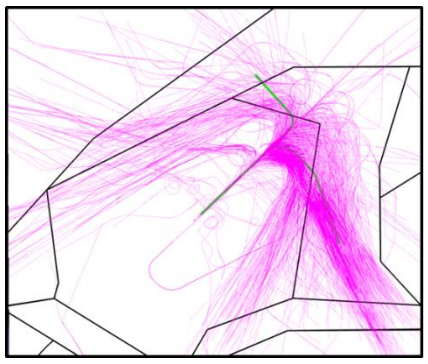
The north-east component of the existing L_{Aeq} contours extends to around 8-8.5nm from the landing threshold. The northerly arrival component of option C joins the final approach at 12nm and therefore we do not expect this to impact the shape/size of the L_{Aeq} contour. The southerly arrival component joins at 8nm and therefore there is the possibility that this may influence the shape of the outer most 51dB contour although we would expect this to be relatively minor with the contour shape adjusting slightly south-east to reflect the turn to join final approach.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option C will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	Table 92 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline. *Table 92 Westerly arrival option C – Tranquil areas overflown 0-7000ft* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 23 Baseline - Vectoring (NTK data)**: 1 / 17.51 / 5 / 79.21 / 8 / 2.29 **RWY 23 Baseline (Centreline – Optioneering tool)**: 1 / 23.63 / 1 / 34.52 / 0 / 0 **Runway 23 Option C**: 0 / 0 / 1 / 26.29 / 0 / 0 The data shows that there is a reduction in NSAs, National Parks and DQAs overflown. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.
	Biodiversity	The routes that form part of Arrival Option C join the final approach at 8nm and 12nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity.
General Aviation	Access	Use of a pure PBN solution for arrivals, with a final approach joining point in the same vicinity as today could be expected to significantly reduce the volume of CAS required and would enable a raise to the base of CTA-1
General Aviation / Commercial airlines	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.
	Fuel burn	We estimate that Option C, when compared to baseline nominal centrelines, will result in a small overall increase in track mileage. **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)** Baseline (centreline): 58.2 / 2380.6 C: 62.8 / 2513.2 This increase in driven largely by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route is almost identical to the baseline centreline which will account for around 69% of westerly arrivals. All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft). As part of Stage 3, should this option progress, we will look to refine this in further detail and as part of this we will review whether we can balance noise and CO2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance

		CO_2 and noise.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[42].
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding. The use of a PBN arrival to RWY 23 may deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. This option would require a re-design of the ILS to move the FAF closer or move the PBN path slightly further east.
All	Interdependencies, conflicts and tradeoffs	As this PBN arrival remains clear of the existing Glasgow-Edinburgh buffer, so long as future Edinbugh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this PBN arrival option.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects of a pure PBN arrival solution at Glasgow include increased delay, reduced economic benefit, increased CO_2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

[42] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.19. Runway 23 Arrival Option D

Runway 23 Westerly Arrivals Option D		
		PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 9nm. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 12nm from the runway, and be used by around 13% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 9nm, and would be used by 69% of overall arrivals.

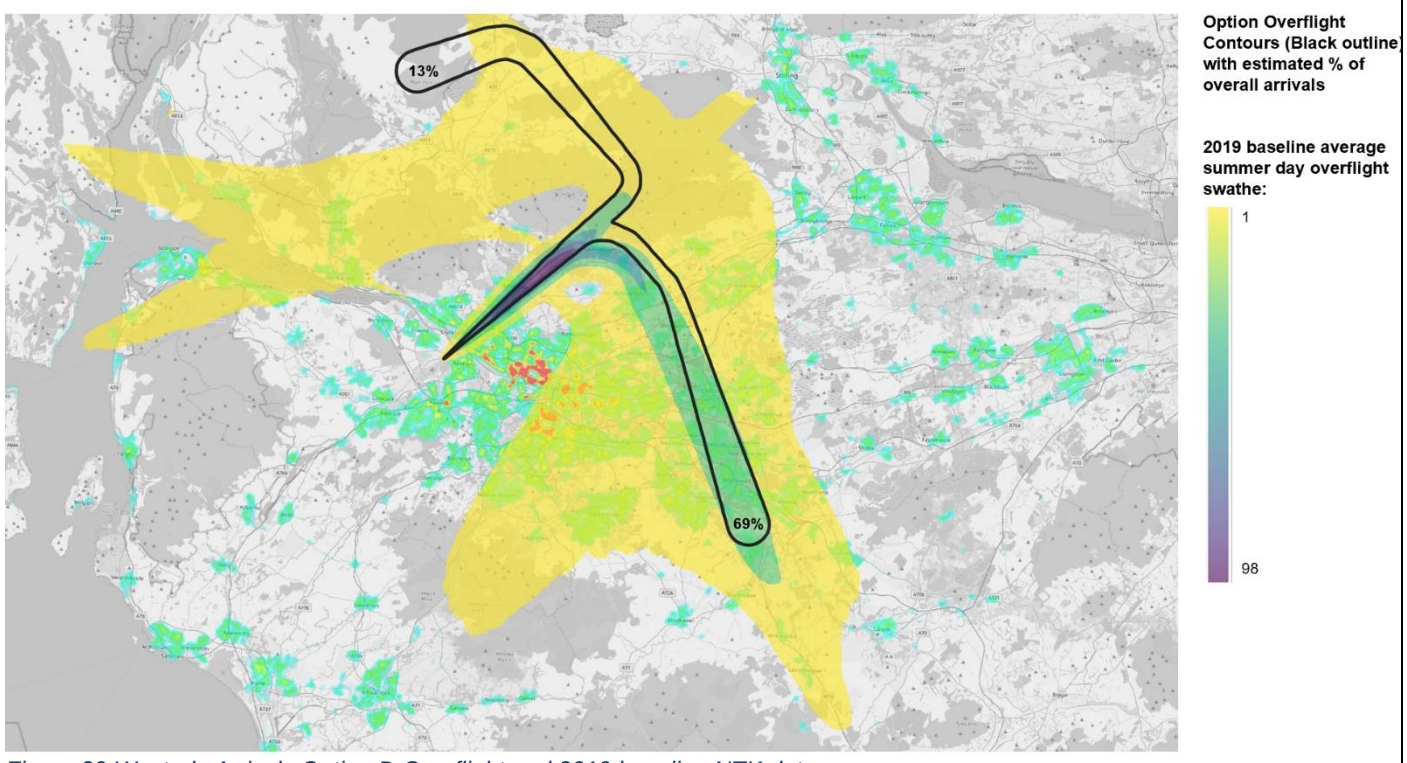


Figure 29 Westerly Arrivals Option D Overflight and 2019 baseline NTK data

Route from the North
This route would see aircraft continuously descending from 7000ft over areas of relatively low population. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map suggests these areas are not heavily populated and by relocating the arrival route to the north, populated areas such as Dryman and Balfron can be avoided. On the base-leg, (as aircraft turn to the south-east), the route continues to avoid overflight of populated areas with the exception of Buchlyvie before turning to join final approach. The NTK data shown in figure 29 suggests that this turn takes place in around the same areas as some concentration occurs today, although this could be more concentrated in future. Aircraft then join the final approach and overfly the same areas as they do today.

Route from the South
The route from the south would see aircraft start a continuous descent at 7000ft from around the northern part of the Larkhall area. When reviewed against the NTK data in figure 29, the route then tracks north/north-west tracking slightly north-east of where the heat map shows the main concentration occurring today. This part of the route flies over the populated areas of Motherwell, Bellshill, Cuparhead, Coatbridge, Croftfoot, and east of Moodiesburn. Aircraft then turn to join final approach at around 9nm from the threshold. The NTK data in figure 29 shows that this happens north-east of today's arrival concentration however this avoids the densely populated area of Kirkintilloch and Milton on Campsie and largely routes over areas with relatively low population density. Aircraft then join the final approach and overfly the same areas as they do today.

Overflight Data
The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 93 Westerly arrivals option D overflight data

System	Area (km^2)	Population
RWY 23 Baseline (Vectoring)	1659.74	1250066
RWY23 Baseline (Centreline)	184.13	139113
RWY23 Option D	178.24	118103

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, and places of worship overflown compared to the centreline baseline data. There is an increase in hospitals. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths

<table>
<tr><td></td><td></td><td>will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB which compare Option D against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 94 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 94 60dB L_{AMax} Data - Rwy23 Arrival Option D

<table>
<tr><th></th><th colspan="2">60dB L_{AMax}</th></tr>
<tr><th>System</th><th>Area (km^2)</th><th>Population</th></tr>
<tr><td>RWY23 Baseline (Centreline – Optioneering tool)</td><td>57.86</td><td>68289</td></tr>
<tr><td>RWY 23 Dep Option D</td><td>54.55</td><td>54040</td></tr>
</table>

L_{Aeq}
The north-east component of the existing L_{Aeq} contours extends to around 8-8.5nm from the landing threshold. Arrival Option D sees a turn onto final approach at 9nm and 12nm and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours.</td></tr>
<tr><td></td><td>Air Quality</td><td>This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that Option D will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience</td><td>Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation.

The introduction of PBN approaches will improve Glasgow’s resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.</td></tr>
<tr><td>Tranquillity</td><td>Table 95 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline:

Table 95 Westerly arrival Option D – Tranquil areas overflown 0-7000ft

<table>
<tr><th>System</th><th>NSA count</th><th>NSA area</th><th>National Parks count</th><th>National Parks area</th><th>DQA count</th><th>DQA area</th></tr>
<tr><td>RWY 23 Baseline - Vectoring (NTK data)</td><td>1</td><td>17.51</td><td>5</td><td>79.21</td><td>8</td><td>2.29</td></tr>
<tr><td>RWY 23 Baseline (Centreline – Optioneering tool)</td><td>1</td><td>23.63</td><td>1</td><td>34.52</td><td>0</td><td>0</td></tr>
<tr><td>Runway 23 Option D</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

The data shows that there is a reduction in NSAs, National Parks and DQAs overflown; all are avoided. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.</td></tr>
<tr><td>Biodiversity</td><td>The routes that form part of Arrival Option D join the final approach at 9nm and 12nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Use of a pure PBN solution for arrivals, with a final approach joining point in the same vicinity as today could be expected to significantly reduce the volume of CAS required and would enable a raise to the base of CTA-1</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.</td></tr>
<tr><td>Fuel burn</td><td>We estimate that Option D, when compared to baseline nominal centrelines, will result in a small overall increase in track mileage.

<table>
<tr><th colspan="3">Track Mileage</th></tr>
<tr><th>Option</th><th>Track miles (nm)</th><th>Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)</th></tr>
<tr><td>Baseline (centreline)</td><td>58.2</td><td>2380.6</td></tr>
<tr><td>D</td><td>63.9</td><td>2589.1</td></tr>
</table>

This increase in driven largely by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a slightly longer path as it joins final approach at 9nm which further than most arrivals typically join today.

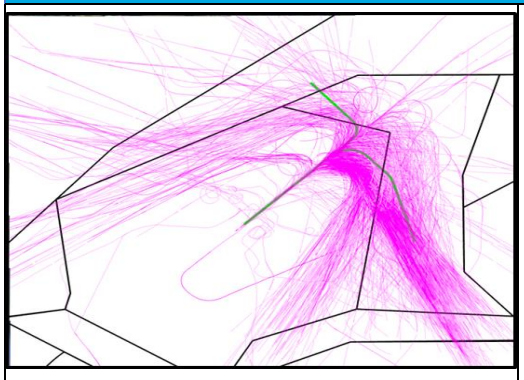
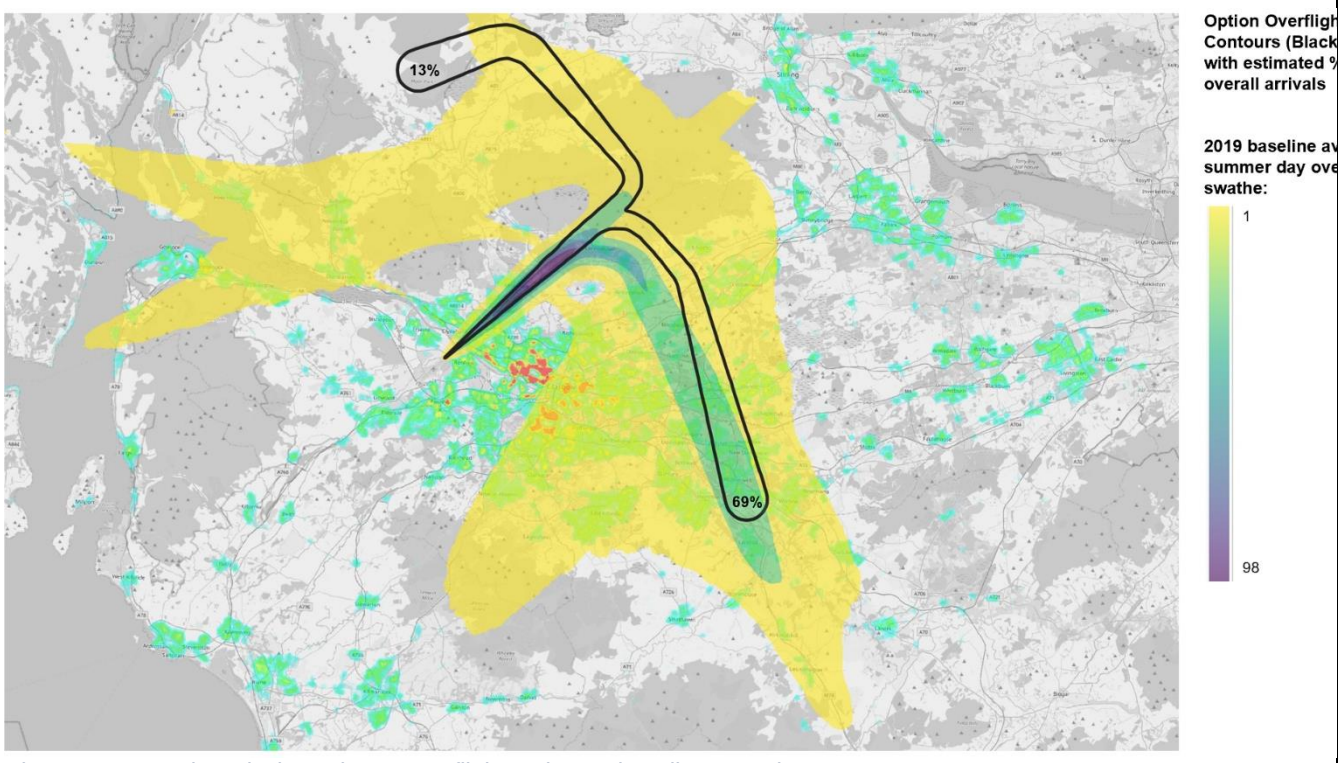
All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft).

As part of Stage 3, should this option progress, we will look to refine this option in further detail and as part of this we will review whether we can balance noise and CO_2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance CO_2 and noise.</td></tr>
<tr><td>Commercial airlines</td><td>Training costs</td><td>Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require</td></tr>
</table>

		any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[43];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding. The use of a PBN arrival to RWY 23 may deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. This option would require a re-design of the ILS to move the FAF closer or move the PBN path slightly further east.
All	Interdependencies, conflicts and tradeoffs	As this PBN arrival remains clear of the existing Glasgow-Edinburgh buffer, so long as future Edinburgh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this PBN arrival option.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

[43] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.20. Runway 23 Arrival Option E

Runway 23 Westerly Arrivals Option E		
		PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 10nm. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 12nm from the runway, and be used by around 13% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 10nm, and would be used by 69% of overall arrivals.  *Figure 30 Westerly Arrivals Option E Overflight and 2019 baseline NTK data* **Route from the North** This route would see aircraft continuously descending from 7000ft over areas of relatively low population. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map suggests these areas are not heavily populated and by relocating the arrival route to the north, populated areas such as Dryman and Balfron can be avoided. On the base-leg, (as aircraft turn to the south-east), the route continues to avoid overflight of populated areas with the exception of Buchlyvie before turning to join final approach. The NTK data shown in figure 30 suggests that this turn takes place in around the same areas as some concentration occurs today, although this could be more concentrated in future. Aircraft then join the final approach and overfly the same areas as they do today. **Route from the South** The route from the south would see aircraft start a continuous descent from 7000ft, from around south of Motherwell. When reviewed against the NTK data in figure 30, the route then tracks north/north-west flying north-east of where the heat map shows the main concentration of arrivals occurring today. This part of the route flies over the populated areas of Motherwell, Bellshill, New Stevenson, Coatbridge, Glenboig, and Croftfoot. Aircraft then turn to join final approach at around 10nm from the threshold. The NTK data in figure 30 shows that this happens north-east of today's arrival concentration however this avoids the densely populated area of Kirkintilloch, Milton on Campsie and Moodiesburn nd largely routes over areas with relatively low population density with the exception of the small areas of Twechar and southern parts of Queenzieburn. Aircraft then join the final approach and overfly the same areas as they do today. **Overflight Data** The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options. Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown. *Table 96 Westerly arrivals option E overflight data* **System** / **Area (km²)** / **Population** **RWY 23 Baseline (Vectoring)** / 1659.74 / 1250066 **RWY23 Baseline (Centreline)** / 184.13 / 139113 **RWY23 Option E** / 175.89 / 115858 Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in

<table>
<tr><td></td><td></td><td>the number of schools, care homes, and places of worship overflown compared to the centreline baseline data. There is an increase in hospitals. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB which compare Option E against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 97 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 97 60dB L_{AMax} Data - Rwy23 Arrival Option E
<table><tr><th></th><th colspan="2">60dB L_{AMax}</th></tr><tr><th>System</th><th>Area (km²)</th><th>Population</th></tr><tr><td>RWY23 Baseline (Centreline – Optioneering tool)</td><td>57.86</td><td>68289</td></tr><tr><td>RWY 23 Dep Option E</td><td>53.19</td><td>53821</td></tr></table>
L_{Aeq}
The north-east component of the existing L_{Aeq} contours extends to around 8-8.5nm from the landing threshold. Arrival Option E sees a turn onto final approach at 9nm and 12nm and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours.</td></tr>
<tr><td></td><td>Air Quality</td><td>This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that Option E will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience</td><td>Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation.

