# London Airspace Management Programme
# Deployment 1.1

## Gateway Documentation
## Stage 4: Submit
## Step 4A: Final Options Appraisal

Roles

| Action | Role | Date |
|---|---|---|
| Produced | Airspace Change Specialist<br>Airspace and Future Operations | 09/2022 |
| Reviewed<br>Approved | Airspace Implementation Manager (ATC Lead)<br>Airspace and Future Operations | 09/2022 |
| Reviewed<br>Approved | Manager Airspace Delivery<br>Airspace and Future Operations | 09/2022 |
| Reviewed<br>Approved | Head of Airspace Development<br>Airspace and Future Operations | 09/2022 |
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Publication history

| Issue | Month/Year | Change Requests in this issue |
|---|---|---|
| 1.0 | 05/2022 | Submitted to CAA |
| 2.0 | 09/2022 | Updated forecast from May 2021 to October 2021 and resultant revised expected benefits throughout document (fuel/$CO_2e$)<br>Revised fuel cost figures used (from July 2021 to Sep 2022)<br>Appendix B: BADA version corrected to v3.14<br>Methodological notes sections added (Section 2 & Section 3)<br>Appendix A: all tables and data updated with revised figures<br>Per flight $CO_2e$ emission data added to Greenhouse Gases section |

References

| Ref No | Description | Hyperlinks |
|---|---|---|
| 1 | LD1.1 Stage 4A Update Design | Link |
| 2 | LD1.1 Stage 3 Full Options Appraisal | Link |
| 3 | Air Navigation Guidance 2017 | Link |

Contents

# 1. Introduction

1.1 This document forms part of the document set requirement of the CAP1616 Airspace Change Process.

1.2 This document aims to provide adequate evidence to satisfy Stage 4 Submit Gateway, Step 4A Options Appraisal (Phase 3 Final), including Safety Assessment.

1.3 This Airspace Change Proposal (ACP) is sponsored by NATS. Today's air traffic services (ATS) route network has evolved over time and does not exploit modern navigation technology. The objective of this project is to update the route network in accordance with the CAA's Airspace Modernisation Strategy (AMS) using Performance Based Navigation (PBN). This will provide benefits in capacity while minimising environmental impacts.

1.4 In a separate ACP, NATS also proposes to implement Free Route Airspace (FRA) above LD1.1, from 24,500ft (FRA Deployment 2, ACP-2019-12). As described in the Consultation document, prior to the COVID-19 pandemic the LD1.1 and FRA D2 projects were being progressed independently. During Stage 3 of the CAP1616 process, the projects, which cover a common geographic region, were combined by NATS to reduce delivery costs, and deliver benefits to the aviation industry earlier. They are cumulatively referred to as West Airspace Deployment (West). The ACPs remain distinct, however they are interdependent[1]. Consultation was conducted concurrently, and the airspace changes will be implemented simultaneously

1.5 As a result of consultation, the proposed design of LD1.1 has been revised and updated. There have also been minor technical amendments made to the design. For a full description of these changes and impacts, see the Stage 4A Update Design document (Ref 1).

1.6 The design changes made in LD1.1 have led to improvements in the expected benefits for the holistic West benefits from those presented at Stage 3 (Ref 2)[2]. This increase is due to the maturity of the overall design and development of procedures and update to the SRD which elicits better profiles for the modelling. The LD1.1 benefits are calculated as a proportion of the overall West benefit; this has also improved the calculated benefits from those previously provided in Stage 3.

# 2. Methodological Notes

2.1 At Stage 2, LD1.1 Initial Option Appraisal assessed the potential impacts of LD1.1 options based solely on the deployment of the proposed changes in the relevant airspace[3]. Quantified fuel and $CO_2e$ benefits were presented for the options for the baseline year (2018) using a traffic sample based on 14 June 2018. When the two projects were combined, a single benefit assessment was completed. For ease of modelling[4], the traffic sample date for LD1.1 was maintained for the West analysis.

2.2 At Stage 3, benefits were calculated for the entire West design, and a proportion of benefit was attributed to each ACP. A combined traffic forecast has been used for the entire airspace.

2.3 The split of benefit was based on the percentage of time that flights spend in the systemised region vs FRA regions within UK airspace. These flight times have been calculated from the baseline AirTOp model of 14th June 2018 cut to the UK to ensure consistency for future analysis. The total number of seconds that traffic within UK airspace spent above FL245 in the

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[1] LD1.1 cannot be implemented independent of FRA because there are no routes proposed above FL245 and no routes in sector 9. Existing routes in sector 9 do not align to the route structure proposed in the LD1.1 ACP. FRA D2 cannot be implemented independent of the LD1.1 ACP because the structural limitation, FRA significant points etc are based on the LD1.1 ACP design.

