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13. Cost and Commercial Viability: Financial Modelling Input Costs

Airports Commission

Final report

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Contents

Important notice

Important notice

This draft document has been prepared for the Airports Commission in accordance with the terms of the Provision of Consultancy for Commercial, Financial and Economic Option Appraisal and Analysis (DfT) framework and the Contract Reference RM 2750 (650) dated 12th February 2014 and solely for the purpose and on the terms agreed with the Airports Commission within the Project Inception Document reference 13.2 dated 13 August 2014. We accept no liability (including for negligence) to anyone else in connection with this document.

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Scope and context

The Airports Commission (AC or the 'Commission'), an independent commission was established in 2012 by the UK Government to consider how the UK can maintain its status as an international hub for aviation in response to increasing concern over existing and future capacity requirements. Since September 2012, the Commission has considered and evaluated a variety of options for meeting the UK's international connectivity needs, the results of which were outlined in the Airports Commission's Interim Report published in December 2013. The Interim Report outlined three firm short-listed options (one option for an additional runway at Gatwick and two options relating to an additional runway at Heathrow). In addition, the option for a new airport development located within the Inner Thames Estuary was considered further by the Commission, with a decision in September 2014 not to shortlist. The AC is due to publish its Final Report in summer 2015.

This report on financial modelling input costs has been prepared by PwC as part of the Cost and Commercial Viability workstream. These costs are based on the AC's view of the costs for each scheme[1], which are in turn based on independent advice, research and analysis. This report presents the AC's approach to calculating costs, and the effect of the proposed schemes on the Regulated Asset Base (RAB) of Heathrow Airport and Gatwick Airport[2]. Further detail is provided in the following reports:

- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway;
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway; and
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Runway.

The report is structured as follows:

- **Introduction**: provides an overview of the AC's approach to calculating costs;
- **Section 1:** Gatwick Airport Limited's (GAL) scheme proposal for a second runway (LGW 2R);
- **Section 2:** Heathrow Airport Limited's (HAL) scheme proposal for a northwest runway (LHR NWR); and
- **Section 3:** Runway Innovations Ltd and Heathrow Hub Limited's (HHL) scheme proposal for an extended northern runway (LHR ENR).

The analysis presented in this report will be used to support the AC in its understanding and thinking around funding and financing of the scheme proposals (including aeronautical charges) and the implications for areas of the evaluation that include passenger experience, financeability and deliverability. It is not the purpose of this report to:

- Consider issues around financing the costs identified (this review forms part of the Module 13. Cost and Commercial Viability: Funding and Financing report); or
- Review delivery risks associated with the costs identified (this review forms part of the Module 13. Cost and Commercial Viability: Literature Review report and, where it relates to financing, as part of the Module 13. Cost and Commercial Viability: Funding and Financing report).

This report forms part of a wider body of work which PwC has been commissioned to undertake to support the AC in its commercial, financial and economic appraisal of the schemes. The report will be made available for public consultation, following which it is expected that readers will comment on the costs presented.

[1] The report considers the full cost of each scheme proposal, including surface access costs and costs associated with existing operations or other committed airport plans.

[2] Since April 2014, GAL has been regulated by the Civil Aviation Authority (CAA) on a license based approach which allows GAL some flexibility in setting airport charges. However, the CAA also requires GAL to undertake a shadow 'Regulated Asset Base' (RAB) calculation in case tighter regulation needs to be re-introduced. Please see the CAA published document, 'Economic regulation at Gatwick from April 2014: notice of the proposed license, CAP1139' for more information on GAL's regulatory requirements.

Introduction and methodology

Methodology

This section of the report provides an overview of the AC's approach to calculating the financial modelling input costs for each scheme. These inputs are used in the financial models which have been developed as part of the evaluation carried out by the AC, to assess the funding and financing of the schemes including the level of increase of aeronautical charges required to develop each scheme.

While this report provides an overview of the AC's view of costs and the assumptions and methodology used to calculate them, the following reports provide further detail on the costs:

- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway report;
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway report; and
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Runway report.

Sections 1 to 3 have been drafted so that they can be read independently of each other resulting in a level of repetition between these sections.

