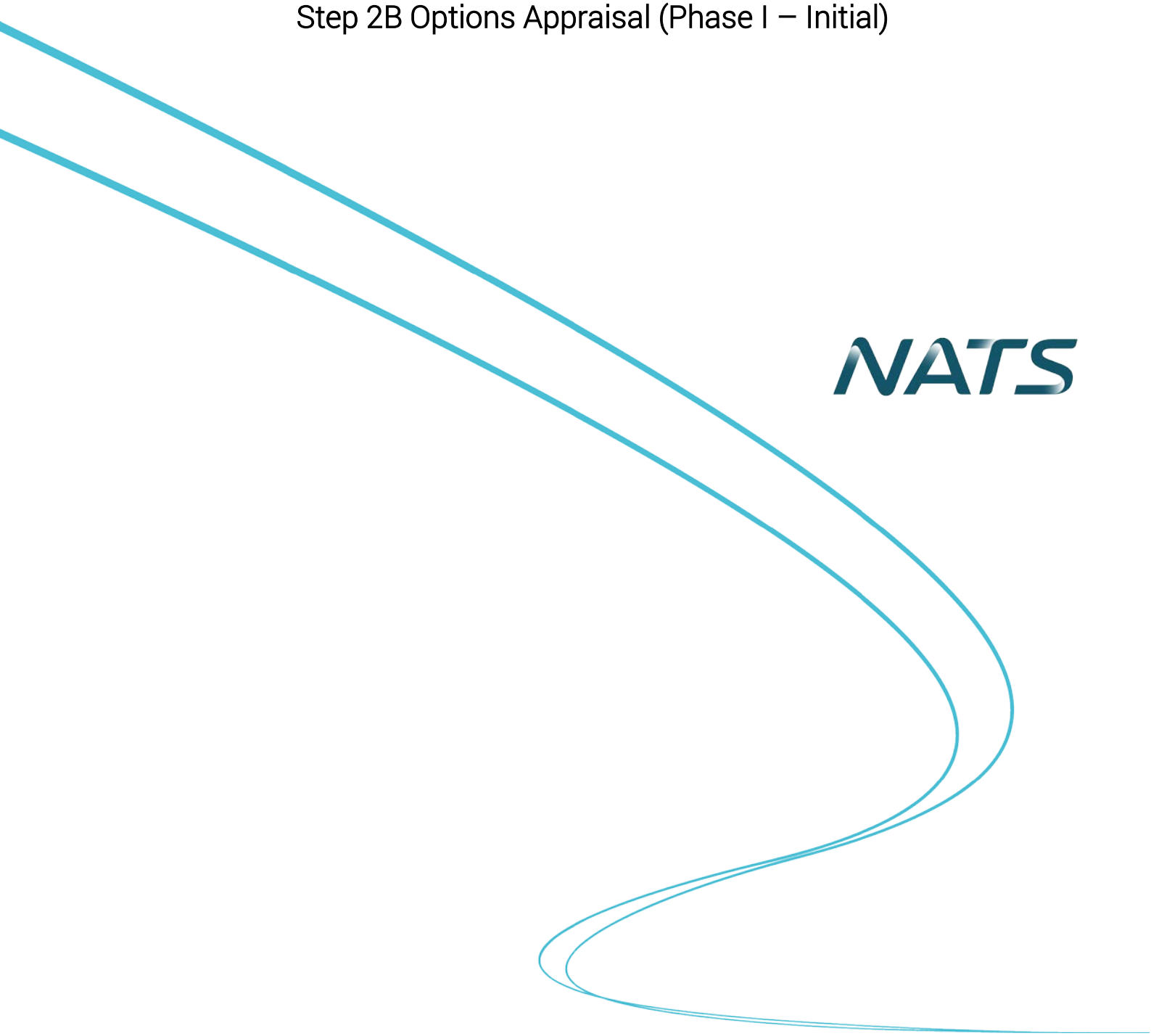
Future Airspace Strategy Implementation: - Manchester Terminal Manoeuvring Area (MTMA) ACP-2019-77

Gateway documentation:
Stage 2 Develop & Assess

Step 2B Options Appraisal (Phase I – Initial)



Roles

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Issue 1.0	January 2023	Submitted to CAA for publication

Contents

1. Introduction

1.1 This Airspace Change Proposal (ACP) is sponsored by NATS EnRoute Ltd. (NERL). Today's Air Traffic Services (ATS) route network has evolved over time and does not fully exploit modern navigation technology. The objective of this ACP is to modernise the route network surrounding the Manchester Terminal Manoeuvring Area (Manchester TMA) airspace in accordance with the Civil Aviation Authority's (CAA's) Airspace Modernisation Strategy (AMS) using Performance Based Navigation (PBN). This seeks to provide capacity benefits through systemisation by reducing conflicts whilst also intending to provide a reduction in fuel burn and CO_2 emissions.

1.2 This document forms part of the document set required for the CAP1616 airspace change process: Stage 2 Develop and Assess, Step 2B Options Appraisal (Phase 1 Initial) including Safety Considerations.

1.3 Its purpose is to consider the shortlist of airspace design options which have progressed through the Step 2A (ii) Design Principle Evaluation, to provide comparisons of each option via qualitative assessment or, if available and proportional, quantitative analysis. These assessments are based on stakeholder feedback and Subject Matter Expert (SME) input to ensure the options are appraised in fair and unbiased manner. This document should be read in conjunction with the Step 2A documentation.

1.4 For this submission, under Stage 2, the design options have been presented as high-level concepts with the tracks presented as indicative swathes and are not yet fully developed, i.e., the exact track locations and quantities are yet to be decided. Therefore, the analysis will be qualitative. Any values presented will be of indicative value only and used to highlight the potential of an option.

1.5 A baseline has been provided for each element which describes the extant airspace design considering any previously approved airspace changes. We are aware of other ongoing ACPs which may have an impact on this proposal. We will continue to work closely with the sponsors of these ACPs through all stages of the CAP1616 process to ensure our designs consider the impact of these as they progress.

1.6 This Manchester TMA Airspace Change incorporates a large volume of airspace with traffic arriving/ departing the Manchester TMA from different locations. These various traffic flows have differing traffic demands and therefore have to be considered independently so as to identify the optimal solution. The ACP seeks to introduce numerous different changes considering these various demands and, as such, the number of potential options detailing the holistic design for this change was vast and unmanageable. Therefore, the impacted airspace was split into 5 geographic elements (Northern Spine, Eastern Arm, Southern Spine, Western Arm and Central), each encompassing similar changes for the ATS route network, with design options, presented as high-level concepts, considered for each element. Additionally, design options, presented as high-level concepts, for Manchester TMA airport connectivity (separated into departure connectivity, arrival connectivity and arrival structures) connecting the enroute ATS route network and the lower airspace were considered.

1.7 Following the Design Principle Evaluation, Step 2A, the design options listed in Table 1 have progressed to this stage:

Element	Design Option
Northern Spine	Option 1: Systemised routes
	Option 2: Part-systemised routes
Eastern Arm	Option 1: Systemised routes
	Option 2: Part-systemised routes
Southern Spine	Option 1: Systemised routes
	Option 2: Part-systemised routes
Western Arm	Option 1: Systemised routes
	Option 2: Part-systemised routes
Central	Option 1: Route Connectivity
Departure Connectivity	Option 1: Departure connectivity without new CAS
	Option 2: Departure connectivity with new CAS
Arrival Connectivity	Option 1: Arrival connectivity without new CAS
	Option 2: Arrival connectivity with new CAS
Arrival Structures	Option 1: Radial Holds

Table 1: Shortlisted Design Options which have progressed through the Design Principle Evaluation.

1.8 The other design options considered have not progressed to this stage following the Design Principle Evaluation which included input from SMEs, airspace design experts and stakeholder feedback. This document should be read in conjunction with the Step 2A Design Options & Design Principle Evaluation document, which gives descriptions of each option and assesses each option against the Design Principles agreed in Step 1B.

1.9 **Where are we in the airspace change process?** We have completed Stage 1: Define, where we recognised the need for an airspace change and the Design Principles underpinning it. We are now in Stage 2: Develop and Assess and this document is Step 2B Options Appraisal, see Figure 1.

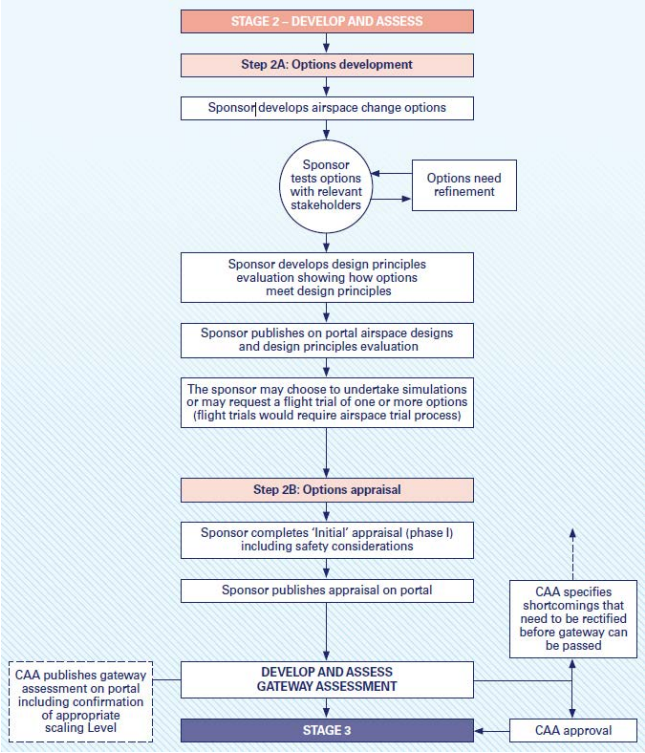


Figure 1: CAP1616 (Ed. 4 Page 45) Airspace Change Process Stage 2

2. How to read this document – illustrations of current and potential impacts

2.1 The following tables are based on CAP1616 4th edition, Table E2, pages 201-203.

2.2 From Step 2A, two options were shortlisted for each element, apart from the Central geographical element and Arrival Structures which each had only a single option progressed. This led to a total of 14 options being considered, see Table 1 above. A separate analysis is presented for each option and for the baseline scenario for each element as a comparison.

2.3 The changes described within this ACP will only affect the enroute network in airspace above 7,000ft. However, the ACP will progress on the assumption of a scaled Level 1. This will continue to allow any airport-led changes to be progressed coincidently.

2.4 In this document we provide tables for the 14 candidate design options. Note that these are compared against the Baseline 'Do-Nothing' scenario.

2.5 We describe broadly what we expect the scale of impact might be, for each option.

2.6 Owing to the presentation of design options as high-level concepts, it would be disproportionate to attempt an accurate quantitative assessment of each option. This document will therefore provide a qualitative assessment and provide some indicative quantitative assessments of potential savings which might be achieved if the design option was implemented. This initial numerical analysis is based on the broad design concepts and will be subject to refinement before the next stage, so the numbers

may change as the design is refined. This is proportionate and in line with the expectations of CAP1616 Stage 2[1].

2.7 It is expected that with more detailed modelling of the designs as they develop in Stage 3, some of the qualitative assessments will be quantified.