The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.</td></tr>
<tr><td>Tranquillity</td><td>Table 98 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline:

Table 98 Westerly arrival Option E – Tranquil areas overflown 0-7000ft
<table><tr><th>System</th><th>NSA count</th><th>NSA area</th><th>National Parks count</th><th>National Parks area</th><th>DQA count</th><th>DQA area</th></tr><tr><td>RWY 23 Baseline - Vectoring (NTK data)</td><td>1</td><td>17.51</td><td>5</td><td>79.21</td><td>8</td><td>2.29</td></tr><tr><td>RWY 23 Baseline (Centreline – Optioneering tool)</td><td>1</td><td>23.63</td><td>1</td><td>34.52</td><td>0</td><td>0</td></tr><tr><td>Runway 23 Option E</td><td>0</td><td>0</td><td>1</td><td>26.29</td><td>0</td><td>0</td></tr></table>
The data shows that there is a reduction in the overflight of National Parks and there is also reduction in NSAs and DQAs which are now avoided.</td></tr>
<tr><td>Biodiversity</td><td>The routes that form part of Arrival Option E join the final approach at 9nm and 12nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>Use of a pure PBN solution for arrivals, with a final approach joining point in the same vicinity as today could be expected to significantly reduce the volume of CAS required and would enable a raise to the base of CTA-1</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.</td></tr>
<tr><td>Fuel burn</td><td>We estimate that Option E, when compared to baseline nominal centrelines, will result in an overall increase in track mileage.

<table><tr><th colspan="3">Track Mileage</th></tr><tr><th>Option</th><th>Track miles (nm)</th><th>Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)</th></tr><tr><td>Baseline (centreline)</td><td>58.2</td><td>2380.6</td></tr><tr><td>E</td><td>72.8</td><td>3203.2</td></tr></table>
This increase in driven by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path as it joins final approach at 10nm which further than most arrivals typically join today.

All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft).

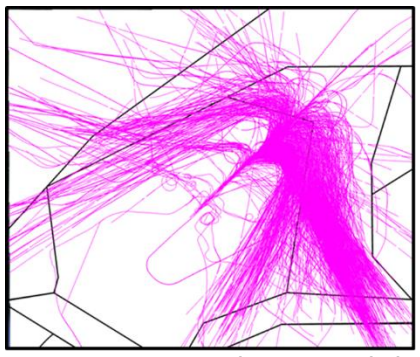
As part of Stage 3, should this option progress, we will look to refine this option in further detail and as part of this we will review whether we can balance noise and CO_2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance CO_2 and noise.</td></tr>
</table>

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[44].
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding. The use of a PBN arrival to RWY 23 may deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. This option would require a re-design of the ILS to move the FAF closer or move the PBN path slightly further east.
All	Interdependencies, conflicts and tradeoffs	As this PBN arrival remains clear of the existing Glasgow-Edinburgh buffer, so long as future Edinburgh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this PBN arrival option.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

[44] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.21. Runway 23 Arrival Vectors only

Runway 23 Westerly Arrivals Vectors only



Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known alongside more information about departures and CAS arrangements.

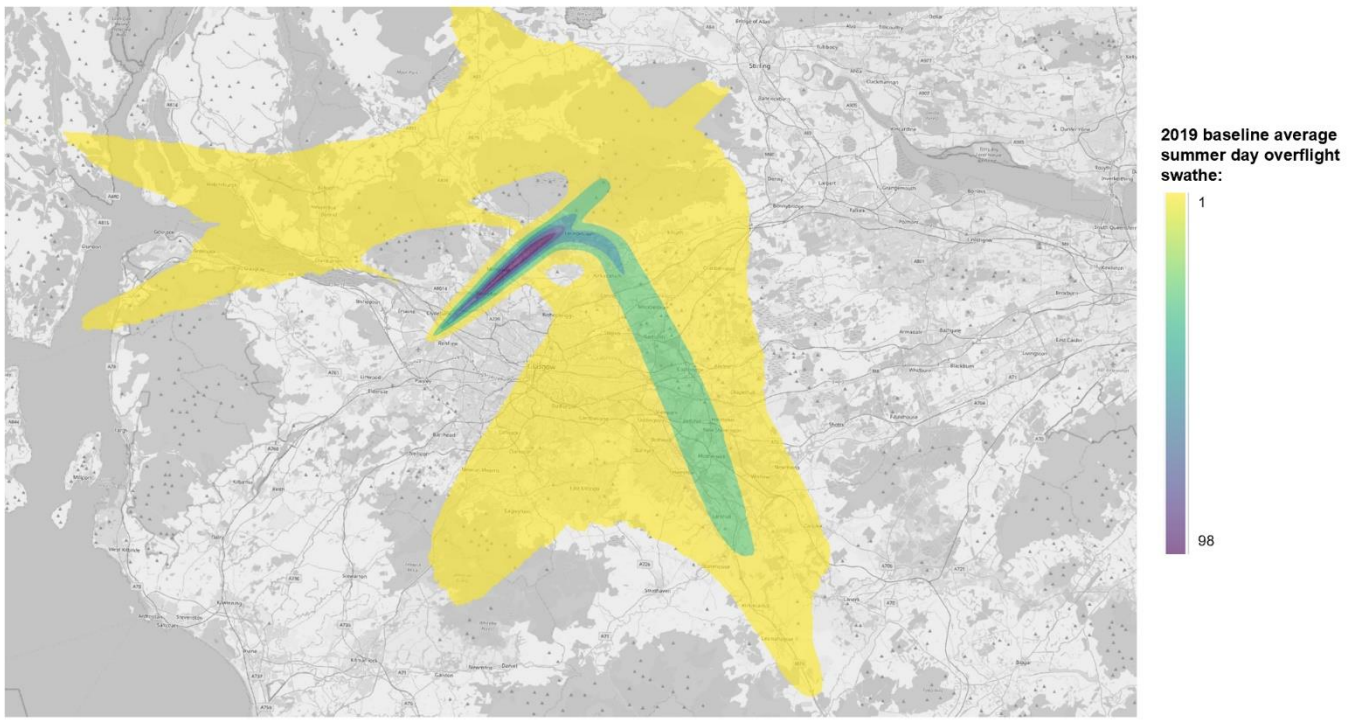
Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. The former, because it is difficult for ATC to deliver accurate final approach spacing to varying runway spacing requirements using PBN only and they can often require more Controlled Airspace than is required by vectoring. The latter because they can often result in longer final approach joining points than vectoring caters for and, in the case of Glasgow would see c.85% of all Westerly arrivals on a single path. Communities can sometimes favour the 'spreading' of arrivals to mitigate against potential adverse effects of concentration as seen in Design Principle 6.

This option would see all arrivals continuing to be vectored with no PBN paths available for routine use.

Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet, so there is not an illustration for this option.

For the Design Principle Evaluation and this Initial Options Appraisal, we will assume similar impacts as the baseline however for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. In this vectoring option, aircraft arriving at Glasgow would continue to be tactically controlled (vectored) by ATC before joining final approach. Today aircraft typically join the runway 23 final approach between 7nm and 13nm before landing although when undertaking an ILS approach they can be as close as 6nm. This option would continue to see aircraft joining the final approach at these distances, although there is a small possibility that this could be influenced by changes to the airspace above 7000ft and departures – this will be explored in further detail at Stage 3 should this option progress. Unlike PBN routes, tactical controlling of aircraft typically leads to higher levels of dispersion of flights and therefore sharing of the noise. The NTK data shown in figure 31, demonstrates the large swathe of overflight created by today's vectoring. It shows that there are wide areas that are overflown between 1-10 times per day on average including Weymess Bay, Fort Glasgow, Inverkip, Helensburgh, Cardross, Boglestone, Birdgend, Greenock, Dumbarton, Bonhill, Balloch, Balfron, Cumbernauld, Kilsyth, Airdrie, Wishaw, Carluke, Udston, Blantyre, East Kilbride, Newton Mearns, Clarkstone, and eastern parts of the city centre of Glasgow. There is some concentration which occurs from a south-easterly direction, before aircraft join the final approach which overflies Larkhall, Motherwell, Belishill, Coatbridge, Gartcosh, Moddlesburn, Muirhead, eastern parts of Kirkintilloch, Milton of Campsie, and Lennoxtown.  *Figure 31 Runway 23 Departure Vectoring Swathe 2019* The vectoring swathe as seen in Figure 31 is influenced by how aircraft arrive from the airspace above 7000ft, how departures operate, and by the structure of the surrounding CAS. This option will therefore evolve as further details are known about where aircraft will enter at 7000ft, where and how the departures might be operated, and the shape and size of the CAS volume. For the purposes of this IOA, we will use the baseline data as the closest representative data for this option. The technical appendix includes NTK and centreline data for the baseline. It's important to note that the NTK data is not modelled in the same way as the other data, however it does provide a preliminary means of comparison between this baseline and the airspace change options. Table 99 below includes data based on the NTK heat map as shown in figure 33 above: *Table 99 Westerly arrivals baseline overflight data 0-7000ft* **System** | **Area (km^2)** | **Population** **RWY 23 Arrivals Baseline - Vectoring (NTK data)** | 1659.74 | 1250066 In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals and places of worship:

System	Schools count	Hospitals count	Care homes count	Places of worship count
RWY 23 Baseline (Vectoring)	399	23	206	695

Although the data shows a higher number of noise sensitive buildings are overflown compared to most of the PBN options, the frequency of overflight will be lower owing to the dispersion created by vectoring. This is something we will explore in further detail at Stage 3.

60dB and 65dB L_{AMax}

Technical Appendix A includes 60dB L_{AMax} contours and data for the baseline, to aid comparison between the baseline and the options. Similar to the overflight data above, the population within the 60dB LAMax contours is highest within the baseline, however this data does not currently take into account the full vectored swathe, as it is modelled from centreline data. It also does not articulate the frequency of overflight which would be lower for some areas compared to equivalent PBN routes. We will explore this in further detail a Stage 3 should the option progress. The 65dB LAMax contours extend partially along the extended runway centreline and are expected to remain the same between all options.

Table 100 Westerly arrivals baseline L_{AMax} data

	60dB L_{AMax}	
System	**Area (km^2)**	**Population**
RWY23 Arrivals Baseline (Centreline – Optioneering tool)	57.86	68289

L_{Aeq}

The north-east component of the existing L_{Aeq} contours extends to around 8-8.5nm from the landing threshold. This option is expected to see aircraft continue to join final approach as they do today and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours. At Stage 3, should it progress, this option will be refined further and the L_{Aeq} contours will be fully quantified.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that vectors only will have a similar track mileage and fuel burn compared to the baseline. We therefore expect neutral benefit/impact to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today's airspace through vectoring could be expected to be delivered through vectoring in the future subject to some potential changes to the vectoring patterns as a result of the changes to surrounding structures. Vectoring only would not improve Glasgow Airport's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	Table 101 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the impacts to tranquillity.
	Biodiversity	This option is unlikely to change where aircraft join the final approach compared to today. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	Option is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today's airspace through vectoring could be expected to be delivered through vectoring in the future subject to some potential changes to the vectoring patterns as a result of the changes to surrounding structures.
	Fuel burn	Table 102 provides baseline centreline data for westerly arrivals. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the benefits and impacts to fuel burn.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables

Table 101 Westerly vectors only – Tranquil areas overflown 0-7000ft

System	NSA count	NSA area	National Parks count	National Parks area	DQA count	DQA area
RWY 23 Baseline (Vectoring)	1	17.51	5	79.21	8	2.29
RWY23 Baseline (Centreline)	1	23.63	1	34.52	0	0

Table 102 Westerly Arrival Track Mileage

Track Mileage		
Option	**Track miles (nm)**	**Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)**
Baseline (centreline)	58.2	2380.6

		VOR rationalisation[45];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	No safety concerns have been identified at this stage.
All	Interdependencies, conflicts and tradeoffs	As detailed in our Stage 2A documentation on the CAA airspace change portal there are currently interdependencies between Westerly arrivals to Glasgow and Easterly arrivals to Edinburgh. We expect some dependencies and airspace buffer arrangement will continue to be required based on the geography of the airports and runways. Any changes to vectoring practices would only be as a result to changes to surrounding airspace and route structures enabled by other options.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* Vectoring of arrivals in the future would not deliver a PBN arrival solution, nor reduce the numbers of people overflown / affected by noise from Glasgow's arrivals. However it is unlikely to change the adverse effects which would be measured within the LOAEL which would not extend out to the final approach joining point. This option would meet future demand however it may not be the best future-proofed option should technological enhancements become available in the future to better rely on a pure PBN arrival solution for Glasgow.

[45] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.22. Runway 23 Arrival Vectors and PBN hybrid

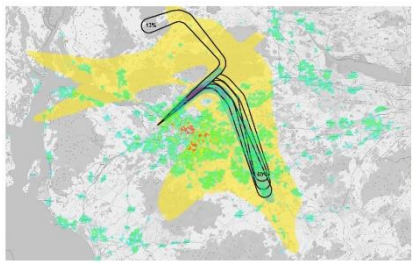
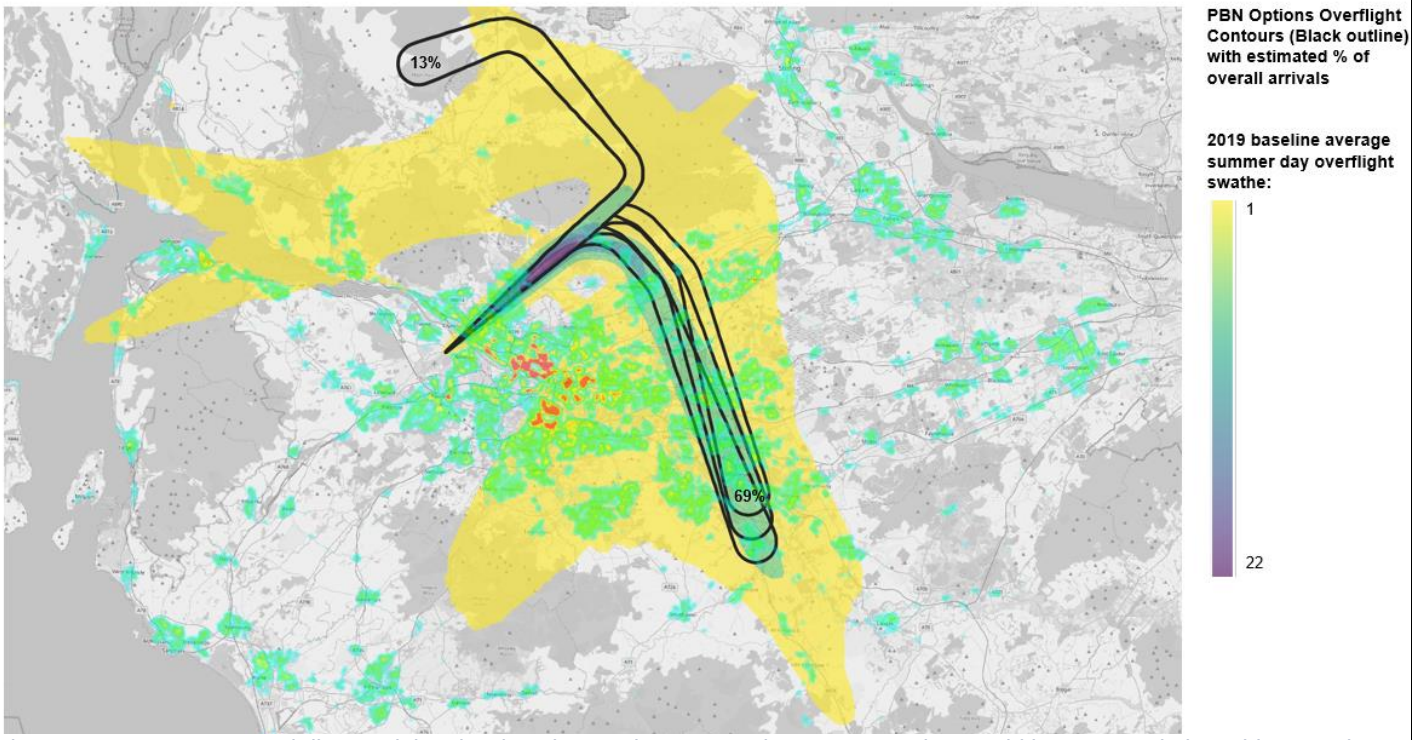
Runway 23 Westerly Arrivals Vectors and PBN hybrid		
 Note: Image shows existing vectoring swathe alongside the overflight contours for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there is further information around vectoring arrangements.		Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. There are however the benefits of PBN for arrivals. This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival(s) would likely be the 'best performing' of Options C-E above which are then optimised in Stage 3 to balance CO_2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival component could be any of the PBN options already assessed; the option taken forward will depend on the shortlisting as part of this IOA and the outcome of the Stage 3 Full Options Appraisal. Below provide links to the four assessments for the PBN Options: Initial Options Appraisal – Runway 23 Arrival Option C Initial Options Appraisal – Runway 23 Arrival Option D Initial Options Appraisal – Runway 23 Arrival Option E The PBN option assessments linked above have shown that there is the potential for PBN routes to reduce the number of people and noise sensitive sites overflown, however due to the concentration created by PBN routes, areas overflown would likely be at a higher frequency than today. By combining with vectoring, some of this concentration from PBN routes could be mitigated, as some aircraft would continue to be tactically controlled and would therefore see the dispersion that occurs today. This dispersion has been described in the vectoring option linked below: Initial Options Appraisal – Runway 23 Arrival Vectors only As described in the Vectoring assessment, the shape/size of the vectoring swathe will be dependent on a number of factors which are yet to be determined including the airspace above 7000ft, the departure options, and the CAS arrangements. We will explore this further at Stage 3. For this IOA, we have included an image which shows all of the potential PBN options alongside the vectoring swathe. In Stage 3 we will refine this in further detail as described above and we will also quantify when we would expect to see the PBN and vectoring used.  *Figure 32 Runway 23 PBN (All potential options) and Vectoring. Note only one PBN option would be proposed alongside vectoring.* **Overflight Data** The individual sections of the PBN Options linked above provide more detailed information on the areas overflown and overflight data. Table 103 below shows the comparison between the baseline NTK vectoring data and the different options. Although the NTK vectoring data is not modelled in the same way as the centreline data, it does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 103 Westerly arrivals Vectors and PBN hybrid overflight data

System	Area	Population	Schools count	Hospitals count	Carehomes count	Places of worship count
RWY23_BASE (Vectoring NTK data)	1659.74	1250066	399	23	206	695
RWY23_BASE (Centreline)	184.13	139113	66	0	22	83
RWY23_C	180.49	129769	58	0	20	82
RWY23_D	178.24	118103	51	1	18	79
RWY23_E	175.89	115858	50	1	15	80

Overall, the data suggests that the PBN routes would overfly fewer people and noise sensitive sites compared to the vectoring baseline however these options will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process.