[2] See 4A Update Design document for all design changes. Enhancement to the Route Availability Document (RAD) to manage traffic flows were also captured in the modelling which provides an improved assessment of potential benefits.

[3] For Option 6 it was noted that this option is anticipated to enable greater benefits in the FRA above such that the combined airspace will yield greater benefit in reduction of CO2e emissions for the whole flight

[4] Traffic data was comparable between the 2 years

baseline AirTOp model has then been compared to the total number of seconds that traffic spent within UK airspace in the same model. Using flight times from the baseline, on average 57% of a flight's time is spent above FL245, so the benefit for West is split 57% (FRA) and 43% (LD1.1). This method removes the risk of 'double-counting' benefits.

2.4 Benefits are presented here for LD1.1, but the combined impact assessment for the West changes is also presented to provide a holistic picture for stakeholders.

## 3. Methodological Notes: Revisions from v1.0

3.1 The CAP1616 process requires that forecasts and analyses are provided for implementation + 10 years. It should be noted that the aviation industry is recovering from the COVID-19 pandemic, which may result in discrepancies between forecast and how air traffic will be impacted in the medium to long term. As a result, whilst the forecasts used are the best available, there is still a degree of uncertainty associated with them.

3.2 During the timeline of this ACP, there have also been significant national economic impacts linked to COVID-19, Brexit, and the war in the Ukraine, which include a significant increase in fuel costs. CAP1616 stipulates a requirement for data to be consistent across assessments (Appendix F, para 14), however it also requires data to be up-to-date and credible (E11).

3.3 At Stage 3 and in Stage 4 v1.0, the West benefits were calculated using the May 2021 STATFOR forecast. CAP1616 Para B31 states that where applicable, the forecast information should be consistent across the two assessments. At the request of the CAA, the forecast has been revised in this document to the October 2021 STATFOR extended forecast, to align with CAP1616 paragraph E11[5], to best reflect the impact of the COVID-19 pandemic on aviation.

3.4 WebTAG calculations at Stage 3 were based on EU ETS (emissions trading system). In line with CAP1616 Appendix F para 14, this was also used in Stage 4 v1.0. However, as the UK is no longer part of the EU, the UK ETS is now applicable. The CAA has requested that, in line with CAP1616 paragraph E11, the UK ETS is applied in the WebTAG calculations for this document.

3.5 UK ETS (i.e. traded) include UK domestic flights, flights between the UK and Gibraltar, and flights departing the UK to European Economic Area states conducted by all included aircraft operators, regardless of nationality. The traded proportion was calculated based on flights within West airspace in 2019 using CFMU data.

3.6 Also in line with Appendix F para 14, in v1.0 the benefit costs were calculated using the fuel costs presented in Stage 3. However, as described in footnote 5 of v1.0, the cost of fuel has risen significantly since the Full Options Appraisal, and this does not reflect the benefits of today. To reflect this, and in line with CAP1616 para E11, the CAA have requested current day fuel costs are utilised. This document provides current day (September 2022) fuel prices.

## 4. Change Level

4.1 The changes proposed in this ACP affect flights below 20,000ft but above 7,000ft and in accordance with the Levels as defined in CAP1616, this proposal is categorised as a Level 2A change.

4.2 In line with the requirements for a Level 2A change the environmental impact assessment has been conducted on the basis of $CO_2e$ emissions. In accordance with Air Navigation Guidance 2017 (Ref 3), there would be no perceptible change to noise impacts to stakeholders on the ground, so no noise analysis has been conducted.

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[5] The CAA expects the change sponsor to use the most up-to-date, credible and clearly referenced sources of data.

## 5. Capacity Metric

5.1 NATS has developed a method to quantitively evaluate the impact on ATC capacity of proposed airspace change. This metric was assessed qualitatively at the Full Options Appraisal but has now been quantified in the Final Option Appraisal. We have retained the qualitative assessment in this Final Options Appraisal to enable effective comparison.

## 6. Option Appraisal (Final) Option 6 Systemised routes with FRA above FL245

6.1 Following consultation and feedback, NATS proposes to progress Option 6 to implement LD1.1, which is NATS' preferred design. This comprises systemised routes across the deployment area from FL70 – FL245, with FRA implemented above.

6.2 The key analysis is given below, consistent with CAP1616 4th edition, Appendix E.

6.3 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.

