

ARCADIS GUIDANCE TO THE CIVIL AVIATION AUTHORITY
REGARDING SECRETARY OF STATE SECTION 16 REPORT

HEATHROW EXPANSION PROGRAMME COST EFFICIENCY REVIEW

WESTERLY OPTION REVIEW



MAY 2018

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Westerly Option Review Report

Version

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Report No.	01
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Date	01 May 2018
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CONTENTS

Glossary	4
Tables & Figures.....	5
1 Introduction.....	7
2 Executive Summary.....	9
2.1 Recommendations.....	10
3 Version Summary	11
3.1 Introduction.....	11
3.2 Version 0.61.....	11
3.3 Version 0.63.....	12
3.4 Westerly Option	13
4 Detailed Review.....	14
4.1 Evaluation.....	14
4.2 Facility Area Benchmarks.....	17
4.3 IFS Findings	21
5 Benchmarking Analysis	22
5.1 Approach and Methodology	22
5.2 Analysis Overview	24
5.3 London Heathrow Airport	29
5.4 Frankfurt Airport, Germany	31
5.5 Charles de Gaulle Airport, Paris, France.....	33
5.6 Amsterdam Schiphol, Netherlands.....	35
5.7 Dubai International Airport, UAE.....	37
5.8 Hong Kong International Airport.....	39
5.9 Changi Airport, Singapore	41
5.10 Auckland Airport, New Zealand	43
6 Conclusion & Recommendations.....	45
6.1 Detailed Review	45
6.2 Benchmarking Analysis	45
6.3 Recommendations.....	46

Glossary

Abbreviation	Description
3R	Third Runway
AC	Airports Commission
AGV	Automated Guided Vehicle
APM	Automated People Mover
ATM	Air Traffic Movements
AWG	Airline Working Group
BAU	Business as Usual
BHS	Baggage Handling System
CAA	Civil Aviation Authority
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
CIP	Commercially Important Person
CUSS	Common Use Self Service
DCO	Development Consent Order
DfT	Department for Transport
EBS	Early Baggage Storage
G&T	Gardiner & Theobald

Abbreviation	Description
GIFA	Gross Internal Floor Area
HEP	Heathrow Expansion Programme
IATA	International Air Transport Association
IB	Integrated Baseline
IDL	International Departure Lounge
IFS	Independent Fund Surveyor
L&L	Leadership & Logistics
MPPA	Million Passengers Per Annum
OH&P	Overhead & Profit
PBB	Passenger Boarding Bridge
QC	Quicker & Cheaper
REPEX	Replacement Expenditure
SSBD	Self Service Bag Drop
TTS	Track Transit System
VCC	Vertical Circulation Core
VIP	Very Important Person
WBS	Work Breakdown Structure

Tables & Figures

LIST OF TABLES

Table 1. Arcadis Executive Summary Recommendations	10
Table 2. Benchmark Percentage Comparison	14
Table 3. 0.61 to 0.63 Estimate Comparison (figures at 3Q14 prices)	15
Table 4. Version 0.63 to Westerly Option Estimate Comparison (figures at 3Q14 prices)	16
Table 5. T5C Expansion T-Bar Estimate Comparison	17
Table 6. Airport Facility Size Average Benchmark m ² /mppa split by region	18
Table 7. IFS Report	21
Table 8. Airport Benchmarking Projects	26
Table 9. Westerly Option - High Level Summary	30
Table 10. Westerly Option - Cost Breakdown	30
Table 11. Arcadis Recommendations.....	46

LIST OF FIGURES

Figure 1. Masterplan Evolution.....	11
Figure 2. Version 0.61 Masterplan	12
Figure 3. Version 0.63 Masterplan	12
Figure 4. Westerly Option Masterplan	13
Figure 5. Airport Terminal m ² per mppa	19
Figure 6. Visual overview of the selected airports.....	24
Figure 7. Terminal Development Metrics – Project Costs	27
Figure 8. Terminal Development Metrics - £/mppa	27
Figure 9. Runway Development Metrics.....	28
Figure 10. London Heathrow Factsheet	29
Figure 11. Frankfurt Airport Factsheet.....	31
Figure 12. Frankfurt Airport benchmark data.....	32
Figure 13. Charles de Gaulle Airport Factsheet	33
Figure 14. Charles de Gaulle Airport benchmark data	34
Figure 15. Schiphol Airport Factsheet	35
Figure 16. Schiphol Airport benchmark data	36
Figure 17. Dubai International Airport Factsheet.....	37
Figure 18. Dubai International Airport benchmark data.....	38

Figure 19. Hong Kong Airport Factsheet 39

Figure 20. Hong Kong Airport benchmark data 40

Figure 21. Changi Airport Factsheet 41

Figure 22. Changi Airport benchmark data 42

Figure 23. Auckland Airport Factsheet 43

Figure 24. Auckland Airport benchmark data 44

1 Introduction

Arcadis has been appointed by the Civil Aviation Authority (CAA) to provide technical advice in support of their work on capacity expansion at Heathrow Airport.

This report, the Westerly Option Review, forms part of Arcadis' holistic appraisal of the cost efficiency of the Heathrow Expansion Programme (HEP) at this stage of the scheme. This report also includes a high-level review of benchmark data of other comparable global hub airports to compare the high-level cost implications of developing the Westerly Option.

As part of Heathrow's journey towards a fixed development masterplan, several iterations of the Heathrow's Capital Expenditure (CAPEX) plan for the Third Runway (3R) programme of works (known as the Integrated Baseline Purple Book, or 'Purple Book') have been produced. These reflect the continuing evolution of requirements with the aim of increasing the overall scheme affordability. The latest iterations include:

- **Version 0.61 - Airports Commission (AC):** This version represents the fifth iteration of the Purple Book, also referred to as the Airports Commission (AC) submission.
- **Version 0.63 - Quicker & Cheaper (QC):** This version of the Purple Book, also referred to as the Quicker & Cheaper (QC) option, incorporates amendments from version 0.62 (not issued formally by Heathrow Airport) and omits the provision of certain commercial development proposals and includes a revised Work Breakdown Structure (WBS) whilst also reallocating risk across the estimate.
- **Westerly Option:** This option was extrapolated from version 0.63. It includes scope omissions (such as the proposed T6A and T6B) and moves the focus onto extending existing facilities at the western end of the airport campus (such as the addition of the T5C T-Bar and T5X).

The emphasis of Arcadis' scope of work for this report is:

Detailed Review (section 4):

- Review Heathrow's methodology and progress on the masterplan options process culminating in the Westerly Option.
- Establish a clear understanding of scope differences, highlighting whether best practice is being followed and to undertake a 'Bottom Up' review of the Westerly Option CAPEX.
- This exercise was undertaken after the benchmarking analysis (described below) when more detailed information had been provided by Heathrow. The CAPEX analysed includes the full scope of the Westerly Option incorporating the extensions to T5B & C and the midfield pier.

Benchmarking Analysis (section 5):

- Analyse the benchmark data of comparable global hub airports from a 'Top Down' approach to review the high-level costs against relevant airport metrics. This analysis was undertaken, during February 2018, utilising very high-level publicly available data detailed within Appendix C.
- This analysis has looked at the T5X terminal expansion only which delivers an additional 25 million passengers per annum (mppa).

The analysis completed for this report was conducted in two distinct phases and comprised of the following:

Detailed Review:

- Review of the documentation supplied by Heathrow upon Arcadis request, supplementing the work carried out by the Independent Fund Surveyor (IFS).
- Further interrogation of items in the reconciliation (both between version 0.61 to 0.63 and version 0.63 to the Westerly Option), including:
 - High level check on CAPEX values and scope alignment with Purple Book version 0.61.
 - Identification of any scope additions and how these new values have been derived.
 - Overall review of scope to ensure any omissions and additions have been captured.
 - Provision of commentary around Heathrow's approach to risk adjustment between options.
- Provision of benchmarking analysis to understand the feasibility of the terminal facility target for T5X of 8,000m²/mppa compared with the 12,000m²/mppa stated in the Purple Book version 0.61.

- Provision of recommendations for areas warranting further investigation.

Benchmark Analysis:

- Select airports which are comparable to the HEP.
- Identify relevant airport metrics and detail any major development works in progress or recently completed.

Our scope of work has sought to capture and provide the above information for the benefit of the CAA, in line with a Project Charter produced by Arcadis and the scope described therein. This has been monitored through ongoing conversations between the CAA and Arcadis.

To become familiar with Heathrow's proposals and for the benefit of context regarding capacity expansion, reviews of publicly available information such as those on Heathrow's website, other airport operator's websites, industry publications and the Airports Commission materials have been performed.

Given the breadth and scope of the Westerly Option Review, Arcadis requested that Heathrow provided further data and supporting evidence, a summary of which is contained within Queries and Responses listed in Appendix D.

In addition to the review and analysis of the documentation which was made available, Arcadis have had ongoing engagement and meetings with Heathrow to obtain further clarity on the information supplied.

Arcadis believe it is worth noting that the structured and planned approach to engagement with Heathrow supported our review and the meetings with Heathrow have been of a productive nature, and the exchange of information and response to queries has generally been direct and forthcoming.

Arcadis considers that both the amount and detail of documentation available is appropriate to the current level of scheme development.

In this report we refer to some of Heathrow's activities as being 'best practice'. In this context we use this term to describe 'commercial or professional procedures that are accepted or prescribed as being correct or most effective'. This is Arcadis' view, given our deep aviation sector experience and drawing from lessons learnt across other capital-intensive industries (e.g. rail, highways, energy, utilities, etc.). In this report we differentiate the design of best practice methodologies, from the implementation and operation of commercial or professional procedures.

Finally, the following report has been provided to the CAA in two formats; unredacted and redacted. The unredacted version is provided to the CAA for full disclosure of the work completed by Arcadis and all details of the analysis, assessments and recommendations. The redacted version of this report has been provided to protect information that is deemed commercially sensitive at the time of the reports publication (May 2018).

2 Executive Summary

This report is intended to complement and be read in tandem with other works provided for the CAA by Arcadis; the Integrated Baseline Purple Book (0.61) Review Report and the Key Component Green Review Report.

Our detailed review of the Westerly Option broadly supports Heathrow's approach to the evaluation of the Westerly option. This enables the CAA to advise the Department for Transport (DfT) and other interested parties that the Westerly Option, whilst recognising the current high-level status, is a reasonable scenario warranting further consideration by Heathrow and that Heathrow is following best practice in its development of the options.

Our scope of work has identified the following key observations and findings:

Detailed Review

- After reviewing current information Arcadis consider the Heathrow aim for an 8,000m²/mppa is a stretch target based on current data evidenced in figure 5 of this report. Arcadis recommend that Heathrow indicate which functions are to be included within the terminal facility and which are to be decentralised in the future. This would further assist in the development and investigation of the Westerly Option and its viability.
- The extent of new facilities being provided under the Westerly Option is a significant reduction in new build areas from the previous options, based on a facility target for T5X of 8,000m²/mppa compared to 12,000m²/mppa from previous versions of the Purple Book.
- Arcadis has interrogated all items in the reconciliation between version 0.61 to version 0.63 of the Heathrow Airport Integrated Baseline Purple Book and version 0.63 to the Westerly Option:
 - For version 0.63 the base construction CAPEX values of any scope not omitted are aligned exactly with version 0.61, providing a high-level verification of the IFS study.
 - Reasoning behind the scope omissions in version 0.63 and the risk adjustment have been explained adequately by Heathrow. The adjustments between the estimates are generally logical and consistent. The scope reductions between versions 0.61 and 0.63 require confirmation that they are adequately covered by separate business cases outside HEP.
 - For CAPEX additions to the Westerly Option Heathrow has prepared high level estimates. Arcadis has reviewed the T5C T-Bar estimate and concurs with the general approach taken with only minor adjustments to the benchmark rate utilised by Heathrow in order to align with the Purple Book. For the T5X estimate Arcadis concurs with the narrative supplied by Heathrow but considers that the provisional sum of ■ for Gateways would benefit from further granularity.
 - The specific scope movements identified within the Westerly Option are understood at a high level, future exercises of this nature would benefit from a more detailed supporting narrative.
- In assessing the transition between the 2035 and 2048 estimates some judgement has been necessary to understand the expenditure profile of the relevant CAPEX. Arcadis understands the rationale behind this split but has not seen the specific reasoning behind it.

Benchmarking Analysis

- International benchmarking is a complex exercise due to the number of variables involved in the comparisons. These include:
 - Foreign exchange.
 - Inflation in different countries.
 - Project specifics.
- Arcadis also recognises that benchmarking development costs for international hub airports, at a top down level, is a difficult exercise. As such, all the information that Arcadis has found to compare against R3 is from publicly available sources. However, Arcadis has not had discussions with respective airport management teams to understand what is or is not included in the information and as such the overall conclusions should be used with caution. Arcadis recommended no further study in this area due to the limitations in the data and quality of the information available.

- Limited comparison (Hong Kong Airport and Frankfurt Airport) of runway developments indicates that the cost of the Westerly Option is within a comparable range to that of similar projects at a pound per million passengers per annum (£/mppa) metric.
- Comparison of terminal developments demonstrates that the cost of the Westerly Option is similar to a number of other developments at a £/mppa metric.
- The nature of the benchmarking information has included high-level costs rather than detailed breakdowns of each component.

2.1 Recommendations

For the benefit of the CAA, Arcadis has provided recommendations throughout this document that they may wish to be shared with Heathrow with the aim of collaboration and assisting Heathrow achieve their objectives.

These recommendations for Heathrow include, but are not limited to, the following:

Ref	Recommendation: Detailed Review
1	Produce area schedules for the terminals and satellites to ensure a full understanding of the facility size requirements is included in the Westerly Option scope.
2	Further develop estimates (such as T5X and T5C T-Bar) during the masterplan formation process to enable greater clarity around the scope and cost of the Westerly Option.
3	Greater input and buy-in from the Airline Working Group (AWG) to enable the terminal design to be developed taking cognisance of airline needs regarding, but not limited to, check-in and Commercially Important Person (CIP) lounges.
4	Indicate which facilities are included within the new terminal areas and which are to be decentralised, to enable further understanding of how the 8,000m ² /mppa target can be achieved.
5	Ensure that the areas can cater for peak passenger flow, as well as providing space for resilience. The 8,000m ² /mppa may lend itself more towards a short-haul arrangement rather than long haul with its associated significant passenger peaks.
6	Provide greater clarity around phasing assumptions and the split between scope delivered to 2035 and scope to be delivered up to 2048.
7	Ensure that the areas can provide the requisite levels of passenger service and that the airport can still receive the required commercial revenues, which underpin the business case decisions, from the reduced space.
Recommendation: Benchmarking Analysis	
8	Continue or commence benchmarking on non-aviation areas e.g. property, environmental and highway related with aviation and non-aviation projects.

Table 1. Arcadis Executive Summary Recommendations

3 Version Summary

3.1 Introduction

Heathrow has produced several revised versions of the estimate for the delivery of HEP that reflect movements in the Masterplan. These are highlighted in the figure below and the Westerly Masterplan Option (Westerly Option) is the current iteration.

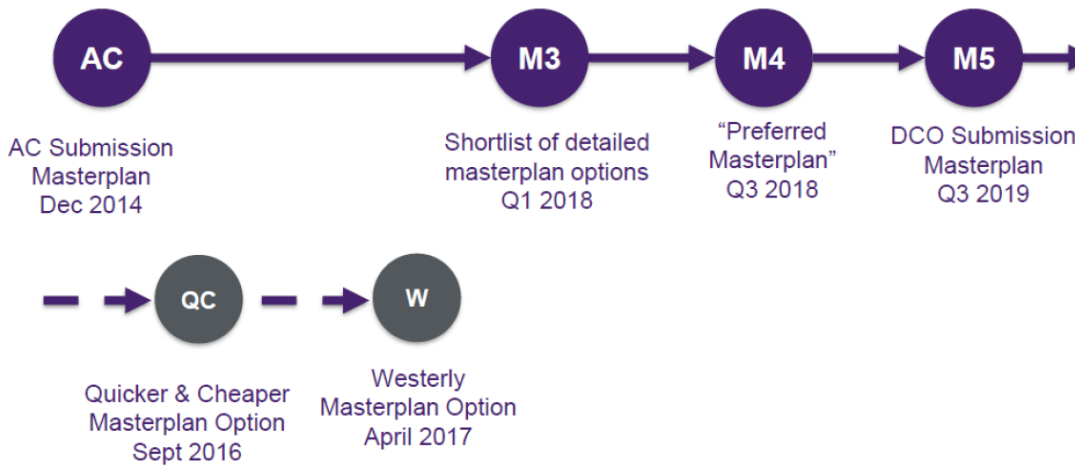


Figure 1. Masterplan Evolution

Arcadis has reviewed the estimates, undertaking a high-level check that the modifications between version 0.61 (AC) to version 0.63 (QC), and version 0.63 (QC) to the Westerly Option follow a logical path with any changes clearly articulated.

The objective of Arcadis has been to provide the CAA with reassurance that the Westerly Option, developed by Heathrow at a high level, is a reasonable scenario and includes all scope necessary (as far as can be ascertained) to achieve this.

At this point in the process, Arcadis consider that Heathrow has produced a reasonable scenario warranting further development.

3.2 Version 0.61

The first Purple Book was produced in December 2015 and version 0.61 represents the fifth iteration. The figure below depicts a high-level representation of the Masterplan version 0.61 scheme.