Presentation of costs

The reader should note the following key points on the presentation of costs throughout the report:

- Cost profiles presented in 'figures' throughout the report are in real terms (at 2014 prices);
- Costs presented in 'tables' are generally presented in real, nominal and Net Present Costs (NPC) terms and are clearly labelled accordingly (see table 1 for inflation and discounting assumptions used);
- Where only one set of numbers is presented in a figure or table, it should be assumed that these relate to Case 2 (see 'Cost cases' section of this 'Introduction and methodology' for further discussion on cost cases);
- All costs presented throughout this report have been provided to PwC by LeighFisher Inc. (LF) or Jacobs Engineering Group Inc. (Jacobs) who are providing technical advice to the AC;
- The assumptions and approach underlying the narrative explaining the AC's approach to cost calculations and the differences between the AC's and Scheme Promoters' (SP) estimates of costs, has been provided to PwC by LF;
- Note that any discrepancies in tables, between the totals presented and the individual items presented, are due to rounding errors; and
- General assumptions have been applied to all costs to allow for comparability between schemes (for example, all costs have been re-based / discounted to the same dates). These assumptions are as follows:

Table 1: General assumptions

Parameter	Assumption	Basis for assumption
Base date for all costs	1 January 2014	Current year applied as the basis for real prices and NPC calculations presented in this report.
Start of the cost	1 January 2014	Current year applied.

Parameter	Assumption	Basis for assumption
review period		
End of the cost review period	31 December 2050	The AC's demand modelling work generates forecasts up to 2050, at which point it is expected that a second additional runway may be required as set out in the Airports Commission Interim Report.
Inflation on capex (annual)	3.5%	Historically, construction inflation has been above general inflation and therefore a long term assumption of 3.5% has been used throughout the assessment period.
Inflation on asset replacement (annual)	3.5%	Historically, construction inflation has been above general inflation and therefore a long term assumption of 3.5% has been used throughout the assessment period.
Inflation on opex (annual)	3.0% Retail Price Index (RPI)	The types of operational costs considered in this report are typically modelled on the basis of RPI. For instance, contract costs with cleaning or maintenance providers are typically linked to RPI. RPI is also more reflective of wage rate increases than CPI.
Annual Discount Rate (Real)	3.5% (0 to 30 years) 3.0% (31 to 75 years)	The Green Book (HM Treasury)[3].

For more information on the inflation assumptions in table 1, please refer to the following reports:

- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway;
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway; and
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway.

The following cost categories and associated terminology will be considered throughout this report:

- **Scheme capex** – the capex required to build out the schemes in their entirety, not taking into account the related surface access costs;
- **Surface access costs –** the cost of incremental surface access works (road and rail) to accommodate the heightened traffic at either airport following the implementation of one of the schemes at that airport. Surface access costs are made up of capex, and ongoing asset replacement and opex; and
- **Other airport costs –** in addition to the scheme capex and surface access costs, these costs include the 'other airport costs' incurred by the airport. These are costs associated with the ongoing running and development of the airport and include:
  - **Core capex –** Core capex relates to expenditure that could be expected to take place regardless of whether new runway capacity is developed at the airport. These costs are separate and distinct from the scheme capex;
  - **Asset replacement** – the investment required to maintain or replace the capital assets of the airport (for the whole airport including the proposed scheme) as well as to update infrastructure to maintain the assets as a modern airport; and

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

- **Opex** – the cost associated with operating the airport (for the whole airport including the proposed scheme) which includes cost components such as staff costs, facilities management and utilities.

The AC has assessed costs based on the high level capex and opex categories listed in table 2. The AC recognises that further detail and breakdown of costs will be required at a later stage of development, after the conclusion of the AC's work, but considers these cost categories to be appropriate for this stage of the analysis.

Table 2: Capex and opex components

Capex	Opex
Terminal buildings	Staff
Plant	Routine maintenance
Tunnels and bridges	Utilities
Transit systems	Rent and rates
Runways	Rail
Taxiways and aprons	Other[4]
Equipment	
Land	
Rail	
Airfield Ancillary	
Car Parks	
Third Party land users[5]	
Environment	
Community	

Cost cases

In developing the costs, the AC has considered various risk and optimism bias assumptions to account for the tendency for actual project costs to be higher than those forecast. There is always a degree of uncertainty when estimating future project costs both in the public and private sectors. Unexpected issues arise which can often result in higher than forecast costs.

[4] The 'other' cost item within opex includes IT & Telecoms, police, NATS, cleaning, insurance, uniforms and payroll costs.

[5] Third party land user costs relate to the procurement and preparation of land which will be leased to third parties looking to operate services or facilities in and around the airport site that are not built or operated by the airport. These parties could include hotel providers or shipping companies looking to provide onsite storage or a number of other service facilities. These parties in effect provide revenues to the airport and will not be a cost to the airport. This cost does not include the cost incurred by the third parties to build and operate their facilities on the land which could range between £0.5bn -£2bn depending on the type of third party facilities built (e.g. basic warehouses versus hotels).

Risk allowances are included to reflect the fact that known cost items may ultimately cost more than forecast due to unforeseen circumstances, even though the scope of works may be reasonably well defined.