6.4 The planned implementation date for FRA D2/LD1.1 is the March 2023 AIRAC. This analysis reflects this and contains forecast data for 2023 (1-year post implementation) and 2033 (10 years post implementation).

<table>
<tr><th>Group</th><th>Impact</th><th>Level of Analysis</th><th>Evidence</th></tr>
<tr><td>Communities</td><td>Noise impact on health and quality of life</td><td>N/A</td><td>This Airspace change only affects airspace above 7,000 ft. The Air Navigation Guidance 2017 altitude-based priorities state that noise is not a priority above 7,000ft. This proposal covers a large portion of the Southwest of England and Wales. This area encompasses the following AONBs and National Parks; Llŷn, Shropshire Hills, Cannock Chase, Gower, Wye Valley, Cotswolds, North Wessex Downs, Chilterns, Mendip Hills, Quantock Hills, Cranborne Chase and West Wiltshire Downs, Dorset, East Devon, Blackdown Hills, North Devon, South Devon, Cornwall, Tamar Valley, Isles of Scilly, Snowdonia, Pembrokeshire Coast, Brecon Beacons, Exmoor, Dartmoor, New Forest. This area also encompasses the following designated quiet areas: Swansea and Neath Port Talbot; Cardiff and Penarth; Newport. No flight trajectories below 7,000 ft will be altered over these AONBs, quiet areas and National Parks.</td></tr>
<tr><td>Communities</td><td>Air quality</td><td>N/A</td><td>Government guidance[6] states that aircraft flying higher than 1,000ft are unlikely to have significant impact on local air quality. This airspace change only affects airspace above 7,000ft and will therefore have no significant impact on air quality.</td></tr>
<tr><td>Wider society</td><td>Greenhouse gas impact</td><td>Monetise and quantify</td><td>The impact assessment indicates that c. 476,048 flights per year would be affected by the change in 2023, rising to 566,904 in 2033. This is for the entire West airspace (FRA D2 & LD1.1) area.<br>The forecast reduction of $CO_2e$ emissions in the opening year, and 10 years post-implementation are shown below
<table>
<tr><th>Year</th><th>No. of Movements</th><th>Simulated $CO_2e$ (T) saving</th></tr>
<tr><td>2023</td><td>476,048</td><td>5,208</td></tr>
<tr><td>2033</td><td>566,904</td><td>6,201</td></tr>
</table>
The proposed changes could enable a beneficial net reduction of $CO_2e$ emissions of 5,208 tonnes in 2023. In 2033 there is forecast to be a reduction of $CO_2e$ emissions of 6,201 tonnes for the year. The average calculated network CO2e saving per flight is 11kg[7].</td></tr>
</table>

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[6] Air Navigation Guidance 2017 para 3.28

[7] This is calculated by dividing total emissions by number of aircraft.

<table>
<tr><td></td><td></td><td></td><td>WebTAG was used to assess the greenhouse gas (GHG) impact over 10 years after the proposed changes. 24.3% of flights are traded, under the UK ETS, and 75.7% are non-traded[8].<br><br>The monetised Net Present Value (NPV) benefit calculated by WebTAG due to the reduction in per flight GHG emissions is £5,674,157.<br><br>Note that this analysis only includes flight planned routes and does not include any holding, vectoring, or streaming. Therefore, improvements in predictability leading to improved flight planning and reduced delay and holding could further increase this benefit.<br><br>The WebTAG GHG worksheet outputs are shown in Appendix A.<br><br>The NATS October 21 STATFOR extended forecast was used, and traffic figures grown year-on-year for the WebTAG input.</td></tr>
<tr><td>Wider society</td><td>Capacity/ resilience</td><td>Qualitative</td><td>The changes contained within this design option introduce new systemised routes. These routes will provide an efficient deconflicted network with added connectivity to UK FIR exit areas yielding capacity benefits and a reduction in ATC complexity. This increases the resilience of the ATC network.<br>The connectivity to FRA at higher levels enables increased flight planning flexibility which would allow aircraft operators to flight plan more efficiently and give them the option of avoiding capacity constrained areas. This ability to avoid restrictions by utilising alternative flight plan trajectories would reduce the likelihood of delay and improve the resilience of the wider network.</td></tr>
<tr><td></td><td></td><td>Quantitative</td><td>The expected impact of this airspace change on operational performance (controller workload, controller enabled capacity) has been modelled and assessed. This modelling predicts a 13.4% increase in controller enabled capacity on average across the affected sectors. This supports the qualitative statement above. This figure is the maximum possible benefit from the modelling and covers the West project (LD1.1 and FRA D2) cumulatively.</td></tr>
<tr><td>General Aviation (GA)</td><td>Access</td><td>Qualitative</td><td>There will be no change to GA access to the extant Controlled Airspace (CAS). This ACP will require an increase in CAS in some areas and a reduction in others, with a reduction in CAS overall. The proposed controlled airspace and the airspace classification is described in full in 4B.</td></tr>
<tr><td>General Aviation/ commercial airlines</td><td>Economic impact from increased effective capacity</td><td>Qualitative</td><td>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.</td></tr>
<tr><td>General Aviation/ commercial airlines</td><td>Fuel burn</td><td>Monetise</td><td>The forecast reduction of fuel burn in the opening year, and 10 years post-implementation are shown below<br><br>
<table>
<tr><th>Year</th><th>No. of Movements</th><th>Simulated Fuel (T) saving</th></tr>
<tr><td>2023</td><td>476,048</td><td>1,637</td></tr>
<tr><td>2033</td><td>566,904</td><td>1,950</td></tr>
</table>
<br>The average calculated network fuel burn saving per flight is 3.44kg[9].</td></tr>
</table>