The Purple Book is Heathrow’s CAPEX plan for the HEP of works. The CAPEX values contained within the Purple Book are based upon the scope of works as defined in the AC Submission in May 2014 and their recommendations in July 2015 and the subsequent government announcement on 25 October 2016.

It includes Third Runway (3R) scope derived from the Baseline 0.5 with scope adjusted for a faster delivery and reduced capital expenditure. It also includes scope for the main airport consistent with the business case development from autumn 2015. The base date for all the costs is 2014 which aligns with the submission date.

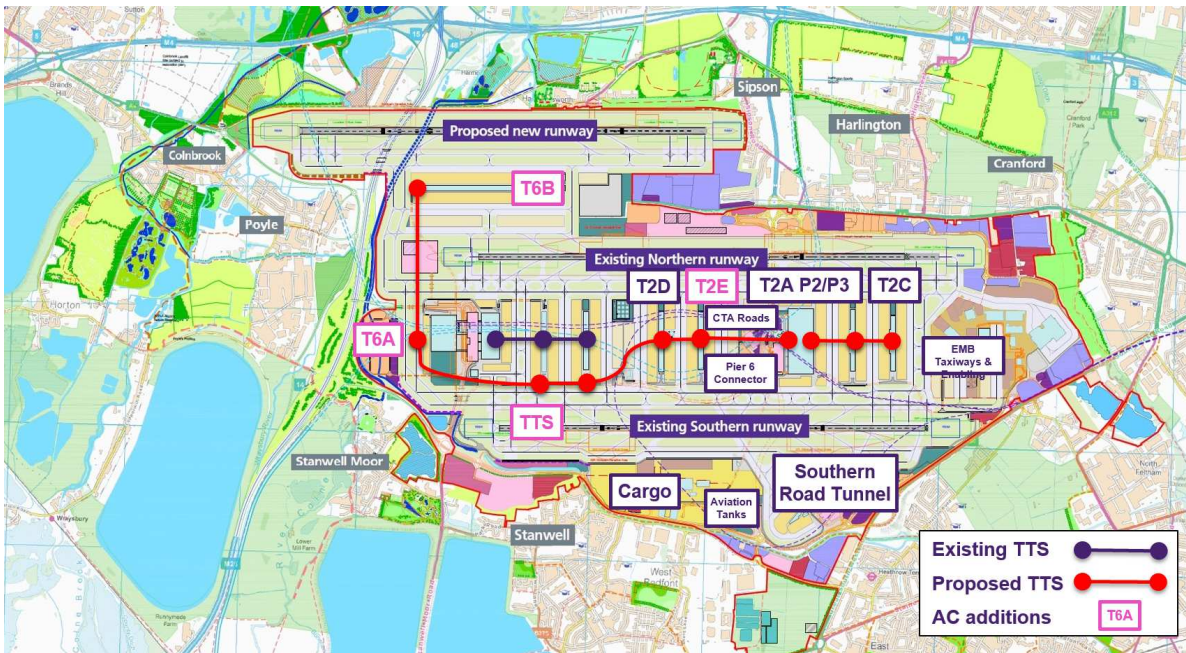


Figure 2. Version 0.61 Masterplan

3.3 Version 0.63

Version 0.63 builds upon version 0.61 and incorporates additional amendments within version 0.62 and a revised WBS reallocating risk across the estimate. It also includes some further scope adjustments and omissions largely related to works currently being executed under the Q6 programme described as being subject to separate business case considerations.

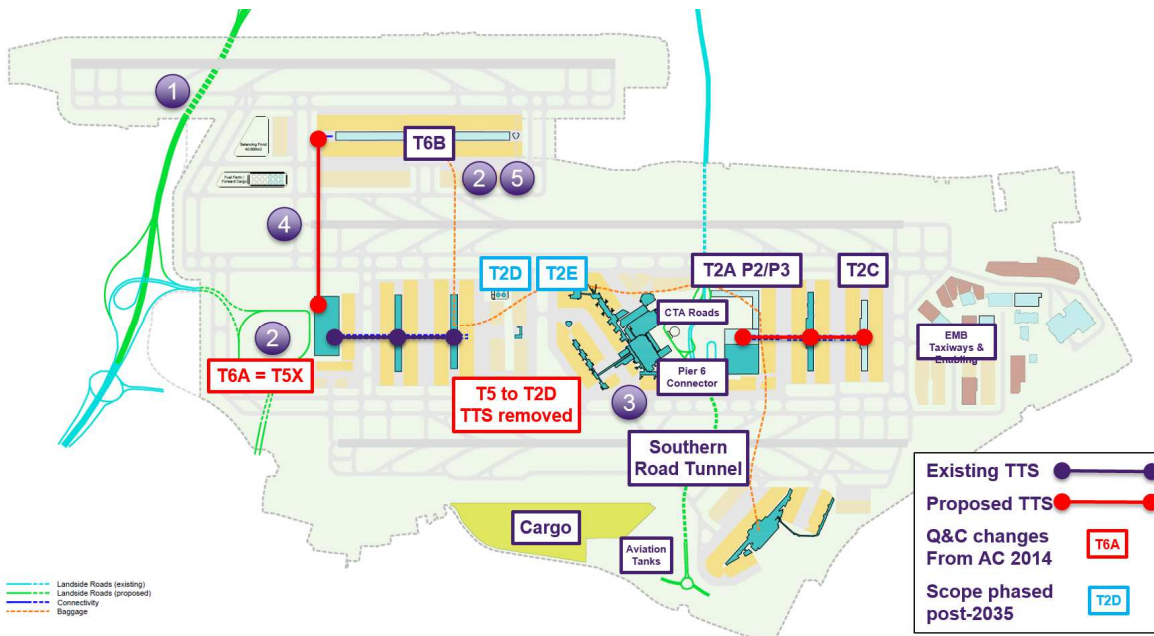


Figure 3. Version 0.63 Masterplan

These scope adjustments are split into pre-2035 and post-2035 scope. Amendments include T3 remaining operational for longer, and T6B containing more facilities and a landside reception centre connected to T5X utilising Automated Guided Vehicle (AGV) technology.

3.4 Westerly Option

This is a high-level estimate that moves the focus onto extending the facilities at the Western end of the existing campus and omitting T6A and T6B in the process. The figure below shows the omissions, additions and scope phased post-2035.

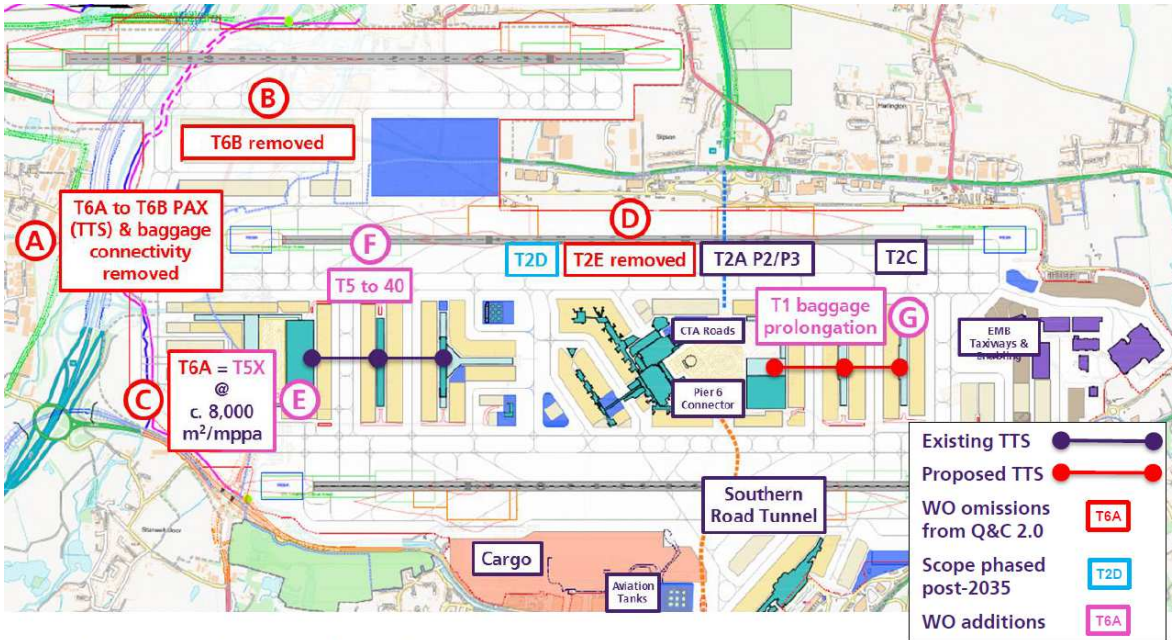


Figure 4. Westerly Option Masterplan

The Westerly Option scheme has been summarised in a dashboard issued by Heathrow. The key driver of which is an assessment of the impact that this scheme will have on reducing landing charges to near current levels to enable consistency with the statement in the Airports Commission’s findings that landing charges should remain at or near current levels.

This takes account of the changes in scope and phasing and the IFS recognises that this provides an indication of the capital budget required to achieve affordability.

Heathrow believe that they can deliver expansion approximately in line with the current charges for every year to 2035. Working with airlines Heathrow has developed ideas that, if taken forward following consultation, have the potential to further cut the capital cost and cost per passenger.

4 Detailed Review

4.1 Evaluation

Arcadis completed and provides a commentary on the changes between the estimates: Version 0.61 - Airports Commission (AC); Version 0.63 - Quicker & Cheaper (QC); Westerly Option.

Due to the high-level nature of each of the estimates (particularly the Westerly Option) there is relatively minimal documentation available from Heathrow. However, Arcadis considers that both the amount and detail of documentation available is appropriate to the current level of scheme development. The documents made available for Arcadis to review are listed in Appendix A.

In general, the IFS has verified, and Arcadis has confirmed, that the cost movements between each of the options have been captured. Arcadis has interrogated the additional scope items and has formed an understanding of how Heathrow has calculated the allowances and consider that they have followed best practice in their approach at this stage.

In tandem with this, Arcadis has reviewed and compared the percentage of the direct net construction costs (exclusive of scheme enablers such as land purchase and compensation), for each of the options that have been assessed against benchmark data, as shown in the table below.

Benchmark Percentage Comparison				
	Item	Version 0.61 (£m)	Version 0.63 (£m)	Westerly Option (£m)
	Total Gross			
1.1	Adjustments			
1.2	Direct Costs			
1.2.1	Scheme Enablers			
1.2.2	Net Construction			
1.2.2.1	Amount benchmarked			
1.2.2.2	Percentage benchmarked	39%	43%	47%

Table 2. Benchmark Percentage Comparison

The data indicates that following the reduction of the total scheme costs at each of the options, the percentage benchmarked increases from 39% in version 0.61 to 47% in the Westerly Option. Arcadis considers that this provides a greater level of assurance around the evolving costs.

4.1.1 Version 0.61 to Version 0.63

Arcadis has reviewed and compared the Purple Book version 0.61 and version 0.63. In doing so, Arcadis utilised the reconciliation provided by Heathrow and we also undertook a full reconciliation of our own.

Following our review of the data made available to us, Arcadis can confirm that for the majority of the direct costs the CAPEX amount and scope aligns exactly with Purple Book 0.61. The only changes are in the reapportionment of the risk provision against each item and the scope items removed. Arcadis considers that the omissions to scope and amendments to risk apportionment undertaken by Heathrow are justified.

Although not part of HEP, confirmation is required that the costs in the scope omissions are captured elsewhere by separate business cases. Upon review, the scope items removed are a mixture of separate business case items undertaken as part of Business as Usual (BAU), and those items pushed post-2035.

Estimate Comparison 0.61 to 0.63			
	Description	Version 0.61 (£m)	Version 0.63 (£m)
A	3R		
B	2R		
	Combined Total		
1	Omission of lump sum risk allowance		
2	Scope Omissions		
3	Risk allowance reallocated across remaining scope		

Table 3. 0.61 to 0.63 Estimate Comparison (figures at 3Q14 prices)

Arcadis has reviewed these options utilising the same split as for the Key Components. The Key Components are; Runway, Rivers and Flood Storage, M25 and Junctions, Local Roads, and Terminals, Satellites and Apron. There is only change to the base construction costs for the Terminals, Satellites and Apron as shown below:

- **Terminals, Satellites & Apron**

- T3 will remain operational until post-2035, resulting in continuing maintenance and therefore greater replacement expenditure (repex) on the ageing asset. Changes to terminal provision include:
 - T5 to T2D underground Track Transit System (TTS) removed.
 - T2D and T2E scope phased post-2035, with T3 remaining operational for longer.
 - T6A = T5X.

Although the percentages applied for Project Specifics, Preliminaries and Overhead & Profit (OH&P) remain unchanged between version 0.61 and 0.63, Heathrow has amended other add-on costs as below:

- **Leadership & Logistics (L&L) & Design**

- The design element was a lump sum figure. Design costs have been disaggregated from the gross component costs, so that design can be more appropriately apportioned against each item.

- **Risk & Uncertainty**

- This version allocates risk figures to each section of the estimate as opposed to the lump sums included in version 0.61. The main changes are the apportionment of the risk and uncertainty allowance both at P50 and P80 levels to the individual estimate groups. This is an improvement in the approach of apportionment of the risk and uncertainty allowance. Arcadis would expect further improvements and detail in Heathrow's approach to risk and uncertainty management going forward.

4.1.2 Version 0.63 to Westerly Option

Development from Version 0.63 - Quicker & Cheaper (QC) option to the Westerly Option meant the deletion of some items of scope, the movement of other scope beyond 2035 and the addition of other scope to compensate. In the Western campus the Westerly option deleted T6A (located next to T5) and also deleted T6B (the 25mppa northern satellite), including the baggage and the Automated People Mover (APM) connectivity between T6A and T6B. Therefore, to re-accommodate the required capacity T5X was included in the masterplan.

To undertake this evaluation Arcadis requested from Heathrow and received back-up to Heathrow's evaluation of the three new scope items: T5C T-Bar; T5X and T1 baggage prolongation.

The Westerly Option lowers CAPEX through more efficient phasing and build compared with version 0.63. Discussion with the AWG indicates a strong opportunity to consolidate growth across the western and eastern

campuses and drive operating efficiencies for airlines and improve passenger experience without a significant increase in charges.

Arcadis recognise that the Westerly Option is currently at a very early stage of design and will continue to be evaluated and optimised by Heathrow. There are still a significant number of choices, including scope, which will present further opportunity and risk to this option.

The table below indicates the changes between version 0.63 and the Westerly Option.

Estimate Comparison 0.63 to Westerly Option			
	Description	Version 0.63 (£m)	Westerly Option (£m)
A	3R		
B	2R		
	Combined Total		
1	T1 baggage system prolonged		
2	T5C T-Bar extended		
3	T2E removed		
4	T6 replaced with T5X		
5	T6 Baggage and PAX connectivity removed		

Table 4. Version 0.63 to Westerly Option Estimate Comparison (figures at 3Q14 prices)

As with the scope changes between versions 0.61 to 0.63, Arcadis has reviewed this option utilising the same split as for the Key Components. There have been no appreciable changes to the base construction costs of the Runway, Rivers & Flood Storage, M25 and Junctions, and Local Roads. However, further significant changes have been made to the Terminals, Satellites and Apron as below:

- **Terminals, Satellites & Apron:**

- Both T2E, T6B and the T6A to T6B TTS and baggage connectivity have been removed, resulting in the requirement for T6A = T5X. Heathrow have allowed a reduced area of 8,000m²/mppa.
- For T5X, Heathrow carried out a high-level review as to what could be done differently rather than the production of an estimate from a detailed design. Hence their aim for 8,000m²/mppa rather than 12,000m²/mppa resulting in a figure of £■■■■bn. The validity of the 8,000m²/mppa target is displayed in greater detail in figure 5. Arcadis' findings include:
 - Heathrow's estimate is based on a very high-level briefing paper with no design drawings or sketches which demonstrates the potential of the scheme.
 - From the target range for the new facility of 25-30mppa, Heathrow used the upper figure of 30mppa for the purposes of costing. By using the upper figure Heathrow have built in a level of tolerance to their CAPEX numbers. Arcadis believe that the way this has been calculated is to drive efficiencies in the design. Arcadis is satisfied with the approach taken by Heathrow at this stage of the programme.
 - Heathrow demonstrated that the CAPEX for T5X is based on a gross internal floor area (GIFA) of 240,000m² multiplied by the £■■■■ m² net rate (totalling ■■■■m) and 240,000m² multiplied by the net ■■■■ m² rate for Vertical Circulation Cores (VCCs) and nodes (totalling ■■■■m). These rates are aligned with previous iterations of the Purple Book.
 - Heathrow has allowed an ■■■■m undefined provisional sum for a decentralised Gateway area to allow modal shift between different forms of transport to and from the airport. This includes opportunities to outsource items from the main terminal building (i.e. remote passenger processing, bussing from Gateway to central area, etc.), and is a way of providing terminal facilities outside of constrained spaces. Arcadis believe that this ■■■■m allowance is a large lump sum and should be broken down into further detail in future versions of option analysis.

- The additional amount for on-costs and adjustments (project specifics, On-costs and adjustments) is █% and has been retained by Heathrow in line with previous iterations of the Purple Book. Arcadis consider that this is a valid approach.
- The addition of the T5C T-Bar involves the reconfiguration of the T5C satellite to enable increased passenger throughput. Heathrow has based their estimate on a high-level design team note. Arcadis has received the estimate for this and has reviewed quantities, rates, add-ons and risk, as below, with a detailed breakdown contained within Appendix F.