This suggests that the combination of utilising PBN routes alongside vectoring may have some noise benefits; vectoring would mitigate some of the impacts of concentration for those communities living under the PBN routes, and the PBN routes would mean that when traffic allowed, a far lower number of people would be overflown compared to today. This will be explored in further detail should this option progress to Stage 3.

60dB and 65dB L_{AMax}

Technical Appendix A includes a table which shows the 60dB L_{AMax} data for each option against the centreline baseline. At this stage we do not have L_{AMax} data for the vectoring or overall N60 metrics - we will quantify these at Stage 3. The data shows that the PBN arrivals routes result in a reduction in area and population within the 60dB L_{AMax} contour although at this stage, this data does not take into account the frequency of overflight which would likely increase. Similar to the overflight assessment above, by offering a hybrid PBN/vectoring option, there would be opportunities to mitigate the impacts of PBN with some of the benefits of vectoring which may result in favourable L_{AMax} and N60 data; this will be explored further in Stage 3 when this option is refined (if this option is progressed).

L_{Aeq}

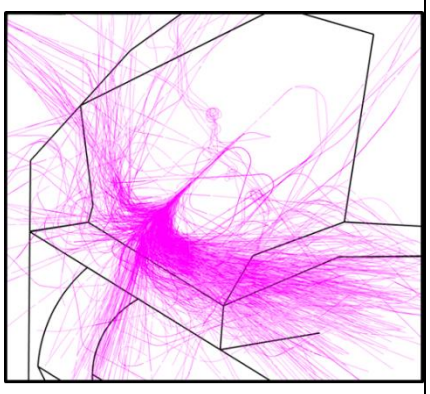
The north-east component of the existing L_{Aeq} contours extends to around 8-8.5nm from the landing threshold. The IOA of the PBN Options and the Vectors only option have suggested that there will be no impact to the shape and size of the LAeq contour and therefore this hybrid option is also unlikely to significantly impact the shape or size.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated this option will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Option is expected to enhance Glasgow's operational performance in the future. This is because ATC can use the PBN arrivals when traffic levels are low-medium and this will also facilitate the use of combined Tower and Approach services (Radar In Tower) offering additional resilience to ATC resource. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that there are benefits to areas of tranquillity for all runway 23 PBN options. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this component of a hybrid option would offer neutral benefits/impacts to areas of tranquillity. Overall, at this stage, the IOA suggests there may therefore be some benefits to the overall hybrid option owing to the use of the PBN routes. We will explore this tranquillity assessment further in Stage 3 should this option progress.
	Biodiversity	This option is unlikely to change where aircraft join the final approach compared to today. The PBN options also all join the final approach from at 10 or 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	Option is likely to contribute to a reduction in bottlenecks outside CAS because this option can be contained within existing CAS whilst offering some opportunity to reduce the total volume of CAS.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today's airspace through vectoring could be expected to be delivered through vectoring in the future and the feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders.
	Fuel burn	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that there may be increases in track mileage and fuel burn as a result of the PBN options. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this component of a hybrid option would offer neutral benefits/impacts to fuel burn. Overall, at this stage, the IOA suggests there may therefore be some impacts to fuel burn as a result of a hybrid option although these will be less than operating purely PBN arrivals alone.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[46];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3

[46] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	Use of a PBN solution to RWY 23 may reduce the number of false GPWS alerts occasionally experienced by some arrivals. No other safety issues identified with this option.
All	Interdependencies, conflicts and tradeoffs	So long as future Edinburgh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this hybrid-PBN arrival option.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* This option is considered to best meet the requirements of the AMS for Westerly arrivals. It introduces a PBN arrival solution without being reliant on it which ensures that demand can be met but allowing improved CDA for arrivals using the PBN structure. The feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders. It would help to reduce the number of people overflown by Glasgow's arrivals without concentrating all arrivals permanently onto 2 routes.

4.23. Runway 05 Easterly Arrivals Baseline

Runway 05 Easterly Arrivals Baseline		
		The majority of aircraft are vectored to join final approach between approximately 8nm and 11nm from touchdown however they are allowed to join final approach as close as 2000ft/6nm when using the ILS. The tracks shown which join final approach inside 6nm are likely performing a visual approach. For more information on our do nothing scenario, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Aircraft arriving at Glasgow are tactically controlled (vectored) by ATC before joining final approach which is aligned with the extended runway centreline. Aircraft typically join the runway 05 final approach between 8nm and 11nm before landing although when undertaking an ILS approach they can be as close as 6nm. Aircraft may also undertake visual approaches closer than 6nm. The NTK data shown in figure 33, demonstrates the large swathe of overflight created by today's vectoring. It shows that there are wide areas to the south of the airport that are overflown between 1-10 times per day on average including Darvel, Newmilns, Galston, Kilmarnock, Kilmaurs, Dunlop, Kilwinning, Dalry, and Kilbirnie. There is some concentration which occurs from a south-easterly direction, before aircraft join the final approach which overflies Fenwick, Stewarton and Beith:

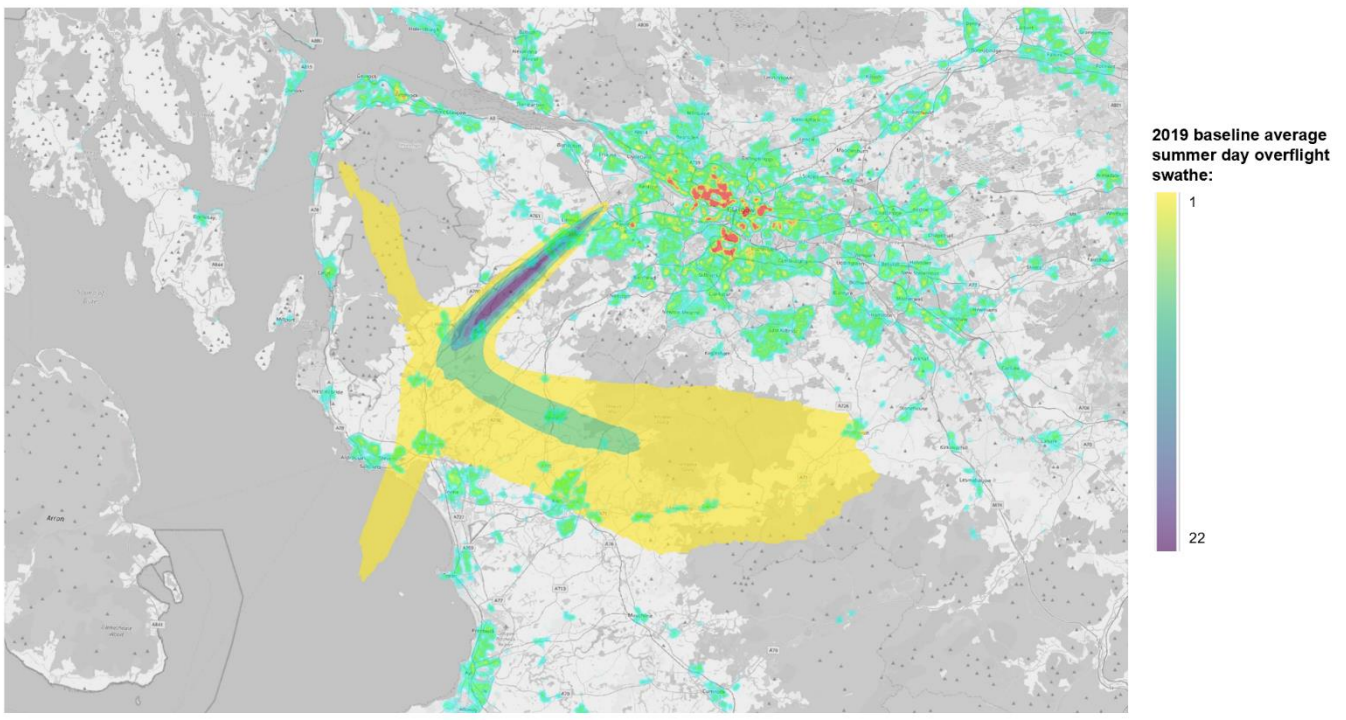


Figure 33 Runway 23 Departure Vectoring Swathe 2019

The technical appendix to this document includes a larger version of this map along with overflight data. It's important to note that this data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline and the airspace change options.

The technical appendix also includes a baseline arrivals centreline contour and associated data. Glasgow Airport does not have any published PBN arrivals and therefore this centreline has been generated by reviewing 92 day summer NTK data for 2019 and analysing the arrivals concentration which occurred across the vectored swathe. The output centreline has then been processed through the optioneering tool in order to output the data tables and contours.

Table 104 below includes data based on the NTK heat map as shown in figure 33 above, and data output from the optioneering tool for if aircraft were to follow one centreline arrival:

Table 104 Easterly arrivals baseline overflight data 0-7000ft

System	Area (km^2)	Population
RWY 05 Arrivals Baseline - Vectoring (NTK data)	691.95	140596
RWY 05 Arrivals Baseline (Centreline – optioneering tool)	182.63	51256

The data from these tables will be used to compare the easterly arrival options against the 'do nothing' baseline.

In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals and places of worship; the full data around these is shown in technical appendix a, and as part of this IOA we will provide a qualitative statement around this data.

60dB and 65dB L_{AMax}

Technical Appendix A includes 60dB L_{AMax} contours and data for the baseline, to aid comparison between the baseline and the options. Although we have shown a 65dB L_{AMax} contour in the appendix, this does not change between the options as the scope of the contour is only on the final approach. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal.

		Table 105 Westerly arrivals baseline L_{AMax} data **60dB L_{AMax}** **System** / **Area (km²)** / **Population** **RWY 05 Arrivals Baseline (Centreline – optioneering tool)** / 56.96 / 34798 The data from these tables will be used to compare the easterly arrivals options against the 'do nothing' baseline. **L_{Aeq}** Easterly arrivals make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025 as it is expected that contours will be a similar shape and size.
	Air Quality	Impacts to air quality are considered for changes below around 1000ft (200m). Aircraft flying above this are unlikely to have a significant impact on local ground air quality. Aircraft arriving at Glasgow fly a standard 3.0 degree approach and are aligned with the runway centreline at 1000ft. This is when they are very close to landing. It's therefore highly unlikely that any of our arrival's options will have any lateral changes below 1000ft however we will compare this baseline against each option.
Wider Society	Greenhouse gas impact	Emissions of greenhouse gases arise from the combustion of aviation fuel, and as the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly arrivals. The greenhouse gas assessment is therefore linked to the fuel burn assessment detailed in the section below. We will estimate the differences between the baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today. As CO_2 emissions are linked to the difference in aviation fuel burnt, this will allow us to qualitatively describe anticipated greenhouse gas impacts as a result of the option. Full data tables are shown in technical appendix a.
	Capacity / resilience	In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. Although vectoring of arrivals is expected to be able to meet the forecast demand, we anticipate changes to the vectoring practices may be required to facilitate the wider changes to CAS, the network and the departures. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme. For some approaches, Glasgow Airport is dependent on conventional ground based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. Although ILS approaches will remain available, the decommissioning of VORs results in reduced resilience for Glasgow Airport in the event on an ILS outage.
	Tranquillity	CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB. Table 106 shows data on the overflight of these areas, based on the NTK heatmap and if aircraft were to follow Glasgow's existing SID centrelines. The data from this table will be used to compare the westerly arrivals to the baseline. *Table 106 Westerly arrival baseline – Tranquillity overflown 0-7000ft* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Arrival Baseline - Vectoring (NTK data)** / 0 / 0 / 0 / 0 / 0 / 0 **RWY05 Arrival Baseline (Centreline – optioneering tool)** / 0 / 0 / 0 / 0 / 0 / 0
	Biodiversity	The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance 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." 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 500m (~1,640ft). Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft. Aircraft arriving at Glasgow fly a standard 3.0 degree approach and are aligned with the runway centreline at 1640ft; this typically occurs at around 5nm (9-10km) from landing. The NTK vectoring baseline shows some low frequency overflight of Castle Semple and Barr Lochs SSSI below 2000ft (Located north of the extended runway centerline). It's highly unlikely that any of our arrival's options will have any lateral changes between 5nm and landing however we will compare this baseline against each option.
General Aviation	Access	This baseline scenario would not offer any change from the existing Controlled Airspace (CAS) arrangements in place today. The options will be qualitatively compared against this existing scenario. Within c.35nm of Glasgow airports are Edinburgh and Glasgow Prestwick Airport each with their own Controlled Airspace (CAS) volumes. In addition to this, the Scottish TMA airspace sits above and around the airports' airspace which generates the volumes shown in Figure 34. The controlled airspace at Glasgow has varying lower and upper limits with the volume closest to the airport going down to ground level. This is the Glasgow CTR shown in red outline. Also, in this figure can be seen Cumbernauld Airport approximately 15nm to the east of Glasgow airport which sits outside CAS where the base of the CTA is 3000ft. This is indicated with a yellow dot.

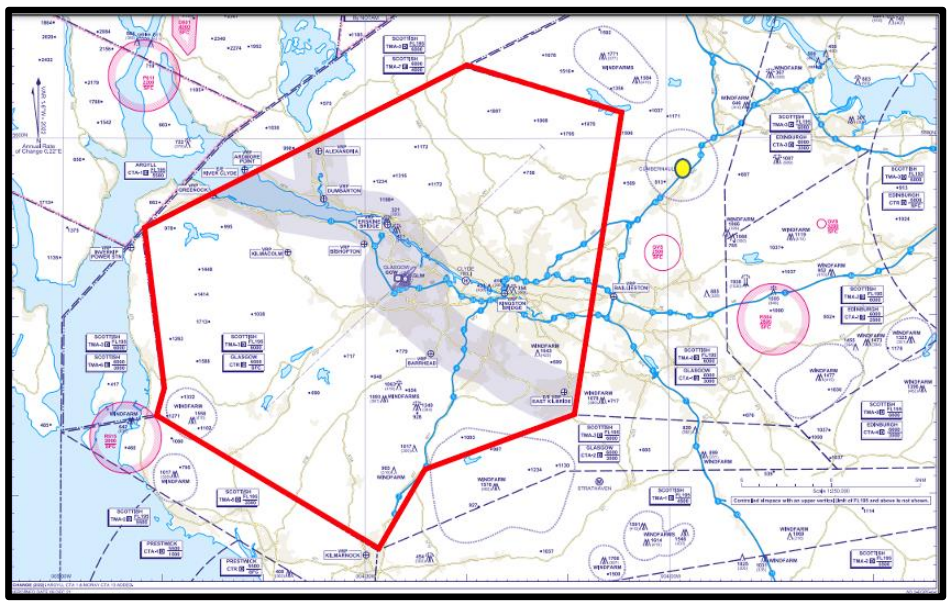


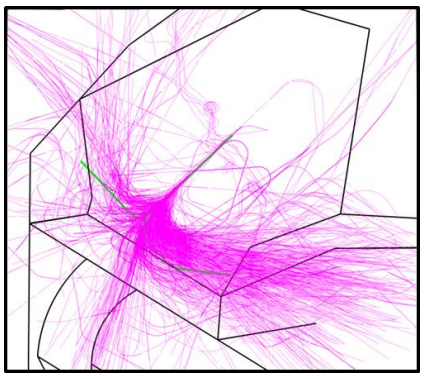
Figure 34 Glasgow Airport Control Zone and Control Area Chart (See eAIP for full details)

It is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size.

Whilst the existing baseline scenario will not result in the requirement for more airspace, doing nothing with westerly arrivals would constrain departure options and therefore offers less opportunity to simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to achieve.