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[8] In accordance with CAA guidance, $CO_2e$ emissions for UK domestic flights, flights between the UK and Gibraltar, and flights departing the UK to European Economic Area states conducted by all included aircraft operators, regardless of nationality, are accounted for in WebTAG as traded. All other flights are non-traded. Proportions of flights are derived from analysis of traffic by NATS.

[9] This is calculated by dividing total emissions by number of aircraft.

| | | | |
|---|---|---|---|
| | | | Analysis predicts an enabled decrease in fuel burn, at a saving of £1,581,549 in 2023, increasing to a saving of £1,883,946 in 2033 (both Net Present Value).<br>This was based on the IATA jet fuel price of 2 September 2022, at $1.110 US per tonne and converted to GBP at 0.87£/$1[10] (£966 per tonne) and presumes a constant fuel price and exchange rate.<br>The forecast used was NATS October 21 STATFOR extended forecast. |
| Commercial airlines | Training cost | Qualitative | Flight procedures worldwide are updated with each AIRAC cycle and airlines would 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 and quantitative | This proposal is not expected to change Airport or ANSP infrastructure, beyond the initial deployment phase which will require some systems engineering amendments. |
| Airport/ Air navigation service provider | Operational costs | Qualitative | This proposal would not lead to changes in operational costs. |
| Airport/ Air navigation service provider | Deployment costs | Qualitative | This proposal is expected to require air traffic controller familiarisation training, in the order of 120-150 controllers and c.50 assistants at NATS Swanwick, 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.<br>The MoD may also require briefing prior to deployment. |

Table 1: Options Appraisal (CAP1616 E2) – LD1.1 Option 6 Systemised routes with FRA above FL245

## 7. Cost Benefit Analysis

7.1 The monetised benefits of the final preferred option are presented in the cost benefit analysis below.

7.2 The discount rate of 3.5% has been applied as per the standard rate given in the Treasury Green Book Annex A6.

7.3 There is a significant degree of uncertainty in predicting how aircraft operators will use FRA.

7.4 A benefit assessment is provided for the LD1.1 implementation. Given the interdependency with FRA D2, and to be consistent with data provided in the Full Options Appraisal (Ref 2), the combined benefits assessment for both FRA D2 and LD1.1 implementation are also included.

7.5 LD1.1 Option 6 is the proposed final option for this ACP with NPV benefits to 2033 of £23.7million.

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[10] Fuel costs have been calculated at today's prices, in line with CAP1616 para E11 (see Methodology section).

CAP1616 cost-benefit example - FRA D2 Final Option, LD1.1 Final Option and Combined West Benefits

| | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | NPV |
| Discount factor | 1 | 0.96618357 | 0.9335 | 0.9019 | 0.8714 | 0.8420 | 0.8135 | 0.7860 | 0.7594 | 0.7337 | 0.7089 | |
| FRA D2 Final Option | | | | | | | | | | | | |
| Net community benefit (CO2) | £901,757 | £922,331 | £917,280 | £913,566 | £909,175 | £905,211 | £901,184 | £897,208 | £893,279 | £889,393 | £885,544 | |
| Net airspace users benefit (Fuel) | £2,097,460 | £2,186,344 | £2,217,260 | £2,251,074 | £2,283,923 | £2,318,703 | £2,353,484 | £2,388,264 | £2,424,011 | £2,460,724 | £2,497,436 | |
| Net sponsor benefit | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | |
| Present value | £2,999,217 | £3,034,740 | £2,987,116 | £2,943,906 | £2,899,482 | £2,857,497 | £2,815,744 | £2,774,362 | £2,734,101 | £2,694,902 | £2,656,024 | £31,397,092 |
| **LD1.1 Final Option** | | | | | | | | | | | | |
| **Net community benefit (CO2)** | **£680,334** | **£695,784** | **£691,920** | **£689,181** | **£685,932** | **£682,793** | **£679,873** | **£676,929** | **£673,962** | **£670,971** | **£667,955** | |
| **Net airspace users benefit (Fuel)** | **£1,581,549** | **£1,650,144** | **£1,672,365** | **£1,698,450** | **£1,723,569** | **£1,748,689** | **£1,774,774** | **£1,801,826** | **£1,828,877** | **£1,855,929** | **£1,883,946** | |
| **Net sponsor benefit** | **£0** | **£0** | **£0** | **£0** | **£0** | **£0** | **£0** | **£0** | **£0** | **£0** | **£0** | |
| **Present value** | **£2,261,883** | **£2,290,126** | **£2,253,090** | **£2,221,086** | **£2,187,924** | **£2,155,142** | **£2,123,653** | **£2,093,148** | **£2,062,832** | **£2,032,723** | **£2,003,520** | **£23,685,127** |
| Combined: FRA D2/LD1.1 (West) | | | | | | | | | | | | |
| Net community benefit (CO2) | £1,582,091 | £1,618,115 | £1,609,200 | £1,602,747 | £1,595,107 | £1,588,005 | £1,581,057 | £1,574,137 | £1,567,241 | £1,560,363 | £1,553,500 | |
| Net airspace users benefit (Fuel) | £3,679,009 | £3,836,488 | £3,889,624 | £3,949,524 | £4,007,492 | £4,067,392 | £4,128,258 | £4,190,090 | £4,252,888 | £4,316,652 | £4,381,383 | |
| Net sponsor benefit | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | £0 | |
| Present value | £5,261,100 | £5,324,866 | £5,240,206 | £5,164,992 | £5,087,405 | £5,012,639 | £4,939,397 | £4,867,510 | £4,796,933 | £4,727,625 | £4,659,544 | £55,082,219 |

## 8. Safety Assessment

8.1 At Stage 3, in the Full Options Appraisal, we said that project activities so far have included Real Time Simulations (Development and Pre-ACP Validation) and associated Safety and Human Factors workshops.

8.2 The initial work undertaken concluded that the proposed designs could be implemented safely. The concept of operations for the systemised airspace is “File it, fly it”, so aircraft will fly the filed flight plan. As such, the level of tactical intervention required will be reduced from that of today. Initial work indicated that the Air Traffic Controllers regard the systemised airspace mode of operation as being similar to the flows of traffic experienced today, achieved with substantial tactical traffic intervention but with more emphasis on monitoring traffic flows and less active intervention being required. Key factors underlying this are that routings that are provided (tactically) today are expected to be reflected in flight plans and that the tools will continue to support Controllers in foreseeing and resolving potential conflicts.

8.3 The proposed ATS route structure will consist of defined PBN routes, meaning that route spacing and route containment will be designed to a modern standard using current CAA policies and guidance. During the simulations the participants did not identify any significant safety related issues.

8.4 The changes introduced are aimed at reducing ATC workload - the concept underlying the proposed design is the introduction of a systemised ATS route network and this proposed solution is seen as beneficial from an ATC perspective. It is shown in Table 3 that it is modelled that controller enabled capacity will be improved by up to 13.4%.

8.5 The safety related activities have been completed and will be supplied to the CAA as part of the ACP submission (Step 4B). The safety appraisal finds that nothing is presently foreseen in the LD1.1 option which appears to have the potential to preclude maintenance of the existing level of safety performance undertaken within the current operation.

## 9. Conclusion and Next Steps

9.1 This document provides an appraisal of the expected economic and environmental impacts of the implementation of this proposal.

9.2 It demonstrates that the LD1.1 changes provide economic and environmental benefits, as well as capacity benefits. This proposal is interdependent on the FRA D2 proposal, and the combined implementation of these two ACPs will deliver further benefits.

9.3 This option has been developed thus far with significant assistance, input, feedback and effort from senior MoD staff, senior representatives of all bordering ANSPs, the European Network Manager, representatives from airlines and flight planning service providers.