T5C Expansion T-Bar Estimate Comparison					
	Item	Heathrow (£m)	Arcadis (£m)	Variance (£m)	Comments
1	Base Construction Costs				Baggage allowance high
2	Project Specifics				No Project Specifics
3	Project On-Costs				Reduced due to baggage
4	Risks				Reduced due to baggage
	TOTAL				

Table 5. T5C Expansion T-Bar Estimate Comparison

- The Arcadis assessment of T5C T-Bar, based on detail provided, is approximately 20% lower than the Heathrow estimate. This is predominately due to the costs apportioned to baggage which area higher value included by Heathrow than the figure assessed by Arcadis. Heathrow have detailed an allowance of £█m, whereas Arcadis have considered £█m an appropriate figure. In future reviews it would be beneficial for Heathrow to provide an indication as to the breakdown and reasoning behind the baggage allowance for the T5C T-Bar project.
- Quantities have been derived from a high-level design assessment. Arcadis has reviewed this assessment and concurs with the quantities produced by Heathrow.
- The rates utilised are a mixture of Heathrow benchmarks and Purple Book data. Arcadis has checked that these align with the Purple Book and there appear to be only a single difference; while the terminal expansion rate of £█m² is in full alignment, the rate used for the pier is 10% lower at █m² rather than █m². Arcadis suggest that this is revisited by Heathrow as the design develops.
- The provision of T2D has been phased post-2035 and the useful life of the baggage system at T1 has been prolonged, both of which Arcadis consider to be justifiable scope changes as part of the Westerly Option.

4.2 Facility Area Benchmarks

4.2.1 Approach

The extent of the new terminal facilities being provided by Heathrow under the Westerly Option is a significant reduction in area from the previous schemes, with a facility target for T5X of 8,000m²/mppa compared with the 12,000m²/mppa stated in version 0.61.

The CAA has requested that Arcadis comment upon the validity of this target by carrying out a review of existing airport facility sizes against their design passenger throughput.

A key aspect of assessing efficiency is how the implemented rates compare to those from similar facilities. As such, Arcadis has sought benchmarking information on terminal extensions, the construction of new terminals and new airport facilities from airports around the world, with a focus on Europe.

The data for the airports has been obtained from available information in the public domain, primarily from the airport operator and industry publications. However, the nature of the metrics provided has not enabled us to analyse how these figures have been developed.

4.2.2 Results

The graph overleaf details the m²/mppa for each of the airports investigated, summarised by global region as per the table below:

Airport Facility Size Benchmarks			
	Region	Airports Identified (nr)	Average (m ² /mppa)
1	Africa	2	9,200
2	Europe	29	10,800
3	Americas	6	12,300
4	Asia	12	12,800
5	Middle East	8	13,400
	Worldwide	57	11,700

Table 6. Airport Facility Size Average Benchmark m²/mppa split by region

From this data, the European average is 10,800m²/mppa while the global average is 11,700m²/mppa.

The large range of approximately 6,000-23,000m²/mppa may lead to questions as to the validity of this benchmark as a tool for decision making, therefore any extrapolations from the data must be considered carefully, taking into account the following factors:

- It is hard to definitively measure with confidence and understand what facilities are included within the GIFA supplied, potentially resulting in inconsistencies between the data compared.
- It is difficult to confirm design passenger throughput and ensure areas are aligned between airports in terms of what is and is not included (i.e. incorporation of public areas and transport interchanges, etc).
- Larger m²/mppa figures may result from older, less efficient airport designs.
- The short haul versus long haul passenger split of each airport is likely to influence the analysis.

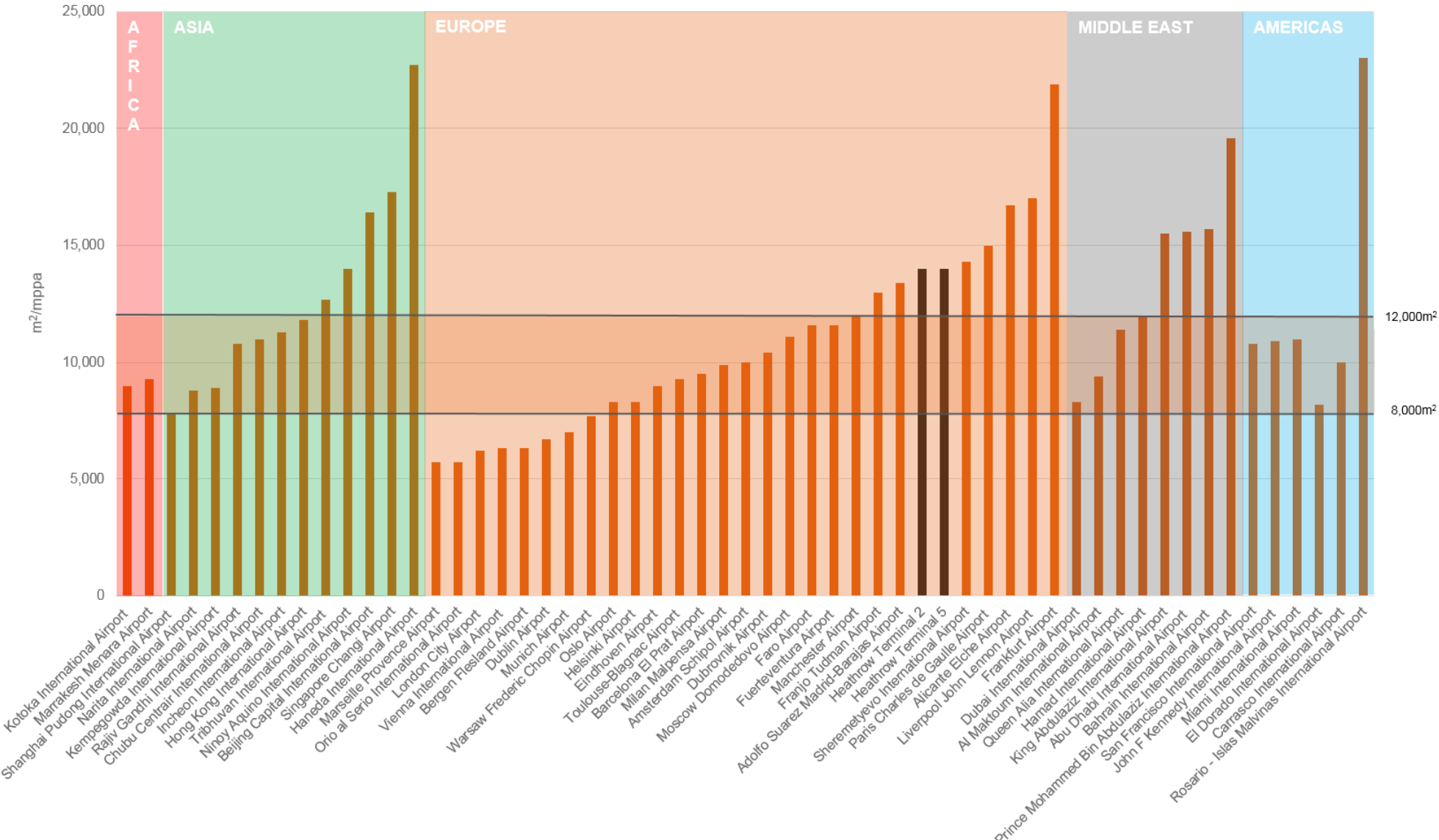


Figure 5. Airport Terminal m² per mppa

4.2.3 Observations

Arcadis understand that Heathrow aim to achieve 8,000m²/mppa. Arcadis have noted however that in aiming to achieve 8,000m²/mppa it may put pressure on service levels and require reposition of space elsewhere. Heathrow are aware of this pressure and are seeking to alleviate with proposed efficiencies and activities detailed below.

Heathrow have advised that once areas related to the Track Transit System (TTS) and Automated People Mover (APM) have been omitted, T5 is approximately 14,000m²/mppa containing large areas of office and check-in concourse space, while T2 is also in the region of 14,000m²/mppa. Arcadis have been advised that these figures are based on current throughput and not necessarily total capacity.

For a new facility, there is the potential to out-source some of these functions to gateways around the airport thereby reducing the head-house space required.

Reviewing current information Arcadis consider the 8,000m²/mppa figure an ambitious target. Arcadis recommend that Heathrow indicate which functions are to be included within the terminal facility and which are to be decentralised. This would further assist in the development and investigation of the Westerly Option and its viability. This should be included for future analysis of the option.

Notwithstanding the above, to achieve 8,000m²/mppa target efficiencies must be gained through continual innovation while ensuring that requisite levels of passenger experience and throughput are maintained. Arcadis suggest these are discussed by Heathrow with all relevant stakeholders.

Arcadis consider that the m²/mppa can be reduced through the employment of technology enablers to provide a more integrated and personalised passenger experience throughout the passenger journey.

These enablers, which either reduce the space required or increase passenger throughput for each function on the passenger journey, include:

- **Forecourt** - Autonomous electric vehicles (i.e. pods, buses, APMs, etc) transporting passengers from off-site gateways may assist in reducing drop-off space requirements.
- **Check-In** - Increased use of Common-Use Self Service (CUSS) and Self-Service Bag Drop (SSBD) kiosks negating the need for traditional full-service check-in desks. Alternative off-airport bag drop points (e.g. train stations, city centre, etc.) will also reduce space, as will 'home to hotel' baggage services.
- **Baggage** - Increased use of automation within Baggage Handling Systems (BHS), including the use of Early Bag Storage (EBS) where bags are individually coded and recognised allowing for longer storage both for connecting passengers and those utilising alternatives off-airport bag drop points. Automated Guided Vehicle (AGV) based systems can provide space efficient baggage sortation, transportation and storage.
- **Security** - The application of walk-through tunnel screening has the potential to decrease passenger queuing time and space requirements, utilising both offsite image viewing and blockchain security (integrated facial recognition tracked using airport Closed-Circuit Television (CCTV) systems).
- **Departures** - Increased use of click and collect facilities and personalised shoppers may reduce traditional shop floor display space within international departure lounge (IDL). Centralised versus decentralised IDL and dedicated terminals catering for specific passenger types (short haul, premium, etc.) will further impact upon the space requirements, as will the imposition of common use CIP Lounges. Technological solutions to streamline and enhance the connections process will improve the overall passenger experience and provide more time to engage in leisure activities thereby improving airport commercial prospects.
- **Boarding** - As well as greater use of eGates and digital boarding cards, the use of automated self-docking Passenger Boarding Bridges (PBBs) will decrease the time taken for passenger embarkation and disembarkation and speed up aircraft turnaround.
- **Circulation** - Passenger wayfinding assistance with interactive screens, and augmented reality navigational systems and virtual assistants making use of smart technology to offer localised information to passengers, ranging from flight information to retail offerings, and speeding up passenger throughput.
- **Immigration** - Solutions to optimise passenger flow by reducing queue duration will enable the reduction of space required in immigration. These solutions include the enhancement of existing techniques

including eGates and ePassport biometric technology, fast track and Very Important Person (VIP) immigration services, trusted traveller programmes and digital landing cards. Employment of pre-clearance at origin schemes and walk-through immigration using a combination of techniques to scan passengers as they pass would further speed up the immigration process and reduce space requirements. It is foreseeable that the use of eGates and ePassport biometric technology may change with the impact of Brexit and Heathrow should be aware of a need for a wider adoption of the technology for all third country passports for this option to be viable.

- **Reclaim** - By optimising flow at immigration, efficiencies at baggage reclaim can be achieved. Passengers can track via an app the progress of their bags through the system and utilise off-airport collection points (i.e. home, hotel, etc) to further reduce the facility space required.

Several considerations exist for any reduced m²/mppa proposed and Arcadis suggest these are discussed by Heathrow with all relevant stakeholders to ensure that they include:

- That the reduced area can cater for peak passenger flow, as well as providing space for resilience. The 8,000m²/mppa may lend itself more towards a short-haul arrangement rather than long-haul with significant passenger peaks.
- That the smaller areas are capable of providing the requisite passenger service levels.
- That the airport can still receive the commercial revenues, which underpin business case decisions, which can be derived from the reduced space.

4.3 IFS Findings

Heathrow and the Heathrow Airline Working Group (AWG) commissioned Gardiner & Theobald (G&T) to act as an Independent Fund Surveyor (IFS) to analyse Heathrow's findings at each stage of masterplan development and provide a review of progress to date. The IFS produced the report described below.

IFS Report			
	Key Component	Date Issued to Heathrow	Date Issued to Arcadis
1	Heathrow Expansion Programme – IFS Review of Cost Plan Development (Westerly Option)	07 February 2018	07 February 2018

Table 7. IFS Report

Key areas of focus for the IFS included:

- Ensuring that there is a clear understanding of the progression between various estimates.
- Ensuring movements in the estimates maintain alignment between scope and cost.
- Reviewing the cost changes proposed in the context of the progression of the estimates.
- Reviewing the risk allowance since the issue of the Purple Book version 0.61.

Arcadis conducted a high-level appraisal of this report and broadly support the findings of the IFS. Arcadis had no significant differences of opinion to the IFS regarding their analysis, findings and recommendations. The key areas addressed by the IFS include but are not limited to:

- The ability to achieve the 8,000m²/mppa design aspiration.
- The current challenge around risk and the maturity of risk management going forward.
- The transition of scope between 2035 and 2048.
- The specific scope movements between iterations of the CAPEX plan.

5 Benchmarking Analysis

5.1 Approach and Methodology

Arcadis recognises that benchmarking development costs for international hub airports, at a top down level, is a difficult exercise. As such, all the information that Arcadis has found to compare against R3 is from publicly available sources.

However, Arcadis has not had discussions with respective airport management teams to understand what is or is not included in the information and as such the overall conclusions should be used with caution. Arcadis recommended no further study in this area due to the limitations in the data and quality of the information available.

5.1.1 Approach

A key aspect of assessing the cost efficiency is how the implemented direct cost rates compare to those in other similar programmes of works.

Cost benchmarks, by definition, are the analysis of historical data adjusted for known variances to provide an indication, at high level, of the likely cost of a similar product if replicated at a given time and location.

Arcadis proposed the following facility level benchmarks to compare against Heathrow's programme of works:

- Terminal Infrastructure (T5X only)
- Runway Infrastructure

The metrics and data used in the report have been obtained from a variety of sources which are listed in Appendix B. The data for Heathrow is based upon the cost breakdown of each component of the Westerly Option. The data for the other airports included in the study has been obtained from publicly available information only, primarily from airport operator and industry publications.

Our review has not analysed how the final and publicly available figures have been developed in comparison to the costs of the Westerly Option. This is essentially due to the sources and nature of development costs and metrics being obtained from public information rather than broken down detailed costs that would only be available by directly engaging and requesting from the airport operator. This activity did not form part of the Arcadis scope and Arcadis believe it is not a worthwhile exercise at this stage. Therefore, the benchmark metrics used in comparison to the Westerly Option have focused on the total cost of the relevant project and only analyses the breakdown of costs where possible. For instance, if the cost of a development includes all ancillary and non-airport infrastructure costs then this has been stated in the analysis. Given the high-level nature of the exercise, currently no adjustments have been made due to location factors. In reading the results of the analysis, Arcadis ask that due cognisance of this be taken into consideration. Arcadis are aware that the constrained location of Heathrow can increase costs in comparison to other airports contained within the data set and detailed within our report.

International benchmarking is a complex process and it is important to clarify the parameters of the exercise. The developments at the comparison airports have been completed over different time scales. Therefore, to provide a relevant comparison with the Westerly Option the prices and costs of the projects described in the report have been adjusted to account for exchange rates between the relevant currency and sterling at the approximate date of the project.

The prices have then been adjusted to account for inflation to align with the 2014 rates of the costing for the Westerly Option. To maintain a consistent approach the rates of inflation are based on Bank of England data and a calculation tool available on their website. This has enabled a cost based on £/mppa to be calculated for each project. This is the metric Arcadis have used to assess the Westerly Option against the benchmark airports.

Finally, Arcadis have determined the annual passenger capacity increase to allow for a degree of comparison for the incremental per passenger cost to deliver the infrastructure. We do note significant limitations with this annualised approach to passenger capacity, particularly due to how that capacity is measured against the deployment of the current or future schedule.

5.1.2 Selection of Airports Methodology

The data within this benchmarking exercise is intended to compare the costs of major projects at airports in order to provide a high-level analysis of the Westerly Option to the CAA.

Based on the information available to Arcadis and the development of the Westerly Option to date the analysis includes a high-level cost comparison of airport infrastructure across a range of selected airports. This has enabled a cost per passenger figure to be applied to the relevant expansion works. The costs per passenger figure is based on the increase in passenger capacity of the respective development at each of the airports.

The benchmarking exercise has selected a range of airports for the purposes of comparing against relevant metrics for Heathrow.

The selected airports are as follows:

- Frankfurt Airport, Frankfurt
- Charles de Gaulle Airport, Paris
- Schiphol Airport, Amsterdam
- Dubai International Airport
- Hong Kong International Airport
- Changi Airport, Singapore
- Auckland Airport, New Zealand

The range of airports were selected based on several factors. Firstly, the main hub airports within Europe are considered as competitors and are similar in size to Heathrow and have therefore been chosen. These are hub airports, similar to Heathrow, have large airlines operating significant networks serving business, leisure and transfer traffic.

Our review also includes similar sized airports outside of Europe. Dubai International is the largest airport in the world for international passengers. Hong Kong and Changi are major airports in Asia acting as both destinations in their own right and they both have large numbers of passengers transferring. These airports have therefore been included.