2.8 The following assumptions are made in the Initial Options Appraisal:

- The quantity of fuel burnt is proportional to the distance flown. i.e., increased track miles will result in increased fuel burn
- It is more efficient to fly at a higher altitude than a lower one
- It is more beneficial to enable Continuous Descent Operations (CDO) over Continuous Climb Operations (CCO)[2]
- A "radial hold" is analogous with a left-hand or right-hand standard "racetrack hold"
- There is a fixed correlation between fuel burnt and greenhouse gases emitted. For every 1kg of fuel that is burnt 3.18kg of CO_2 equivalent (CO_2e) is emitted. Therefore, greenhouse gasses emitted are directly proportional to distance flown.
- Noise impacts at and above FL70/7,000ft are not considered as a priority for consideration by Government guidance. This includes tranquillity impacts on Areas of Outstanding Natural Beauty (AONBs) and National Parks.

[1] CAP1616, 4th ed tion, page 41 paragraph 133 and page 197 paragraph E12
[2] https://www.eurocontrol.int/concept/continuous-climb-and-descent-operations#:~:text=Aircraft%20applying%20CCO%20employ%20optimum,to%20the%20final%20approach%20fix.

3. Route Network Design Options

3.1 Northern Spine

Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Northern Spine predominantly covers Northern England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the Lake District, the Yorkshire Dales, the North Pennines, Arnside and Silverdale, the Forest of Bowland and Nidderdale. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[3]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Northern Spine seeks to review and improve the existing ATS route structure overhead Northern England. The routes contained within this airspace provide connectivity for traffic to/from the ScTMA, Reykjavik FIR and North Atlantic tracks to/from the Manchester TMA, London TMA, and northbound/southbound overflights. Additionally, traffic to/from Newcastle, Aberdeen, and Norway FIR to/from the Manchester TMA, northbound/southbound overflights and inbounds/outbounds to/from Birmingham, East Midlands, and London TMA. Traffic flying between the Manchester TMA and the ScTMA is currently orientated with northbound traffic predominantly kept to the Eastern edge of the CTAs and southbound traffic on the West. Traffic flying between the Manchester TMA and Newcastle are similarly orientated. This orientation of traffic reduces conflictions between aircraft routing north and those routing south. However, routes are not separated by design and aircraft are routinely vectored away from the route structure to maintain separation from other aircraft. The existing route structure within this element is predicated around the historic dependence on ground-based navigation aids and therefore does not provide direct, great circle connectivity between the south and the ScTMA resulting in increased greenhouse gas emissions. The base of CAS currently restricts CDO unnecessarily, forcing aircraft to stagger their descents, increasing CO_2 emissions. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the greenhouse gas impact.
Wider society	Capacity/ resilience	Qualitative	The Northern Spine seeks to review and improve the existing ATS route structure overhead the North of England. The routes contained within this

[3] See Air Navigation Guidance 2017

			airspace provide connectivity for traffic to/from the ScTMA, Reykjavik FIR and North Atlantic tracks to/from the Manchester TMA, London TMA, and northbound/southbound overflights. Additionally, traffic to/from Newcastle, Aberdeen, and Norway FIR to/from the Manchester TMA, northbound/southbound overflights and inbounds/outbounds to/from Birmingham, East Midlands and London TMA. Should the routes in this element not be modernised, aircraft will continue to be managed as per today. Therefore, there will be no change to the existing capacity or resilience of the airspace. This airspace is currently operating near to capacity and as traffic numbers grow in line with the forecast, effective sector capacity will become increasingly constrained, partially due to increasing controller workload. This could in turn lead to a reduction in resilience.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace impacted by this element will remain a mixture of Class A and Class D airspace. GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes as they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Northern Spine seeks to review and improve the existing ATS route structure overhead Northern England. These routes provide connectivity for aircraft arriving/departing the Manchester TMA airspace from/to the North. Aircraft are currently orientated with northbound traffic predominantly on the Eastern edge of the CTAs and southbound traffic on the West. This orientation of traffic reduces conflictions between aircraft routing north and those routing south. However, aircraft are routinely vectored away from the route structure to maintain separation from other aircraft. The existing routes are structured around the historic dependence on ground-based navigation aids and therefore do not provide direct, great circle connectivity between the south and the ScTMA resulting in increased fuel burn. The extant routes currently converge overhead these navigation aids before diverging which adds superfluous track miles, and introduces conflictions requiring controller intervention (vectoring) to resolve which further increases the track miles flown from the flight planned route. The base of CAS currently prevents optimal CDO, unnecessarily forcing aircraft to stagger their descents, resulting in additional fuel burn. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the fuel burn.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 2: Options Appraisal (CAP1616 E2), Northern Spine Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Not Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)

- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1. Systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Northern Spine predominantly covers Northern England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the Lake District, the Yorkshire Dales, the North Pennines, Arnside and Silverdale, the Forest of Bowland and Nidderdale. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[4]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Northern Spine seeks to review and improve the existing ATS route network overhead Northern England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the North. It is estimated that the provision of more direct, great circle connectivity within the Northern Spine could save up to 3.5 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may facilitate more optimal CDO and CCO further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option introduce a new systemised route structure between the Manchester TMA and the ScTMA and Newcastle. These routes would provide an efficient deconflicted network where possible, providing more efficient use of the airspace, increased predictability of the traffic flows and reduced controller and pilot workload, improving the capacity and resilience of the ATC network. However, a fully systemised airspace design does not have the flexibility required to maximise the efficiency of the interface with the surrounding airspace. The route structure will need to provide alignment with the existing traffic flows, affecting the efficacy of the design and impacting the capacity and resilience of the network. Additional entry/exit points may also be required (e.g., for connectivity to FRA) as well as modifications to routes within the neighbouring airspace to ensure connectivity to the wider network.
General Aviation (GA)	Access	Qualitative	Introduction of a systemised route structure within the Northern Spine may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. The proposed airspace classification has not yet been determined. However, SMEs have identified that introducing systemised routes would lead to a reduction in airspace complexity which may enable a reduction in airspace classification. This would improve access to the airspace for all airspace users. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic would be able to access the airspace subject to appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no

[4] See Air Navigation Guidance 2017

			longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Northern Spine seeks to review and improve the existing ATS route network overhead Northern England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle, routes between the Manchester TMA and the North. It is estimated that the provision of more direct, great circle connectivity within the Northern Spine could save up to 3.5 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention allowing aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of fuel burn will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[5]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 3: Options Appraisal (CAP1616 E2), Northern Spine Option 1

[5] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

Conclusion

Compared to the baseline, the performance of Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the ATS route network through a reduction in controller workload.
Option 1 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures.
However, this additional airspace could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS would be the minimum volume and appropriate classification to safely contain the proposed systemised routes.

Option 1 offers comparable benefits to Option 2 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual impacted traffic flows. Therefore, this option could require a greater quantity of CAS than Option 2 without offering any additional benefits. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 1 is REJECTED in preference to Option 2 at this stage.

Option 2. Part-systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Northern Spine predominantly covers Northern England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the Lake District, the Yorkshire Dales, the North Pennines, Arnside and Silverdale, the Forest of Bowland and Nidderdale. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[6]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Northern Spine seeks to review and improve the existing ATS route network overhead Northern England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the North. It is estimated that the provision of more direct, great circle connectivity within the Northern Spine could save up to 3.5 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an additional reduction in CO_2 emissions. A review of the bases of CAS may allow for more optimal CDO and CCO further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option introduce a new systemised route structure between the Manchester TMA and the ScTMA and Newcastle. These routes will be complemented with non-systemised routes where systemisation is not warranted. This would provide an efficient deconflicted network where possible with added connectivity to Free Route Airspace (FRA) yielding capacity benefits and a reduction in air traffic control (ATC) complexity. This would increase the capacity and resilience of the ATC network through a reduction in controller workload.
General Aviation (GA)	Access	Qualitative	Introduction of systemised routes within the Northern Spine may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. This additional airspace requirement is reduced by complementing the systemised routes with non-systemised routes when these are more suitable. The proposed airspace classification has not yet been determined. However, SMEs have identified that introducing systemised routes would lead to a reduction in airspace complexity which may enable a reduction in airspace classification. This would improve access to the airspace for all airspace users. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic would be able to access the airspace subject to appropriate ATC clearance.

[6] See Air Navigation Guidance 2017

			The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Northern Spine seeks to review and improve the existing ATS route network overhead Northern England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the North. It is estimated that the provision of more direct, great circle connectivity within the Northern Spine could save up to 3.5 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an additional reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO further reducing fuel burn. This analysis is qualitative and more detailed quantitative analysis of fuel burn will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[7]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to

[7] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

	airspace users as appropriate and providing compatibility with national security requirements.

Table 4: Options Appraisal (CAP1616 E2) – Northern Spine Option 2

Conclusion

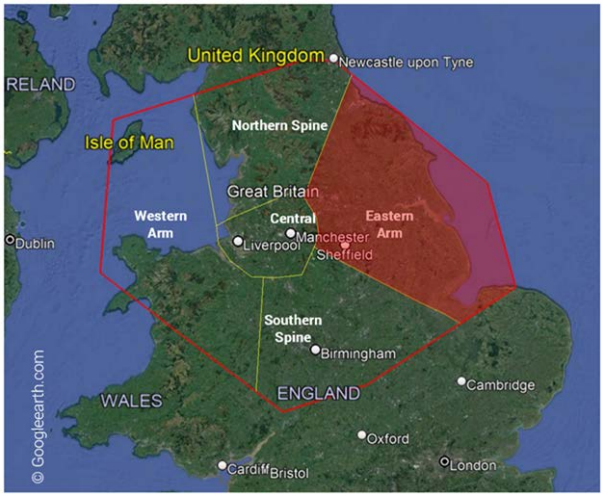
Compared to the baseline the performance of Option 2 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the route network through a reduction in controller workload.

Option 2 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. However, any additional airspace requirements may be reduced when compared to Option 1 by the inclusion of non-systemised routes where systemisation is not warranted. Any additional airspace requirements could additionally be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS requirement for this element would be the minimum volume and appropriate classification to safely contain the proposed part-systemised routes.

Option 2 offers comparable benefits to Option 1 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual impacted traffic flows. Therefore, the inclusion of non-systemised routes could offer greater benefits when compared to Option 1 whilst reducing any additional CAS requirements. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 2 is considered viable and will be PROGRESSED to Stage 3 in preference of Option 1.

3.2 Eastern Arm



Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Eastern Arm predominantly covers the Northeast of England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the North York Moors, the Peak District, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, and the Norfolk Coast. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[8]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Eastern Arm seeks to review and improve the existing ATS Route structure overhead the Northeast of England. The routes contained within this airspace provide connectivity for traffic arriving, departing or overflying the Manchester TMA from/ to Europe. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with eastbound traffic kept on the Southern side and westbound traffic on the Northern side. This orientation of traffic reduces conflictions between aircraft routing east and those routing west. However, routes are not separated by design and aircraft are routinely vectored away from the route structure to maintain separation from other aircraft. The existing route structure within this element is predicated around the historic dependence on ground-based navigation aids and therefore does not provide direct, great circle connectivity between the Manchester TMA airspace and Europe. Following the closure of Doncaster Sheffield airport and the associated denotification of the airspace, aircraft arriving at Leeds Bradford are no longer able to descend direct from the route network to the runway whilst remaining within CAS. Subsequently, Leeds Bradford arrivals are penalised due to the extant CTA bases within the Eastern Arm. The base of CAS currently prevents optimal CDO, resulting in additional greenhouse gas emissions. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the greenhouse gas impact.