9.4 NATS thanks all these stakeholders and looks forward to implementing this proposal.

## Appendix A: WebTAG Calculations for LD1.1 Option 6

The data used for the inputs to WebTAG are given below:

Traffic forecasts:

| Year | Base Growth Flights (000's) | Base Growth Rate |
|---|---|---|
| 2023 | 2,404 | 6.60% |
| 2024 | 2,507 | 4.30% |
| 2025 | 2,542 | 1.40% |
| 2026 | 2,581 | 1.50% |
| 2027 | 2,618 | 1.50% |
| 2028 | 2,658 | 1.50% |
| 2029 | 2,698 | 1.50% |
| 2030 | 2,738 | 1.50% |
| 2031 | 2,779 | 1.50% |
| 2032 | 2,821 | 1.50% |
| 2033 | 2,863 | 1.50% |

Table A1: Base Case forecast traffic growth 2023-2031 (NATS October 21 STATFOR extended forecast)

Computer Modelling Results:

| Flights per Year in FRA D2/LD1 Area | Simulated Fuel Saving (T) | Simulated CO2 saving (T) | CO2 Traded 24.3% | CO2 non-traded 75.7% | Fuel Cost (GBP) |
|---|---|---|---|---|---|
| 476,048 | -1,637 | -5,208 | -1,266 | -3,942 | -£1,581,549 |
| 496,388 | -1,708 | -5,430 | -1,319 | -4,111 | -£1,650,144 |
| 503,261 | -1,731 | -5,505 | -1,338 | -4,167 | -£1,672,365 |
| 511,022 | -1,758 | -5,590 | -1,358 | -4,232 | -£1,698,450 |
| 518,458 | -1,784 | -5,672 | -1,378 | -4,294 | -£1,723,569 |
| 526,235 | -1,810 | -5,756 | -1,399 | -4,357 | -£1,748,689 |
| 534,129 | -1,837 | -5,843 | -1,420 | -4,423 | -£1,774,774 |
| 542,140 | -1,865 | -5,931 | -1,441 | -4,490 | -£1,801,826 |
| 550,272 | -1,893 | -6,020 | -1,463 | -4,557 | -£1,828,877 |
| 558,527 | -1,921 | -6,110 | -1,485 | -4,625 | -£1,855,929 |
| 566,904 | -1,950 | -6,201 | -1,507 | -4,694 | -£1,883,946 |

Table A2, computer simulation results for LD1.1

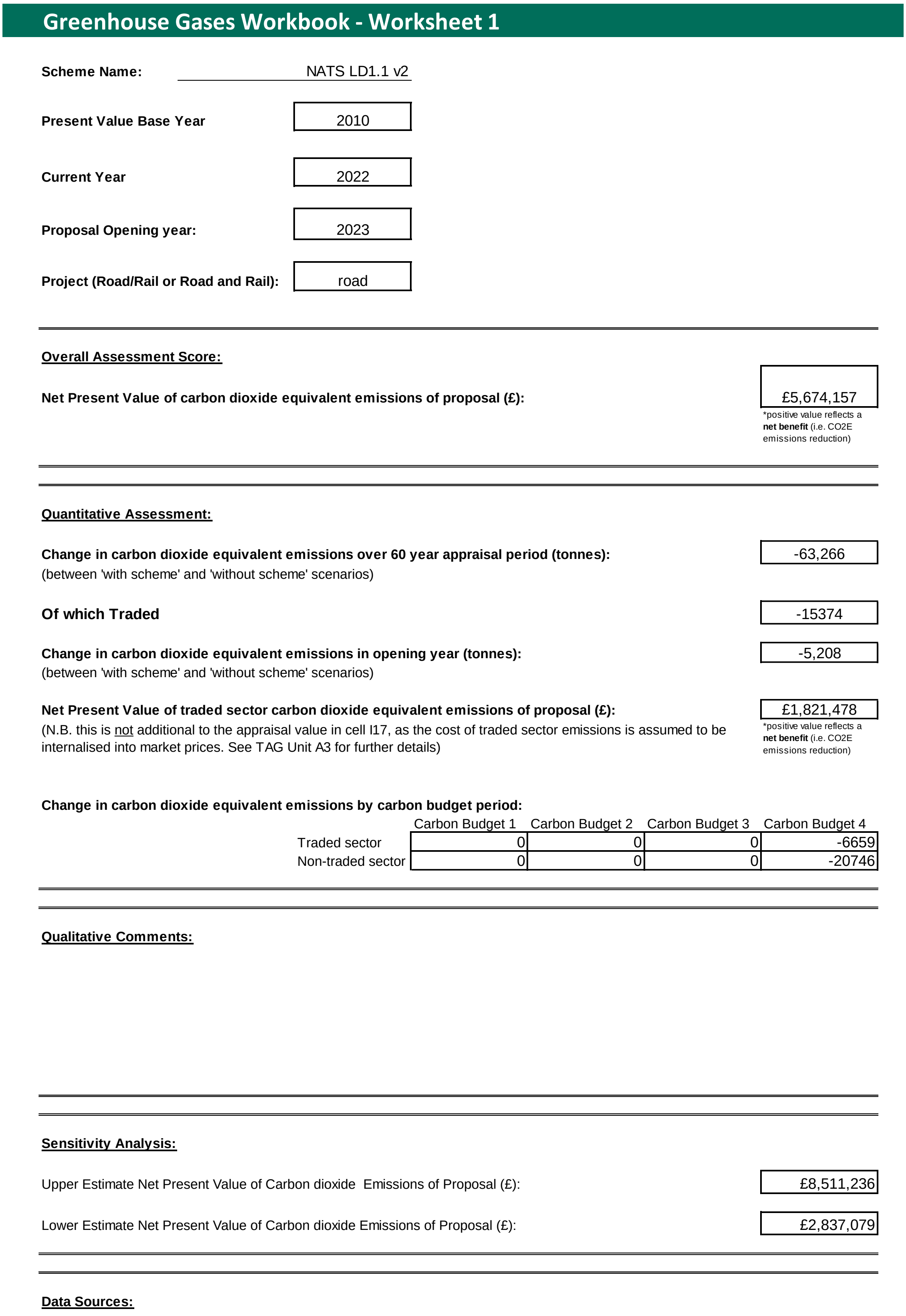
The results calculated by NATS Analytics for the fuel saving and $CO_2e$ savings are given in Table A2 Columns 3 and 4. A negative figure indicates a saving (benefit).