Auckland Airport has also been included. Whilst Auckland is not as large an airport as others selected in the comparison, it was deemed relevant as it is a significant destination for several major airlines, its status as a major international airport from the perspective of passenger destination and origin and is characterised by having a high proportion of international traffic. Auckland was, therefore, deemed a relevant comparison.

For the purposes of consistency, our review uses passenger and air traffic movement data from 2016. This is the last complete year where this data is available across the above selection of airports. At the date of the Arcadis report verified passenger numbers from 2017 are available from only a selection of the airports.

5.2 Analysis Overview

5.2.1 Airports Overview

The figure below provides a high-level overview of all airports included within the study showing relevant introductory background data.

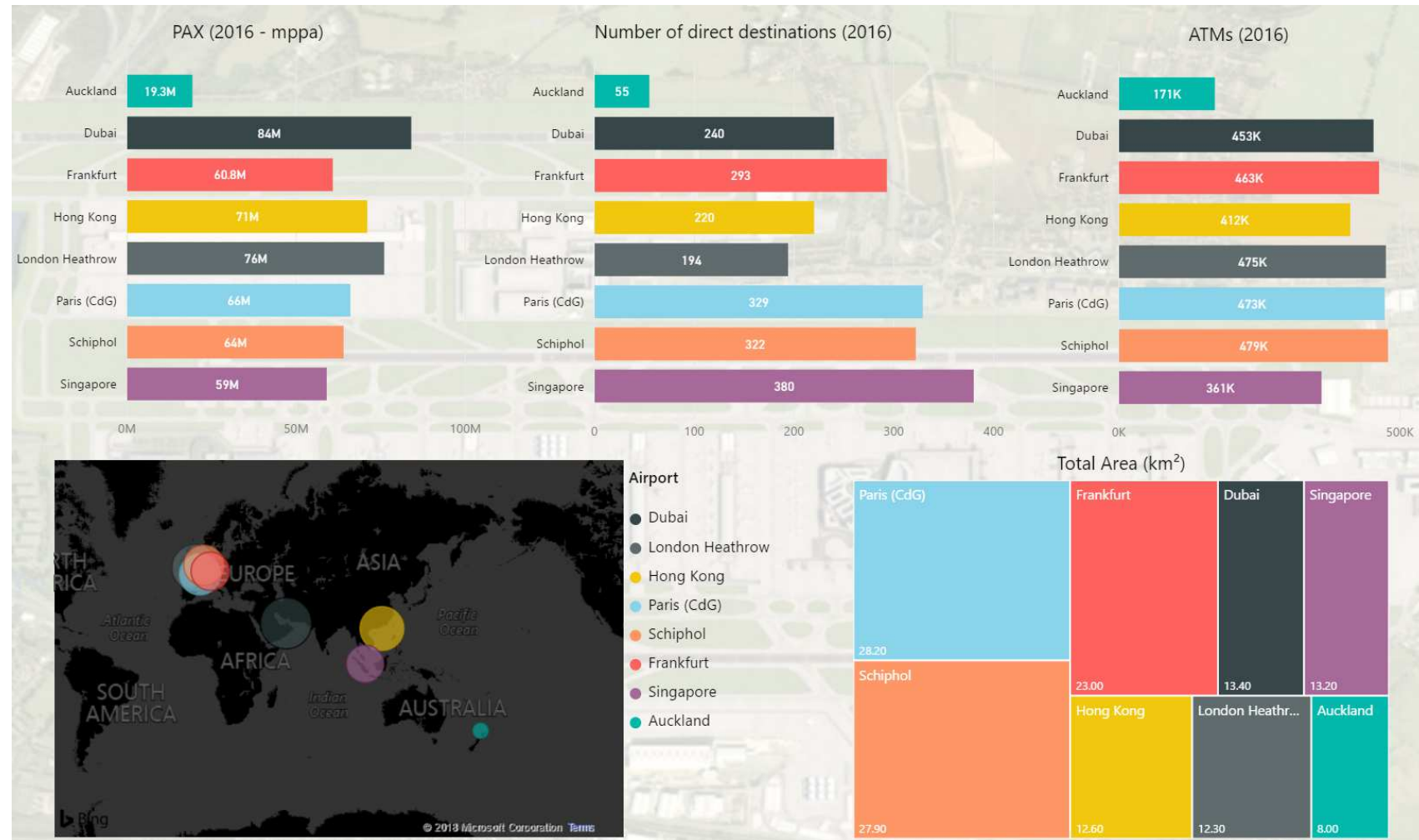


Figure 6. Visual overview of the selected airports

The data in the figure 6 presents a useful background to compare and consider Heathrow and the other airports in our review. Further analysis is provided within our report, however figure 6 demonstrates notable comparisons such as, but not limited to;

- Air Traffic Movements (ATMs) correlate with the ranking of airports by passenger numbers.
- Singapore Changi Airport is the smallest by passenger number of the major hubs yet it is the best connected airport by number of direct destinations.
- Excluding Auckland, Heathrow has the fewest direct destinations despite being the third largest by passenger numbers. Arcadis is aware that this reflects the nature of several routes at Heathrow with multiple daily frequencies as opposed to other airports where there are many destinations but served less frequently.

5.2.2 Cost Comparison Overview

The table below includes a summary of the airport projects analysed within this report. It includes the cost of the projects adjusted to 2014 prices with an indication of the costs per mppa of these projects, along with the stated annual passenger capacity increase.

As noted, these figures are based on publicly available data and are likely to indicate the overall construction cost of each project (i.e. the base construction cost including all preliminaries and add-on costs). However, due to the lack of clarity over the make-up of the data it has not been possible to confirm this in all cases and for all airports.

The figure provided for the Westerly Option Terminal and Runway is the overall cost of construction of these elements. It excludes all other infrastructure required to deliver the Westerly Option. This is detailed further in Section 5.3.1.

Figures below break these projects down and illustrates them into two main workstreams highlighting the same metrics as presented in the table below:

- Terminal Infrastructure:
 - This includes the construction costs of the terminal building and associated connectivity to the existing airport infrastructure.
 - This does not include baggage requirements or design elements.
- Runway Infrastructure:
 - This includes airside works (runway, taxiways, aprons) but excludes landside infrastructure.
 - This does not include land reclamation, property purchase, environmental mitigation and transport infrastructure works.

Heathrow have provided two passenger (pax) numbers to detail the comparison between the capacity for T5X and overall capacity for 3R from 2035 onwards, 30mppa and 40mppa respectively.

Airport Benchmarking Developments			
Airport Development	Project Cost £UK (2014 FX & Inflation Adjusted)	£/mppa	Additional Capacity (Annual Pax)
Auckland Airport Terminal Expansion			4,700,000
Changi Airport New Terminal			16,000,000
Charles de Gaulle Airport Connecting Terminals			2,300,000
Dubai Int. Airport Terminal Expansion			30,000,000
Frankfurt Airport New Runway			35,600,000
Frankfurt Airport New Terminal			14,000,000
Hong Kong Airport New Runway			30,000,000
Hong Kong Airport New Terminal			10,000,000
Hong Kong Airport West Apron Expansion			10,000,000
Schiphol Airport New Terminal and Pier			15,000,000
Westerly Option New Runway			40,000,000
Westerly Option Terminal Expansion (T5X)			30,000,000

Table 8. Airport Benchmarking Projects

Terminal Infrastructure

As is shown in figure 7, based on publicly available data, the facility benchmarks of the £/mppa of terminal related capacity for Heathrow is in the middle of the data set.

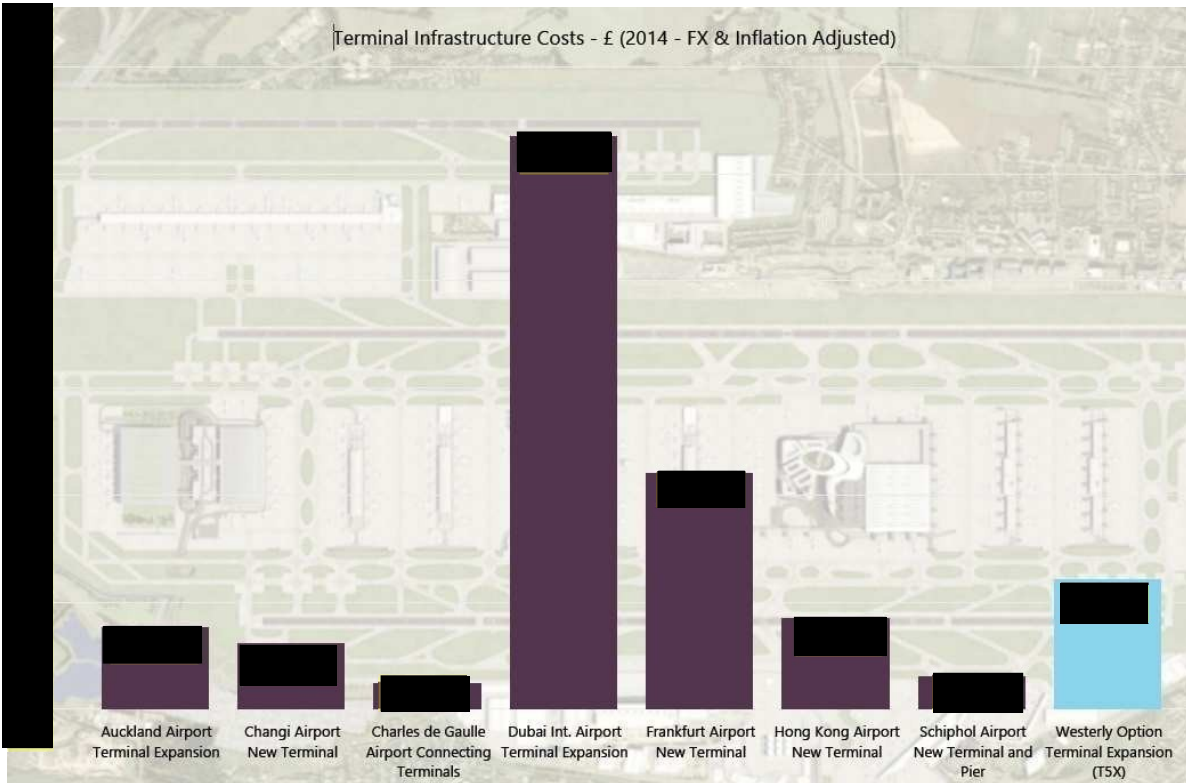


Figure 7. Terminal Development Metrics – Project Costs

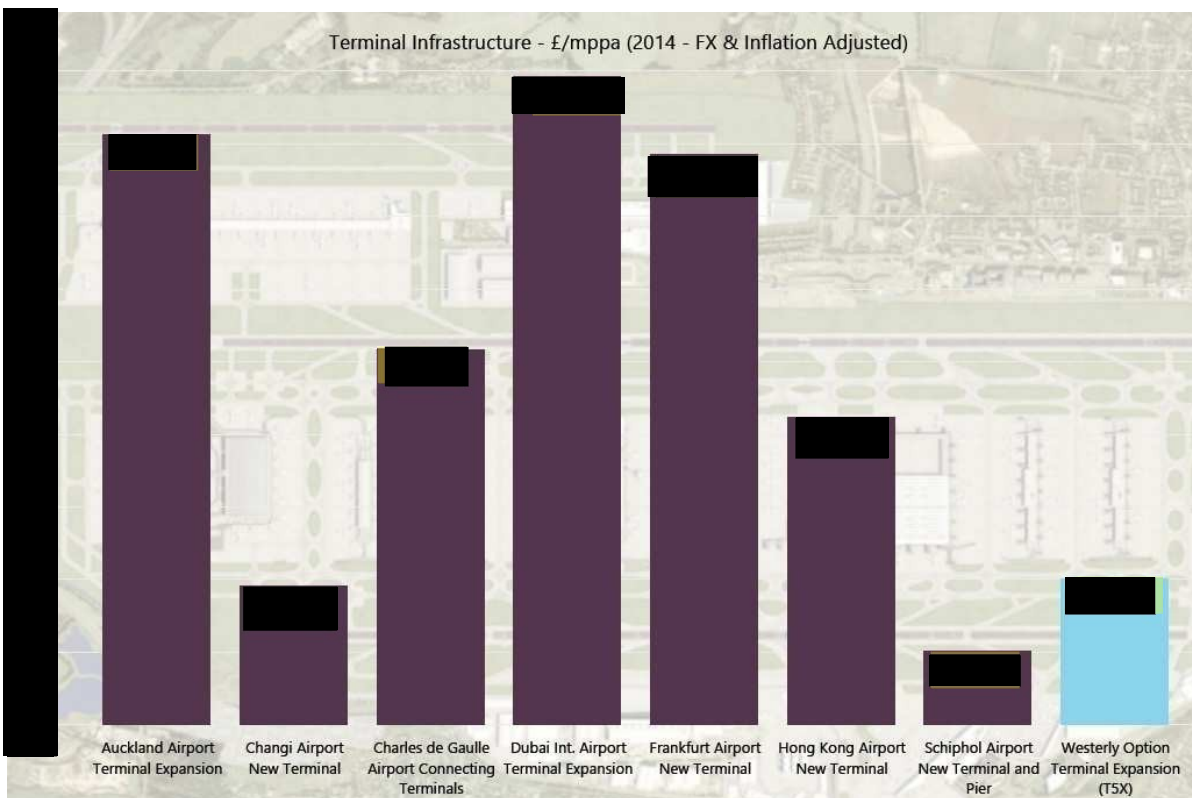


Figure 8. Terminal Development Metrics - £/mppa

Runway Infrastructure

As is shown in the figure 9, based on limited publicly relevant and available data, the facility benchmarks of the £/mppa of runway related capacity place Heathrow in the middle of the (limited) comparison.