[8] See Air Navigation Guidance 2017

Wider society	Capacity/ resilience	Qualitative	The Eastern Arm seeks to review and improve the existing ATS route structure overhead the Northeast of England. The routes contained within this airspace provide connectivity for traffic arriving, departing or overflying the Manchester TMA and Europe. Should the routes in this element not be modernised, aircraft will continue to be managed as per today. Therefore, there will be no change to the existing capacity or resilience of the airspace. Whilst it is anticipated that the Eastern Arm baseline could accommodate the forecast growth, as traffic numbers grow in line with the forecast, effective sector capacity will become increasingly constrained, partially due to increasing controller workload. This could in turn lead to a reduction in resilience.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace impacted by this element will remain a mixture of Class A and Class D airspace. GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes as they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Eastern Arm seeks to review and improve the existing ATS Route structure overhead the Northeast of England. The routes contained within this airspace provide connectivity for traffic arriving, departing or overflying the Manchester TMA from/ to Europe. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with eastbound traffic kept on the Southern side and westbound traffic on the Northern side. This orientation of traffic reduces conflictions between aircraft routing east and those routing west. However, aircraft are routinely vectored away from the route structure to maintain separation from other aircraft. The existing routes are structured around the historic dependence on ground-based navigation aids and therefore do not provide direct, great circle connectivity between the Manchester TMA airspace and Europe. Following the closure of Doncaster Sheffield airport and the associated denotification of the airspace, aircraft arriving at Leeds Bradford are no longer able to descend direct from the route network to the runway whilst remaining within CAS. Subsequently, Leeds Bradford arrivals are penalised due to the extant CTA bases within the Eastern Arm. The base of CAS currently prevents optimal CDO, unnecessarily forcing aircraft to stagger their descents, resulting in additional fuel burn. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the fuel burn.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 5: Options Appraisal (CAP1616 E2), Eastern Arm Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Not Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)

- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational - CCO/CDO (Medium, Partially Met)

For further information please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1. Systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Eastern Arm predominantly covers the Northeast of England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the North York Moors, the Peak District, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, and the Norfolk Coast. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[9]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Eastern Arm seeks to review and improve the existing ATS route network over the Northeast of England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with eastbound traffic kept on the Southern side and westbound traffic on the Northern side. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and Europe. It is estimated that the provision of more direct, great circle connectivity within the Eastern Arm could save up to 3.8 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may facilitate more optimal CDO and CCO, including for Leeds Bradford arrivals following the denotification of Doncaster Sheffield airspace; further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option introduce a new systemised route structure between the Manchester TMA and Europe. These routes would provide an efficient deconflicted network where possible, providing more efficient use of the airspace, increased predictability of the traffic flows and reduced controller and pilot workload, improving the capacity and resilience of the ATC network. However, a fully systemised airspace design does not have the flexibility required to maximise the efficiency of the interface with the surrounding airspace. The route structure will need to provide alignment with the existing traffic flows, affecting the efficacy of the design and impacting the capacity and resilience of the network. Additional entry/exit points may also be required (e.g., for connectivity to FRA) as well as modifications to routes within the neighbouring airspace to ensure connectivity to the wider network
General Aviation (GA)	Access	Qualitative	Introduction of a systemised route structure within the Eastern Arm may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. Following the closure of Doncaster Sheffield airport and the subsequent denotification of the Doncaster Sheffield airspace, aircraft arriving at Leeds Bradford airport are unable to descend direct from the route network to the runway whilst remaining within CAS. As a result, there is an increased likelihood that the bases of CAS will require lowering in this element to facilitate optimal CDO. This would reduce GA access from the baseline. The proposed airspace classification has not yet been determined. However, SMEs have identified that introducing a systemised routes would lead to a

[9] See Air Navigation Guidance 2017

			reduction in airspace complexity which may enable a reduction in airspace classification. This would improve access to the airspace for all airspace users. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic would be able to access subject to appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Eastern Arm seeks to review and improve the existing ATS route network over the Northeast of England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with eastbound traffic kept on the Southern side and westbound traffic on the Northern side. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct routes between the Manchester TMA and Europe. It is estimated that the provision of more direct, great circle connectivity within the Eastern Arm could save up to 3.8 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention allowing aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO, including for Leeds Bradford arrivals following the denotification of the Doncaster Sheffield airspace, further reducing fuel burn. This analysis is qualitative and more detailed quantitative analysis of fuel burn will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[10]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental

[10] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

	objectives of the AMS	and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 6: Options Appraisal (CAP1616 E2), Eastern Arm Option 1

Conclusion

Compared to the baseline the performance of Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the ATS route network through a reduction in controller workload.

Option 1 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. Additional CAS is also likely to be required to enable improved CDO. CDO into Leeds Bradford was impacted following the closure of Doncaster Sheffield airport and the denotification of their airspace. However, this additional airspace will, in part, be a return to the airspace which existed prior to the closure of Doncaster Sheffield airport and any additional airspace requirements could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS will be the minimum volume and appropriate classification to safely contain the proposed systemised routes.

Option 1 offers comparable benefits to Option 2 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual traffic flows. Therefore, this option could require a greater quantity of CAS than Option 2 without offering any additional benefits. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 1 is REJECTED in preference to Option 2 at this stage.

Option 2. Part-systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Eastern Arm predominantly covers the Northeast of England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the North York Moors, the Peak District, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, and the Norfolk Coast. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[11]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Eastern Arm seeks to review and improve the existing ATS route network over the Northeast of England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with eastbound traffic kept on the Southern side and westbound traffic on the Northern side. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and Europe. It is estimated that by the provision of more direct, great circle connectivity within the Eastern Arm could save up to 3.8 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an additional reduction in CO_2 emissions. A review of the bases of CAS may allow for more optimal CDO and CCO, including for Leeds Bradford arrivals following the denotification of Doncaster Sheffield airspace, further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option introduce a new systemised route structure between the Manchester TMA and Europe. These routes will be complemented with non-systemised routes where systemisation is not warranted. This would provide an efficient deconflicted network where possible with added connectivity to Free Route Airspace (FRA) yielding capacity benefits and a reduction in air traffic control (ATC) complexity. This would increase the capacity and resilience of the ATC network through a reduction in controller workload.
General Aviation (GA)	Access	Qualitative	Introduction of a systemised route structure within the Eastern Arm may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. This additional airspace requirement is reduced by complementing the systemised routes with non-systemised routes when these are more suitable. Following the closure of Doncaster Sheffield airport and the subsequent denotification of the Doncaster Sheffield airspace, aircraft arriving at Leeds Bradford airport are unable to descend direct from the route network to the runway whilst remaining within CAS. As a result, there is an increased likelihood that the bases of CAS will require lowering in this element to facilitate optimal CDO. This would reduce GA access from the baseline. The proposed airspace classification has not yet been determined. However, SMEs have identified that introducing systemised routes would lead to a

[11] See Air Navigation Guidance 2017

			reduction in airspace complexity which may enable a reduction in airspace classification. This would improve access to the airspace for all airspace users. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic would be able to access the airspace subject to appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Eastern Arm seeks to review and improve the existing ATS route network overhead the Northeast of England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with eastbound traffic kept on the Southern side and westbound traffic on the Northern side. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct routes between the Manchester TMA and Europe. It is estimated that the provision of more direct, great circle connectivity within the Eastern Arm could save up to 3.8 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an additional reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO, including for Leeds Bradford arrivals following the denotification of the Doncaster Sheffield airspace, further reducing fuel burn. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and

	objectives of the AMS	economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 7: Options Appraisal (CAP1616 E2) – Eastern Arm Option 2

Conclusion

Compared to the baseline the performance of Option 2 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the route network through a reduction in controller workload.

Option 2 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. However, any additional airspace requirements may be reduced when compared to Option 1 by the inclusion of non-systemised routes where systemisation is not warranted. The closure of Doncaster Sheffield airport, and subsequent denotification of the airspace, is likely to impact the CDO of arrivals into Leeds Bradford. Additional airspace is likely to be required to compensate for this closure and reintroduce direct CDO for Leeds Bradford arrivals.

Any additional airspace requirements could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS requirement for this element would be the minimum volume and appropriate classification to safely contain the proposed part-systemised routes.

Option 2 offers comparable benefits to Option 1 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual impacted traffic flows. Therefore, the inclusion of non-systemised routes could offer greater benefits when compared to Option 1 whilst reducing any additional CAS requirements. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 2 is considered viable and will be PROGRESSED to Stage 3 in preference of Option 1.

3.3 Southern Spine

Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Southern Spine predominantly covers Central England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the Peak District, the Cotswolds, the Malvern Hills, Cannock Chase, and the Shropshire Hills. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[12]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Southern Spine seeks to review and improve the existing ATS Route structure overhead Central England. The routes contained within this airspace provide connectivity for traffic arriving and/or departing the Manchester TMA to/from the LTMA and Southern Europe, as well as traffic overflying the Manchester TMA from southern airspace and eastbound/westbound traffic to/from the Midlands group airports from/from the Isle of Man, Belfast TMA, Dublin, and Shannon. Traffic flying between the Manchester TMA and the LTMA is currently orientated with northbound traffic predominantly kept to the Eastern edge of the CTAs and southbound traffic on the West. This orientation of traffic reduces conflictions between aircraft routing north and those routing south. However, routes are not separated by design and aircraft are routinely vectored away from the route structure to maintain separation from other aircraft. The existing route structure within this element is predicated around the historic dependence on ground-based navigation aids and therefore does not provide direct, great circle connectivity between the south and the Manchester TMA. The base of CAS currently restricts CDO unnecessarily, forcing aircraft to stagger their descents, increasing CO_2 emissions. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the greenhouse gas impact.
Wider society	Capacity/ resilience	Qualitative	The Southern Spine seeks to review and improve the existing ATS Route structure overhead Central England. The routes contained within this airspace provide connectivity for traffic arriving and/or departing the Manchester TMA to/from the LTMA and Southern Europe, as well as traffic overflying the Manchester TMA from southern airspace and eastbound/westbound traffic to/from the Midlands group airports from/from the Isle of Man, Belfast TMA,

[12] See Air Navigation Guidance 2017

			Dublin, and Shannon. Should the routes in this element not be modernised, aircraft will continue to be managed as per today. Therefore, there will be no change to the existing capacity or resilience of the airspace. As traffic numbers grow in line with the forecast, effective sector capacity will become increasingly constrained, partially due to increasing controller workload. This could in turn lead to a reduction in resilience.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace impacted by this element will remain a mixture of Class A and Class D airspace. GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes as they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Southern Spine seeks to review and improve the existing ATS Route structure overhead Central England. The routes contained within this airspace provide connectivity for traffic arriving and/or departing the Manchester TMA to/from the LTMA and Southern Europe, as well as traffic overflying the Manchester TMA from southern airspace and eastbound/westbound traffic to/from the Midlands group airports from/from the Isle of Man, Belfast TMA, Dublin, and Shannon. Traffic flying between the Manchester TMA and the LTMA is currently orientated with northbound traffic predominantly kept to the Eastern edge of the CTAs and southbound traffic on the West. This orientation of traffic reduces conflictions between aircraft routing north and those routing south. However, aircraft are routinely vectored away from the route structure to maintain separation from other aircraft. The existing routes are structured around the historic dependence on ground-based navigation aids and therefore do not provide direct, great circle connectivity between the south and the Manchester TMA resulting in increased fuel burn. The extant routes currently converge overhead these navigation aids before diverging which adds superfluous track miles, and introduces conflictions requiring controller intervention (vectoring) to resolve which further increases the track miles flown from the flight planned route. The base of CAS currently prevents optimal CDO, unnecessarily forcing aircraft to stagger their descents, resulting in additional fuel burn. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in fuel burn.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 8: Options Appraisal (CAP1616 E2), Southern Spine Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Partially Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)
- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)