General Aviation / Commercial airlines	Economic impact from increased effective capacity	There will be no increase to effective capacity by doing nothing with Easterly arrivals (in isolation to the rest of the system) and doing nothing would constrain the ability to change easterly departures.
	Fuel burn	As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline easterly arrivals. When arriving at Glasgow, aircraft are vectored by ATC before joining the final approach. This means that track length is varied from flight to flight. For the purposes of comparing our westerly arrival options against the baseline scenario, we have used the NTK vectoring baseline data and information from ATC to estimate an arrivals centreline; we have then used the track mileage from this centreline as an initial indication of 'do nothing' track length. We have then applied a weighting based on arrival direction to provide an overall total track mileage for the system. At the Stage 3 full options appraisal track length and fuel burn will be modelled in further detail. *Table 107 Easterly Arrival Track Mileage* **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)** Baseline (centreline) / 50 / 428.4 Aircraft arriving at Glasgow are sometimes prevented from continuously descending due to the tactical coordination with other traffic in the airspace. We will qualitatively estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option against current day. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today and will also consider the opportunity for continuous descent from 7000ft.
Commercial airlines	Training costs	As this option is already in operation, there are no training costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
	Other costs	As this option is already in operation, there are no other costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
Airport / Air navigation service provider	Infrastructure costs	As this option is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
	Operational costs	As this option is already in operation, there are no operational costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline. For some approaches, Glasgow Airport is dependent on conventional ground based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is considered an interim measure and failure to implement a long term solution may result in additional operational costs.
	Deployment costs	As this option is already in operation, there are no deployment costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.
All	Safety	At current traffic levels, there are no safety concerns with the current arrangements at Glasgow. Future traffic growth could however result in increased complexity and workload for Air Traffic Controllers and pilots, which may lead to traffic levels within the Scottish TMA being capped, on increased aircraft holding in order to maintain safety.
All	Interdependencies, conflicts and tradeoffs	This option would result in constraining some of Glasgow's own departure options as well as some of NERL's options should they consider a relocation of the LANAK holding stack.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* Whilst vectoring of arrivals is a perfectly reasonable options in a future operating environment, doing nothing with Easterly departures will not align with the AMS as it would constrain other options. Limiting our options to one which sees no change to vectoring practices could also reduce the ability to change CAS boundaries and improve CDA performance.

4.24. Runway 05 Arrival Option A

Runway 05 Easterly Arrivals Option A		
	PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.	
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would also join the final approach at around 11nm, and would be used by 15% of overall arrivals.

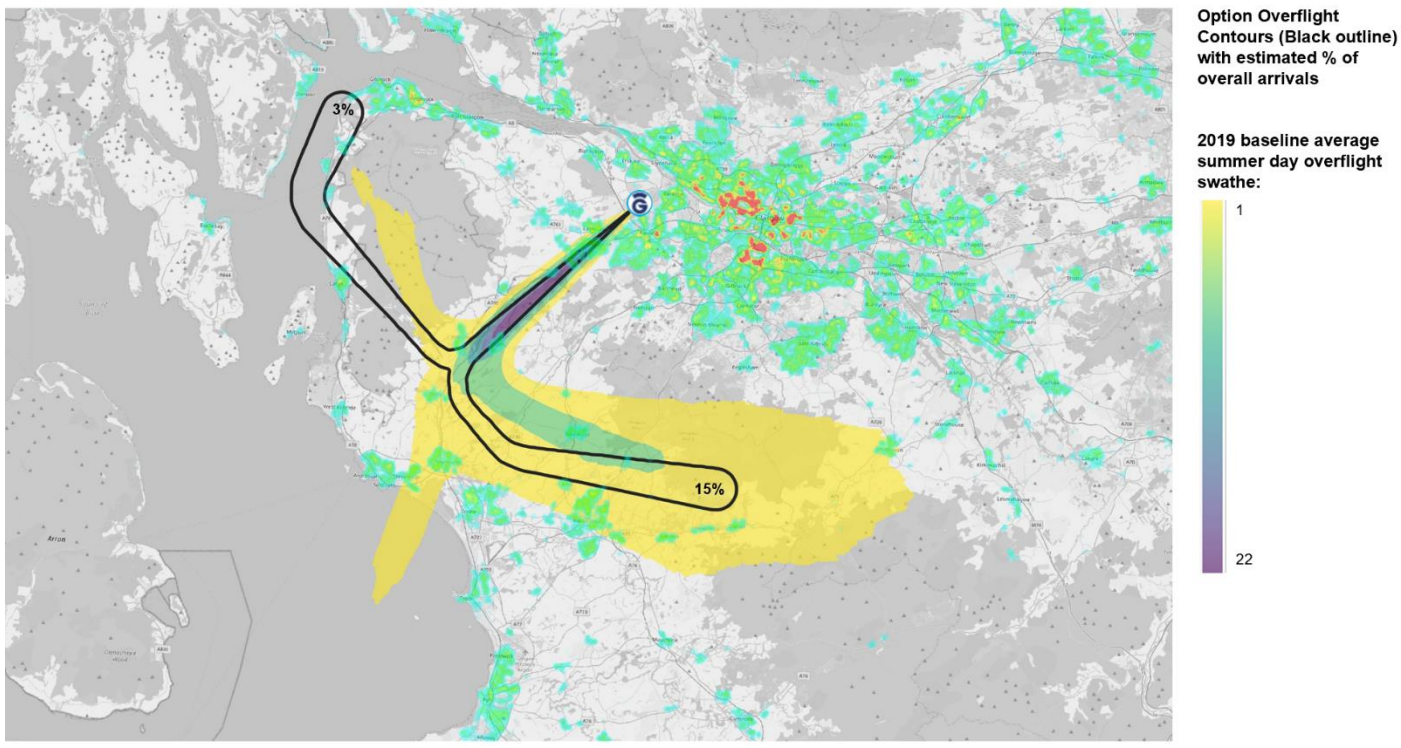


Figure 35 Easterly Arrivals Option A Overflight and 2019 baseline NTK data

Route from the North
This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today.

Route from the South
The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Forest. Aircraft would then route slightly west, largely avoiding Kilmarnock and Stewarton, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 11nm. This largely avoids dense areas of population with the exception of the southern parts of Fenwick. The NTK heatmap in figure 35 shows that this route remains south of the existing areas of concentration however by doing so, it avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 11nm. This join occurs earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final approach. Beyond this point, aircraft overfly the same areas as they do today.

Overflight Data
The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 108 Easterly arrivals option A overflight data

System	Area (km^2)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option A	174.72	21006

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data.

There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB which compare Option A against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 109 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 109 60dB L_{AMax} Data – Rwy05 Arrival Option A

	60dB L_{AMax}	
System	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	56.96	34798
RWY 05 Dep Option A	52.74	27292

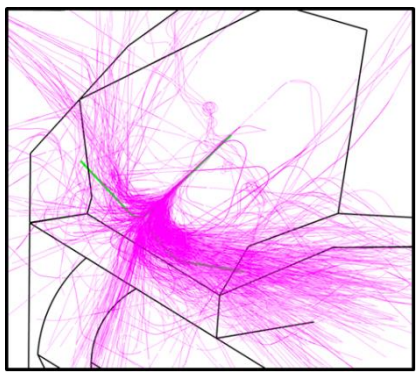
L_{Aeq}
The south-west component of the existing L_{Aeq} contours extends to around 6-7nm from the landing threshold. Arrival Option A sees turns onto final approach at 11nm and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option A will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	Table 110 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline: *Table 110 Easterly arrival A – Tranquil areas overflown 0-7000ft* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline - Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 0 / 0 **Runway 05 Option A**: 0 / 0 / 0 / 0 / 0 / 0 The data shows that there will be no change in areas of tranquillity overflown – all areas will be avoided as they are today.
	Biodiversity	The routes that form part of Arrival Option A join the final approach at 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	The design option may require changes to the existing CAS boundaries. The arrival routes as illustrated would not be contained within ScTMA 5 in accordance with the CAA CAS containment policy. This could be mitigated by positioning the route closer to final approach in line with existing arrangements although this would overfly more people than the PBN route in its existing position.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.
	Fuel burn	We estimate that Option A when compared to baseline nominal centrelines, will result in a small overall increase in track mileage. **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 15% (South), 3% (North) based on 2019 modal split)** Baseline (centreline): 50 / 428.4 A: 57.5 / 492.9 This increase in driven largely by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path to avoid some populated areas and noise sensitive sites; it joins final approach at around 11nm which is further than most arrivals typically join today. All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft). As part of Stage 3, should this option progress, we will look to refine this in further detail and as part of this we will review whether we can balance noise and CO2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance CO_2 and noise.

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[47].
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies, conflicts and tradeoffs	No interdependencies, conflicts and trade-offs have been identified with other sponsors' ACPs below 7000ft.
All	AMS	CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

[47] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.25. Runway 05 Arrival Option B

Runway 05 Easterly Arrivals Option B		
		PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 10nm, and would be used by 15% of overall arrivals.

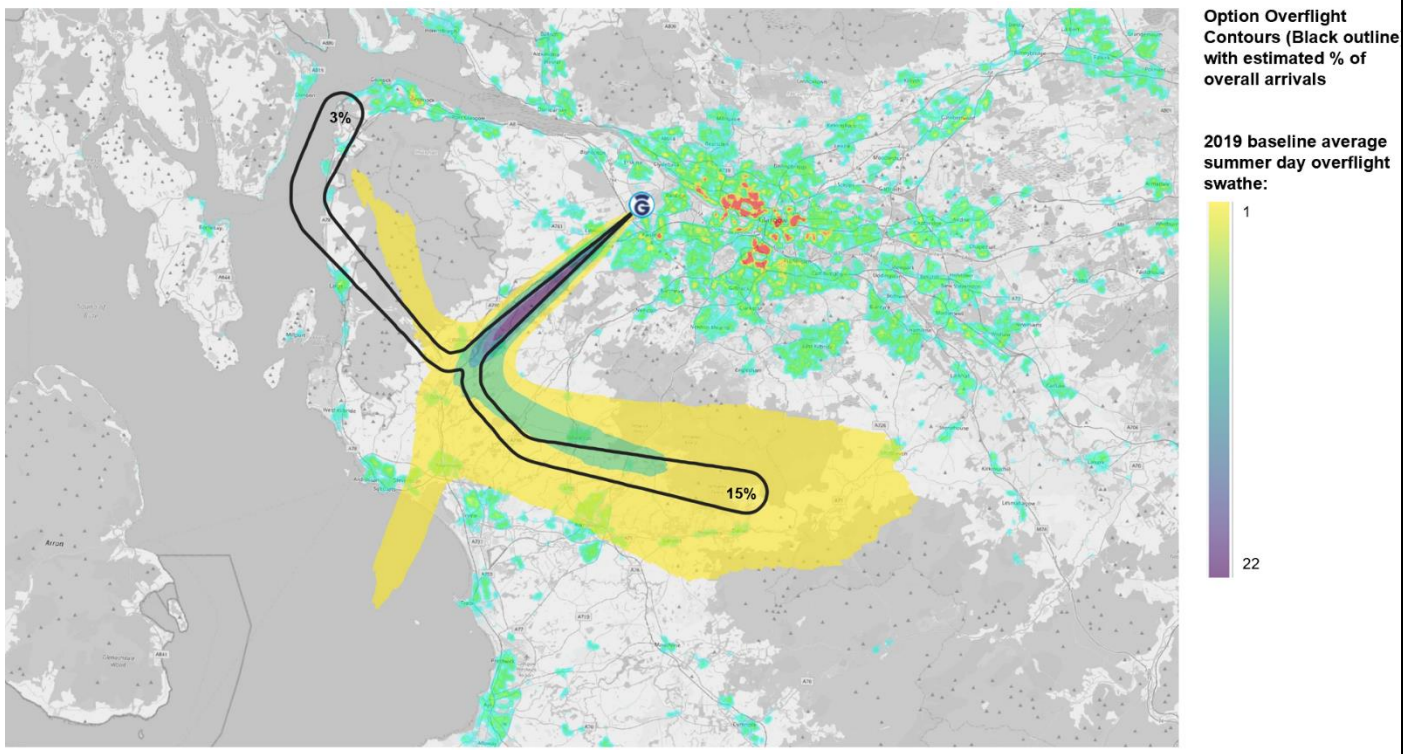


Figure 36 Easterly Arrivals Option B Overflight and 2019 baseline NTK data

Route from the North
This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today.

Route from the South
The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Forest. Aircraft would then route slightly west, overflying Fenwick and Waterside but largely avoiding Kilmarnock and Stewarton, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 10nm. The NTK heatmap in figure 36 shows that this route remains south of most of the existing areas of concentration however by doing so, it avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 10nm. This join occurs slightly earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final approach. Beyond this point, aircraft overfly the same areas as they do today.

Overflight Data
The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 111 Easterly arrivals option B overflight data

System	Area (km^2)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option B	176.02	21242

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction

in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB which compare Option A against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 112 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 112 60dB L_{AMax} Data - Rwy23 Arrival Option B

	60dB L_{AMax}	
System	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	56.96	34798
RWY 05 Dep Option B	53.79	27446

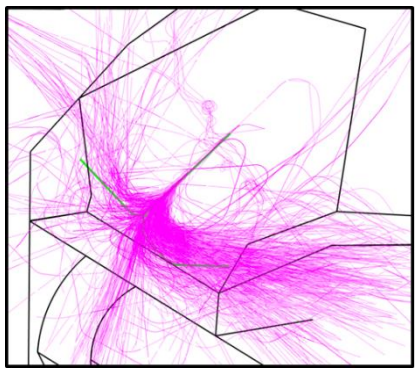
L_{Aeq}
The south-west component of the existing L_{Aeq} contours extends to around 6-7nm from the landing threshold. Arrival Option A sees turns onto final approach at 11nm and 10nm and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option B will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	Table 113 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline: *Table 113 Easterly arrival B – Tranquil areas overflown 0-7000ft* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline - Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 0 / 0 **Runway 05 Option A**: 0 / 0 / 0 / 0 / 0 / 0 The data shows that there will be no change in areas of tranquillity overflown – all areas will be avoided as they are today.
	Biodiversity	The routes that form part of Arrival Option B join the final approach at 11nm and 10nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	The design option may require changes to the existing CAS boundaries. The arrival routes as illustrated would not quite be contained within ScTMA 5 in accordance with the CAA CAS containment policy. This could be mitigated by positioning the route slightly closer to final approach in line with existing arrangements although this would overfly more people than the PBN route in its existing position.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.
	Fuel burn	We estimate that Option B when compared to baseline nominal centrelines, will result in a small overall increase in track mileage. **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 15% (South), 3% (North) based on 2019 modal split)** Baseline (centreline): 50 / 428.4 B: 56.3 / 474.9 This increase in driven largely by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path to avoid some populated areas and noise sensitive sites; it joins final approach at around 10nm which is further than most arrivals typically join today. All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft). As part of Stage 3, should this option progress, we will look to refine this in further detail and as part of this we will review whether we can balance noise and CO2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance CO_2 and noise.
Commercial	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update

airlines		their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[48];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies, conflicts and tradeoffs	No interdependencies, conflicts and tradeoffs have been identified with other sponsors' ACPs below 7000ft.
All	AMS	CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

[48] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.26. Runway 05 Arrival Option C

Runway 05 Easterly Arrivals Option C		
	PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway. Slightly different track to Option A above 5000ft. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.	
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would also join the final approach at around 11nm, and would be used by 15% of overall arrivals. The southerly route option differs slightly from option A above 5000ft.

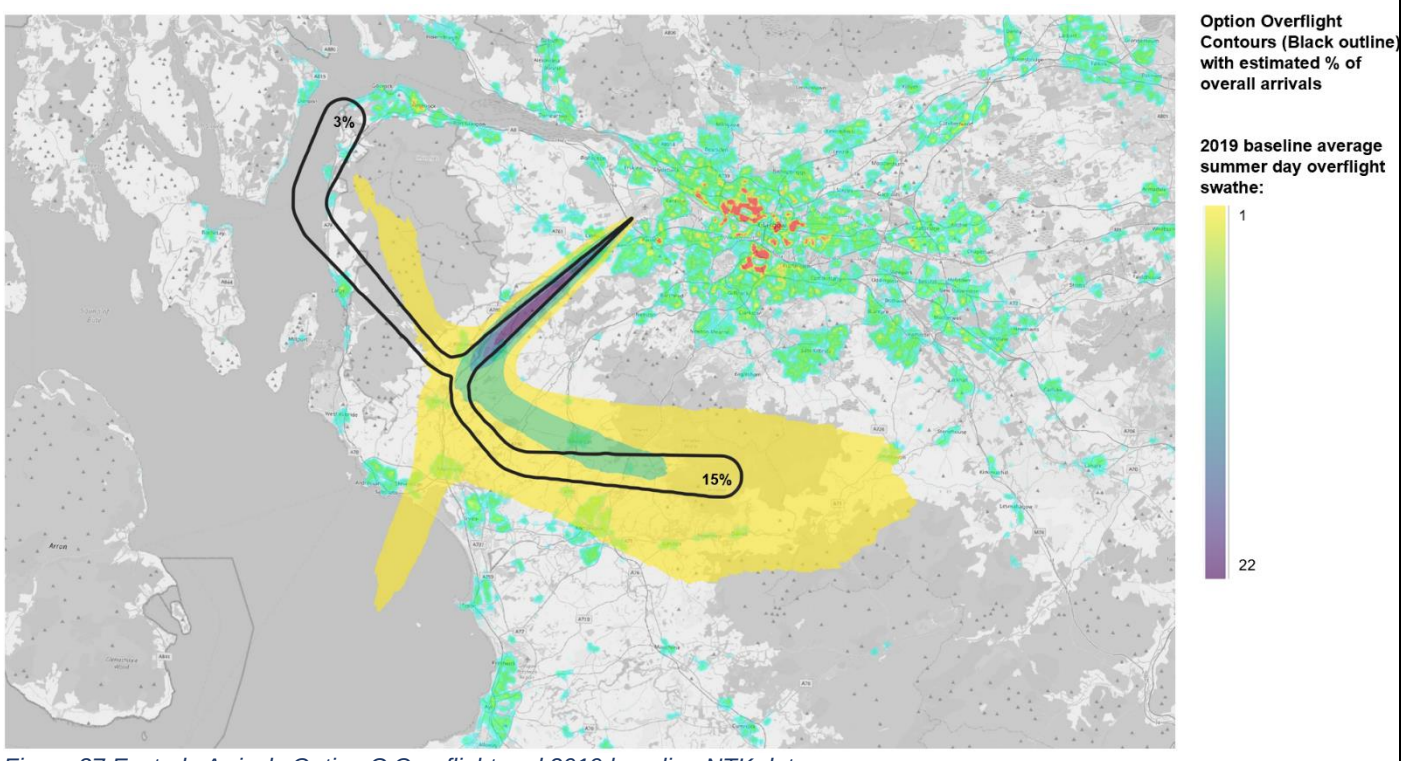


Figure 37 Easterly Arrivals Option C Overflight and 2019 baseline NTK data

Route from the North
This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today.