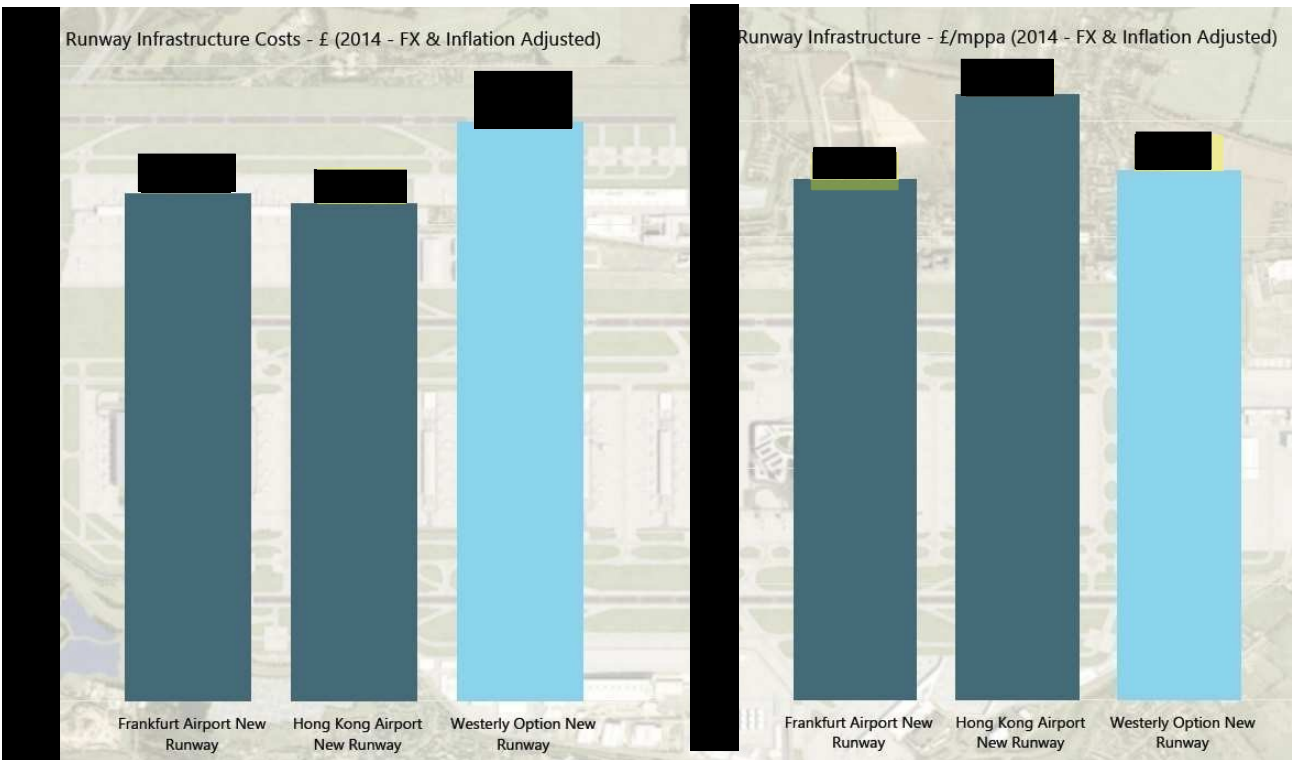


Figure 9. Runway Development Metrics

5.3 London Heathrow Airport

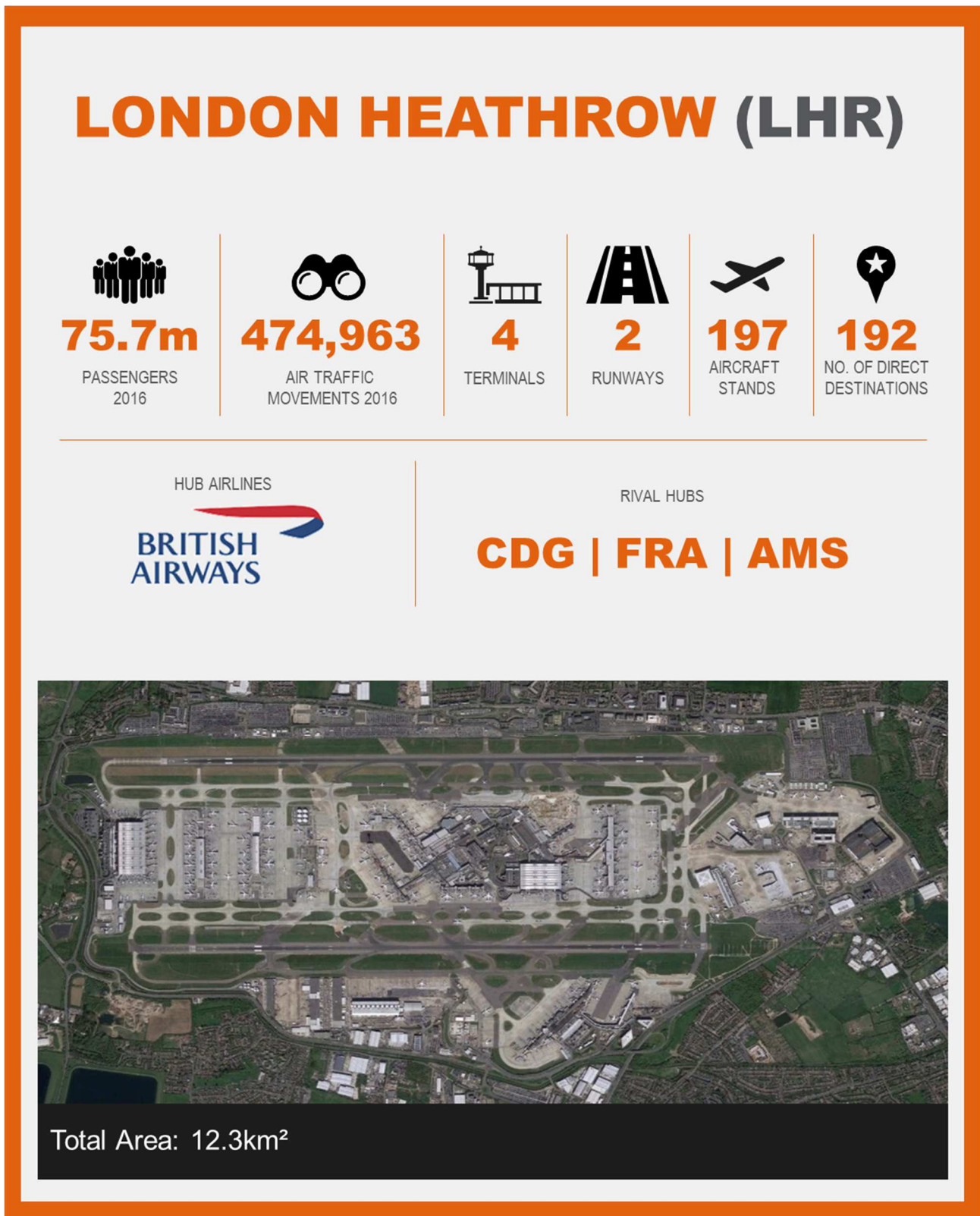


Figure 10. London Heathrow Factsheet

5.3.1 Airport Development Review

Westerly Option

The Westerly Option has been developed as part of the wider master planning process for the development of the airport and a summary of this option, including the relevant cost data, is provided below for context. The costs detailed below are taken from the 31 August 2017 Heathrow Expansion Programme Cost and Benefit Working Group slide deck. The costs are 2014 prices. The benchmark analysis for each airport in the study has been assessed against the Westerly Option depending on the detail of information available for each airport.

The high-level estimated cost of the Westerly Option is £[redacted] on based on 2014 prices. The split of the workstreams is indicated in the table below:

Westerly Option – High-Level Cost Breakdown (£m)	
Design	[redacted]
Non-Terminal Infrastructure	[redacted]
T5 Expansion	[redacted]
Baggage & TTS	[redacted]
Total	[redacted]

Table 9. Westerly Option - High Level Summary

The Westerly Option costs illustrated above is the total cost including external non-airport infrastructure works.

The table below breaks the non-terminal infrastructure figure down to provide greater detail into the various aspects. We have used the highlighted elements for our comparisons:

- Terminal (T5 expansion) related: £[redacted] on.
- Runway (R3) related: [redacted] on. This CAPEX number also includes for landside and this portion equates to [redacted]. Therefore costs attributed directly to the construction of the runway amount to [redacted].

Westerly Option – Non-Terminal Infrastructure Cost Breakdown (£m)	
Design	[redacted]
Property	[redacted]
Motorway, Roads and Highways	[redacted]
Airside and Landside Infrastructure	[redacted]
Other – Environmental, Demolition, Noise Mitigation Etc	[redacted]
Total Non-Terminal Infrastructure	[redacted]
T5 Expansion	[redacted]
Baggage & TTS	[redacted]
Total	[redacted]

Table 10. Westerly Option - Cost Breakdown

5.4 Frankfurt Airport, Germany

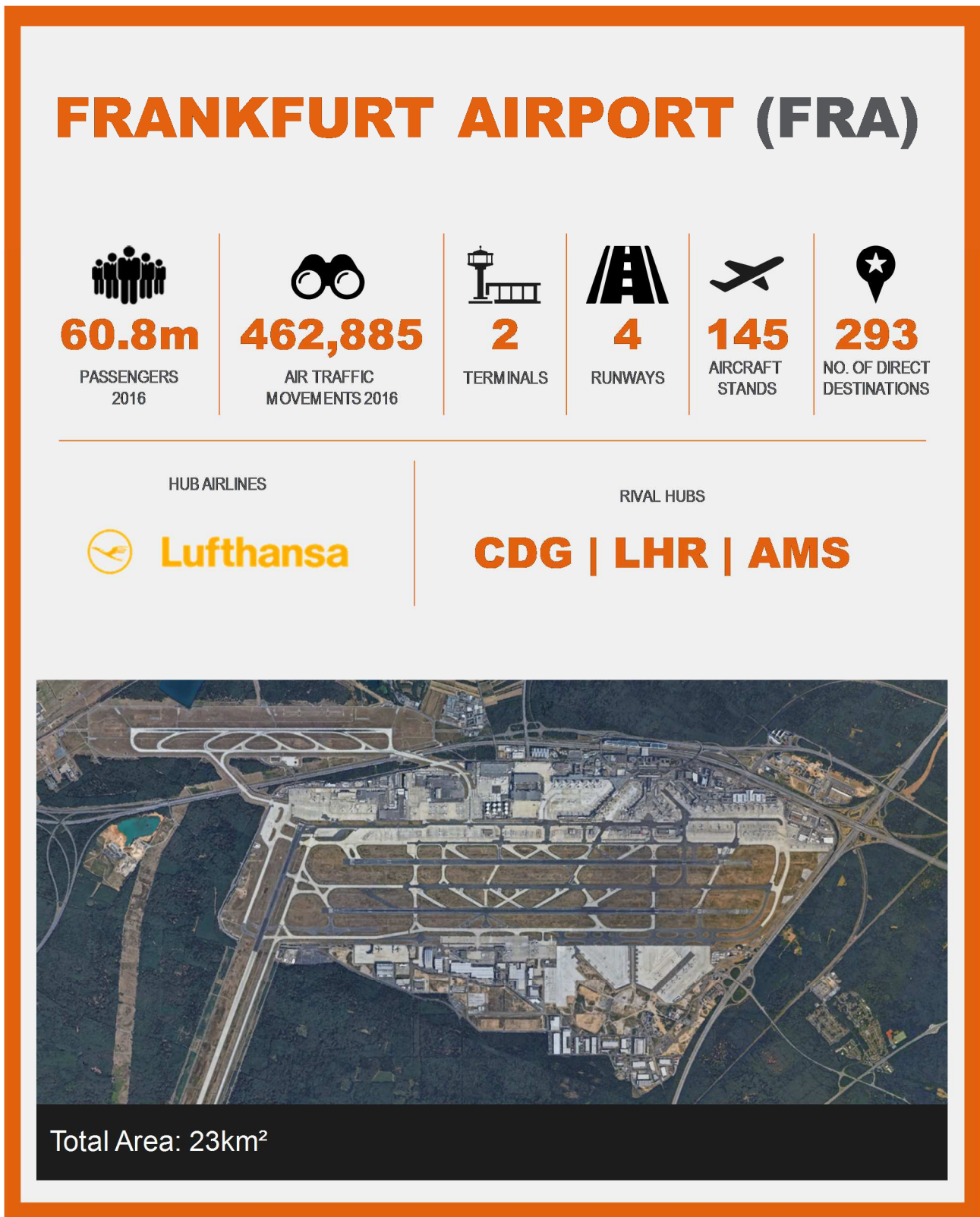


Figure 11. Frankfurt Airport Factsheet

5.4.1 Airport Development Review

Following additional airfield capacity with a new runway opening in 2011, Frankfurt Airport has focused on providing additional terminal capacity.

Terminal

The largest scale major project currently under construction is a new terminal at Frankfurt Airport. The new Terminal 3 is located to the south of the airfield and is due to open in 2023. It will have a capacity of 14mppa over 90,000sqm with two new piers and 24 new aircraft stands.

The land to develop this terminal was already within the boundary of the airport. The site was formerly a US Air Force base and when the land was no longer required the area became available for redevelopment by Fraport. Therefore, no significant infrastructure works were required to prepare the site in advance of the main terminal construction works.

The cost of the new terminal is approximately £2.2bn. As this is currently under construction a direct comparison can be made with the proposed works at Heathrow.

Airfield

The most recent major development completed at Frankfurt Airport was the opening of a new 2,800m north-west runway at a cost of £1.6bn. This is the direct cost of constructing the runway and excludes a further cost of €670m to relocate a chemical factory to enable the runway to be accommodated.

The new runway provides enough capacity to increase total air traffic movements to 700,000 per year. However, of the four runways, one is used only for arrivals and one is used only for departures.

Total ATM capacity at Frankfurt is approximately 700,000 with a 4-runway system, adding an additional 35.6mppa of capacity. The newest runway is only used for arrivals and the runway opened in 1984 is only used for departures. Airfield capacity at Heathrow will be 740,000 ATMs per year with a three-runway system. The main difference in airfield capability is that each runway at Heathrow will be capable of accommodating both arrivals and departures.

5.4.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Frankfurt Airport. Data is available to provide a comparison for both terminal and runway infrastructure.

The information available regarding the construction of the fourth runway appears to show a cost per passenger marginally lower than the Westerly Option. The costs for the runway at Frankfurt do not include any external works to relocate non-airport infrastructure, similar to the costs analysed for the Westerly Option. For instance, the relocation of the chemical factory has been omitted from the cost comparison.

The new terminal at Frankfurt Airport is significantly more expensive than the Westerly Option. This could be attributed to being an entirely new development, rather than an expansion of existing infrastructure.

5.4.3 LHR/FRA Benchmark Data

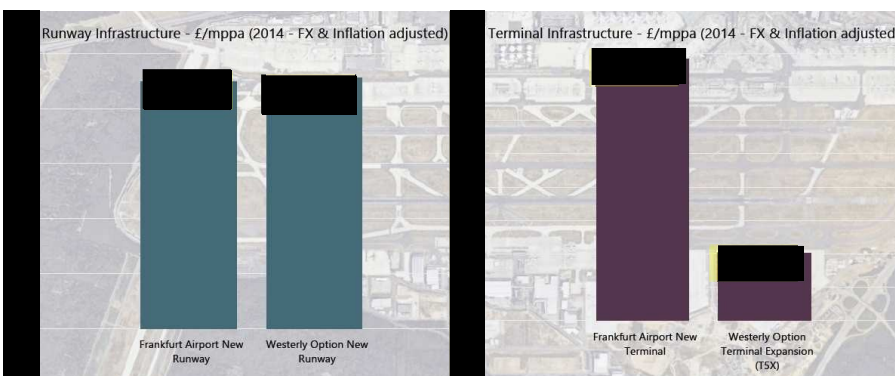


Figure 12. Frankfurt Airport benchmark data

5.5 Charles de Gaulle Airport, Paris, France

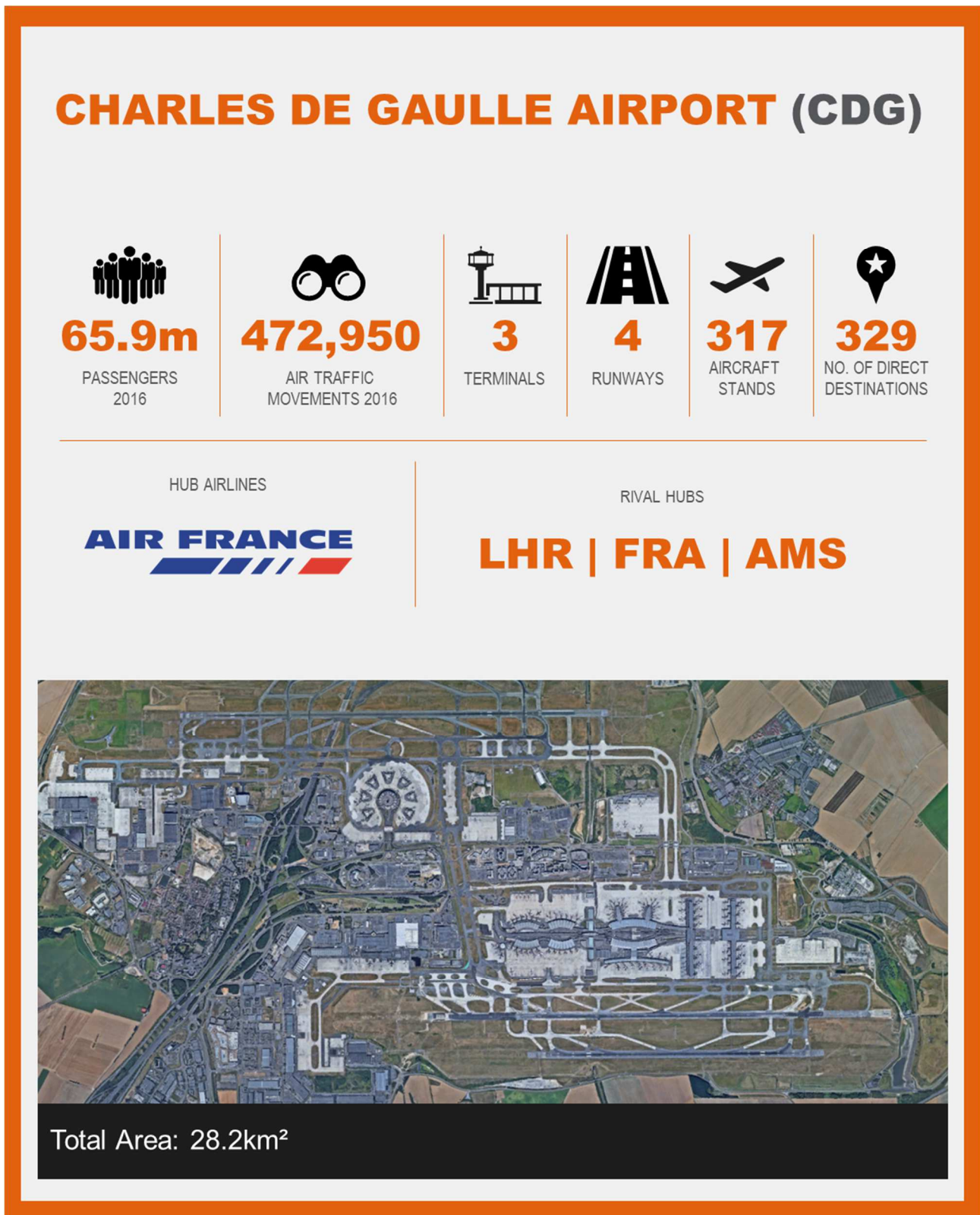


Figure 13. Charles de Gaulle Airport Factsheet

5.5.1 Airport Development Review

The main developments at Paris Charles de Gaulle Airport are contained within the Connect 2020 Strategic Plan. This was published by Aeroports de Paris for the period 2016-2020 and details developments for both Charles de Gaulle and Paris Orly Airports. The main developments at Charles de Gaulle Airport are based upon terminal upgrade and expansion.

Terminal

The most significant and comparable capacity enhancement projects at Charles de Gaulle Airport are the merger of the international satellites in Terminal 1 and the new connecting building between Terminals 2B and 2D. This will create an additional 72,800m² of floorspace, increase capacity by 2.3mppa, enable the terminal to operate more efficiently and enhance the passenger experience, at a cost of £292m. The land to develop this terminal was already within the boundary of the airport.

Related works to the baggage facility at Charles de Gaulle Airport will be required for these works but this in itself is not a comparison with the extent of works at Heathrow, therefore the only direct comparison is the terminal reconfiguration works.

Airfield

There are no development works on the airfield at Charles de Gaulle during this period to compare against the proposals at Heathrow. Two of the four runways at Charles de Gaulle Airport are scheduled to be renovated between 2016 and 2020. However, no capital expenditure is proposed to increase airfield capacity.