| Year | Flights per Year in FRA D2/LD1 Area | Simulated Fuel Saving (T) | Simulated CO2 saving (T) | CO2 Traded 24.3% | CO2 non-traded 75.7% | Fuel Cost (GBP) |
|---|---|---|---|---|---|---|
| 2023 | 476,048 | -2,171 | -6,903 | -1,677 | -5,226 | -£2,097,460 |
| 2024 | 496,388 | -2,263 | -7,198 | -1,749 | -5,449 | -£2,186,344 |
| 2025 | 503,261 | -2,295 | -7,298 | -1,773 | -5,525 | -£2,217,260 |
| 2026 | 511,022 | -2,330 | -7,410 | -1,801 | -5,609 | -£2,251,074 |
| 2027 | 518,458 | -2,364 | -7,518 | -1,827 | -5,691 | -£2,283,923 |
| 2028 | 526,235 | -2,400 | -7,631 | -1,854 | -5,777 | -£2,318,703 |
| 2029 | 534,129 | -2,436 | -7,745 | -1,882 | -5,863 | -£2,353,484 |
| 2030 | 542,140 | -2,472 | -7,861 | -1,910 | -5,951 | -£2,388,264 |
| 2031 | 550,272 | -2,509 | -7,979 | -1,939 | -6,040 | -£2,424,011 |
| 2032 | 558,527 | -2,547 | -8,099 | -1,968 | -6,131 | -£2,460,724 |
| 2033 | 566,904 | -2,585 | -8,221 | -1,998 | -6,223 | -£2,497,436 |

Table A3, computer simulation results for FRA D2

The results calculated by NATS Analytics for the fuel saving and $CO_2e$ savings are given in Columns 3 and 4. A negative figure indicates a saving (benefit).

# WebTAG GHG Workbook Output: LD1.1 Option 6



## Greenhouse Gases Workbook - Worksheet 1

**Scheme Name:** NATS LD1.1 v2

**Present Value Base Year** 2010

**Current Year** 2022

**Proposal Opening year:** 2023

**Project (Road/Rail or Road and Rail):** road

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**Overall Assessment Score:**

**Net Present Value of carbon dioxide equivalent emissions of proposal (£):** £5,674,157

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

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**Quantitative Assessment:**

**Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes):** -63,266
(between 'with scheme' and 'without scheme' scenarios)

**Of which Traded** -15374

**Change in carbon dioxide equivalent emissions in opening year (tonnes):** -5,208
(between 'with scheme' and 'without scheme' scenarios)

**Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£):** £1,821,478
(N.B. this is not additional to the appraisal value in cell I17, as the cost of traded sector emissions is assumed to be internalised into market prices. See TAG Unit A3 for further details)

*positive value reflects a **net benefit** (i.e. CO2E emissions reduction)

**Change in carbon dioxide equivalent emissions by carbon budget period:**

| | Carbon Budget 1 | Carbon Budget 2 | Carbon Budget 3 | Carbon Budget 4 |
|---|---|---|---|---|
| Traded sector | 0 | 0 | 0 | -6659 |
| Non-traded sector | 0 | 0 | 0 | -20746 |

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**Qualitative Comments:**

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**Sensitivity Analysis:**

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £8,511,236

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £2,837,079

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**Data Sources:**

## Appendix B: Combined benefits for LD1.1 and FRA D2 (West)

These ACPs are interdependent, cover a common geographic region, and are being implemented concurrently. They are cumulatively referred to by NATS as West Airspace Deployment (West). It is important to note the interdependency of LD1.1 with the FRA D2 ACP, and to recognise the cumulative impact of both ACPs when considering the potential benefits.