- DP12 Technical - LAMP interface (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1. Systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Southern Spine predominantly covers Central England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the Peak District, the Cotswolds, the Malvern Hills, Cannock Chase, and the Shropshire Hills. This change will only impact flight paths at or above FL70 or 7,000ft, any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[13]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Southern Spine seeks to review and improve the existing ATS route network overhead Central England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct routes between the Manchester TMA and the South. It is estimated that the provision of more direct, great circle connectivity within the Southern Spine could save up to 6.7 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO, further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option introduce a new systemised route structure between the Manchester TMA and Southern UK airspace. These routes would provide an efficient deconflicted network where possible, providing more efficient use of the airspace, increased predictability of the traffic flows and reduced controller and pilot workload, improving the capacity and resilience of the ATC network. However, a fully systemised airspace design does not have the flexibility required to maximise the efficiency of the interface with the surrounding airspace. The route structure will need to provide alignment with the existing traffic flows, affecting the efficacy of the design and impacting the capacity and resilience of the network. Additional entry/exit points may also be required (e.g., for connectivity to FRA) as well as modifications to routes within the neighbouring airspace to ensure connectivity to the wider network
General Aviation (GA)	Access	Qualitative	Introduction of a systemised route structure within the Southern Spine may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. The proposed airspace classification has not yet been determined. However, SMEs have identified that introducing systemised routes would lead to a reduction in airspace complexity which may enable a reduction in airspace classification. This would improve access to the airspace for all airspace users. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic will be able to access the airspace subject to appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no

[13] See Air Navigation Guidance 2017

			longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes will increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Southern Spine seeks to review and improve the existing ATS route network overhead central England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the South. It is estimated that the provision of more direct, great circle connectivity within the Southern Spine could save up to 6.7 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention allowing aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO further reducing fuel burn. This analysis is qualitative and more detailed quantitative analysis of fuel burn will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[14]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 9: Options Appraisal (CAP1616 E2), Southern Spine Option 1

[14] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

Conclusion

Compared to the baseline the performance of Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the ATS route network through a reduction in controller workload.

Option 1 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. However, this additional airspace could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS would be the minimum volume and appropriate classification to safely contain the proposed systemised routes.

Option 1 offers comparable benefits to Option 2 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual impacted traffic flows. Therefore, this option could require a greater quantity of CAS than Option 2 without offering any additional benefits. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 1 is REJECTED in preference to Option 2 at this stage.

Option 2. Part-systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, Northern Wales. The Southern Spine predominantly covers Central England. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: the Peak District, the Cotswolds, the Malvern Hills, Cannock Chase, and the Shropshire Hills. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[15]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Southern Spine seeks to review and improve the existing ATS route network overhead Central England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation will deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the South. It is estimated that the provision of more direct, great circle connectivity within the Southern Spine could save up to 6.7 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an increased reduction in CO_2 emissions. A review of the bases of CAS may allow for more optimal CDO and CCO, further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option would introduce a new systemised route structure between the Southern UK airspace and the Manchester TMA. These routes will be complemented with non-systemised routes where systemisation is not warranted. This would provide an efficient deconflicted network where possible with added connectivity to Free Route Airspace (FRA) yielding capacity benefits and a reduction in air traffic control (ATC) complexity. This would increase the capacity and resilience of the ATC network through a reduction in controller workload.
General Aviation (GA)	Access	Qualitative	Introduction of systemised routes within the Southern Spine may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. This additional airspace requirement is reduced by complementing the systemised routes with non-systemised routes when these are more suitable. The proposed airspace classification has not yet been determined. However, SMEs have identified that introducing systemised routes would lead to a reduction in airspace complexity which may enable a reduction in airspace classification. This would improve access to the airspace for all airspace users. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic would be able to access the airspace subject to appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no

[15] See Air Navigation Guidance 2017

			longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes will increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Southern Spine seeks to review and improve the existing ATS route network overhead Central England. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic, with southbound traffic kept on the Western side and northbound traffic on the East. However, these existing routes are not systemised, they converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the South. It is estimated that the provision of more direct, great circle connectivity within the Southern Spine could save up to 6.7 NM over the published routes. This reduction in track miles would offer a corresponding reduction fuel burn. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e , low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an increased reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may allow for more optimal CDO and CCO, further reducing fuel burn. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[16]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 10: Options Appraisal (CAP1616 E2) – Southern Spine Option 2

[16] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

Conclusion

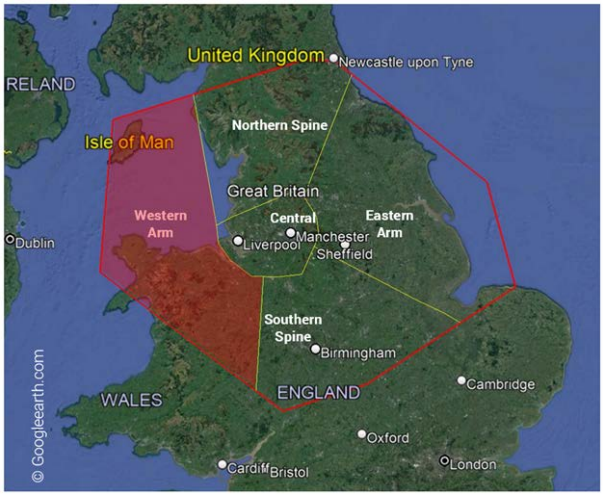
Compared to the baseline the performance of Option 2 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the route network through a reduction in controller workload.

Option 2 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. However, any additional airspace requirements may be reduced when compared to Option 1 by the inclusion of non-systemised routes where systemisation is not warranted. Any additional airspace requirements could additionally be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS requirement for this element would be the minimum volume and appropriate classification to safely contain the proposed part-systemised routes.

Option 2 offers comparable benefits to Option 1 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual traffic flows. Therefore, the inclusion of non-systemised routes could offer greater benefits when compared to Option 1 whilst reducing any additional CAS requirements. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 2 is considered viable and will be PROGRESSED to Stage 3 in preference of Option 1.

3.4 Western Arm



Option 0: Baseline 'Do-Nothing'

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Western Arm predominantly covers North Wales. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: Eryri (Snowdonia), the Shropshire Hills, the Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[17]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Western Arm seeks to review and improve the existing ATS route structure predominantly overhead North Wales. The routes contained within this airspace provide connectivity for traffic routing to/from Dublin, Shannon, the North Atlantic, Belfast TMA and Ronaldsway from/to the Manchester TMA, Leeds, Doncaster Sheffield[18], Newcastle, Teesside, Birmingham, East Midlands, London TMA and northbound/ southbound/ eastbound/ westbound overflights. Additionally, traffic to/from the Manchester TMA, ScTMA, Belfast TMA, Leeds, Doncaster Sheffield[18], Humberside, Newcastle and Teesside and northbound/southbound overflights from/to the south. The existing route structure ensures westbound (outbound) traffic is positioned north of eastbound (inbound) traffic and northbound traffic (Manchester TMA arrivals) is positioned west of southbound traffic (Manchester TMA departures). Overflying traffic also adopts this general orientation scheme. The Western Arm contains two major flows, one each from the west and the northwest. These converge near the coast as they head east towards the Dee Estuary in the vicinity of WAL. This convergence happens within the Western Arm, with the flows needing to be organised before they leave to the east (WAL/BARTN). Thus, the main congestion issues caused by the Western Arm's eastbound flows happen outside the Arm itself. The convergence of multiple routes results in arriving and departing aircraft that are not deconflicted and requires controllers to resolve the conflictions via tactical intervention. These conflictions might be resolved by controllers issuing aircraft with headings to provide lateral separation or by delaying descent or climb instructions to keep the aircraft vertically separated. This tactical intervention increases the fuel burn and the associated emissions of aircraft. The Baseline 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the greenhouse gas impact.

[17] See Air Navigation Guidance 2017
[18] Doncaster Sheffield airport ceased operations in December 2022.

Wider society	Capacity/ resilience	Qualitative	The Western Arm seeks to review and improve the existing ATS route structure predominantly overhead North Wales. The routes contained within this airspace provide connectivity for traffic routing to/from Dublin, Shannon, the North Atlantic, Belfast TMA and Ronaldsway from/to the Manchester TMA, Leeds, Doncaster Sheffield[19], Newcastle, Teesside, Birmingham, East Midlands, London TMA and northbound/ southbound/ eastbound/ westbound overflights. Additionally, traffic to/from the Manchester TMA, ScTMA, Belfast TMA, Leeds, Doncaster Sheffield[19], Humberside, Newcastle and Teesside and northbound/southbound overflights from/to the south. SMEs have identified that the current airspace is near to operating at full capacity and unable to absorb future traffic growth; specifically, the current route structure creates high density/complexity traffic in the WAL, MIRSI and BARTN areas. Should the routes in this element not be modernised, aircraft will continue to be managed as per today. Therefore, there will be no change to the existing capacity or resilience of the airspace. As traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a reduction in resilience.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace in this region will remain, as today, predominantly Class C airspace. GA access will remain unchanged in the Baseline 'Do-Nothing' option.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Western Arm seeks to review and improve the existing ATS route structure predominantly overhead North Wales. The routes contained within this airspace provide connectivity for traffic routing to/from Dublin, Shannon, the North Atlantic, Belfast TMA and Ronaldsway from/to the Manchester TMA, Leeds, Doncaster Sheffield[19], Newcastle, Teesside, Birmingham, East Midlands, London TMA and northbound/ southbound/ eastbound/ westbound overflights. Additionally, traffic to/from the Manchester TMA, ScTMA, Belfast TMA, Leeds, Doncaster Sheffield[19], Humberside, Newcastle and Teesside and northbound/southbound overflights from/to the south. The Western Arm contains two major flows, one each from the west and the northwest. These converge near the coast as they head east towards the Dee Estuary in the vicinity of WAL. This convergence happens within the Western Arm, with the flows needing to be organised before they leave to the east (WAL/BARTN). Thus, the main congestion issues caused by the Western Arm's eastbound flows happen outside the Arm itself. The convergence of multiple routes results in arriving and departing aircraft that are not deconflicted and requires controllers to resolve the conflictions via tactical intervention. These conflictions might be resolved by controllers issuing aircraft with headings to provide lateral separation or by delaying descent or climb instructions to keep the aircraft vertically separated. This tactical intervention increases the fuel burn and the associated emissions of aircraft. The base of CAS currently prevents optimal CDO unnecessarily forcing aircraft to stagger their descents, resulting in additional fuel burn. The Baseline 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in fuel burn.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.

[19] Doncaster Sheffield airport ceased operations in December 2022.