5.5.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Charles de Gaulle Airport. Data is only available to provide a comparison of terminal infrastructure.

The proposals detailed in the Connect 2020 vision and outlined in this report specifically for Charles de Gaulle Airport do not compare in scale or nature to the Westerly Option. With four runways and an airport capacity of 80mppa Charles de Gaulle Airport is not currently proposing a development of a comparable scale to the Westerly Option.

The main comparable work in merging satellite terminals for international passengers is the largest development at the airport within the current development phase. Limited landside external infrastructure works are required to complete the Connect 2020 vision at Charles de Gaulle Airport.

5.5.3 LHR/CDG Benchmark Data

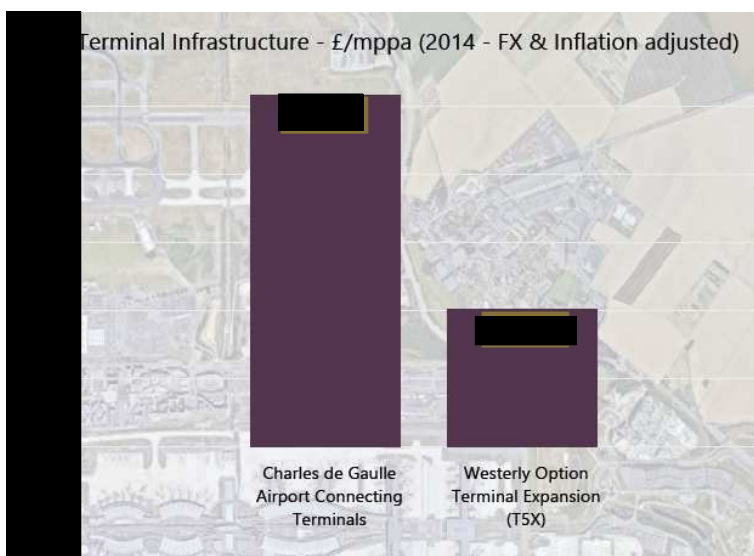


Figure 14. Charles de Gaulle Airport benchmark data

5.6 Amsterdam Schiphol, Netherlands

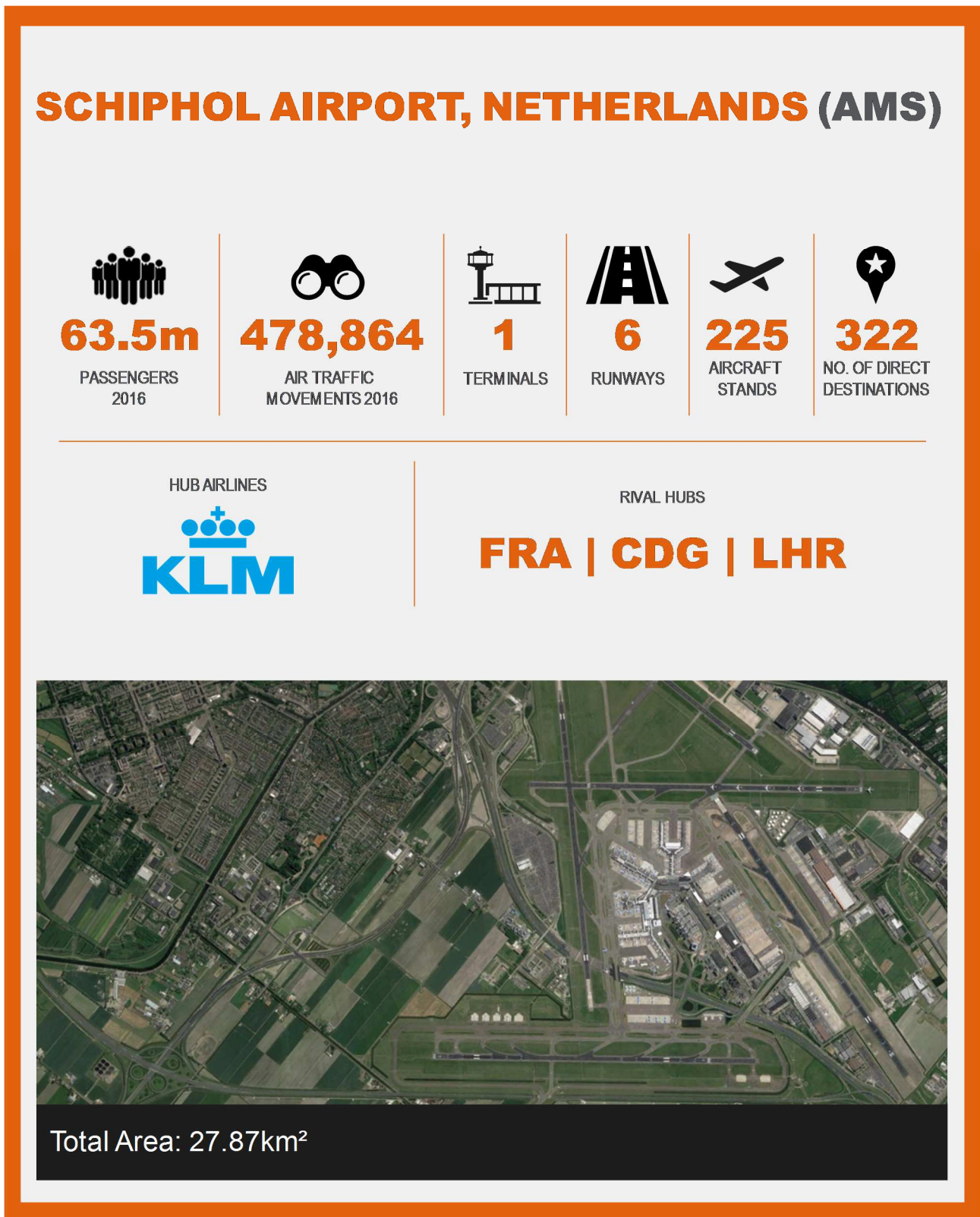


Figure 15. Schiphol Airport Factsheet

5.6.1 Airport Development Review

As a major European hub with six runways, the capital development and capacity enhancement at Schiphol Airport is now concentrated on terminal facilities. The airfield has sufficient capacity to handle current and projected passenger numbers.

Terminal

The airport terminal at Schiphol is under one roof, albeit split internally into different piers and with distinct areas for both Schengen and non-Schengen flights. The most significant capacity enhancement project underway at Schiphol Airport is the construction of a new terminal and pier. The terminal is actually an extension of the existing building rather than a separate facility and this will maintain the overall one-roof concept. This will provide capacity for an additional 15mppa, at a cost of £306m. As this is a terminal expansion rather than a new terminal, there is no requirement for capital works to physically connect terminals.

Airfield

The airfield developments at Schiphol Airport are directly related to the new terminal and pier. Therefore, the main airfield development is simply to accommodate the changes associated with the terminal expansion. These costs are included with the terminal expansion so there are no airfield works that can be directly compared to the proposals at Heathrow.

5.6.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Schiphol Airport. Data is only available to provide a comparison of terminal infrastructure.

The phase of development currently in progress at Schiphol Airport includes the main terminal expansion and new piers alongside various ancillary upgrades including temporary works to accommodate long term construction, landside alterations and upgrades to baggage systems.

There is a material difference in the cost comparison per passenger between the Westerly Option and Schiphol Airport. The terminal development at Schiphol Airport is being constructed within the current airport boundary and does not require external landside infrastructure work to accommodate it.

The cost of the projects underway or recently completed are entirely and directly attributed to the actual expansion works.

5.6.3 LHR/AMS Benchmark Data

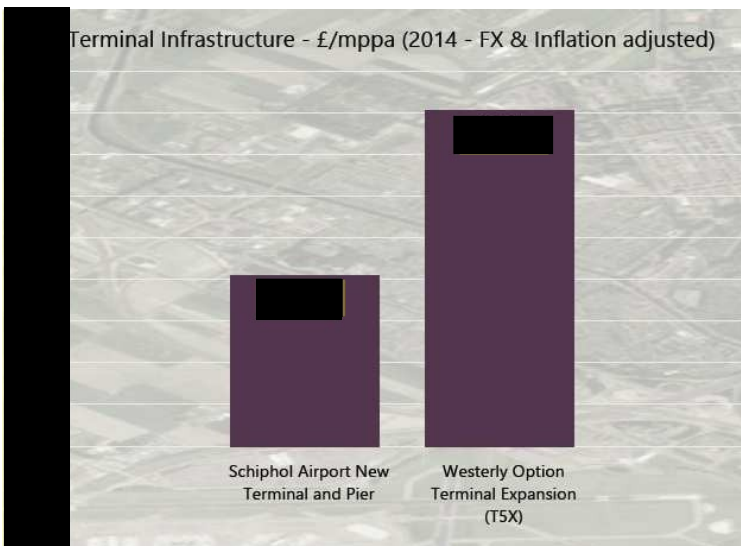


Figure 16. Schiphol Airport benchmark data

5.7 Dubai International Airport, UAE



Figure 17. Dubai International Airport Factsheet

5.7.1 Airport Development Review

The Dubai Airports Strategic Plan 2020 details the significant expansion either in progress or planned at Dubai International Airport. The combined projects total 28.8 billion AED (£5.3bn) enabling capacity to grow to 90mppa.

Terminal

Dubai International Airport has significantly increased terminal space as part of the Strategic Plan for 2020. This has culminated in an increase in terminal space of 675,000m², which is twice the footprint of Heathrow Terminal 5. A brief review of the main relevant projects within Strategic Plan for 2020 are described below.

Concourse A opened in 2013 and is the largest purpose-built A380 dedicated facility in the world.

The latest expansion of the Strategic Plan was the opening of Concourse D in 2016, which is connected to Terminal 1. Concourse D is 65,000m², has a capacity of 18mppa and has 32 aircraft stands. Concourse D itself cost 3.35 billion AED (£643m).

In addition to these major expansions the airport continues to invest in existing terminals with the expansion of Terminal 2 and the refurbishment of the original areas of Terminal 1.

Airfield

As part of the major expansion of terminal capacity further stands are being built and capacity will increase from 144 to 230 stands.

Dubai International Airport is geographically constrained with no space to accommodate further additional runways within its existing boundary. Further runway capacity in Dubai has been developed at Dubai World Central / Al Maktoum International Airport, which is a relatively new facility and does not process comparable passenger numbers.

5.7.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Dubai International Airport. Data is only available to provide a comparison of terminal infrastructure.

The major developments at Dubai International Airport have been concentrated within the existing airport boundary with no additional external works required. Despite this, the cost per mppa for the terminal expansion is significantly larger than the Westerly Option.

5.7.3 LHR/DXB Benchmark Data

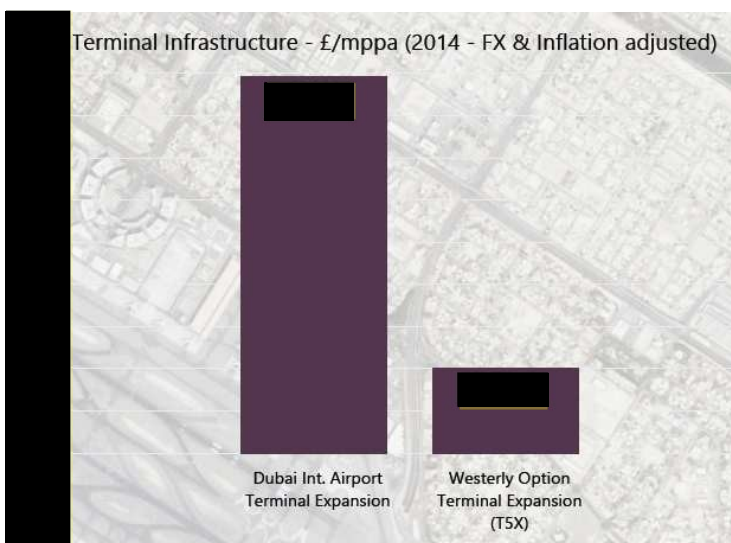


Figure 18. Dubai International Airport benchmark data

5.8 Hong Kong International Airport



Figure 19. Hong Kong Airport Factsheet

5.8.1 Airport Development Review

As an airport built on a purpose-built island Hong Kong International Airport has limited room for physical expansion without further land reclamation. When Hong Kong International Airport opened there was sufficient land available on the new island for further expansion of terminal facilities. Two recent major expansions have been completed providing additional terminal and apron capacity.

Terminal

The Midfield Concourse opened in 2015 providing an additional 10mppa over 105,000m², at a cost of £850m. This is a five-storey building with 20 aircraft stands and connecting to Terminal one with an automated people mover.

Airfield

The West Apron Expansion also opened in 2015 and this provided additional stand capacity.

However, these developments will not provide sufficient capacity for the airport to accommodate the forecast traffic growth. Therefore, a major development is underway to construct a new runway at a cost of £1.6bn, excluding land reclamation costs. This requires approximately 650 hectares of reclaimed land to the north of the existing airport boundary.

5.8.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Hong Kong International Airport. Data is available to provide a comparison of both airfield and terminal infrastructure.

Data available from the airport splits the cost of this project and it is possible to compare the costs of the runway infrastructure with the Westerly Option. The costs presented for Hong Kong have been stripped of all external works required to deliver the runway, including land reclamation. Therefore, the costs analysed are only the direct costs of the constructing the runway. The total costs of constructing the two runways indicate that the Westerly Option is less expensive. Further detailed analysis would be required to determine the precise reasons for this.

There is a notable difference in the costs of the new terminal infrastructure. This could largely be due to the terminal at Hong Kong being an entirely new terminal as opposed to an expansion.

5.8.3 LHR/HKG Benchmark Data

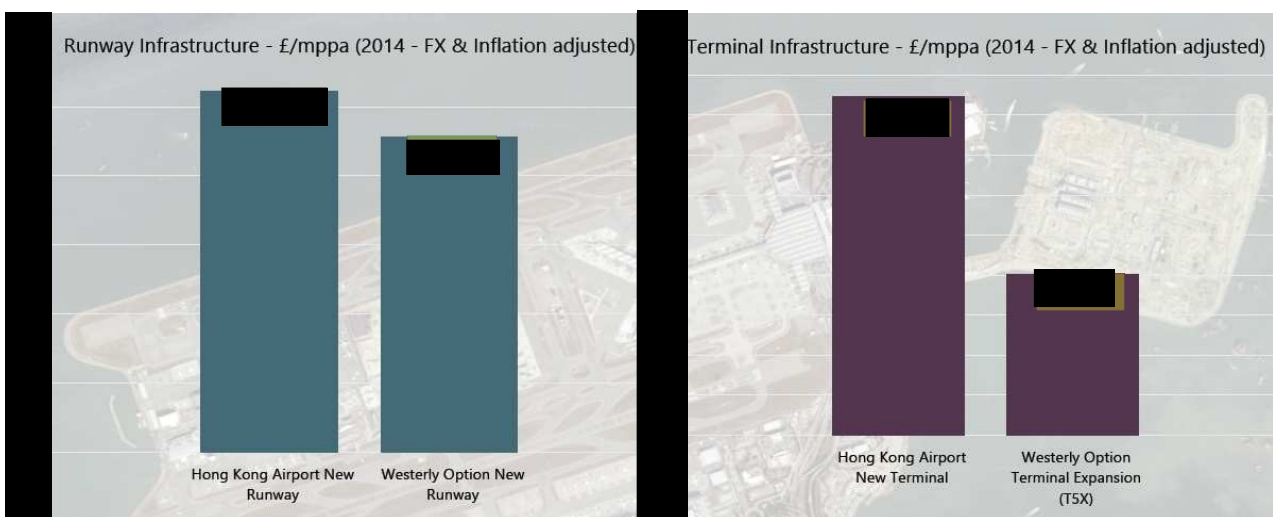


Figure 20. Hong Kong Airport benchmark data

5.9 Changi Airport, Singapore

CHANGI AIRPORT, SINGAPORE (SIN)


58.7m
PASSENGERS
2016


360,500
AIR TRAFFIC
MOVEMENTS 2016


4
TERMINALS


2
RUNWAYS


159
AIRCRAFT
STANDS

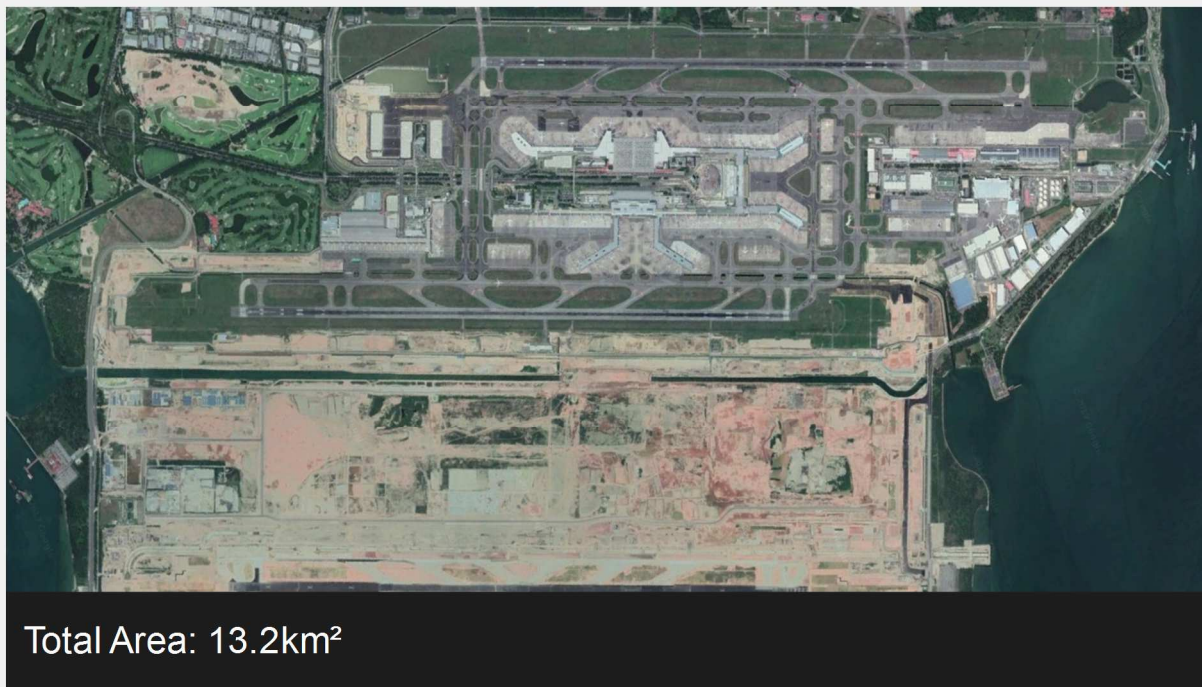

380
NO. OF DIRECT
DESTINATIONS

HUB AIRLINES



RIVAL HUBS

KUL | HKG



Total Area: 13.2km²

Figure 21. Changi Airport Factsheet

5.9.1 Airport Development Review

Changi Airport opened its fourth terminal in 2017, significantly increasing the capacity of the airport. However, further development is proposed to enable capacity to exceed 100mppa. This involves further terminal expansion and runway capacity, proposed to be completed by around 2030.