To give the complete (combined) picture, the benefits for FRA D2 and LD1.1 are presented, with the summed overall impacts for each option summarised below. This presents the overall expected benefits for the West project as a whole:

| | 2023 $CO_2e$ (T) reduction | 2033 $CO_2e$ (T) reduction | 2023 $CO_2e$ (£ saved) (traded) | 2033 $CO_2e$ (£ saved) (non-traded) |
|---|---|---|---|---|
| LD1.1 impacts | -5,208 | -6,201 | £1,821,478 | £5,674,157 |
| FRA D2 impacts | -6,903 | -8221 | £2,414,337 | £7,521,591 |
| West (combined) impacts | -12,111 | -14,422 | £4,235,816 | £13,195,749 |

Table B1 Combined $CO_2e$ benefits for LD1.1 and FRA D2

| | 2023 Fuel saving (T) | 2033 Fuel saving (T) | 2023 Fuel Fuel saving (£) | 2033 Fuel Fuel saving (T) |
|---|---|---|---|---|
| LD1.1 impacts | -1,637 | -1,950 | £1,581,549 | £1,883,946 |
| FRA D2 impacts | -2,171 | -2,585 | £2,097,460 | £2,497,436 |
| West (combined) impacts | -3,808 | -4,535 | £3,679,009 | £4,381.383 |

Table B2 Combined fuel impact for LD1.1 and FRA D2

### Modelling assumptions

The AirTOp ATC computer simulation software was utilised plus RALPH pre-processor v1.3.17, and NEMo post processorv2.6

Traffic levels were grown as per the October 21 STATFOR extended forecast.

The same traffic sample has been used in all baseline and scenario models to ensure a valid comparison. One sample day (14th June 2018) was modelled in a westerly configuration. To account for the 2 easterly SID Truncations for EGGD/EGFF as part of the West project, the easterly configuration of these flows has been modelled and accounted for in the overall figures using a 30/70 split for Easterly/Westerly.

Trajectory profiles are calculated using NATS business intelligence (BI) data statistics on observed climb/descend rates, speeds and turn rates for BADA aircraft groups.

No “go-arounds” were simulated.

The current airspace was connected to the proposed designs inside West Airspace where possible.

Validation of the model was conducted by the West ATC design team and Analytics, this task was completed to a level acceptable with the design team.

The baseline model included SAIP AD4/5 and Farnborough ACP.

The West P8 design for Stage 4 modifies one of the EGGW STAR changes introduced as part of SAIP AD6. Therefore, this STAR has been adjusted to route via MOREZ instead of OCK in the baseline.

As the West design utilises two EGLC SID truncations being introduced as part of OSEP before the planned West implementation date, these have been included in both the baseline and scenario models for Stage 4.

Unconstrained demand was modelled, thereby excluding the naturally occurring influence of flow restrictions (i.e. no regulations were applied to the traffic sample).

A "blue sky" weather scenario, where no wind effects are present, was assumed.

No conflict resolution was applied en-route.

No network effects are simulated (i.e. no holding, vectoring, AMAN, runway arrival and departure separations).

No randomisation of flight plan departure times was utilised.

Fuel burn was calculated using NATS NEMO tool which uses BADA 4.2 data. Aircraft types not in BADA 4.2 use BADA 3.14 data.

Controller tasks were completed instantaneously with each controller able to control multiple aircraft simultaneously (i.e. no workload or response time constraints).

Sectorisation has been based on the Eurocontrol sector definitions.

The following updates were made to the traffic sample as requested by the project team:

- B744 and A380 aircraft types for BAW were replaced with 60% B772 and 40% B788
- A318 aircraft types for BAW were removed from our sample
- A340 aircraft types for VIR were replaced with B789

Following validation with the design team, aircraft arriving at EG* airports (except domestics) were modelled using the respective BADA low weight fuel burn rates. All others were modelled using BADA's nominal weight fuel burn rates.