Route from the South
The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Hill. Aircraft would then route west, avoiding Kilmarnock and Stewarton, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 11nm. This avoids dense areas of population with the exception of Fenwick. The NTK heatmap in figure 37 shows that this route remains south of the existing areas of concentration however by doing so, it avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 11nm. This join occurs earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final approach. Beyond this point, aircraft overfly the same areas as they do today.

Overflight Data
The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 114 Easterly arrivals option C overflight data

System	Area (km^2)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option C	174.44	21211

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction

in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB which compare Option C against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 115 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 115 60dB L_{AMax} Data – Rwy05 Arrival Option C

	60dB L_{AMax}	
System	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	56.96	34798
RWY 05 Dep Option C	52.74	27292

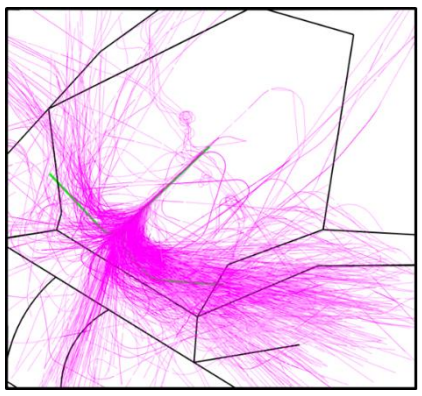
L_{Aeq}
The south-west component of the existing L_{Aeq} contours extends to around 6-7nm from the landing threshold. Arrival Option C sees turns onto final approach at 11nm and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option C will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	Table 116 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline: *Table 116 Easterly arrival C – Tranquil areas overflown 0-7000ft* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline - Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 0 / 0 **Runway 05 Option C**: 0 / 0 / 0 / 0 / 0 / 0 The data shows that there will be no change in areas of tranquillity overflown – all areas will be avoided as they are today.
	Biodiversity	The routes that form part of Arrival Option C join the final approach at 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	The design option may require changes to the existing CAS boundaries. The arrival routes as illustrated would not be contained within ScTMA 5 in accordance with the CAA CAS containment policy. This could be mitigated by positioning the route closer to final approach in line with existing arrangements although this would overfly more people than the PBN route in its existing position.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.
	Fuel burn	We estimate that Option C when compared to baseline nominal centrelines, will result in a small overall increase in track mileage. **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 15% (South), 3% (North) based on 2019 modal split)** Baseline (centreline): 50 / 428.4 C: 57.8 / 497.4 This increase in largely driven by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path to avoid some populated areas and noise sensitive sites; it joins final approach at around 11nm which is further than most arrivals typically join today. Compared to Option A, which also joins at 11nm, this route is slightly longer when considering connectivity with the network, due to the positioning of the 7000ft point. All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft). As part of Stage 3, should this option progress, we will look to refine this in further detail and as part of this we will review whether we can balance noise and CO2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance CO_2 and noise.

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[49];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies, conflicts and tradeoffs	No interdependencies, conflicts and tradeoffs have been identified with other sponsors' ACPs below 7000ft.
All	AMS	CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

[49] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.27. Runway 05 Arrival Option D

Runway 05 Easterly Arrivals Option D		
		PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm. Slightly different track to Option B above 5000ft For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	**Impact**	**Qualitative Assessment**
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 10nm, and would be used by 15% of overall arrivals.

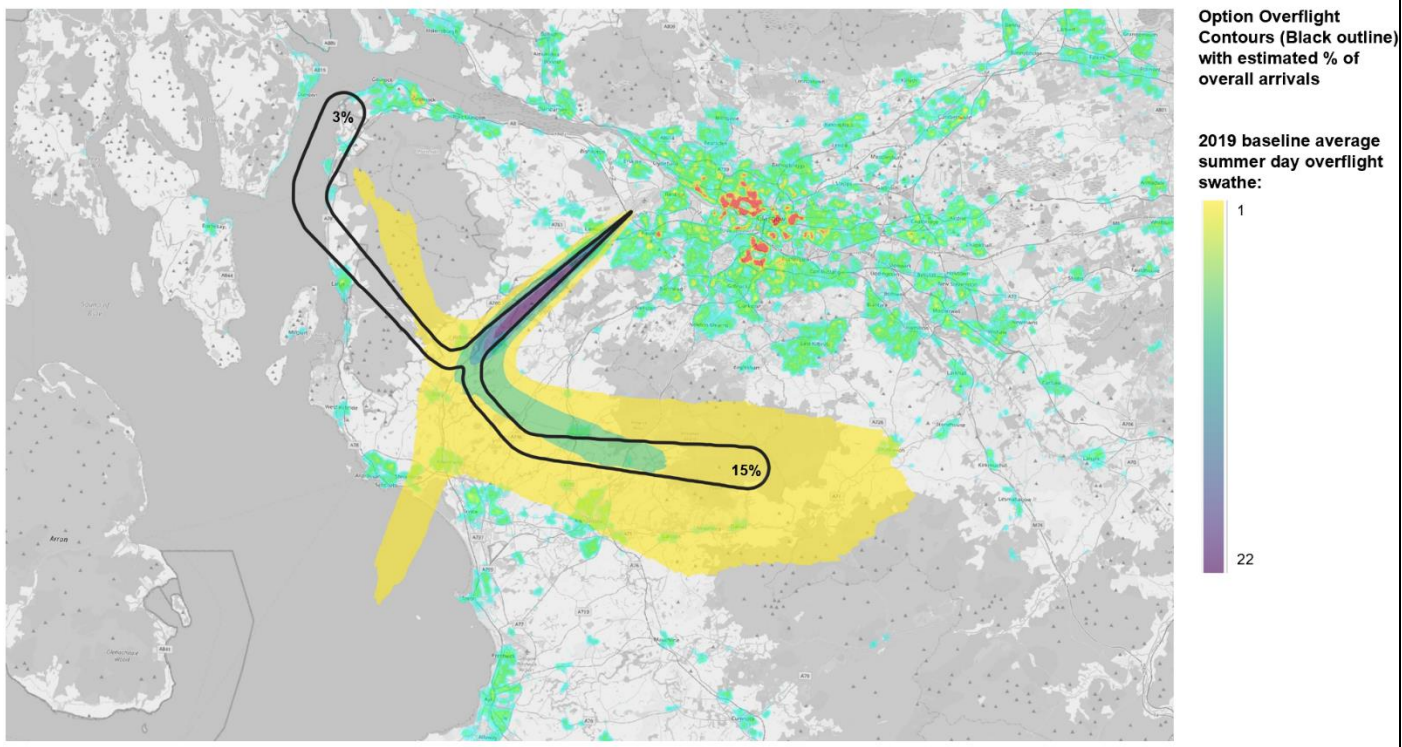


Figure 38 Easterly Arrivals Option D Overflight and 2019 baseline NTK data

Route from the North
This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today.

Route from the South
The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Forest. Aircraft would then route west, overflying Fenwick and Waterside and the very southern parts of Stewaton, but avoiding Kilmarnock, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 10nm. The NTK heatmap in figure 38 shows that the initial part of this route aligns with some existing concentration however then heads slightly further west than the concentration seen today. In doing so, the route avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 10nm. This join occurs slightly earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final approach. Beyond this point, aircraft overfly the same areas as they do today.

Overflight Data
The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 117 Easterly arrivals option D overflight data

System	Area (km^2)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option B	176.01	21379

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage

none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB which compare Option D against the centreline baseline. These 60dB contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 118 shows a decrease in the area and population within the 60dB L_{AMax} contour. The 65dB L_{AMax} contours remain the same between the baseline and this option.

Table 118 60dB L_{AMax} Data - Rwy23 Arrival Option B

	60dB L_{AMax}	
System	**Area (km²)**	**Population**
RWY05 Baseline (Centreline – Optioneering tool)	56.96	34798
RWY 05 Dep Option D	53.88	27446

L_{Aeq}
The south-west component of the existing L_{Aeq} contours extends to around 6-7nm from the landing threshold. Arrival Option D sees turns onto final approach at 11nm and 10nm and therefore we do not expect this option to alter the shape or size of the L_{Aeq} contours.

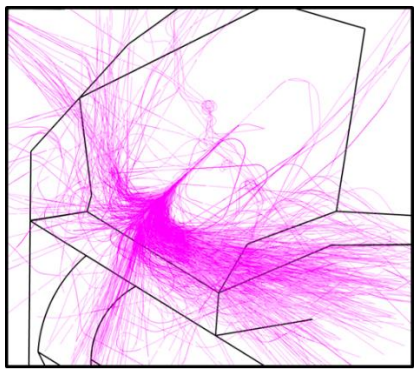
	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option D will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	Table 119 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and centreline baseline. *Table 119 Easterly arrival D – Tranquil areas overflown 0-7000ft* **System** / **NSA count** / **NSA area** / **National Parks count** / **National Parks area** / **DQA count** / **DQA area** **RWY 05 Baseline - Vectoring (NTK data)**: 0 / 0 / 0 / 0 / 0 / 0 **RWY 05 Baseline (Centreline – Optioneering tool)**: 0 / 0 / 0 / 0 / 0 / 0 **Runway 05 Option D**: 0 / 0 / 0 / 0 / 0 / 0 The data shows that there will be no change in areas of tranquillity overflown – all areas would be avoided as they are today.
	Biodiversity	The routes that form part of Arrival Option D join the final approach at 11nm and 10nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	The design option may require changes to the existing CAS boundaries. The arrival routes as illustrated would not quite be contained within ScTMA 5 in accordance with the CAA CAS containment policy. This could be mitigated by positioning the route slightly closer to final approach in line with existing arrangements although this would overfly more people than the PBN route in its existing position.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.
	Fuel burn	We estimate that Option D when compared to baseline nominal centrelines, will result in a small overall increase in track mileage. **Track Mileage** **Option** / **Track miles (nm)** / **Track miles (Weighted 15% (South), 3% (North) based on 2019 modal split)** Baseline (centreline): 50 / 428.4 D: 56.5 / 477.9 This increase in largely driven by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path to avoid some populated areas and noise sensitive sites; it joins final approach at around 10nm which is further than most arrivals typically join today. Compared to Option B, which also joins at 10nm, this route is slightly longer when considering connectivity with the network, due to the positioning of the 7000ft point. All arrival options have been designed to continuously descend from 7000ft (subject to the NATS NERL ACP for the airspace above 7000ft). As part of Stage 3, should this option progress, we will look to refine this in further detail and as part of this we will review whether we can balance noise and CO2 on the northern route. We will also quantify fuel burn in further detail to understand the impacts of the increases in track length and benefits of continuous descent, in order to try to balance

		CO_2 and noise.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[50];
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies, conflicts and tradeoffs	No interdependencies, conflicts and tradeoffs have been identified with other sponsors' ACPs below 7000ft.
All	AMS	CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. Howevrr the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into juyst 2 arrival routes to each runway.

[50] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

4.28. Runway 05 Arrival Vectors only

Runway 05 Easterly Arrivals Vectors only



Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known alongside more information about departures and CAS arrangements.

Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. The former, because it is difficult for ATC to deliver accurate final approach spacing to varying runway spacing requirements using PBN only and they can often require more Controlled Airspace than is required by vectoring. The latter because they can often result in longer final approach joining points than vectoring caters for and, in the case of Glasgow would see c.85% of all Easterly arrivals on a single path. Communities can sometimes favour the 'spreading' of arrivals through vectoring to mitigate against potential adverse effects of concentration.

This option would see all arrivals continuing to be vectored with no PBN paths available for routine use.

Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet so there is not an illustration for this option.

For the Design Principle Evaluation and Initial Options Appraisal we will assume similar impacts as the baseline however, for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. In this vectoring option, aircraft arriving at Glasgow would continue to be tactically controlled (vectored) by ATC before joining final approach. Today aircraft typically join the runway 05 final approach between 8nm and 11nm before landing although when undertaking an ILS approach they can be as close as 6nm. This option would continue to see aircraft joining the final approach at these distances, although there is a possibility that this could be influenced by changes to the airspace above 7000ft and departures – this will be explored in further detail at Stage 3 should this option progress. Unlike PBN routes, tactical controlling of aircraft typically leads to higher levels of dispersion of flights and therefore sharing of the noise. The NTK data shown in figure 33, demonstrates the large swathe of overflight created by today's vectoring. It shows that there are wide areas to the south of the airport , and some areas to the north, that are overflown between 1-10 times per day on average including Darvel, Newmilns, Galston, Kilmarnock, Kilmaurs, Dunlop, Kilwinning, Dalry, and Kilbirnie. There is some concentration which occurs from a south-easterly direction, before aircraft join the final approach which overflies Fenwick, Stewarton and Beith:

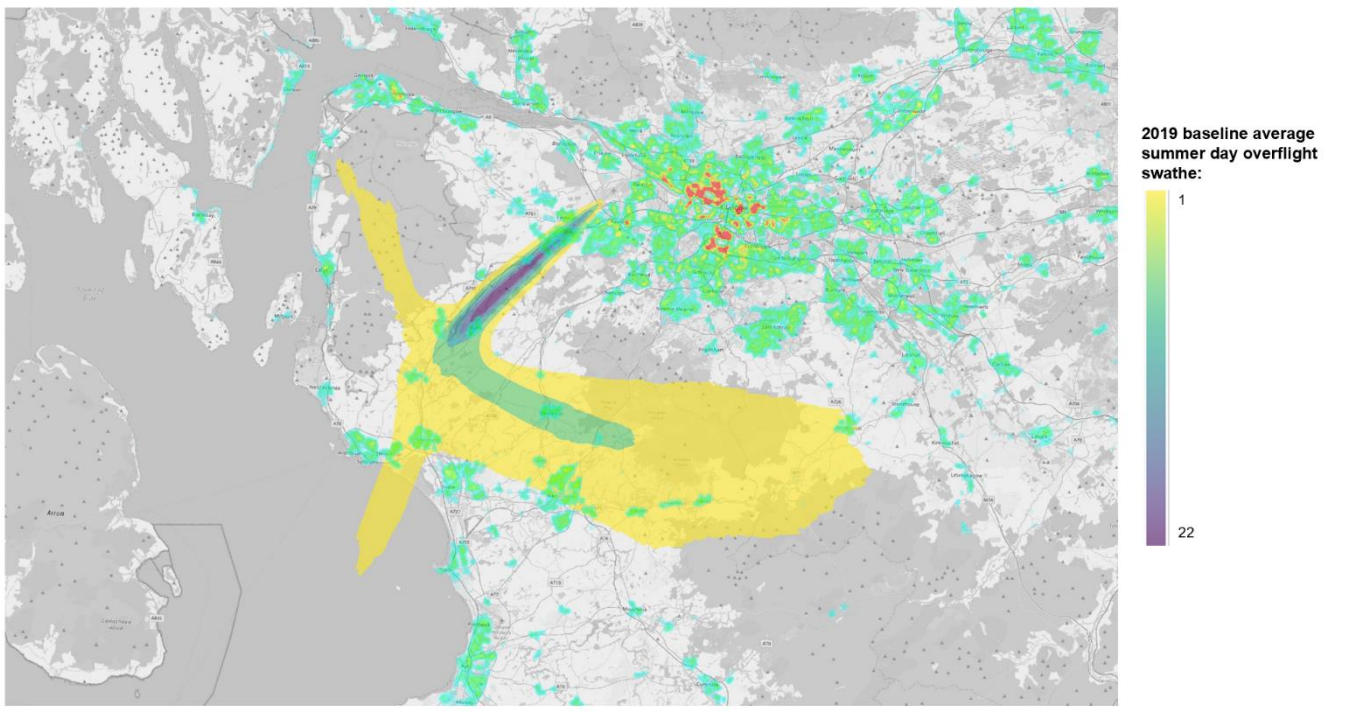


Figure 39 Runway 23 Departure Vectoring Swathe 2019

The vectoring swathe as seen in Figure 39 is influenced by how aircraft arrive from the airspace above 7000ft, how departures operate, and by the structure of the surrounding CAS. This option will therefore evolve as further details are known about where aircraft will enter at 7000ft, where and how the departures might be operated, and the shape and size of the CAS volume.

For the purposes of this IOA, we will use the baseline data as the closest representative data for this option. The technical appendix includes NTK and centreline data for the baseline. It's important to note that the NTK data is not modelled in the same way as the other data, however it does provide a preliminary means of comparison between this baseline and the airspace change options.

Table 120 below includes data based on the NTK heat map as shown in figure 39 above:

Table 120 Easterly arrivals baseline overflight data 0-7000ft

System	Area (km^2)	Population
RWY 05 Arrivals Baseline - Vectoring (NTK data)	691.95	140596

In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals and places of worship:

System	Schools count	Hospitals count	Care homes count	Places of worship count
RWY 05 Baseline (Vectoring)	51	0	32	77

Although the data shows a higher number of noise sensitive buildings are overflown compared to most of the PBN options, the frequency of overflight will be lower owing to the dispersion created by vectoring. This is something we

<table>
<tr><td></td><td></td><td>will explore in further detail at Stage 3.

60dB and 65dB L_{AMax}
Technical Appendix A includes 60dB L_{AMax} contours and data for the baseline, to aid comparison between the baseline and the options. Similar to the overflight data above, the population within the 60dB LAMax contours is highest within the baseline, however this data does not currently take into account the full vectored swathe, as it is modelled from centreline data. It also does not articulate the frequency of overflight which would be lower for some areas compared to equivalent PBN routes. We will explore this in further detail a Stage 3 should the option progress. The 65dB LAMax contours extend partially along the extended runway centreline and are expected to remain the same between all options.