All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 11: Options Appraisal (CAP1616 E2), Western Arm Baseline Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Not Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)
- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information, please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1: Systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Western Arm predominantly covers North Wales. This area includes the following National Parks, and Areas of Outstanding Natural Beauty: Eryri (Snowdonia), the Shropshire Hills, the Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[20]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Western Arm seeks to review and improve the existing ATS route network predominantly overhead North Wales. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic; westbound (outbound) traffic is positioned north of eastbound (inbound) traffic and northbound traffic (Manchester TMA arrivals) is positioned west of southbound traffic (Manchester TMA departures). Whilst some systemisation exists in this region, not all the existing routes are systemised; the routes converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the West/Southwest. It is estimated that the provision of more direct, great circle connectivity within the Western Arm could save up to 4 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. A review of the bases of CAS may facilitate more optimal CDO and CCO further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option extend the existing systemised airspace structures, providing connectivity for Manchester TMA traffic to route to/from Ireland, the Isle of Man and the southwest. These routes would provide an efficient deconflicted network where possible, providing more efficient use of the airspace, increased predictability of the traffic flows and reduced controller and pilot workload, improving the capacity and resilience of the ATC network. However, a fully systemised airspace design does not have the flexibility required to maximise the efficiency of the interface with the surrounding airspace. The route structure will need to provide alignment with the existing traffic flows, affecting the efficacy of the design and impacting the capacity and resilience of the network. Additional entry/exit points may also be required (e.g., for connectivity to FRA) as well as modifications to routes within the neighbouring airspace to ensure connectivity to the wider network.
General Aviation (GA)	Access	Qualitative	The extension of the systemised route structure within the Western Arm may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. The proposed airspace classification has not yet been determined. However, the potential to reduce airspace classification in the Western Arm is considered limited as the majority of the CTAs within this airspace are Class C. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic will be able to access the airspace subject to the appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to

[20] See Air Navigation Guidance 2017

			releasing airspace that is no longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Western Arm seeks to review and improve the existing ATS route network predominantly overhead North Wales The existing route structure deconflicts arriving and departing aircraft by orientating the traffic; westbound (outbound) traffic is positioned north of eastbound (inbound) traffic and northbound traffic (Manchester TMA arrivals) is positioned west of southbound traffic (Manchester TMA departures). Whilst some systemisation exists in this region, not all the existing routes are systemised; the routes converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the West/Southwest. It is estimated that the provision of more direct, great circle connectivity within the Western Arm could save up to 4 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention allowing aircraft to follow their planned route more closely. A review of the bases of CAS may facilitate more optimal CDO and CCO further reducing fuel burn. This analysis is qualitative and more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs[21].
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 12: Options Appraisal (CAP1616 E2), Western Arm Option 1

[21] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

Conclusion

Compared to the baseline the performance of Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the ATS route network through a reduction in controller workload.

Option 1 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. However, this additional airspace could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS would be the minimum volume and appropriate classification to safely contain the proposed systemised routes.

Option 2 offers comparable benefits to Option 1 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual impact traffic flows. Therefore, this option could require a greater quantity of CAS than Option 2 without offering any additional benefits. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 1 is REJECTED in preference to Option 2 at this stage.

Option 2: Part-systemised

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. the Western Arm predominantly covers North Wales. This area includes the following National Parks, and Areas of Outstanding Natural Beauty where tranquillity must be considered: Eryri (Snowdonia), the Shropshire Hills, the Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[22]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Western Arm seeks to review and improve the existing ATS route network predominantly overhead North Wales. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic; westbound (outbound) traffic is positioned north of eastbound (inbound) traffic and northbound traffic (Manchester TMA arrivals) is positioned west of southbound traffic (Manchester TMA departures). Whilst some systemisation exists in this region, not all the existing routes are systemised; the routes converge on existing navigation aids which adds superfluous track miles increasing CO_2 emissions. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the West/Southwest. It is estimated that the provision of more direct, great circle connectivity within the Western Arm could save up to 4 NM over the published routes. This reduction in track miles would offer a corresponding reduction in CO_2 emissions. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in CO_2 emissions by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an additional reduction in CO_2 emissions. A review of the bases of CAS may allow for more optimal CDO and CCO further reducing fuel burn and associated CO_2 emissions. This analysis is qualitative, and a more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option extend the existing systemised airspace structures, providing connectivity for Manchester TMA traffic to route to/from Ireland, the Isle of Man and the southwest. These routes will be complemented with non-systemised routes where systemisation is not warranted. This would provide an efficient deconflicted network where possible with added connectivity to Free Route Airspace (FRA) yielding capacity benefits and a reduction in air traffic control (ATC) complexity. This would increase the capacity and resilience of the ATC network through a reduction in controller workload.
General Aviation (GA)	Access	Qualitative	The extension of the systemised route structure within the Western Arm may require additional lateral airspace to ensure appropriate separation can be provided between the routes, in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. This additional airspace requirement is reduced by complementing the systemised routes with non-systemised routes when these are more suitable. The proposed airspace classification has not yet been determined. However, the potential to reduce airspace classification in the Western Arm is considered limited as the majority of the CTAs within this airspace are Class C. NATS will endeavour to use the most appropriate airspace classification and therefore it is expected that VFR traffic will be able to access the airspace

[22] See Air Navigation Guidance 2017

			subject to the appropriate ATC clearance. The FASI Manchester TMA project will undertake a comprehensive review of airspace bases and classification with a view to releasing airspace that is no longer required or increasing access to existing airspace. This will help to offset any additional airspace requirements.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Western Arm seeks to review and improve the existing ATS route network predominantly overhead North Wales. The existing route structure deconflicts arriving and departing aircraft by orientating the traffic; westbound (outbound) traffic is positioned north of eastbound (inbound) traffic and northbound traffic (Manchester TMA arrivals) is positioned west of southbound traffic (Manchester TMA departures). Whilst some systemisation exists in this region, not all the existing routes are systemised; the routes converge on existing navigation aids which adds superfluous track miles increasing fuel burn. Should this option be introduced, systemisation would deconflict aircraft by design and procedure and offer more direct, great circle routes between the Manchester TMA and the West/Southwest. It is estimated that the provision of more direct, great circle connectivity within the Western Arm could save up to 4 NM over the published routes. This reduction in track miles would offer a corresponding reduction in fuel burn. Furthermore, the simplification of conflicts where ATS routes currently converge would result in an additional reduction in fuel burn by removing the necessity for controller intervention. This allows aircraft to follow their planned route more closely. In addition, the introduction of non-systemised routes where a systemised route would not be warranted i.e., low traffic volume, predominantly single direction traffic or limited anticipated conflictions, could further reduce any superfluous planned track miles leading to an additional reduction in fuel burn A review of the bases of CAS may allow for more optimal CDO and CCO further reducing fuel burn. This analysis is qualitative, and a more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[23]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.

[23] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 13: Options Appraisal (CAP1616 E2), Western Arm Option 2

Conclusion

Compared to the baseline the performance of Option 2 offers benefit in terms of CO_2 emissions and fuel burn as well as improving the capacity and resilience of the route network through a reduction in controller workload.

Option 2 may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes in line with CAP1385 (Performance-based Navigation (PBN): Enhanced Route Spacing Guidance) requirements and the CAA Policy For The Design Of Controlled Airspace Structures. However, any additional airspace requirements may be reduced when compared to Option 1 by the inclusion of non-systemised routes where systemisation is not warranted. Additional airspace requirements could additionally be offset through a reduction in airspace classification or release of airspace elsewhere within this change. Any additional CAS requirement for this element would be the minimum volume and appropriate classification to safely contain the proposed part-systemised routes.

Option 2 offers improved benefits to Option 1 in terms of fuel burn and CO_2 emissions. However, the inflexibility of a fully systemised structure prohibits a seamless interface with the surrounding airspace and does not consider the suitability of a systemised design for the individual impacted traffic flows. Therefore, the inclusion of non-systemised routes could offer greater benefits when compared to Option 1 whilst reducing any additional CAS requirements. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 2 is considered viable and will be PROGRESSED to Stage 3 in preference of Option 1.

3.5 Central

Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Central geographic element predominantly covers extant Manchester TMA airspace. This area does not contain any National Parks, or Areas of Outstanding Natural Beauty. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[24]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Central geographic element seeks to provide connectivity to/from the Manchester TMA and the surrounding geographic elements. The existing route structure within this element is predicated around the historic dependence on ground-based navigation aids and as such does not offer direct connectivity, nor is it systemised. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in the greenhouse gas impact.
Wider society	Capacity/ resilience	Qualitative	The Central geographic element seeks to provide connectivity to/from the Manchester TMA and the surrounding geographic elements. The existing route structure within this element is predicated around the historic dependence on ground-based navigation aids and as such does not offer direct connectivity, nor is it systemised. Should this connectivity not be improved, aircraft will continue to fly via the existing routes and there will be no change to the current operation. Holds within, and around, the Manchester TMA region are not currently routinely used, therefore it is considered that the current airspace may accommodate some limited future traffic growth, however the airspace provides no capacity benefit and in the long term would constrain the capacity and resilience of the ATC network.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace in this region will remain, as today, predominantly Class A airspace. GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.

[24] See Air Navigation Guidance 2017

General Aviation / commercial airlines	Fuel burn	Qualitative	The Central geographic element seeks to provide connectivity to/from the Manchester TMA and the surrounding geographic elements. The existing route structure within this element is predicated around the historic dependence on ground-based navigation aids and as such does not offer direct connectivity, nor is it systemised. The 'Do-Nothing' option will lead to no change to the existing operation and therefore no change in fuel burn.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 14: Options Appraisal (CAP1616 E2), Central geographic element Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Partially Met)
- DP4 Technical - Airspace interface (High, Partially Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)
- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information, see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1: Route Connectivity

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. The Central geographic element predominantly covers extant Manchester TMA airspace. This area does not contain any National Parks, or Areas of Outstanding Natural Beauty. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[25]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The Central geographic element seeks to provide connectivity to/from the Manchester TMA and the surrounding geographic elements. Modern navigation standards allow a re-design of the Central geographic element which could remove the convergence of ATS routes at a single point, resulting in more efficient routes and therefore reduced track miles and a corresponding reduction in CO_2 emissions compared to today. This element is for overflight provision and therefore has no impact on CDO or CCO. This analysis is qualitative, and a more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Wider society	Capacity/ resilience	Qualitative	The changes contained within this design option introduce new routes, improving connectivity between the Central geographic element and the surrounding elements and reducing controller workload by reducing conflictions, thereby enhancing the capacity and resilience of the ATC network.
General Aviation (GA)	Access	Qualitative	This option will be contained within existing CAS; however, there is the potential to raise the base of northern Manchester TMA airspace thereby providing increased accessibility for GA traffic in this region.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes will increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	The Central geographic element seeks to provide connectivity to/from the Manchester TMA and the surrounding geographic elements. Modern navigation standards allow a re-design of the Central geographic element which could remove the convergence of ATS routes at a single point, resulting in more efficient routes and therefore reduced track miles and a corresponding reduction in fuel burn compared to today. This element is for overflight provision and therefore has no impact on CDO or CCO. This analysis is qualitative, and a more detailed quantitative analysis of greenhouse gas impact will be presented in Stage 3.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs[26].
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and

[25] See Air Navigation Guidance 2017

[26] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

			c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 15: Options Appraisal (CAP1616 E2), Central geographic element Option 1

Conclusion

Compared to the baseline, Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving capacity and resilience of the ATS route network through a reduction in controller workload.

The potential to raise the base of Manchester TMA airspace could provide increased accessibility for GA traffic in this region

For these reasons Option 1 is considered viable and will be PROGRESSED to Stage 3.

4. Manchester TMA Airport Connectivity Design Options

4.1 Departure Connectivity

Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Connectivity to the airport departure routes is required throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[27]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The departure connectivity element seeks to provide connectivity from Manchester, Liverpool, Leeds Bradford and East Midlands airport SIDs, (these are being updated through separate airport sponsored ACPs), to the ATS route network. Currently at the end of a SID aircraft either join the existing route network (SID finishes at a published waypoint on the route), join a link route to connect to the route network, continue their flight planned route via a flight plannable DCT or leave CAS. Should there be no change, connectivity will be as per the existing connectivity and greenhouse gas impact will remain unchanged.
Wider society	Capacity/ resilience	Qualitative	The departure connectivity element seeks to provide connectivity from Manchester, Liverpool, Leeds Bradford and East Midlands airport SIDs, (these are being updated through separate airport sponsored ACPs), to the ATS route network. Currently at the end of a SID aircraft either join the existing route network (SID finishes at a published waypoint on the route), join a link route to connect to the route network, continue their flight planned route via a flight plannable DCT or leave CAS. Should there be no change, the capacity and resilience of the network will not change. The baseline does not provide connectivity to any newly proposed SIDs which could limit future capacity. In the long term, the impact of increased controller workload (with increasing traffic levels) could have a negative impact on resilience & capacity.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace in this element will remain unchanged. GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The departure connectivity element seeks to provide connectivity from Manchester, Liverpool, Leeds Bradford and East Midlands airport SIDs, (these are being updated through separate airport sponsored ACPs), to the ATS route network. Currently at the end of a SID aircraft either join the existing route network (SID finishes at a published waypoint on the route), join a link route to connect to the route network, continue their flight planned route via a flight plannable DCT or leave CAS. Should there be no change, connectivity will be as per the existing connectivity and fuel burn will remain unchanged.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.