Terminal

Terminal 4 opened in October 2017 with a capacity of 16mppa. This has increased the capacity of the airport to 82mppa without requiring additional airfield capacity, at a cost of £614m.

There are plans to construct a further new terminal from around 2020 onwards as part of the Changi East proposals, which also includes a new runway as highlighted below.

Airfield

Recent changes to the airfield have largely been associated with increased terminal capacity. However, a third runway is proposed at Changi Airport and this would be constructed as part of the Changi East Project. This would be a major undertaking, but the costs are not currently in the public domain.

5.9.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Changi Airport. Data is only available to provide a comparison of terminal infrastructure.

Details are not publicly available for the costs of the new runway. The only cost comparison currently available is with the new Terminal 4. The cost is aligned with the development costs for the Westerly Option.

5.9.3 LHR/SIN Benchmark Data

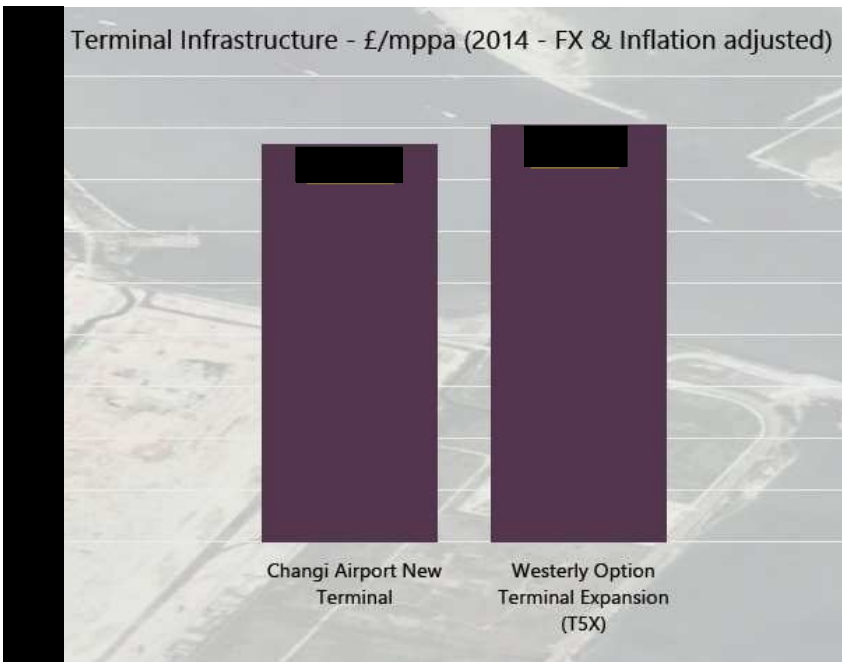


Figure 22. Changi Airport benchmark data

5.10 Auckland Airport, New Zealand



Figure 23. Auckland Airport Factsheet

5.10.1 Airport Development Review

Auckland Airport is unique amongst the other airports included within this study in that it does not have an obvious direct competitor and it is considerably smaller than the airports regarding passenger numbers and air traffic movements. However, it is a useful comparison as it is progressing with a large-scale expansion of both terminal and airfield infrastructure.

Terminal

Approximately £764m is being invested in the airport to expand the terminal facilities to cater for an increase in passenger numbers, particularly for further Code F movements. The main focus of this is to extend an existing pier to provide further gate capacity for Code F movements with a capacity increase of around 5mppa.

Airfield

There are longer term plans to construct a second runway at the airport and this would be situated north of the existing terminal area. This is expected to be operational by 2028 and will be Code F compliant to reflect the traffic mix on the airfield; direct costs for the runway are not available.

5.10.2 Commentary

The figure below illustrates the relevant comparisons between Heathrow and Auckland Airport. Data is only available to provide a comparison of terminal infrastructure.

Development costs of the expansion projects at Auckland Airport are significantly higher than the Westerly Option. The expansion currently under construction at Auckland Airport is significantly more expensive per mppa than the Westerly Option. Whilst this is a major investment at the airport it only equates to an increase in passenger capacity of around 5mppa in comparison to the larger scale expansion the Westerly Option provides.

We believe that this project is driven by the primary need to accommodate Code F aircraft, rather than capacity per se and as such the benchmark data should be used with caution.

5.10.3 LHR/AUK Benchmark Data

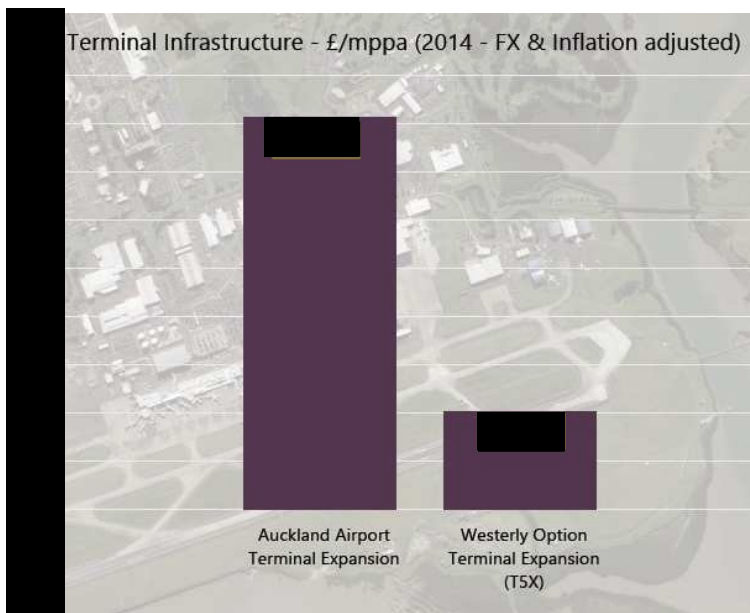


Figure 24. Auckland Airport benchmark data

6 Conclusion & Recommendations

6.1 Detailed Review

Upon review of the Heathrow data supplied and taking cognisance of the limitations of the high-level nature of the material, Arcadis consider that the Westerly Option is a credible scenario which warrants further consideration by Heathrow that should be developed in future stages of the Masterplan.

Key findings include:

- Arcadis has reviewed all items in the reconciliation between version 0.61 to version 0.63 and version 0.63 to the Westerly option:
 - For version 0.63 the base construction CAPEX values of any scope not omitted are aligned exactly with version 0.61, providing a high-level verification of the IFS study.
 - Reasoning behind the scope omissions in version 0.63 and the risk adjustment have been explained adequately by Heathrow. The adjustments between the estimates are generally logical and consistent. The scope reductions between versions 0.61 and 0.63 require confirmation that they are adequately covered by separate business cases outside HEP.
 - For CAPEX additions to the Westerly option Heathrow has prepared high level estimates. Arcadis has reviewed the T5C T-Bar estimate and concurs with the general approach taken with only minor adjustments to the benchmark rate utilised by Heathrow in order to align with the Purple Book. For the T5X estimate Arcadis concurs with the narrative supplied by Heathrow but considers that the provisional sum of ■■■ for Gateways would benefit from further granularity.
 - The specific scope movements identified within the Westerly Option are understood at a high level, future exercises of this nature would benefit from a more detailed supporting narrative.
- In assessing the transition between the 2048 and 2035 estimates some judgement has been necessary to cash-flow the relevant capital expenditure. Arcadis understands the rationale behind this split but has not seen the specific reasoning behind it.
- The extent of new facilities being provided under the Westerly Option is a significant reduction in new build areas from the previous options, based on a facility target for T5X of 8,000m²/mppa compared to 12,000m²/mppa.
- The aspiration for 8,000m²/mppa for new terminal facilities is understood but may put pressure on service levels and require re-provision of space elsewhere. Arcadis consider that Heathrow's objective of 8,000m²/mppa is a stretch but potentially achievable target. Nonetheless, in order to achieve this target efficiencies must be gained through continual innovation while ensuring that the requisite levels of passenger experience and throughput are maintained.

6.2 Benchmarking Analysis

This report has presented a comparison of airport infrastructure development costs across a range of airports in order to provide a benchmark analysis with the Westerly Option.

The findings in the report provide a high-level analysis of the Westerly Option to determine the extent that the development costs are within the range expected of similar infrastructure across comparable airports. The analysis has concentrated on benchmark data that is publicly available for the selection of airports.

A limitation of the analysis is that the data used has been obtained from publicly available sources and by its nature has not been broken down into detailed components. However, it has still been possible to provide a benchmarking exercise against the Westerly Option.

As expected with a range of different airports and scale of development, alongside the local and national variations, there are a wide range of comparisons. There are examples in the report of close cost comparisons with the Westerly Option for both terminal and runway infrastructure. Similarly, there are wide variations with different explanations.

The **key terminal** finding is that development costs vary between the selected airports, although the cost of the Westerly Option is comparable with a number of other developments at a £/mppa metric.

The **key runway** finding is that the £/mppa metric of the Westerly Option appears to be within range of the two new runways presented in the analysis.

6.3 Recommendations

For the benefit of the CAA, Arcadis has provided recommendations throughout this document that they may wish to be shared with Heathrow with the aim of collaboration and assisting Heathrow achieve their objectives.

These recommendations include, but are not limited to, the following:

Ref	Recommendation: Detailed Review
1	Produce area schedules for the terminals and satellites to ensure a full understanding of the facility size requirements is included in the Westerly Option scope
2	Further develop estimates (such as T5X and T5C T-Bar) during the masterplan formation process to enable greater clarity around the scope and cost of the Westerly Option.
3	Greater input and buy-in from the Airline Working Group (AWG) to enable the terminal design to be developed taking cognisance of airline needs regarding check-in and Commercially Important Person (CIP) lounges.
4	Indicate which facilities are included within the new terminal areas and which are to be decentralised, to enable further understanding of how the 8,000m ² /mppa target can be achieved.
5	Ensure that the areas can cater for peak passenger flow, as well as providing space for resilience. The 8,000m ² /mppa may lend itself more towards a short-haul arrangement rather than long haul with its significant passenger peaks.
6	Provide greater clarity around phasing assumptions and the split between scope delivered to 2035 and scope to be delivered up to 2048.
7	Ensure that the areas can provide the requisite levels of passenger service and that the airport can still receive the required commercial revenues, which underpin the business case decisions, from the reduced space.
Recommendation: Benchmarking Analysis	
8	Continue or commence benchmarking on non-aviation areas e.g. property, environmental and highway related with aviation and non-aviation projects.

Table 11. Arcadis Recommendations

APPENDIX A

Documents Received from Heathrow

Westerly Option			
	Document Reference	Format	Date Received
1	Cost & Benefit Working Group Slides Progress on 'close to current charges' dated 31 August 2017	PDF	20-Dec-17
2	Cost & Benefit Working Group slides dated 29 th November 2017	PDF	20-Dec-17
3	2017.12.20 Westerly Option – Additional Capex Detail H Period	PDF	20-Dec-17
4	20171213 – Key Component Options and the Westerly Scenario	PDF	20-Dec-17
5	Heathrow Expansion- IB Purple Book 0.61	PDF	01-Aug-17
6	20171213 – Westerly Option Dashboard C&BWG slides	PDF	13-Dec-17
7	20171213 – Key Component Options and the Westerly Scenario	PDF	13-Dec-17
8	2017.12.20 Westerly Option – Additional Capex Detail H Period	PDF	19-Dec-17
9	Cost Plan Developments and Westerly Option Review 07 02 18	PDF	07-Feb-18
10	0.63 to Westerly Option Reconciliation	XLS	19-Feb-18
11	HEP Purple Book Summary 2018_01_12	XLS	19-Feb-18
12	Purple_Book_Detail_0_63_20170630	PDF	28-Feb-18
13	CAA Pathway to Affordability February 2018	PPT	01-Mar-18
14	T5C T-Bar.Rev 2	PDF	02-Mar-18
15	2017.08.31 HEP C+BWG – Dashboard A3 (updated)	PDF	12-Mar-18
16	60HC0301 – SK064 V3.1	PDF	23-Mar-18
17	60HC0301 – SK064 V3.2	PDF	23-Mar-18
18	T5C T Bar	PDF	23-Mar-18
19	T5C T-bar	MSG	23-Mar-18
20	Masterplan to 2035	PDF	23-Mar-18
21	T5X Costing Note	PDF	23-Mar-18

APPENDIX B

Arcadis Benchmark Sources

References	
Airport	References
Frankfurt	frankfurt-airport.com
	fraport.com
	<i>Fraport Article: Ground-breaking Ceremony Launches Construction Start of Frankfurt Airport's New Terminal 3, 05OCT15</i>
	<i>CAPA Article: New runway opened at Frankfurt Airport, 24OCT11</i>
Auckland	aucklandairport.co.nz
	<i>Auckland Airport Article: Building the future</i>
Paris (CDG)	parisaeroport.fr
	<i>Groupe ADP Press Release 16NOV16</i>
Schiphol	schiphol.nl
	<i>European Investment Bank (EIB) Article: EIB supports extension of Schiphol Airport, 02MAR17</i>
Dubai	<i>TR Business Article: Schiphol invests \$369m in new pier and terminal, MAR17</i>
	dubaiairports.ae
Singapore	<i>Dubai Airport Strategic Plan 2020</i>
	changiairport.com
Hong Kong	<i>Changi Airport Group Document: Overview of T4 25JUL17</i>
	hongkongairport.com
	<i>HSBC Financial Advisor Report for HKIA: 3RS consultancy study</i>
	<i>Financial arrangement for 3-Runway System (3RS) at HKIA, SEP15</i>
	<i>HKIA Document: The Three-runway System of Hong Kong International Airport, JAN17</i>
London Heathrow	<i>HKIA Press Release: HKIA Celebrates Grand Opening of Midfield Concourse On-schedule Full Operation Increases Airport's Passenger Handling Capacity, MAR2016</i>
	<i>HKIA Article: Future Development - Medium-Term Development - West Apron Expansion</i>
	<i>Various Heathrow Airport Documents</i>