Table 121 Westerly arrivals baseline L_{AMax} data
<table><tr><th></th><th colspan="2">60dB L_{AMax}</th></tr><tr><th>System</th><th>Area (km^2)</th><th>Population</th></tr><tr><td>RWY 05 Arrivals Baseline (Centreline – Optioneering tool)</td><td>56.96</td><td>34798</td></tr></table>
L_{Aeq}
The south-west component of the existing L_{Aeq} contours extends to around 6-7nm from the landing threshold. This option is expected to see aircraft continue to join final approach as they do today which typically occurs before 6-7mn. We therefore do not expect this option to alter the shape or size of the L_{Aeq} contours.</td></tr>
<tr><td></td><td>Air Quality</td><td>This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.</td></tr>
<tr><td rowspan="4">Wider Society</td><td>Greenhouse gas impact</td><td>Our fuel burn assessment (see below) has anticipated that vectors only will have a similar track mileage and fuel burn compared to the baseline. We therefore expect neutral benefit/impact to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.</td></tr>
<tr><td>Capacity / resilience</td><td>This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today’s airspace through vectoring could be expected to be delivered through vectoring in the future subject to some potential changes to the vectoring patterns as a result of the changes to surrounding structures.

Vectoring only would not improve Glasgow Airport’s resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.</td></tr>
<tr><td>Tranquillity</td><td>Table 122 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the impacts to tranquillity.

Table 122 Easterly arrival vectors only – Tranquil areas overflown 0-7000ft
<table><tr><th>System</th><th>NSA count</th><th>NSA area</th><th>National Parks count</th><th>National Parks area</th><th>DQA count</th><th>DQA area</th></tr><tr><td>RWY 05 Baseline - Vectoring (NTK data)</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>Runway 05 Baseline Centreline</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table></td></tr>
<tr><td>Biodiversity</td><td>This option is unlikely to change where aircraft join the final approach compared to today. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.</td></tr>
<tr><td>General Aviation</td><td>Access</td><td>This option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS as a result of enabling changes the other surrounding route structures.</td></tr>
<tr><td rowspan="2">General Aviation / Commercial airlines</td><td>Economic impact from increased effective capacity</td><td>This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today’s airspace through vectoring could be expected to be delivered through vectoring in the future subject to some potential changes to the vectoring patterns as a result of the changes to surrounding structures.</td></tr>
<tr><td>Fuel burn</td><td>Table 123 provides baseline centreline data for easterly arrivals. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the benefits and impacts to fuel burn.

Table 123 Easterly Arrival Track Mileage
<table><tr><th colspan="3">Track Mileage</th></tr><tr><th>Option</th><th>Track miles (nm)</th><th>Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)</th></tr><tr><td>Baseline (centreline)</td><td>50</td><td>428.4</td></tr></table></td></tr>
<tr><td rowspan="2">Commercial airlines</td><td>Training costs</td><td>Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.</td></tr>
<tr><td>Other costs</td><td>No other airline costs are foreseen.</td></tr>
<tr><td rowspan="3">Airport / Air navigation service provider</td><td>Infrastructure costs</td><td>The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.</td></tr>
<tr><td>Operational costs</td><td>This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow’s dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL’s operational costs as it enables VOR rationalisation[51];</td></tr>
<tr><td>Deployment costs</td><td>This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.</td></tr>
</table>

[51] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

All	Safety	ATC advised that with any option which sees a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05, a PBN waypoint to direct RWY 05 arrivals to would be preferable to help them ensure separation. This would not be available in a vectoring only option. No other safety concerns have been identified at this stage.
All	Interdependencies, conflicts and tradeoffs	To accommodate a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05 may also require a relocation of the LANAK hold in the network. This could slightly change the vectoring swathe to Runway 05 but most likely above 5/6000ft. There are not expected to be tradeoffs between arrivals below 7000ft and NERL or Edinburgh's options.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* Vectoring of arrivals in the future would not deliver a PBN arrival solution, nor reduce the numbers of people overflown / affected by noise from Glasgow's arrivals. However it is unlikely to change the adverse effects which would be measured within the LOAEL which would not extend out to the final approach joining point. Conversely a PBN arrival to RWY 05 in the lowest areas of population would require additional CAS to ensure CAS containment therefore a vectoring solution may be preferable from a CAS perspective. This option would meet future demand however it may not be the best future-proofed option should technologoical enhancements become available in the future to better rely on a pure PBN arrival solution if desired by Glasgow and its stakeholders.

4.29. Runway 05 Arrival Vectors and PBN hybrid

Runway 05 Easterly Arrivals Vectors and PBN hybrid	
 Note: Image shows existing vectoring swathe alongside the overflight contours for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there is further information around vectoring arrangements.	Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. There are however the benefits of PBN for arrivals. In addition, from an operational perspective for RWY 05, due to the interaction of NORBO departures with arrivals, ATC have advised than the option of PBN for arrivals would be extremely desirable. This is because it would provide a Waypoint for use which, when combined with an altitude restriction, could be used to guarantee separation against NORBO departures. This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival(s) would likely be the 'best performing' of Options A-D above which are then optimised in Stage 3 to balance CO2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

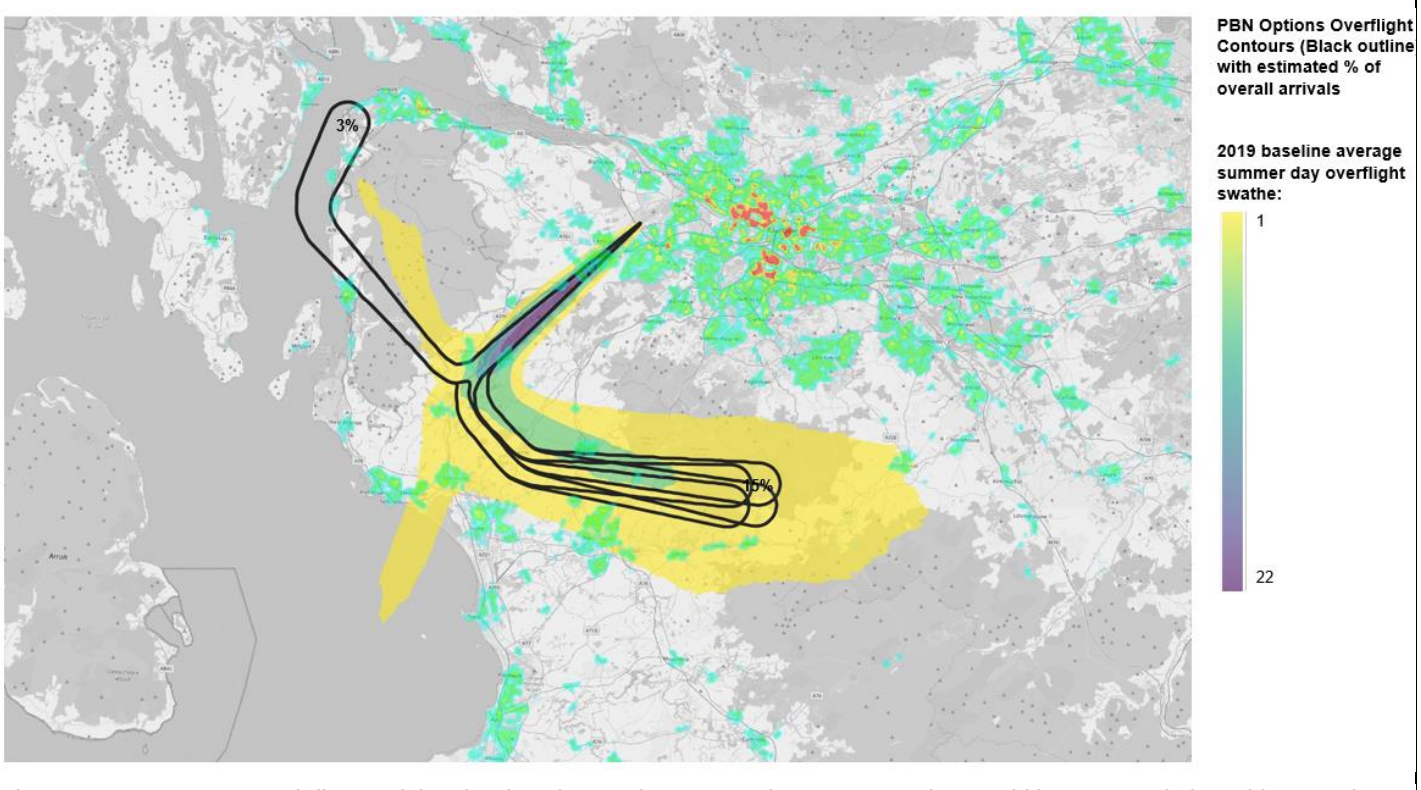
Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival component could be any of the PBN options already assessed; the option taken forward will depend on the shortlisting as part of this IOA and the outcome of the Stage 3 Full Options Appraisal. Below provide links to the four assessments for the PBN Options: Initial Options Appraisal – Runway 05 Arrival Option A Initial Options Appraisal – Runway 05 Arrival Option B Initial Options Appraisal – Runway 05 Arrival Option C Initial Options Appraisal – Runway 05 Arrival Option D The PBN option assessments linked above have shown that there is the potential for PBN routes to reduce the number of people and noise sensitive sites overflown, however due to the concentration created by PBN routes, areas overflown would likely be at a higher frequency than today. By combining with vectoring, some of this concentration from PBN routes could be mitigated, as some aircraft would continue to be tactically controlled and would therefore see the dispersion that occurs today. This dispersion has been described in the vectoring option linked below: Initial Options Appraisal – Runway 05 Arrival Vectors only As described in the Vectoring assessment, the shape/size of the vectoring swathe will be dependent on a number of factors which are yet to be determined including the airspace above 7000ft, the departure options, and the CAS arrangements. We will explore this further at Stage 3. For this IOA, we have included an image which shows all of the potential PBN options alongside the vectoring swathe. In Stage 3 we will refine this in further detail as described above and we will also quantify when we would expect to see the PBN and vectoring used.  *Figure 40 Runway 05 PBN (All potential options) and Vectoring. Note only one PBN option would be proposed alongside vectoring.* **Overflight Data** The individual sections of the PBN Options linked above provide more detailed information on the areas overflown and overflight data. Table 124 below shows the comparison between the baseline NTK vectoring data and the different options. Although the NTK vectoring data is not modelled in the same way as the centreline data, it does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 124 Easterly arrivals Vectors and PBN hybrid overflight data

System	Area	Population	Schools count	Hospitals count	Carehomes count	Places of worship count
RWY05_BASE (Vectoring NTK data)	691.95	140596	51	0	32	77
RWY05_BAS (Centreline)	182.63	51256	19	2	9	26
RWY05_A	174.72	21006	7	0	5	10
RWY05_B	176.02	21242	6	0	5	10
RWY05_C	174.44	21211	7	0	5	10
RWY05_D	176.01	21379	6	0	6	10

Overall, the data suggests that the PBN routes would overfly fewer people and noise sensitive buildings compared to the vectoring however these options will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process.

This suggests that the combination of utilising PBN routes alongside vectoring may have some noise benefits; vectoring would mitigate some of the impacts of concentration for those communities living under the PBN routes, and the PBN routes would mean that when traffic allowed, a far lower number of people would be overflown compared to today. This will be explored in further detail should this option progress to Stage 3.

60dB and 65dB L_{AMax}

Technical Appendix A includes a table which shows the 60dB L_{AMax} data for each option against the centreline baseline. At this stage we do not have L_{AMax} data for the vectoring or overall N60 metrics - we will quantify these at Stage 3. The data shows that the PBN arrivals routes result in a reduction in area and population within the 60dB $L_{AMax\ contour}$ although at this stage, this data does not take into account the frequency of overflight which would likely increase. Similar to the overflight assessment above, by offering a hybrid PBN/vectoring option, there would be opportunities to mitigate the impacts of PBN with some of the benefits of vectoring which may result in favourale L_{AMax} data; this will be explored further in Stage 3 when this option is refined (if this option is progressed).

L_{Aeq}

The south-west component of the existing L_{Aeq} contours extends to around 6-7nm from the landing threshold. The IOA of the PBN Options and the Vectors only option have suggested that there will be no impact to the shape and size of the LAeq contour and therefore this hybrid option is also unlikely to significantly impact the shape or size.

	Air Quality	This option has no change to how aircraft fly below 1,000ft compared to the baseline and so there are no anticipated changes to local air quality (positive or negative) as a result of this airspace design option.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated this option will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity / resilience	Option is expected to enhance Glasgow's operational performance in the future. This is because ATC can use the PBN arrivals when traffic levels are low-medium and this will also facilitate the use of combined Tower and Approach services (Radar In Tower) offering additional resilience to ATC resource. The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.
	Tranquillity	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that all of the options will continue to avoid NSAs, DQAs and National Parks, as they do today. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this too avoids these areas. We therefore expect there to be no change to overflight of tranquil areas as a result of a hybrid PBN/vectoring scenario.
	Biodiversity	This option is unlikely to change where aircraft join the final approach compared to today. The PBN options also all join the final approach from at 10 or 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.
General Aviation	Access	All of the existing PBN arrival options from the South may require changes to CAS boundaries to protect the PBN arrival in accordance with CAA's policy on CAS containment. This could be avoided by positioning a PBN arrival route further to the East or in the middle of the existing swathe which would avoid any increase in additional CAS although it would result in more people being overflown compared to any of the existing PBN options. Options B and D would require less adjustment to CAS then Options A and C.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today's airspace through vectoring could be expected to be delivered through vectoring in the future and the feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders.
	Fuel burn	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that there may be increases in track mileage and fuel burn as a result of all of the PBN options. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this component of a hybrid option would offer neutral benefits/impacts to fuel burn. Overall, at this stage, the IOA suggests there may therefore be some impacts to fuel burn as a result of a hybrid option although these will be less than operating purely PBN arrivals alone. There is scope to position a PBN arrival route in the middle of the existing swathe which would avoid any increase in CO2 emissions although it would result in more people being overflown compared to any of the existing PBN options.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation[52].

[52] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	ATC advised that with any option which sees a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05, a PBN waypoint to direct RWY 05 arrivals to would be preferable to help them ensure separation. This would be available with this option. No other safety concerns have been identified at this stage.
All	Interdependencies, conflicts and tradeoffs	To accommodate a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05 may also require a relocation of the LANAK hold in the network. This could slightly change the position of the upper portion of the PBN arrival options to Runway 05 but most likely above 5/6000ft. There are not expected to be tradeoffs between arrivals below 7000ft and NERL or Edinburgh's options.
All	AMS	CAP1711 describes the objective as: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.* This option is considered to best meet the requirements of the AMS for Easterly arrivals. It introduces a PBN arrival solution without being reliant on it which ensures that demand can be met but allowing improved CDA for arrivals using the PBN structure. The feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders. It would help to reduce the number of people overflown by Glasgow's arrivals without concentrating all arrivals permanently onto 2 routes. However it could require additional CAS to contain the arrival routes in accordance with CAA policy.

5. IOA Summary and Conclusion

The following sections provide an overview of the outcome of the IOA before explaining whether an option has been progressed into Stage 3 and the rationale around this. Within this document, we have identified that further qualitative assessment is required for some categories; details have been included, where applicable, in the full IOA tables and is also summarised in the 'preferred option' section below.

Discounting Methodology

When discounting or progressing an option, each category within the IOA for each option has been reviewed in detail before being summarised as per the categories shown in table 125 below. The summary tables shown in the following sections for each runway mode provide an overview of this categorisation and show how the option has performed overall as part of the IOA when compared against the baseline 'do nothing' scenario.

Table 125 IOA Summary Table Key

IOA Summary Key	
	Anticipated overall net impacts/costs; the option may have only impacts (negatives compared to the baseline) or may have a mix of benefits and impacts where the impacts outweigh the benefits
	Neutral; the option either offers neutral benefit, or may have a mix of benefits and impacts (some of which may require quantified assessment at Stage 3 should the option progress).
	Anticipated overall net benefits/costs; the option may have only benefits (positives compared to the baseline) or may have a mix of benefits and impacts where the benefits outweigh the impacts

We have used the detailed IOA assessment as well as the summary tables as the basis for determining whether to continue or discount an option. In some cases there may be multiple options that perform well against the baseline and in these cases we have also looked at the comparative performance of each option; details of this are included in the conclusion tables below. Alongside this, we have considered the Design Principles developed with stakeholders at Stage 1 as well as the requirement to meet the Airspace Modernisation Strategy (AMS). The threshold for discounting an option cannot be based on quantitative assessments alone but must also come down to the qualitative appraisals and professional judgment, as there are many factors to balance - many of which will not be quantified until the Full Options Appraisal at Stage 3. Therefore, alongside the summary tables shown in the sections below, we have included the rationale for discounting or progressing an option which explains these qualitative elements.

5.1. Runway 23 Westerly Departures

Group	Impact	Option A	Option B	Option C	Option D	Option E
Communities	Noise impact on health and quality of life					
	Air Quality					
Wider Society	Greenhouse gas impact					
	Capacity / resilience[53]					
	Tranquillity					
	Biodiversity					
General Aviation	Access					
General Aviation / Commercial airlines	Economic impact from increased effective capacity					
	Fuel burn					
Commercial airlines	Training costs					
	Other costs					
Airport / Air navigation service provider	Infrastructure costs					
	Operational costs					
	Deployment costs					
All	Safety					
All	Interdependencies, conflicts and trade-offs					
All	AMS					
Option progressed to Stage 3		✓	X	X	X	✓

Today, all of Glasgow's SIDs turn at 5nm however in order to deliver CO_2 reductions through reduced track mileage and delays, all of Glasgow design options require SIDs to turn before 5nm which unavoidably means overflying new communities and more people overall. All the options were generated to explore the pros and cons of various configurations alongside their positive and negative effects. The options being taken forward into Stage 3 are those believed to best balance the range of competing environmental and operational requirements for Glasgow and its stakeholders.