[27] See Air Navigation Guidance 2017

Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 16: Options Appraisal (CAP1616 E2), Departure Connectivity Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Partially Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)
- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information, please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1. Departure connectivity without new CAS

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Connectivity to the airport departure routes is required throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[28]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	Option 1 will provide efficient connectivity from the finalised airport SID end points to the ATS route network within the confines of existing CAS. This option will seek to provide more direct routes which minimise track miles and reduce the greenhouse gas impact. However, by remaining within the confines of existing CAS this benefit is limited.
Wider society	Capacity/ resilience	Qualitative	Option 1 will provide efficient connectivity from the finalised airport SID end points to the ATS route network within the confines of existing CAS. The design could improve the efficiency of the SID/route network interface potentially enabling more direct routes and reducing route conflictions, thereby reducing controller workload and improving the capacity and resilience of the ATC network. However, by remaining within the confines of existing CAS this benefit is limited.
General Aviation (GA)	Access	Qualitative	Option 1 could improve the efficiency of the SID/route network interface potentially allowing for the release of some CAS, increasing accessibility for GA traffic in this airspace.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	Option 1 departure connectivity will seek to ensure more direct routes, reduced confliction points, and more continuous climb profiles. This would reduce the flight plannable track miles and fuel burn. However, by remaining within the confines of existing CAS these benefits are limited.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[29]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility.

[28] See Air Navigation Guidance 2017

[29] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

			Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 17: Options Appraisal (CAP1616 E2), Departure Connectivity Option 1

Conclusion

Compared to the baseline, the performance of Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving the capacity and resilience of the ATS route network through a reduction in controller workload.

Option 2, however, offers increased benefits to Option 1 in terms of fuel burn and CO_2 emissions; within Option 1 realisation of the benefits is limited by the extant base of CAS, whereas Option 2 can improve the efficiency of the SID/route network interface without being constrained by extant airspace. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 1 is REJECTED in preference to Option 2 at this stage.

Option 2: Departure connectivity with new CAS

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Connectivity to the airport departure routes is required throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[30]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	Option 2 will provide efficient connectivity from the finalised airport SID end points to the ATS route network without having to remain within the confines of existing CAS. This option will seek to provide more direct routes which minimise track miles and reduce the greenhouse gas impact. By considering additional CAS, additional track miles could be saved, further improving the reduction in greenhouse gas compared to Option 1.
Wider society	Capacity/ resilience	Qualitative	Option 2 will provide efficient connectivity from the finalised airport SID end points to the ATS route network without having to remain within the confines of existing CAS. The design could improve the efficiency of the SID/route network interface potentially enabling more direct routes and reducing route conflictions, thereby reducing controller workload and improving the capacity and resilience of the ATC network. By considering additional CAS, other route efficiencies can be afforded, further improving the capacity and resilience of the ATC network compared to Option 1.
General Aviation (GA)	Access	Qualitative	This option would require additional CAS; however, the impact to GA access is considered minor, as the levels at which additional CAS volumes are required are likely to be above the levels of interest for GA. A full review of departure profiles will take place and it is anticipated that once the new climb profiles are analysed, including looking at existing profiles, then some of the lower CAS bases could be raised to help offset the impact of any changes.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	Option 2 will provide efficient connectivity from the finalised airport SID end points to the ATS route network without having to remain within the confines of existing CAS. Option 2 departure connectivity will seek to ensure more direct routes, reduced confliction points, and more continuous climb profiles. By considering additional CAS, additional track miles can be saved, further improving the reduction in fuel burn compared to Option 1.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.

[30] See Air Navigation Guidance 2017

Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[31]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 18: Options Appraisal (CAP1616 E2), Departure Connectivity Option 2

Conclusion

Compared to the baseline the performance of Option 2 offers benefit in terms of CO_2 emissions and fuel burn as well as improving the capacity and resilience of the ATS route network through a reduction in controller workload.

In Option 2, optimisation of the SID/route network interface may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes.

Any additional airspace requirements could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. The use of additional CAS may impact the Military and GA community however the impact is considered minor only; the levels at which additional CAS volumes are required are likely to be above the levels of interest for GA. Any additional CAS requirement for this change would be the minimum volume and appropriate classification to safely contain the proposed routes.

Option 2, through the inclusion of additional CAS, offers improved benefits compared to Option 1 in terms of fuel burn and CO_2 emissions, capacity, and resilience of the route network. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 2 is considered viable and will be PROGRESSED to Stage 3 in preference of Option 1.

[31] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

4.2 Arrival Connectivity

Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Connectivity between the UK ATS route network and airport arrival structures is required throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[32]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The arrival connectivity element seeks to provide connectivity between the UK ATS route network and the Manchester, Liverpool, Leeds Bradford and East Midlands airport arrival structures (the low-level procedures are being updated through separate airport sponsored ACPs). Currently this connectivity is provided through STARs or Standard Inbound Routes published within the relevant airport's AIP. Should there be no change, connectivity will be as per the existing connectivity and greenhouse gas impact will remain unchanged.
Wider society	Capacity/ resilience	Qualitative	The arrival connectivity element seeks to provide connectivity between the UK ATS route network and the Manchester, Liverpool, Leeds Bradford and East Midlands airport arrival structures (the low-level procedures are being updated through separate airport sponsored ACPs). Currently this connectivity is provided through STARs or Standard Inbound Routes published within the relevant airports AIP. Should there be no change, the capacity and resilience of the network will not change. The baseline would not provide connectivity to any newly proposed holding structures which could limit future capacity. In the long term, the impact of increased ATC workload (with increasing traffic levels) could have a negative impact on resilience & capacity.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace in this region will remain unchanged; GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to fly the ATS routes they do today. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The arrival connectivity element seeks to provide connectivity between the UK ATS route network and the Manchester, Liverpool, Leeds Bradford and East Midlands airport arrival structures (the low-level procedures are being updated through separate airport sponsored ACPs). Currently this connectivity is provided through STARs or Standard Inbound Routes published within the relevant airports AIP. Should there be no change, connectivity will be as per the existing connectivity and fuel burn will remain unchanged.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.

[32] See Air Navigation Guidance 2017

Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 19: Options Appraisal (CAP1616 E2), Arrival Connectivity Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 does not meet, or partially meets, the following Design Principles:

- DP3 Operational - Capacity (High, Partially Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)
- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Not Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information, please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1: Arrival connectivity without new CAS

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, Northern Wales. Connectivity between the UK ATS route network and airport arrival structures is required throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[33]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	Option 1 will provide efficient connectivity from the UK ATS route network to the finalised airport arrival structures within the confines of existing CAS. The arrival structure locations will be included within this change but will be determined through collaboration with the airports as they need to be suitably located for the ATS route structure and the airport approach procedures. This option will seek to provide more direct routes which minimise track miles and reduce the greenhouse gas impact. However, by remaining within the confines of existing CAS this benefit is limited.
Wider society	Capacity/ resilience	Qualitative	Option 1 will provide efficient connectivity from the UK ATS route network to the finalised airport arrival structures within the confines of existing CAS. The design could improve the efficiency of STAR/Standard Inbound Route profiles potentially enabling more direct routes and reducing route conflictions, thereby reducing controller workload, and improving the capacity and resilience of the ATC network. However, by remaining within the confines of existing CAS this benefit is limited.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, access to the impacted airspace will remain unchanged.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	Option 1 arrival connectivity will seek to ensure more direct routes, reduced confliction points, and more continuous arrival profiles. This would reduce the flight plannable track miles and fuel burn. However, by remaining within the confines of existing CAS these benefits are limited.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[34]

[33] See Air Navigation Guidance 2017

[34] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 20: Options Appraisal (CAP1616 E2), Arrival Connectivity Option 1

Conclusion

Compared to the baseline, the performance of Option 1 offers benefit in terms of CO_2 emissions and fuel burn as well as improving the capacity and resilience of the ATS route network through a reduction in controller workload.

Option 2, however, offers increased benefits to Option 1 in terms of fuel burn and CO_2 emissions; within Option 1 realisation of the benefits is limited by the extant base of CAS, whereas Option 2 can improve the efficiency of STAR/Standard Inbound Route profiles without being constrained by extant airspace. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 1 is REJECTED in preference to Option 2 at this stage.

Option 2: Arrival connectivity with new CAS

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Connectivity between the UK ATS route network and airport arrival structures is required throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There would be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[35]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	Option 2 will provide efficient connectivity from the UK ATS route network to the finalised airport arrival structures without having to remain within the confines of existing CAS. The arrival structure locations will be included within this change but will be determined through collaboration with the airports as they need to be suitably located for the ATS route structure and the airport approach procedures. This option will seek to provide more direct routes which minimise track miles and reduce the greenhouse gas impact. By considering additional CAS, additional track miles could be saved, further improving the reduction in greenhouse gas compared to Option 1.
Wider society	Capacity/ resilience	Qualitative	Option 2 will provide efficient connectivity from the UK ATS route network to the finalised airport arrival structures without having to remain within the confines of existing CAS. The design could improve the efficiency of STAR/Standard Inbound Route profiles potentially enabling more direct routes and reducing route conflictions, thereby reducing controller workload, and improving the capacity and resilience of the ATC network. By considering additional CAS, other route efficiencies could be afforded, further improving the capacity and resilience of the ATC network compared to Option 1.
General Aviation (GA)	Access	Qualitative	This option would require additional CAS; however, the impact to GA access is considered minor, as the levels at which additional CAS volumes are required are likely to be above the levels of interest for GA. A full review of arrival profiles will take place and it is anticipated that once the new descent profiles are analysed, including looking at existing profiles, then some of the lower CAS bases could be raised to help offset the impact of any changes.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	Option 2 will provide efficient connectivity from the UK ATS route network to the finalised airport arrival structures without having to remain within the confines of existing CAS. The arrival structure locations will be included within this change but will be determined through collaboration with the airports as they need to be suitably located for the ATS route structure and the airport approach procedures. This option will seek to provide more direct routes which minimise track miles and reduce the fuel burn. By considering additional CAS, additional track miles could be saved, further improving the reduction in fuel burn compared to Option 1.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

[35] See Air Navigation Guidance 2017

Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.
Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[36]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 21: Options Appraisal (CAP1616 E2), Arrival Connectivity Option 2

Conclusion

Compared to the baseline the performance of Option 2 offers benefit in terms of CO_2 emissions and fuel burn as well as improving the capacity and resilience of the ATS route network through a reduction in controller workload.

In Option 2, optimisation of STAR/Standard Inbound Route profiles may require additional CAS to contain the proposed routes and to ensure appropriate separation can be provided between the routes.

Any additional airspace requirements could be offset through a reduction in airspace classification or release of airspace elsewhere within this change. The use of additional CAS may impact the Military and GA community however the impact is considered minor; the levels at which additional CAS volumes are required are likely to be above the levels of interest for GA. Any additional CAS requirement for this change would be the minimum volume and appropriate classification to safely contain the proposed routes.