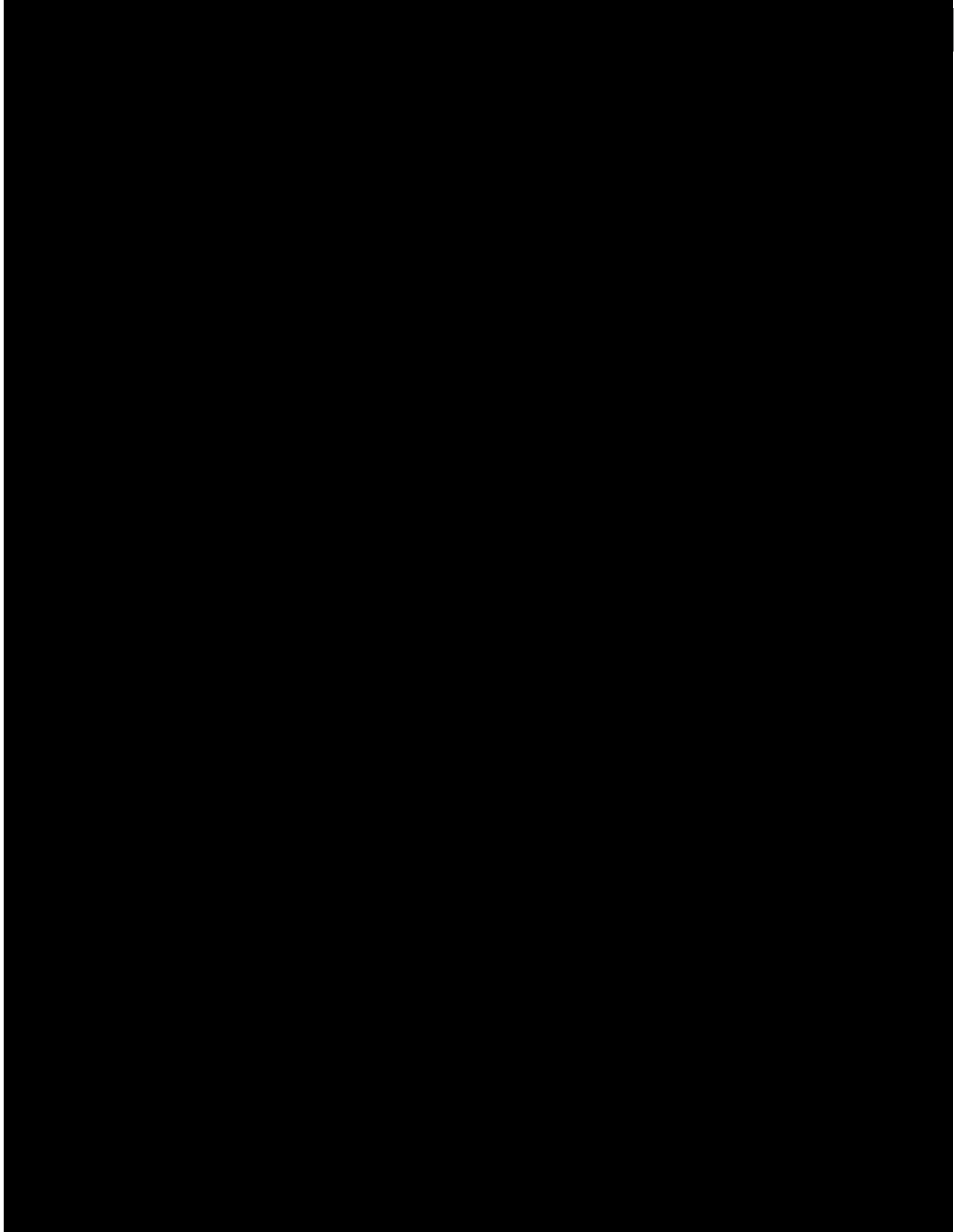
APPENDIX C

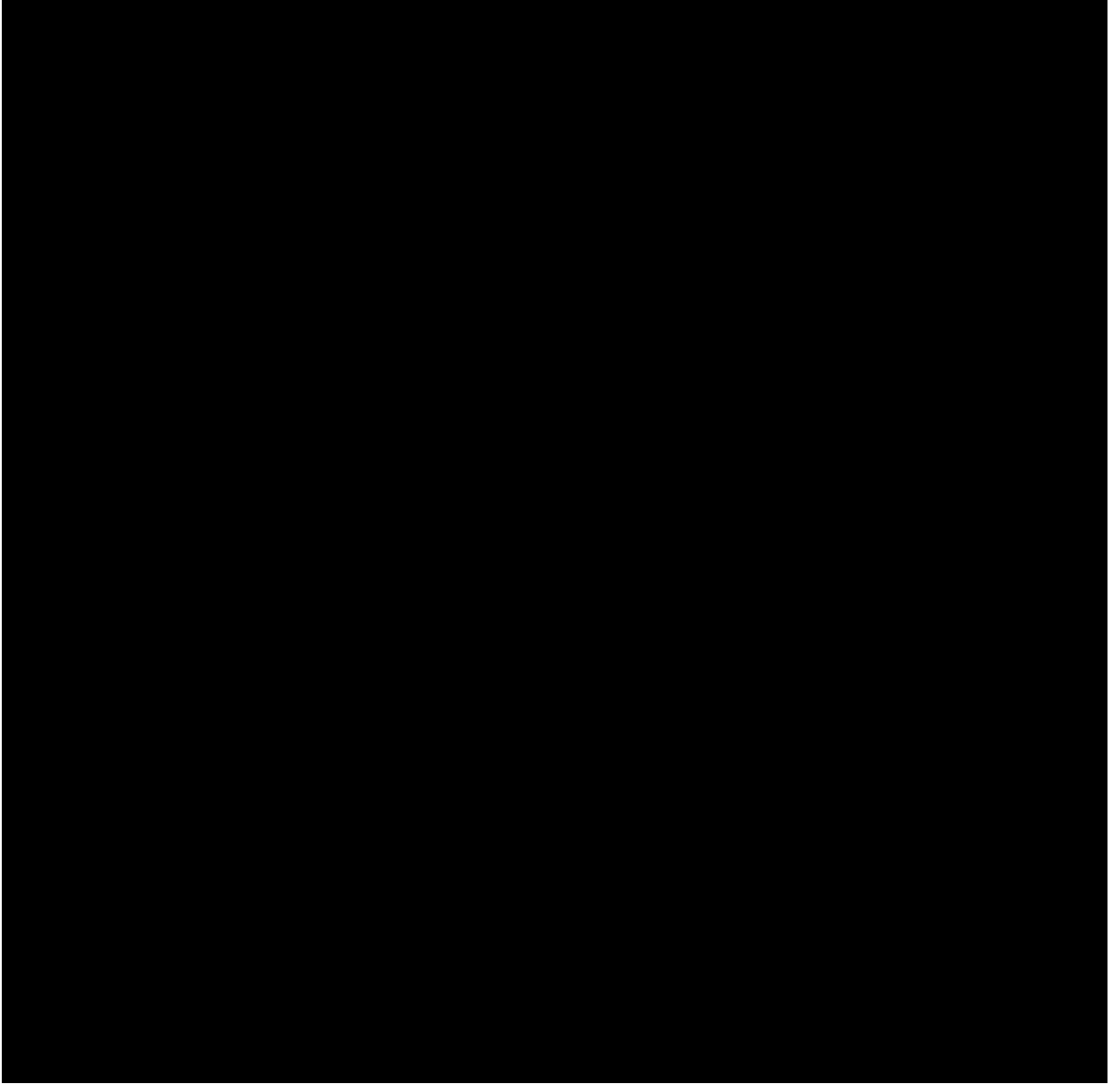
Benchmarking Report Metrics

Airport	Airport Development	Cost	Currency	£UK 2014 Exchange rate	£UK (2014 inflation adjusted)	£/mppa (2014 - FX & Inflation Adjusted)	Additional PAX Capacity (mn)
Frankfurt	Frankfurt Airport New Terminal	3,000,000,000	€	2,220,000,000	2,198,235,000	157.02	14,000,000
Frankfurt	Frankfurt Airport New Runway	1,500,000,000	€	1,335,000,000	1,599,466,000	44.93	35,600,000
Auckland	Auckland Airport Terminal Expansion	2,000,000,000	\$NZ	763,600,000	763,600,000	162.47	4,700,000
Paris (CdG)	Charles de Gaulle Airport Connecting Terminals	292,000,000	€	243,732,400	237,226,000	103.14	2,300,000
Schiphol	Schiphol Airport New Terminal and Pier	369,000,000	€	325,347,300	305,675,000	20.38	15,000,000
Dubai	Dubai Int. Airport Terminal Expansion	28,800,000,000	AED	4,916,160,000	5,351,715,000	178.39	30,000,000
Singapore	Changi Airport New Terminal	944,000,000	US\$	599,723,200	613,885,000	38.37	16,000,000
Hong Kong	Hong Kong Airport New Runway	16,500,000,000	HK\$	1,608,750,000	1,565,907,000	52.20	30,000,000
Hong Kong	Hong Kong Airport New Terminal	10,000,000,000	HK\$	856,000,000	847,608,000	84.76	10,000,000
Hong Kong	Hong Kong Airport West Apron Expansion	2,500,000,000	HK\$	214,000,000	211,902,000	21.19	10,000,000

APPENDIX D

Queries & Responses





APPENDIX E

Terminal Benchmarks (m²/mppa)

Westerly Option								
	Airport	City	Country	Region	IATA Code	Facility Size (m ²)	Design Pax Capacity	m ² /mppa
01	Kotoka International Airport	Accra	Ghana	Africa	ACC	45,000	5,000,000	9,000
02	Marrakesh Menara Airport	Marrakesh	Morocco	Africa	RAK	42,000	4,500,000	9,300
03	Shanghai Pudong International Airport	Shanghai	China	Asia	PVG	622,000	80,000,000	7,800
04	Narita International Airport	Tokyo	Japan	Asia	NRT	66,000	7,500,000	8,800
05	Kempegowda International Airport	Bangalore	India	Asia	BLR	150,556	17,000,000	8,900
06	Rajiv Gandhi International Airport	Hyderabad	India	Asia	HYD	162,000	15,000,000	10,800
07	Chubu Centrair International Airport	Nagoya	Japan	Asia	NGO	220,000	20,000,000	11,000
08	Incheon International Airport	Seoul	South Korea	Asia	ICN	496,000	44,000,000	11,300
09	Hong Kong International Airport	Hong Kong	Hong Kong	Asia	HKG	710,000	60,000,000	11,800
10	Tribhuvan International Airport	Kathmandu	Nepal	Asia	KTM	95,000	7,500,000	12,700
11	Ninoy Aquino International Airport	Manila	Philippines	Asia	MNL	182,500	13,000,000	14,000
12	Beijing Capital International Airport	Beijing	China	Asia	PEK	986,000	60,000,000	16,400
13	Singapore Changi Airport	Singapore	Singapore	Asia	SIN	380,000	22,000,000	17,300
14	Haneda International Airport	Tokyo	Japan	Asia	HND	159,000	7,000,000	22,700
15	Marseille Provence Airport	Marseille	France	Europe	MRS	20,000	3,500,000	5,700
16	Orio al Serio International Airport	Milan	Italy	Europe	BGY	63,500	11,200,000	5,700
17	London City Airport	London	UK	Europe	LCY	40,000	6,500,000	6,200
18	Vienna International Airport	Vienna	Austria	Europe	VIE	150,000	24,000,000	6,300
19	Bergen Flesland Airport	Bergen	Norway	Europe	BGO	63,000	10,000,000	6,300
20	Dublin Airport	Dublin	Ireland	Europe	DUB	100,000	15,000,000	6,700

	Airport	City	Country	Region	IATA Code	Facility Size (m ²)	Design Pax Capacity	m ² /mppa
21	Munich Airport	Munich	Germany	Europe	MUC	250,800	36,000,000	7,000
22	Warsaw Frederic Chopin Airport	Warsaw	Austria	Europe	WAW	154,500	20,000,000	7,700
23	Oslo Airport	Oslo	Norway	Europe	OSL	265,000	32,000,000	8,300
24	Helsinki Airport	Helsinki	Finland	Europe	HEL	250,000	30,000,000	8,300
25	Eindhoven Airport	Eindhoven	Netherlands	Europe	EIN	13,500	1,500,000	9,000
26	Toulouse-Blagnac Airport	Toulouse	France	Europe	TLS	111,750	12,000,000	9,300
27	Barcelona El Prat Airport	Barcelona	Spain	Europe	BCN	525,000	55,000,000	9,500
29	Milan Malpensa Airport	Milan	Italy	Europe	MLP	297,300	30,000,000	9,900
30	Amsterdam Schiphol Airport	Amsterdam	Netherlands	Europe	AMS	150,000	15,000,000	10,000
31	Dubrovnik Airport	Dubrovnik	Croatia	Europe	DBV	36,500	3,500,000	10,400
32	Moscow Domodedovo Airport	Moscow	Europe	Europe	DME	500,000	45,000,000	11,100
33	Faro Airport	Faro	Portugal	Europe	FAO	93,120	8,000,000	11,600
34	Fuerteventura Airport	Fuerteventura	Spain	Europe	FUE	93,000	8,000,000	11,600
35	Manchester Airport	London	UK	Europe	MAN			12,000
36	Franjo Tudman Airport	Zagreb	Croatia	Europe	ZAG	65,000	5,000,000	13,000
37	Adolfo Suarez Madrid-Barajas Airport	Madrid	Spain	Europe	MAD	470,000	35,000,000	13,400
38	Heathrow Terminal 2	London	UK	Europe	LHR			14,000
39	Heathrow Terminal 5	London	UK	Europe	LHR			14,000
40	Sheremetyevo International Airport	Moscow	Russia	Europe	SVO	172,000	12,000,000	14,300
41	Paris Charles de Gaulle Airport	Paris	France	Europe	CDG	120,000	8,000,000	15,000

	Airport	City	Country	Region	IATA Code	Facility Size (m ²)	Design Pax Capacity	m ² /mppa
42	Alicante Elche Airport	Alicante	Spain	Europe	ALC	333,500	20,000,000	16,700
43	Liverpool John Lennon Airport	Liverpool	UK	Europe	LPL	170,000	10,000,000	17,000
44	Frankfurt Airport	Frankfurt	Germany	Europe	FRA	306,000	14,000,000	21,900
45	Dubai International Airport	Dubai	UAE	Middle East	DXB	150,000	18,000,000	8,300
46	Al Maktoum International Airport	Dubai	UAE	Middle East	DWC	935,000	100,000,000	9,400
47	Queen Alia International Airport	Amman	Jordan	Middle East	AMM	103,000	9,000,000	11,400
48	Hamad International Airport	Doha	Qatar	Middle East	DOH	600,000	50,000,000	12,000
49	Abu Dhabi International Airport	Abu Dhabi	UAE	Middle East	AUH	700,000	45,000,000	15,600
50	Bahrain International Airport	Manama	Bahrain	Middle East	BAH	220,000	14,000,000	15,700
51	Prince Mohammed Bin Abdul-Aziz International Airport	Medina	Saudi Arabia	Middle East	MED	156,940	8,000,000	19,600
52	San Francisco International Airport	San Francisco	USA	North America	SFO	59,500	5,500,000	10,800
53	John F Kennedy International Airport	New York	USA	North America	JFK	185,806	17,100,000	10,900
54	Miami International Airport	Miami	USA	North America	MIA	330,000	30,000,000	11,000
55	El Dorado International Airport	Bogota	Colombia	South America	BOG	163,000	20,000,000	8,200
56	Carrasco International Airport	Montevideo	Uruguay	South America	MVD	45,000	4,500,000	10,000
57	Rosario - Islas Malvinas International Airport	Rosario	Argentina	South America	ROS	69,000	3,000,000	23,000

APPENDIX F

T5C Expansion T-Bar Estimate Comparison

Westerty Option Detailed Review										
T5C Expansion T-Bar										
HAL Description	HAL				Arcadis				Variance	Arcadis Comments
	Quantity	Unit	Rate	Total	Quantity	Unit	Rate	Total		
Base Construction Costs										
Demolition / Reconfiguration Works										
1.01	Demolition of existing Fire Station									
1.02	Demolition of Shell / ExxonMobil workshop									
1.03	Demolition of 1093 Wessex Road office building									
1.04	Break out existing PQQ concrete to provide footprint for new T5C extension									
1.05	General clearance of site (removal of light masts, fences, barriers, support building signage, car park markings, etc).									
1.06	Removal of existing contact stand PBB's VCCs and nodes									
1.07	Removal of SEGS, fuel hydrants, FEGPs, etc									
1.08	Removal of BA Tug parking and substation 82									
1.09	Mass fill of concrete to Southern Road Tunnel to block existing exit by Stand 581									
1.10	Relocation of Piccadilly Line vent shaft and tunnel									
1.11	BA Ground Fleet Services									
New Construction Works										
2.01	New IDL expansion (including CIP to upper level)									
2.02	New Pier expansion									
2.03	Extension of T5C South									
2.04	Break out existing T5C and connect / interface to both extensions									
2.05	New stands (contact stands, FEGP, APCs, SEGS, SNIBs, FOD/POL Bins, Fuel Control System Changes, AGL Control System Changes)									
2.06	New Stands (remote stands, fully services rates including PBB's, VCC's Nodes, SEGS, FEGP, head os stand roads, etc)									
2.07	Reconfiguration of existing stands (move FEGP, fuel hydrant, re-mark lines, etc)									
2.08	Allowance for new fixed links, nodes and airbridges to existing and new stands									
2.09	New taxiway to serve revised stand layout, including all lighting, guidance systems, etc.									
2.10	Allowance for baggage enhancements (scope unknown so based on 6mppa increase)									

HAL Description	HAL				Arcadis				Variance	Arcadis Comments
	Quantity	Unit	Rate	Total	Quantity	Unit	Rate	Total		
Ancillary Works										
3.01	Relocation of existing fire station									
3.02	Relocation of existing Shell / ExxonMobil workshop									
3.03	relocation of parking / site works for Shell ExxonMobil building / 1093 Wessex road building									
3.04	Relocation of 1093 Wessex Road building									
3.05	relocation of fuel mains from fuel farm to stands									
3.06	Re-provision of Substation 82									
3.07	Construct 2nr remote stands for the duration of the works in order to provide stand support whilst permanent stands are out of use									
3.08	Re-provision of BA ground fleet services building									
Total Base Construction Costs										
Project Specifics										
4.01	Phasing, night working, operational disruption									
4.02	Surveys associated with avoidance of existing transportation links (Piccadilly Line, HEX Baggage Tunnels, etc)									
4.03	Monitoring and settlement works / leaks etc to existing tunnels									
Total Project Specifics										
Project On-Costs										
5.01	Prelims									
5.02	OH&P									
5.03	Design									
5.04	L&L									
Total Project On-Costs										
Risks										
6.01	Design, Construction & Business Risk									
6.02	Inflation (keep at constant prices)									
Total Risks										
OVERALL TOTAL										

Arcadis is the leading global Design & Consultancy firm for natural and built assets. Applying our deep market sector insights and collective design, consultancy, engineering, project and management services we work in partnership with our clients to deliver exceptional and sustainable outcomes throughout the lifecycle of their natural and built assets. We are 28,000 people active in over 70 countries that generate more than €3 billion in revenues.

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