[53] Option B, C and D capacity summary colour corrected

Option	Is the option being progressed	Rationale
Runway 23 Departure Option A	Yes	This option is progressed on the basis of it (along with Option E) best meeting the needs of the airport, airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating departure tracks away from final approach and spreading of aircraft noise from Glasgow's busiest departure route. It is not the most optimal in CO_2 reductions owing to one of the NORBO tracks being slightly longer than today but it is still expected to offer significant CO_2 reductions overall. It also does not overfly the fewest people compared to other options but that would have resulted in greater frequency of overflight for communities under a single NORBO route. It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation. However more subtle SID changes could be a potential feature and can be investigated in Stage 3. It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO_2 emissions and cater for future demand throughout the day. By having 2 NORBO SIDs, Glasgow's busiest departure route is split into two which helps mitigate the adverse noise effects of PBN concentration. As articulated within the appraisal, the track adjustments on departure followed by another immediate turn could be too technically challenging to achieve but this will be investigated in more detail in Stage 3. If they are a viable feature, the FOA will then help Glasgow to determine if the track adjustments increase or decrease population numbers within the 63db $L_{Aeq,\ 16hr}$ contour. The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.
Runway 23 Departure Option B	No	This option is discontinued as it does not meet future demand and is the poorest performing option in terms of noise. It would concentrate Glasgow's busiest departure route (NORBO) over the same populations who would be newly overflown without any mitigation against the adverse noise impacts of PBN concentration. It would overfly the fewest people as well as performing well in reducing track miles compared to other options but in turn would lead to greater frequency of overflight for those communities under the new routes. In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO_2 however this constraint on capacity could offset some of those gains in track mileage reductions. The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. When compared to other runway 23 departure options, this option overall performs poorest in terms of noise (as seen in the summary table above). When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
Runway 23 Departure Option C	No	This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns, the options also does not meet future demand, and performs comparatively poorly in the noise assessments compared to some options. The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3. In addition, the IOA noise assessment outlined that this option would concentrate Glasgow's busiest departure route over the same populations for the majority of the day who would be newly overflown. We attempted to mitigate the overflying of new communities by introducing a SID switching feature but that would have resulted in the same communities (to the south of final approach) being overflown even more than without the SID switch, albeit to the benefits of other communities. Overall, the IOA concluded that there are a mix of benefits and impacts to noise with this option however when we compare these to the benefits and impacts of other options, other options comparatively perform better. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer benefits in terms of CO_2 and CAS, there are a mix of impacts with noise, and it is not the most effective at meeting future demand.
Runway 23 Departure Option D	No	This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns. The option also does not meet future demand, and performs comparatively poorly in the noise assessments compared to some options. The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3. In addition, the IOA noise assessment outlined that, like with Option C, the single NORBO track would overfly the same communities all day without any mitigation against the adverse noise impacts of PBN concentration. With this option those communities are also under final approach and are therefore overflown the majority of the time. The result is this option overflies the most people below 4000ft compared to Options A-E. With regards to future demand, although this option offers improved capacity compared to the baseline, without splitting the NORBO route which accounts for the largest % of Glasgow departures, it does not as effectively meet future demand as other options.

		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer benefits in terms of CO_2 and CAS, there are a mix of impacts with noise, and it is not the most effective at meeting future demand.
Runway 23 Departure Option E	Yes (preferred option)	This option is progressed on the basis of it best meeting the needs of the airport, airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating the majority of departure tracks away from final approach and spreading aircraft noise from Glasgow's busiest departure route across two routes. By having 2 NORBO SIDs, Glasgow's busiest departure route is split into two which helps mitigate the noise impacts of PBN concentration. It is the most optimal in CO_2 reductions. The route positioning means it scored 2nd best in terms of population overflown below 4000ft whilst still splitting NORBO departures across 2 different routes. It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation. However more subtle SID changes could be a potential feature and can be investigated in Stage 3. It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO_2 emissions and cater for future demand throughout the day. It also mitigates the adverse impacts of PBN concentration. One of these NORBO SIDs would continue to fly down final approach but the option would result in a significant reduction in frequency of overflight for those under final approach (outside 1-2nm) compared to today. This NORBO route would also reduce the frequency of overflight for those communities to the north of final approach who may experience increased overflight (compared to today) from the northbound departures. The data suggests that the lack of a track adjustment on departure would result in lower population numbers overflown below 4000ft compared to Option A but more granular analysis is required in the FOA. The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.

5.2. Runway 05 Easterly Departures

Group	Impact	Option A	Option B	Option C	Option D	Option E	Option F	Option G	Option H	Option I
Communities	Noise impact on health and quality of life									
	Air Quality									
Wider Society	Greenhouse gas impact									
	Capacity / resilience[54]									
	Tranquillity									
	Biodiversity									
General Aviation	Access									
General Aviation / Commercial airlines	Economic impact from increased effective capacity									
	Fuel burn									
Commercial airlines	Training costs									
	Other costs									
Airport / Air navigation service provider	Infrastructure costs									
	Operational costs									
	Deployment costs									
All	Safety									
All	Interdependencies, conflicts and tradeoffs									
AMS	A qualitative (high-level) assessment of how the Design Options perform against the vision and parameters / strategic objectives of the AMS									
Option progressed to Stage 3		✗	✗	✗	✗	✗	✗	✗	✓	✓

Today, all of Glasgow's SIDs turn at 5nm however in order to deliver CO_2 reductions through reduced track mileage and delays, all of Glasgow design options require SIDs to turn before 5nm which unavoidably means overflying new communities and more people overall. All the options were generated to explore the pros and cons of various configurations alongside their positive and negative effects. The options being taken forward into Stage 3 are those believed to best balance the range of competing environmental and operational requirements for Glasgow and its stakeholders.

[54] Option A-G capacity summary colour corrected

Option	Is the option being progressed	Rationale
Runway 05 Departure Option A	No	This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS. The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route without any mitigation against the noise impacts of PBN concentration. This route would also overfly over the same populations who would be newly overflown without any mitigation, albeit areas of relatively low population compared to under the other SIDs. The Southbound SIDs turn earlier than today, overflying new communities but without offering other benefits. The option would have delivered significant CO_2 savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North. In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO2 however this constraint on capacity could offset some of those gains in track mileage reductions. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
Runway 05 Departure Option B	No	This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS. The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown without any mitigation against the impacts of PBN concentration, albeit over areas of relatively low population compared to under the other SIDs. The option would have delivered significant CO_2 savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North. In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO2 however this constraint on capacity could offset some of those gains in track mileage reductions. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
Runway 05 Departure Option C	No	This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS. The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown without any mitigation against the impacts of PBN concentration, albeit areas of relatively low population compared to under the other SIDs. The Southbound SIDs turn earlier than today, overflying new communities but without offering other benefits. The option would have delivered significant CO_2 savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North. In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO_2 however this constraint on capacity could offset some of those gains in track mileage reductions. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
Runway 05 Departure Option D	No	This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS. The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown without any mitigation against the impacts of PBN concentration, albeit over areas of relatively low population compared to under the other SIDs. The option would have delivered significant CO_2 savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North. In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO_2 however this constraint on capacity could offset some of those gains in track mileage reductions.

		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
Runway 05 Departure Option E	No	This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, performs comparatively poorly for CO2, and has a mixed performance when considering the parameters of the AMS. The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown and this routes over highly populated areas. As all NORBO departures would use one route, there is no mitigation against the impacts of PBN concentration. When compared to the baseline, the option offered better CO2 savings however compared to the other options it was the least optimal in track mileage reductions and subsequent CO2 savings. In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. This constraint on capacity could offset some of those gains in track mileage reductions. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
Runway 05 Departure Option F	No	This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns. The option also does not meet future demand, and performs comparatively poorly in the noise and CO2 assessments compared to some options. The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3. In addition, the IOA noise assessment showed that this option would concentrate Glasgow's busiest departure route over areas of very high population for ½ of the day. This option performed similarly to Option E in terms of CO_2 emissions from track mileage reductions. Whilst the SID switch is assessed as being not operationally viable for safety reasons articulated in the appraisal, it would have also increased CO_2 performance compared to keeping the Period 1 SID as a permanent arrangement. With regards to future demand, although this option offers improved capacity compared to the baseline, without splitting the NORBO route which accounts for the largest % of Glasgow departures, it does not as effectively meet future demand as other options. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that there are a mix of benefits and impacts and it is not the most effective at meeting future demand.
Runway 05 Departure Option G	No	This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns. The option also performs comparatively poorly in the noise and capacity assessments compared to some options. The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3. In addition, the IOA noise assessment showed that this option would concentrate Glasgow's busiest departure route over extremely dense population for most of the day with high numbers of newly overflown people. It would have resulted in the highest numbers of population overflown 0-4000ft and 0-7000ft although would have delivered the greatest CO_2 reductions based on track length. With regards to future demand, although this option offers improved capacity compared to the baseline, and in the peak periods it splits the NORBO route which will meet future demand more effectively that Options A-F however for the remainder of the day the NORBO departures would operate on one route which has the potential to limit capacity in future. When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that there are a mix of benefits and impacts and other options meet the requirements of the AMS more effectively.
Runway 05 Departure Option H	Yes	This option is progressed on the basis of it best meeting the needs of the airport (along with option I), airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating the majority of departure tracks away from final approach and spreading of aircraft noise from Glasgow's busiest departure route. It performs very well in terms of CO_2 reductions. The route positioning means it scored similar to Options A-C in terms of overflight below 4000ft but without overflying new population to the south at low altitude but it still splits NORBO departures (Glasgow's busiest departure) across 2 different routes. By having 2 NORBO SIDs, this helps to mitigate the noise impacts of PBN concentration. It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation (see assessments of Option F and G). However more subtle SID changes could be a potential feature and can be investigated in Stage 3. As articulated within the appraisal, the track adjustments on departure followed by another immediate turn could be too technically challenging to achieve but this will be investigated in more detail in Stage 3. If they are a viable feature, the FOA will then help Glasgow to determine if the track adjustments increase or decrease population numbers within the 63db $L_{Aeq,\ 16hr}$ contour. It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO_2 emissions and caters for future demand throughout the day. One of these NORBO SIDs would continue to fly down final approach but the option would result in a significant reduction in frequency of overflight for those under final approach (outside 1-2nm) compared to today. This NORBO route would also reduce the frequency of overflight for those

		communities to the north of final approach who may experience increased overflight (compared to today) from the northbound departures. The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.
Runway 05 Departure Option I	Yes (preferred option)	This option is progressed on the basis of it best meeting the needs of the airport, airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating the majority of departure tracks away from final approach and spreading of aircraft noise from Glasgow's busiest departure route. It performs very well in terms of CO_2 reductions. The route positioning means it scored similar to Options D in terms of overflight below 4000ft but without overflying new population to the south at low altitude but it still splits NORBO departures across 2 different routes. It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation. However more subtle SID changes could be a potential feature and can be investigated in Stage 3. It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO_2 emissions and caters for future demand throughout the day. One of these NORBO SIDs would continue to fly down final approach but the option would result in a significant reduction in frequency of overflight for those under final approach (outside 1-2nm) compared to today. This NORBO route would also reduce the frequency of overflight for those communities to the north of final approach who may experience increased overflight (compared to today) from the northbound departures. The data suggests that the lack of a track adjustment on departure would result in lower population numbers overflown below 4000ft compared to Option H but more granular analysis is required in the FOA. The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.

5.3. Runway 23 Westerly Arrivals

Group	Impact	Runway 23 Arrival Option C	Runway 23 Arrival Option D	Runway 23 Arrival Option E	Runway 23 Arrival Vectors only	Runway 23 Arrival Hybrid Vectors and PBN
Communities	Noise impact on health and quality of life					
	Air Quality					
Wider Society	Greenhouse gas impact					
	Capacity / resilience					
	Tranquillity					
	Biodiversity					
General Aviation	Access					
General Aviation / Commercial airlines	Economic impact from increased effective capacity					
	Fuel burn					
Commercial airlines	Training costs					
	Other costs					
Airport / Air navigation service provider	Infrastructure costs					
	Operational costs					
	Deployment costs					
All	Safety					
All	Interdependencies, conflicts and tradeoffs					
AMS	A qualitative (high-level) assessment of how the Design Options perform against the vision and parameters / strategic objectives of the AMS					
Option progressed to Stage 3		✗	✓*	✗	✓	✓

*As articulated in our Stage 2A document, use of pure PBN for arrivals into Glasgow does not perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. Therefore, this option was discounted in the DPE. However, the option of a mix of PBN and vectoring does come through very favourable. In this scenario, we would want to use the best performing PBN routes so we will take the PBN arrival options (other than the ones discounted above) into the Full Options Appraisal for further assessment to help inform the Hybrid vectors and PBN options.

Option	Is the option being progressed	Rationale
Runway 23 Arrival Option C	No	Overall, when looking at the IOA summary tables, the three PBN options C, D and E perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each of options C, D and E, within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning) and consideration of safety elements including the known Campsie line ground proximity warning system (GPWS) issues. When considering these elements with the detail available at this stage, the options (C, D and E) are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3. Next, we looked at the IOA categories where the comparative performance of the options C, D and E varies; these were the noise and CO2/Fuel burn assessments. Although this option was the best performing PBN arrival option in terms of CO_2, it was the poorest performer in terms of population numbers, overflying more than double the number of people at 4000ft and below compared to Option E and over two thirds more people than Option D. Given the small variations in track length and subsequent CO2 and Fuel burn impacts between Option C and Option D, we therefore determined that Option D's overall performance achieved a better balance between CO2 performance and noise and therefore we have chosen to discontinue Option C at this stage.
Runway 23 Arrival Option D	No (preferred for Hybrid Vectors and PBN option)	Overall, when looking at the IOA summary tables, the three PBN options C, D and E perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each of options C, D and E, within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning) and consideration of safety elements including the know Campsie line ground proximity warning system (GPWS) issues. When considering these elements with the detail available at this stage, the options (C, D and E) are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3. Beyond the above categories, we've looked at the IOA categories where the comparative performance of the options varies; these were the noise and CO2/Fuel burn assessments. Option D overflies considerable fewer population numbers than Option C 0-4000ft and 0-7000ft with much better CO_2 performance compared to Option E. We therefore concluded that it achieved a good compromise between these two elements and would be most appropriate to take forward to be optimised in Stage 3.
Runway 23 Arrival Option E	No	Overall, when looking at the IOA summary tables, the three PBN options C, D and E perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each of options C, D and E, within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning) and consideration of safety elements including the know Campsie line ground proximity warning system (GPWS) issues. When considering these elements with the detail available at this stage, the options (C, D and E) are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3. Beyond the above categories, we've looked at the IOA categories where the comparative performance of the options varies; these were the noise and CO2/Fuel burn assessments. Although Option E was the best performing PBN arrival option in terms of noise, overflying more than half the numbers of people 4000ft and below than Option C, it was the poorest performer when considering fuel burn and CO2. Compared to Option D, Option D offers a relatively small increase in the number of people overflow compared to Option E however it also offers a more significant improvement in track mileage and subsequent fuel burn/CO2 emissions. We therefore determined that Option D's overall performance achieved a better balance between CO2 performance and noise and therefore we have chosen to discontinue Option E at this stage.
Runway 23 Arrival Vectors only	Yes	Vectoring is a proven and ever flexible method of efficiently managing arrivals. The IOA showed that it offered fewer benefits compared to the other options but also had fewer negative impacts. It is likely that changes to the network as well as to the rest of Glasgow's route structure will result in a change to vectoring practices and this option is carried forward to accommodate those changes.
Runway 23 Arrival Hybrid Vectors and PBN	Yes (preferred)	This is Glasgow's preferred option. In the IOA it offered the most benefits compared to the 'do nothing' baseline, as seen in the summary table above. The availability of PBN arrivals to RWY 23 may be able to address some of the GPWS issues, greatly reduce the numbers of people overflown by avoiding population centers, enhance CDA performance and reduce controller workload to support operation concepts such as Radar In The Tower. By also retaining vectoring, it enables ATC to deliver accurate and variable spacing, mitigates the increase in track miles that a Permanent PBN arrival may require and also ensure some track variation on the ground compared to pure PBN which helps to mitigate adverse effects from PBN concentration. The positioning of the PBN route within this option is still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.

5.4. Runway 05 Easterly Arrivals

Group	Impact	Runway 05 Arrival Option A	Runway 05 Arrival Option B	Runway 05 Arrival Option C	Runway 05 Arrival Option D	Runway 23 Arrival Vectors only	Runway 23 Arrival Hybrid Vectors and PBN
Communities	Noise impact on health and quality of life						
	Air Quality						
Wider Society	Greenhouse gas impact						
	Capacity / resilience						
	Tranquillity[55]						
	Biodiversity						
General Aviation	Access						
General Aviation / Commercial airlines	Economic impact from increased effective capacity						
	Fuel burn						
Commercial airlines	Training costs						
	Other costs						
Airport / Air navigation service provider	Infrastructure costs						
	Operational costs						
	Deployment costs						
All	Safety						
All	Interdependencies, conflicts and trade-offs						
AMS	Performance against the vision and parameters / strategic objectives of the AMS						
Option progressed to Stage 3		✗	✓*	✗	✗	✓	✓

*As articulated in our Stage 2A document, use of pure PBN for arrivals into Glasgow does not perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. Therefore, this option was discounted in the DPE. However, the option of a mix of PBN and vectoring does come through very favourably. In this scenario, we would want to use the best performing PBN routes so we will take the PBN arrival options (other than the ones discounted above) into the Full Options Appraisal for further assessment to help inform the Hybrid vectors and PBN options.

Option	Is the option being progressed	Rationale
Runway 05 Arrival Option A	No	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3. To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/General Aviation. With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, there was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly, when looking at the 60dB LAmax data, there is less than 200 population between the best and worst performing options. When considering track mileage, CO2 and fuel burn, there are only very small differences between the four options A-D. Of the four options, Option A is the second worst performing for track miles. Option A would require additional CAS and this is expected to be a greater volume than options B and D. Given the very small differences between Option A and Options B-D in the other areas outlined above, it is on basis of CAS that Option A is discontinued at this stage.
Runway 05 Arrival Option B	No (preferred for Hybrid Vectors and PBN option)	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.