Option 2, through the inclusion of additional CAS, offers improved benefits compared to Option 1 in terms of fuel burn and CO_2 emissions, capacity, and resilience of the route network. Option 2 does not prohibit any designs captured by Option 1.

For these reasons Option 2 is considered viable and will be PROGRESSED to Stage 3 in preference of Option 1.

[36] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation

4.3 Arrival Structures

Option 0. 'Do-Nothing' (Baseline)

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Airport arrival structures are located throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty; the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. This change will only impact flight paths at or above FL70 or 7,000ft; any associated changes below this level will be included in the corresponding airport ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration. There will be no discernible change in noise or tranquillity impacts from today.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[37]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	The arrival structures element seeks to provide delay absorption structures for aircraft arriving at the Manchester TMA airports: Manchester, Liverpool, Leeds Bradford and East Midlands. There are currently 8 existing holds serving these airports. Holds are used when aircraft are unable to commence their approach into the airport; if a delay is not required aircraft can bypass the hold and continue their approach immediately from the end of the STAR/Standard Inbound Route. If no change is introduced the existing holding facilities will remain and aircraft will continue to use them as required therefore there would be no change in greenhouse gas impact.
Wider society	Capacity/ resilience	Qualitative	The arrival structures element seeks to provide delay absorption structures for aircraft arriving at the Manchester TMA airports: Manchester, Liverpool, Leeds Bradford and East Midlands. There are currently 8 existing holds serving these airports, which offer sufficient holding for the extant airspace design and forecast use. Should there be no change, the capacity and resilience of the network will not change. However, the locations of the existing holds are not optimally positioned for the proposed changes included within this ACP, which could limit future capacity.
General Aviation (GA)	Access	Qualitative	This option would not introduce or release any additional CAS. Therefore, the airspace in this region will remain unchanged; GA access will remain unchanged in the 'Do-Nothing' scenario.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	There will be no change in the economic impact from increased capacity as aircraft will continue to use the existing holds as required. However, as traffic numbers grow in line with the forecast, effective sector capacity will become constrained, partially due to increasing controller workload. This could in turn lead to a negative economic impact due to increased delays.
General Aviation / commercial airlines	Fuel burn	Qualitative	The arrival structures element seeks to provide delay absorption structures for aircraft arriving at the Manchester TMA airports: Manchester, Liverpool, Leeds Bradford and East Midlands. There are currently 8 existing holds serving these airports. Holds are used when aircraft are unable to commence their approach into the airport; if a delay is not required aircraft can bypass the hold and continue their approach immediately from the end of the STAR/Standard Inbound Route. If no change is introduced the existing holding facilities will remain and aircraft will continue to use them as required therefore there would be no change in fuel burn.
Commercial airlines	Training cost	Qualitative	There would be no additional training required as there will be no change to the extant airspace or procedures.
Commercial airlines	Other costs	Qualitative	There would be no additional associated costs for airlines as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	There would be no additional associated infrastructure costs as there will be no change to the extant airspace.

[37] See Air Navigation Guidance 2017

Airport/ Air navigation service provider	Operational costs	Qualitative	There would be no additional associated operational costs as there will be no change to the extant airspace.
Airport/ Air navigation service provider	Deployment costs	Qualitative	There would be no additional associated deployment costs as there will be no change to the extant airspace.
All	Performance against the objectives of the AMS	Qualitative	The Baseline 'Do Nothing' option would not meet the strategic objectives of the AMS.

Table 22: Options Appraisal (CAP1616 E2), Arrival Structure Baseline

Conclusion

The Baseline 'Do-Nothing' Option 0 did not progress past the DPE step as follows:

- DP3 Operational - Capacity (High, Partially Met)
- DP5 Economic - Fuel burn (Medium, Partially Met)
- DP6 Environmental - CO_2 emissions (Medium, Partially Met)
- DP10 Technical - CAS (Medium, Partially Met)
- DP11 Technical - PBN (High, Partially Met)
- DP13 Technical - AMS (High, Partially Met)
- DP14 Operational -CCO/CDO (Medium, Partially Met)

For further information, please see the DP evaluation matrix in the Step 2A Design Options and Evaluation document.

As such this option was REJECTED. It is included here for comparison purposes only.

Option 1: Radial holds

Group	Impact	Level of Analysis	Evidence
Communities	Noise impact on health and quality of life	Qualitative	This proposal covers a large portion of Northern and Central England, and Northern Wales. Airport arrival structures are located throughout the lateral limits of the change. This area contains the following National Parks, and Areas of Outstanding Natural Beauty: the Lake District, the Yorkshire Dales, the North York Moors, the Peak District, Eryri (Snowdonia), the North Pennines, Arnside and Silverdale, the Forest of Bowland, Nidderdale, the Howardian Hills, the Lincolnshire Wolds, the Norfolk Coast, the Cotswolds, the Malvern Hills, Cannock Chase, the Shropshire Hills, Clwydian Range and Dee Valley, Anglesey, and Llŷn. In this option, the potential to introduce new radial holds and/or optimise the current holds will take place at or above FL70 or 7,000ft, and as such there would be no discernible change in noise or tranquillity impacts from today. However, this option may have the consequential impact of altering tracks below 7,000ft. Changes to arrival structures will be determined in collaboration with the airports and any impact on flights below 7,000ft will be included in the corresponding airport's ACP. Government guidance says that 7,000ft is the maximum height at which noise is a priority for consideration.
Communities	Air quality	Qualitative	Government guidance says that aircraft flying higher than 1,000ft are unlikely to have a significant impact on air quality[38]. There will be no changes in aircraft trajectories below 1,000ft proposed in this ACP, therefore there will be no change in air quality from today.
Wider society	Greenhouse gas impact	Qualitative	Option 1 will review the existing holds and introduce new radial holding structures as required. The holds are required to absorb delay which cannot be absorbed during the previous stages of flight. The location and number of holds would not impact the frequency of aircraft holding, although the optimisation of revised/new radial hold locations could reduce the track miles and associated greenhouse gas impact between the ATS route and the airport. Subject to trade-offs and constraints at Stage 3, we would aim to position holds to deliver maximum environmental benefit.
Wider society	Capacity/ resilience	Qualitative	Option 1 will review the existing holds and introduce new radial holding structures as required. The holds are required to absorb delay which cannot be absorbed during the previous stages of flight. Existing holds could be realigned/relocated to create additional space for routes, and potentially reduce route confliction points, thereby reducing controller workload leading to an increase in capacity and resilience of the ATC network. In this option, additional delay absorption could be provided by new holds, designed in more optimal locations, providing additional capacity for airfields arrivals.
General Aviation (GA)	Access	Qualitative	This option could require increased CAS and might impact GA operations. We would seek to use the lowest classification applicable to the airspace.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Qualitative	The proposed changes would increase the effective capacity of the airspace. The economic impact of this would be positive, however it has not been quantified.
General Aviation / commercial airlines	Fuel burn	Qualitative	Option 1 will review the existing holds and introduce new radial holding structures as required. The holds are required to absorb delay which cannot be absorbed during the previous stages of flight. The location and number of holds wiould not impact the frequency of aircraft holding, although the optimisation of revised/new radial hold locations could reduce the track miles and associated fuel burn impact between the ATS route and the airport.
Commercial airlines	Training cost	Qualitative	Flight procedures worldwide are updated with each Aeronautical Information Regulation and Control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Commercial airlines	Other costs	Qualitative	No other airline costs are foreseen.
Airport/ Air navigation service provider	Infrastructure costs	Qualitative	This proposal is not expected to change Airport or Air Navigation Service Provider (ANSP) infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. However, this is dependent on the assumption that any new CAS has sufficient CNS (Communication, Navigation, and Surveillance) coverage for the proposed routes. This will be confirmed prior to Stage 3.

[38] See Air Navigation Guidance 2017

Airport/ Air navigation service provider	Operational costs	Qualitative	This proposal is not expected to change Airport or ANSP operational costs.[39]
Airport/ Air navigation service provider	Deployment costs	Qualitative	This proposal for the holistic Manchester TMA change is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.100 assistants at the NATS Prestwick and Swanwick centres, including extensive use of the NATS simulator facility. Support staff are required to run the simulator – planning, training staff, data preparation and testing, pseudo pilots, safety analysts, outputs to be recorded and reported etc. Some staff may only require briefings. There may be occasions where the reduced availability of operational controllers during their conversion training could mean operational rostering becomes a factor when considering continuous service delivery. The Military ANSP would also require briefing prior to deployment. This requirement will be clarified as designs mature through on-going engagement.
All	Performance against the objectives of the AMS	Qualitative	On balance, this design option has the potential to contribute positively to the AMS, enabling the safe and efficient growth in capacity and environmental and economic improvements, minimising the volume of controlled airspace consistent with safe and efficient air traffic operations, supporting access to airspace users as appropriate and providing compatibility with national security requirements.

Table 23: Options Appraisal (CAP1616 E2), Arrival Structures Option 1

Conclusion

Holds are contingency structures which are required by design at the end of a STAR. They are used when aircraft need to be delayed, for example when it is not possible to continue the approach. In the event aircraft need to hold, the hold location can introduce benefit if it is optimally situated between the ATS route and the airport.

In comparison to the Baseline, Option 1 seeks to optimise the positioning and orientation of existing radial holds offering benefit in terms of CO_2 emissions and fuel burn as well as improving the capacity and resilience of the ATS route network by creating additional space for routes, reducing route confliction points, and reducing controller workload. In this option, additional delay absorption could be provided by new radial holds, designed in more optimal locations, providing additional capacity for airfields arrivals as required.

Option 1 may require additional CAS to contain the new/revised radial holds and to ensure appropriate separation can be provided against the holding structures.

Any additional airspace requirements could be offset, elsewhere within this change, through a reduction in airspace classification or release of airspace. The use of additional CAS may impact the Military and GA community however the impact is considered minor only. Any additional CAS requirement for this change would be the minimum volume and appropriate classification to safely contain the proposed routes.

For these reasons Option 1 is considered viable and will be PROGRESSED to Stage 3.

[39] For details of potentially impacted airports and ANSPs please refer to the Step 2A documentation.

5. Options Appraisal Overview

5.1 14 options across 8 elements were carried forward from the DP Evaluation to the Initial Options Appraisal (IOA).

5.2 The Northern Spine, Eastern Arm, Southern Spine, Western Arm, Departure Connectivity and Arrival Connectivity all bought forward 2 options to the IOA. The Central geographic element and Arrival Structures presented only a single option to the IOA.

5.3 As a result of the qualitative IOA, it was concluded that:

- Northern Spine, Eastern Arm, Southern Spine, and Western Arm: Option 1 should be rejected in preference of Option 2. Any design considered in Option 1 could be included in Option 2 and, additionally, Option 2 provides greater flexibility to interface with surrounding airspace further enhancing benefits associated with reduction of CO_2 emissions and fuel burn as well as improving capacity and resilience of the route network. As such, Option 1 was rejected.

- Arrival Connectivity and Departure Connectivity: Option 1 should be rejected in preference of Option 2. Any design considered in Option 1 could be included in Option 2 and additionally, Option 2, through the inclusion of additional CAS, offers improved benefits compared to Option 1 in terms of fuel burn and CO_2 emissions, capacity, and resilience of the route network. As such, Option 1 was rejected.

5.4 All other options bought forward will be progressed to Stage 3 for further development.

5.5 Within the Arrival Connectivity and Departure Connectivity elements, the progressed options differed by the requirement of additional CAS. This additional CAS would enable additional benefit but would impact our stakeholders. The impacted stakeholders have been engaged and are open to considering these options subject to continued engagement and design refinement. Any enabling compromises will be detailed within the Stage 3 documentation.

5.6 We are aware that the design options discussed involve a wide range of stakeholders with potentially conflicting requirements. These stakeholders will be continually engaged throughout the CAP1616 process to ensure their requirements are considered.

5.7 The remaining options will be refined and fully defined before being joined together, subject to compatibility with each other, during Stage 3 to produce holistic airspace solutions.

5.8 These solutions will be consulted upon at Stage 3.

6. Safety Assessment

6.1 This section provides a brief, qualitative overview of the impact of the holistic change on aviation safety.

Options Appraisal Safety Assessment – Baseline

6.2 The current operation uses a published route structure and airline operators flight plan to follow available ATS routes as published in the UK AIP or flight plannable Directs (DCTs) as published in the Route Availability Document (RAD).

6.3 Flights into and out of the airspace volume are managed via published waypoints between adjacent sectors. Transfer of traffic between these sectors is often conducted via the use of standing agreements and established coordination procedures as detailed in specific sections of the MATS (Manual of Air Traffic Services) pt. 2.

6.4 The published routes are historically predicated on ground-based navigation aids, based upon an outdated airspace design, and traffic needs to be tactically deconflicted by Air Traffic Controllers. This creates a high workload environment with a lack of overall predictability for airlines. The airspace also has a number of inefficiencies; restrictive standing agreements, restrictive controlled airspace base levels, restrictive route options and limited access to the North Sea area except via NATEB and via limited availability route, L975, through the D323 danger area complex.

6.5 The majority of MTMA airspace below FL285 operates within a 3NM separation environment, however, transfer of traffic to airports is based upon a 5NM separation requirement unless coordinated.

6.6 In addition to following routes, some flights may be instructed to take a more direct path through the airspace. This is done in a tactical manner by Air Traffic Controllers based on their judgement that a different path can be followed safely, and flights may be provided with a UK FIS (Flight Information Service) as appropriate.

6.7 NATS has introduced consolidation of the Transition Altitude (TA) within the lateral limits of the MTMA ACP change as a constraint on the design and this will be included in all the options developed. This change will consolidate the TA for Manchester TMA, Liverpool CTA/CTR, Leeds Bradford CTA/CTR and Doncaster Sheffield CTA/CTR[40] airspace, currently at 5,000ft, to 6,000ft. It is predicted to provide improved safety above and beyond the baseline by reducing the possibility of infringement (vertical) into controlled airspace. Furthermore, it simplifies the airspace picture by reducing operational confusion, as well as pilot and controller workload.

Options Appraisal Safety Assessment – Options Development

6.8 Project activities so far have included a questionnaire directed at Prestwick (PC) Air Traffic Controllers and workshops held with Manchester, Liverpool, Leeds Bradford and East Midlands airports. Feedback from these has enabled a range of concepts to be assessed through visualisation simulations based upon iterative development. A second series of visualisation simulations will be conducted based on the feedback received and, additionally, considering feedback from stakeholders.

6.9 Key elements of the proposed change include systemised routes designed to improve traffic flow and increase capacity, as well as new arrival and departure route connectivity which may require additional controlled airspace.

[40] The future of Doncaster Sheffield airspace is, at the time of writing, uncertain. For more details, see ACP-2022-082

6.10 A qualitative high-level safety appraisal indicates that nothing is presently foreseen, in any of the proposed options for the MTMA, that appears to have the potential to preclude maintenance of the existing level of safety performance undertaken within the current operation. Further work is scheduled to review the interface between the network and Liverpool, Leeds Bradford, and East Midlands.

6.11 Safety and Human Performance attended the visualisation simulation in preparation for the closure of the Airspace Safety Review (ASR).

6.12 The completed ASR will inform the real-time development simulations scheduled for Dec 2023.

Summary

6.13 The initial findings from workshops at the time of this Safety Statement are described below. Due to the nature of airspace analysis, the individual elements of the designs have been assessed holistically.

- Visualisation Simulations:

Based on feedback from the workshops held with Manchester, Liverpool, Leeds Bradford and East Midlands, feedback from the controller questionnaire and drawing on previous design work, concepts were created which contained a number of new design elements. These were presented to MTMA controllers, airfield sponsors and airline operators by means of visualisation simulations. These were held at Prestwick Centre in the SPACE research and development facility and used fictional traffic samples to represent the routes within the design concepts on a radar display and were used to show how aircraft would travel through the new airspace. It allowed the new design concepts to be understood and interactions between aircraft to be seen. It also facilitated discussion around sectorisation, coordination sequences and general opinions and ideas about the suitability of the designs and how they could be improved. A number of visualisation simulations were conducted during the period August and September 2022 which included controller participation, in excess of 50%, and significant stakeholder engagement. The output of these simulations will be used to create and refine the designs that will be taken to real-time development simulations scheduled for December 2023.

- Airspace Safety Review:

The Airspace Safety Review (ASR) will take place within Stage 3 to await the maturing of the MTMA designs. In the meantime, an interim ASR will take place in early 2023 which will use existing ASR assessments (completed for previous NERL MTMA projects) as a baseline and will incorporate interfaces for Liverpool, Leeds Bradford, and East Midlands airports. Currently, sufficient data exists pertaining to the Manchester airport interface. However, in order for a reliable and holistic net safety benefit/disbenefit to be realised, a complete safety assessment will be conducted in Stage 3. At this stage, Safety do no foresee safety issues associated with any of the design elements.

Future activities

6.14 Subject to safety analysis, a safety strategy will be captured within the Safety Assurance Plan. Appropriate safety cases will be written, as will an analysis of CAP1385 route separation criteria, as well as the relevant containment policies, of each route segment against adjacent proposed routes.

6.15 Further visualisation simulations are scheduled for March 2023 and will include updated designs based on the feedback received in the first round of visualisation simulations.

6.16 Further analysis and activities will be conducted on the proposed design options that will include:

- Hazard Analysis (Pre Dev/Post Dev)
- Real-time development Simulations

6.17 Work is ongoing to provide detailed quantitative safety assessments for subsequent CAP1616 stages. At this time, there are no indications to suggest any of the current options would be unsafely implemented.

7. Conclusions and next steps

7.1 The Statement of Need for this proposal can be summarised:

This airspace change proposal will make changes to the Manchester Terminal Manoeuvring Area (MTMA) airspace, STARs and ATS route network. The proposed changes will interface with SIDs and arrival transitions serving Manchester and East Midlands airports. Manchester and East Midlands airports are currently in the process of proposing changes to their SIDs/arrival transitions. The changes proposed to the MTMA by this ACP will be coordinated with, and will complement, the airport's proposals.

Current Situation

The extant conventional SIDs/ STARs at Manchester and East Midlands airports are not PBN and will soon be made obsolete by the planned decommissioning of several conventional navigation beacons.

Issue to be addressed

Consideration of interacting traffic flows between Manchester, East Midlands and neighbouring airports (i.e., Liverpool, Warton, Birmingham, Leeds, Doncaster etc). Introduction of improved holding/delay absorption arrangements and ATS routes will reduce conflicts by systemising the traffic, also reducing fuel burn & CO2 emissions for flights using these routes. New ATS routes and STARs may be required to provide network connectivity for changes as proposed by Manchester and East Midlands airports.

This proposal forms part of the plan for delivering the Airspace Modernisation Strategy.

Cause

Legacy ATS structure requires modernisation in accordance with the Airspace Modernisation Strategy.

7.2 The airspace impacted by the MTMA ACP was split into the route network (separated into the 5 geographical elements - Northern Spine, Eastern Arm, Southern Spine, Western Arm and Central) and Manchester TMA Airport Connectivity (separated into departure connectivity, arrival connectivity, and arrival structures). Design options, presented as high-level concepts, which address the Statement of Need, were proposed for each element, and evaluated against the Design Principles developed in Step 1B.

7.3 In total 32 options were considered and shared with our stakeholders. Stakeholder feedback as well as input from SMEs was incorporated into the designs and the resulting design options, including a Baseline 'Do-Nothing' option for each element, were evaluated against the Design Principles developed during Step 1B. This evaluation is detailed in Step 2A and used to determine which design options were suitable for progression. Following the Design Principle Evaluation, 14 options across the route network and Manchester TMA airport connectivity remained and were subjected to a subsequent Initial Options Appraisal (IOA, Step 2B).

7.4 From this IOA, we concluded that 1 option from the Northern Spine, 1 option from the Eastern Arm, 1 option from the Southern Spine, 1 option from the Western Arm, 1 option from Departure Connectivity, and 1 option from Arrival Connectivity could be removed as they did not introduce any additional

benefits over the remaining design options. The remaining design options, as listed in Table 24, will be developed into a holistic design and consulted upon in Stage 3.

	Element	Design Option	Description
Route Network	Northern Spine	Option 2: Part-systemised	Introduces a mix of systemised routes and non-systemised routes providing connectivity for Manchester TMA traffic routing to/from the ScTMA or NATEB (Newcastle). Additionally, connectivity may be required to, from, and between adjacent geographic elements.
	Eastern Arm	Option 2: Part-systemised	Introduces a mix of systemised airspace structures and non-systemised route structures providing connectivity for Manchester TMA traffic routing to /from central Europe and Scandinavia. Additionally, connectivity may be required to, from and between adjacent geographical elements.
	Southern Spine	Option 2: Part-systemised	Introduces a mix of a systemised airspace structures and non-systemised route structures providing connectivity for Manchester TMA traffic which is routing to/from the southern ATS route network. Additionally, connectivity may be required to, from, and between adjacent geographic elements.
	Western Arm	Option 2: Part-systemised	Extends the existing systemised airspace structures and additionally introduce non-systemised route structures providing connectivity for Manchester TMA traffic to route to/from Ireland and the southwest. Additionally, connectivity may be required to, from, and between adjacent geographic elements.
	Central	Option 1: Route connectivity	Provides route connectivity to/from the Central geographic element and the surrounding geographic elements.
Airport Connectivity	Departure Connectivity	Option 2: Departure connectivity with new CAS	Provides departure connectivity from SID end points to the route network requiring new CAS
	Arrival Connectivity	Option 2: Arrival connectivity with new CAS	Provides arrival connectivity from the route network to airport arrival structures via STARs/arrival routes requiring new CAS
	Arrival Structures	Option 1: Radial holds	Existing radial holds will be reviewed and kept, amended, or removed. Additional radial holding structures will be introduced where required

Table 24: Finalised Design Options which will be developed into a holistic design and consulted upon in Stage 3

7.5 We thank all stakeholders who were able to participate in the Stage 2 engagement and look forward to their continued involvement with the development of this proposal.

7.6 It is not proportional for NATS to state their preferred design at this stage as this is dependent on understanding the holistic system wide design. These options will be developed in greater detail in stage 3 and presented for consultation.

7.7 Subject to CAA approval at Stage 2, the ACP will progress to Stage 3 during which detailed consultation is undertaken on those options progressed. The time frame following the Stage 2 gateway is yet to be decided and will be determined in consultation with ACOG to ensure adherence with the Masterplan.

7.8 At Stage 3 we will further develop our remaining design option into a feasible holistic design. At which stage we will indicate our preferred design. In line with the Masterplan, NERL reserves the right to revive a design option eliminated at Stage 2 if the progressed option is found to be incompatible with the designs progressed for the other elements.

7.9 The development of a holistic design will enable more quantitative analysis (as opposed to qualitative analysis) including fuel burn, and WebTAG CO_2e emissions analysis. All benefits and impacts will be monetised at this stage such that the overall benefit/impacts can be assessed. This information will be included in the consultation material we prepare for our formal consultation process.

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