[55] All options avoid overflight of tranquil areas which is the same as the vectoring and centreline baseline.

		To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/General Aviation. With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, there was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly, when looking at the 60dB LAmax data, there is less than 200 population between the best and worst performing options. When considering track mileage, CO2 and fuel burn, there are only very small differences between the four options A-D. Of the four options, Option B is the best performing. Option B would require additional CAS unless moved slightly further East however this is expected to be less of a move than would be required for Options A and C. On balance, Option D and Option B are very similar however Option B performs slightly better in terms of population overflown, and CO2 and is expected to require a similar volume of CAS to Option B. We have therefore chosen to take forward Option B to Stage 3 of the process.
Runway 05 Arrival Option C	No	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3. To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/General Aviation. With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, there was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly, when looking at the 60dB LAmax data, there is less than 200 population between the best and worst performing options. When considering track mileage, CO2 and fuel burn, there are only very small differences between the four options A-D. Of the four options, Option C is the worst performing for track miles. Option C would require additional CAS and this is expected to be a greater volume than options B and D. Given the very small differences between Option C and Options A, and D in the other areas outlined above, it is on basis of CAS that Option A is discontinued at this stage.
Runway 05 Arrival Option D	No	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if any performed comparatively better than others. It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3. To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/General Aviation. With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, there was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly, when looking at the 60dB Lamax data, there is less than 200 population between the best and worst performing options. When considering track mileage, CO2 and fuel burn, there are only very small differences between the four options A-D. Of the four options, Option D is the second best performing for track miles. Option D would require additional CAS unless moved slightly further East however this is expected to be less of a move than would be required for Options A and C. On balance, Option D and Option B are very similar however Option B performs slightly better in terms of population overflown, and CO2 and is expected to require a similar volume of CAS to Option B. We have therefore chosen to take forward Option B and discontinue Option D at this stage.
Runway 05 Arrival Vectors only	Yes	Vectoring is a proven and ever flexible method of efficiently managing arrivals. The IOA showed that it offered fewer benefits compared to the other options but also had fewer negative impacts. It is likely that changes to the network as well as to the rest of Glasgow's route structure will result in a change to vectoring practices and this option is carried forward to accommodate those changes.
Runway 05 Arrival Hybrid Vectors and PBN	Yes	This is Glasgow's preferred option. In the IOA it offered the most benefits compared to the 'do nothing' baseline, as seen in the summary table above. The availability of PBN arrivals to RWY 05 may be able to reduce the numbers of people overflown by avoiding population centres, enhance CDA performance and reduce controller workload to support operation concepts such as Radar In The Tower. However, all of options A-D could require additional CAS to contain the routes in accordance with CAA policy. This CAS requirement will be investigated in Stage 3 to try and avoid the need for any additional CAS through alternative mitigation. By also retaining vectoring, it enables ATC to deliver accurate and variable spacing, mitigates the increase in track miles that a Permanent PBN arrival may require but also ensure some track variation on the ground compared to pure PBN which has some noise benefits. The availability of a PBN waypoint to ensure separation between RWY 05 arrivals and departures is currently considered to be a requirement in the final solution. The positioning of the PBN route within this option is still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.

5.5. Preferred option and information to collect as part of the Full Options Appraisal

We have outlined which options we plan to take forward to Stage 3 as part of our IOA Summary and conclusion section above. As part of this, we have also indicated our preferred options however it's important to note that we will need to refine those options ahead of the Full Options Appraisal (FOA) to ensure they can integrate with the network, the PBN arrivals can connect to final approach in accordance with regulations and that the routes are all flyable. All refinements that lead to the final solution(s) taken to FOA and subsequent consultation will be documented as part of the design evolution.

Throughout this Initial Options Appraisal, we have highlighted where we plan to undertake further detailed appraisal as part of our Stage 3 Full Options Appraisal, in order to further assess the benefits and impacts of an option. This is particularly the case with the primary noise metric data, where at Stage 3 we will fully quantify the L_{Aeq} contours associated with each option to CAP2091 standards, allowing us to quantify the benefits and impacts. We have also identified other categories where further quantitative appraisal work is required.

We plan to collect the following data and undertake the additional assessments as part of our Full Options Appraisal assessment and following this assessment we will outline the options that we intend to take to Consultation:

- Quantify the baseline year (pre-implementation and 10 years post implementation, including 10 year traffic forecast)
- Quantitative L_{Aeq} contours, population counts and size (km^2)
- WebTAG assessment
- Quantitative overflight contours that detail frequency of overflight including 100% easterlies and westerlies, and cumulative impacts from arrivals/departures and other airports
- Detailed track length comparison
- Detailed fuel burn and equivalent CO_2 emissions data
- Further information around interdependencies with the upper network and neighbouring airports
- ATC deployment / training costs
- Quantitative capacity information
- Quantified CAS requirements
- Further information following engagement with gliding areas around airspace availability

5.6. Impacted Audiences

At the 'Develop and assess' gateway, the IOA 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 'Consult' gateway.

The following figures show our options on one map image, displayed using overflight contours and the vectoring NTK heatmap. We will use this mapping as a starting point to identify our impacted audiences and ensure that this is considered when developing our consultation strategy at Stage 3. We're aware that other factors also need to be taken into account when identifying the audience such as other noise metrics, changes to controlled airspace etc and we will ensure these are also factored in.

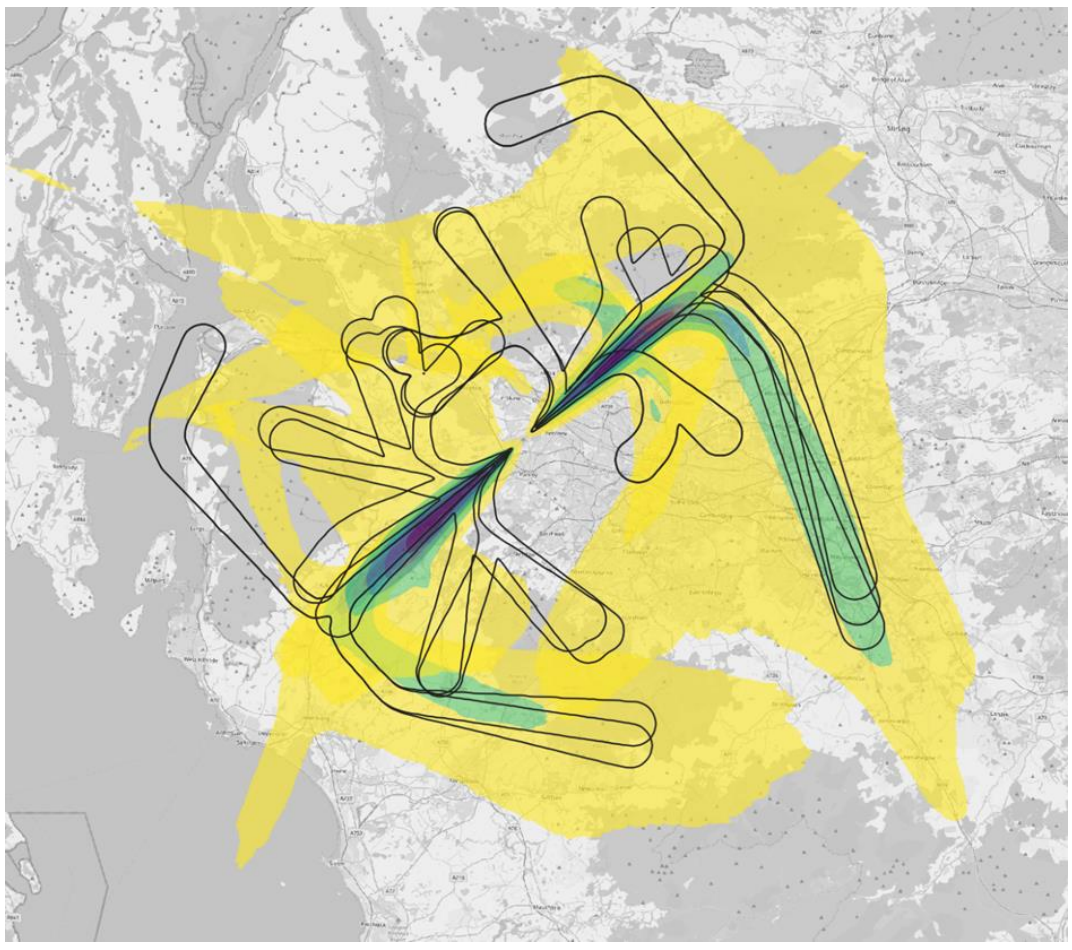


Figure 41 All Options for Stage 3 (Overflight Contours)

Glossary

Acronym	Term	Description
ACOG	Airspace Change Organising Group	Established in 2019 at the request of the Department for Transport and Civil Aviation Authority to coordinate the delivery of key elements of the UK's Airspace Modernisation Strategy.
ACP	Airspace Change Proposal	To carry out any permanent change to the published airspace, the Civil Aviation Authority (CAA) requires the change sponsor to carry out an airspace change proposal in accordance with CAP1616.
ADS-B	Automatic Dependent Surveillance Broadcast	A means by which aircraft can automatically transmit and/or receive data such as identification, position, and additional data, as appropriate in a broadcast mode via a data link.
AIP	Aeronautical Information Publication	A publication which contains details of regulations, procedures and other information pertinent to the operation of aircraft in the particular country to which it relates.
AMS	Airspace Modernisation Strategy	UK Government has tasked the aviation industry to modernise airspace in the whole of the UK. The long-term strategy of the CAA and the UK Government is called the Airspace Modernisation Strategy (AMS). Its CAA document reference number is CAP1711.
AMSL	Above Mean Sea Level	
ANSP	Air Navigation Service Provider	An organisation that provides the service of managing the aircraft in flight or on the manoeuvering area of an airport and which is the legitimate holder of that responsibility.
AONB	Area of Outstanding Natural Beauty	
ATC	Air traffic control	The ground-based personnel and equipment concerned with controlling and monitoring air traffic within a particular area.
ATZ	Aerodrome Traffic Zone	An airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic.
CAA	Civil Aviation Authority	The UK Regulator for aviation matters
CAP1616	Civil Aviation Publication 1616	The airspace change process regulated by the CAA
	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	Generic term for the airspace in which an air traffic control service is provided as standard; note that there are different sub classifications of airspace that define the particular air traffic services available in defined classes of controlled airspace.
-	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	An aircraft operating technique facilitated by the airspace and procedure design and assisted by appropriate ATC procedures, allowing the execution of a flight profile optimised to the performance of aircraft, leading to significant economy of fuel and environmental benefits in terms of noise and emissions reduction
CDO	Continuous Descent Operations	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
-	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.
CTA	Control Area	Controlled airspace extending upwards from a specified limit above the earth. Control Areas are situated above the Aerodrome Traffic Zone (ATZ) and afford protection over a larger area to a specified upper limit.
CTR	Control Zone	Controlled airspace extending upwards from the surface of the earth to a specified upper limit. Aerodrome Control Zones afford protection to aircraft within the immediate vicinity of aerodromes
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.
DER	Declared End of Runway	
-	Dispersal	Refers to the density of aircraft flight paths over a given location, this generally refers to lower density – tracks that are spread out; this is opposite of Concentration
DPE	Design Principle Evaluation	A evaluation of each option against each design principle which forms part of Stage 2A of the CAP1616 process
-	Easterlies	When a runway is operating such that aircraft are taking off and landing in an easterly direction
-	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 a 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 4000 feet above sea level) are flight levels used to indicate altitude; below the transition level feet are used.
FLARM	Flight Alarm	FLARM (an acronym based on 'flight alarm') is the proprietary name for an electronic device which is in use as a means of alerting pilots of small aircraft, particularly gliders, to potential collisions with other aircraft which **are similarly equipped.**
FUA	Flexible Use Airspace	Airspace which is not solely designated for a single purpose, but can be allocated flexibly according to need, or switched entirely on/off according to a schedule or agreed process.
-	Flight-path	The track flown by aircraft when following a route, or when being directed by air traffic control

ft	Feet	The standard measure for vertical distances used in air traffic control
FASI	Future Airspace Strategy Implementation	Under the Government's Airspace Modernisation Strategy (AMS, ref 15) airports in the UK are required to update their airspace and routes in a coordinated way.
GA	General Aviation	All civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire. The most common type of GA activity is recreational flying by private light aircraft and gliders, but it can range from paragliders and parachutists to microlights, balloons, and private corporate jet flights.
IFP	Instrument Flight Procedures	A published procedure used by aircraft flying in accordance with the instrument flight rules, which is designed to achieve and maintain an acceptable level of safety in operations and includes an instrument approach procedure, a standard instrument departure, a planned departure route and a standard instrument arrival.
ILS	Instrument Landing System	An ILS operates as a ground-based instrument approach system that provides precision lateral and vertical guidance to an aircraft approaching and landing on a runway, using a combination of radio signals to enable a safe landing even during poor weather.
IOA	Initial Options Appraisal	A qualitative appraisal of an option against a baseline 'do nothing' scenario, as required at Step 2B of CAP1616
L_{Aeq}		The most common international measure of noise, meaning, 'equivalent continuous sound level'. This is a measurement of sound energy over a period of time.
$L_{Aeq\ 16h}$		The A-weighted Leq measured over the 16 busiest daytime hours (0700-2300) is the normal time-period used to develop the Airport Noise Contours for day-time operations.
$L_{Aeq\ 8h}$		The A-weighted Leq measured over the 8 night-time hours (2300-0700) is the normal time-period used to develop the Airport Noise Contours for night-time operations.
-	Lower Airspace	Airspace in the general vicinity of the airport containing arrival and departure routes below 7,000ft. 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
NAP	Noise Abatement Procedures	Noise abatement procedures are designed to minimise exposure of residential areas to aircraft noise, while ensuring safety of flight operations
NATS (ATC)		NATS ATC - the air navigation service provider at Glasgow Airport under commercial contract for the aerodrome control provision.
NATS NERL		NATS NERL - The UK's licenced air traffic service provider for the en route airspace (upper network) that connects airports with each other, and with the airspace of neighbouring states.
nm	Nautical Mile	Aviation measures distances in nautical miles. One nautical mile (nm) is 1,852 metres. One road mile ('statute mile') is 1,609 metres, making a nautical mile about 15% longer than a statute mile.
-	Network Airspace / Upper network	En route airspace above 7,000ft in which NATS has accountability for safe and efficient air traffic services for aircraft travelling between the UK airports and the airspace of neighbouring states.
NTK	Noise Track Keeping	A system that monitors and records radar data to monitor aircraft operations and report statistics focused around noise.
PANS OPS	Procedures for Air Navigation Services Aircraft Operations	PANS-OPS is contained in an ICAO Document 8168 which sets out the design criteria and rules for instrument flight procedures which include approach and departure procedures.
PBN	Performance Based Navigation	Referred to as PBN; a generic term for modern standards for aircraft navigation capabilities including satellite navigation (as opposed to 'conventional' navigation standards)
PC	Prestwick Centre	Prestwick Centre handles air traffic across northern England, Scotland and out into North East Atlantic.
RMA	Radar Manoeuvring Area	An ATC operational area articulated as a volume of airspace by the ANSP. It facilitates the close-in radar vectoring by ATC that is required to take the aircraft safely from a holding stack and established onto final approach.
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.
RNP-RF	Required Navigation Performance Radius to fix	–An advanced navigation specification under the PBN umbrella. The suffix '1' denotes a requirement that aircraft can navigate to with 1nm of the centreline 95% or more of the time, with additional self-monitoring criteria. In practice the accuracy is much greater than this. The RF means Radius to Fix, where airspace designers can set extremely specific curved paths to a greater accuracy than RNAV1.
RNP-AR	Required Navigation Performance Authorisation required	–An advanced navigation specification under the PBN umbrella. 'Authorisation required' refers to aircraft and operators complying with specific airworthiness and operational requirements. RNP-AR allow airspace designers to set extremely specific curved paths to a greater accuracy than RNAV1, these can be designed before and after the Final Approach Fix.
-	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 1,000ft vertical separation.
SID	Standard Instrument Departure	Usually abbreviated to SID; this is a route for departures to follow straight after take-off.
	Tactical Intervention	Air traffic control methods that involve controllers directing aircraft for specific reasons at that particular moment (see Vector)
TMA / ScTMA	Terminal Manoeuvring Area (Terminal Airspace) / Scottish 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 airspace surrounding Glasgow & Edinburgh airports is described as the Scottish TMA (ScTMA). This is the airspace that contains all the arrival and departure routes for Glasgow & Edinburgh from the surface to 6000ft.

TMZ	Transponder Mandatory Zone	Airspace of defined dimensions where the carriage and operation of transponder equipment is mandatory.
VFR	Visual Flight Rules	Visual Flight Rules (VFR) are the rules that govern the operation of aircraft in Visual Meteorological Conditions (VMC) (conditions in which flight solely by visual reference is possible)
VMC	Visual Meteorological Conditions	Visual meteorological conditions (VMC) are the meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minima
VSA	VFR Significant Area	A volume of airspace which has been identified as being particularly important to VFR operations. A VSA might take the form of a route, a zone, or an area chosen for its particular importance to GA users. These areas do not have any official status but are intended to highlight the importance of a particular area so that future airspace development plans can take account of the GA activity.
-	Vector / vectoring	An air traffic control method that involves directing aircraft off the established route structure or off their own navigation – ATC instruct the pilot to fly on a compass heading and at a specific altitude. In a busy tactical environment, these can change quickly. This is done for safety and for efficiency.
-	Westerly operation	When a runway is operating such that aircraft are taking off and landing in a westerly direction