Optimism Bias (OB) is the term that the public sector uses to describe the risk that a procuring entity's risk evaluation and pricing assumes relatively positive outcomes for a project, when in practice the overall price proves to be higher. In particular, it occurs where there is interplay of risks which may be correctly priced individually, but not collectively (as the integration of the components creates risk in itself). OB means projects have a tendency to cost more than forecast. The application of OB to project appraisals is required by the HMT Green Book[6].

Given the large scale and complex nature of the schemes, the AC has made allowances to account for uncertainty which include both risk and optimism bias premiums to generate a range of potential costs. The following cost cases have been considered:

- Case 1: Base Cost +Risk (low end of the range);
- **Case 2: Base Cost + Risk + Mitigated Optimism Bias[7] (the AC's view of costs)**; and
- Case 3: Base Cost + Risk + Full Optimism Bias[8] (high end of the range).

Case 2 represents the AC's view of costs and has been used as an input to the Module 13. Cost and Commercial Viability: Funding and Financing report to evaluate the funding and financing implications of the scheme.

The AC's risk and OB assumptions are presented in table 3. Please refer to the following reports for further detail on the approach used by LF in deriving risk and OB assumptions.

- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway;
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway; and
- Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway.

Table 3: Risk and OB assumptions

	Risk	Basis	Mitigated OB (MOB)	Basis	Full OB (FOB)	Basis
Airport						
Scheme capex	20% premium (R20)	In line with typical allowances at this stage of project development.	20% premium (MOB20)	Developed using the Green Book approach to OB on civil engineering works.	38% premium (FOB38)	Developed using the Green Book approach to OB on civil engineering works[9].
Core capex	No risk applied (R0)	Core capex was adopted from the SPs' costs, which already include an adjustment for risk.	15% premium (MOB15)	Developed using the Green Book approach to OB on civil engineering works. As these	Same as mitigated OB (FOB15)	Developed using the Green Book approach to OB on civil engineering works. As these

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf

[7] Under certain circumstances a **mitigated OB** (reduced OB) can be applied to cost estimates where key contributory factors giving rise to uncertainty are considered to have been managed to some extent.

[8] **Full OB** reflects the upper bound of optimism bias premiums per The HMT Green Book.

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf

	Risk	Basis	Mitigated OB (MOB)	Basis	Full OB (FOB)	Basis
		No further risk adjustment was considered necessary.		costs are considered to be more understood than others, greater mitigation was considered appropriate.		costs are considered to be more understood than others, greater mitigation was considered appropriate and an application of full OB was not considered necessary.
Asset replacement	20% premium (R20)	In line with typical allowances at this stage of project development. It is not known what specific asset replacement will be required at this (early) stage of project development.	20% premium (MOB20)	Developed using the Green Book approach to OB on civil engineering works.	38% premium (FOB38)	Developed using the Green Book approach to OB on civil engineering works. An upper bound figure has been applied.
Opex	Compounded real growth increase of 0.5% per annum (R0.5 per annum)	Increments applied as opposed to a premium as it more closely represents the downside risk that management cannot fully achieve forecast efficiencies in the long term.	20% premium (MOB20)	Developed using the Green Book approach to OB on outsourcing projects.	41% premium (FOB41)	Supplementary Green Book guidance recommends an upper bound of 41% on outsourcing projects, which is recommended as a proxy for operating costs in the absence of specific guidance.
Surface access						
Capex	No risk applied (R0)	For rail schemes WebTAG states that, at this stage of early development, no additional allowance for risk is required in addition to adjusting for optimism bias. The same approach has been followed for	Same as full OB (MOB44 - road, MOB66 - rail)	It is not considered appropriate to use a mitigated OB level that is less than the full OB level, given the early stage of development of the surface access plans.	44% premium for roads 66% premium for rail (FOB44 - road, FOB66 - rail)	DfT's WebTAG guidance[11].

	Risk	Basis	Mitigated OB (MOB)	Basis	Full OB (FOB)	Basis
		road schemes[10].				
Asset replacement	No risk applied (R0)	For rail schemes WebTAG states that, at this stage of early development, no additional allowance for risk is required in addition to adjusting for optimism bias. The same approach has been followed for road schemes.	Same as full OB (MOB44 - road, MOB66 - rail)	It is not considered appropriate to use a mitigated OB level that is less than the full OB level, given the early stage of development of the surface access plans.	44% premium for roads 66% premium for rail (FOB44 - road, FOB66 - rail)	DfT's WebTAG guidance.
Opex	No risk applied (R0)	For rail schemes WebTAG states that, at this stage of early development, no additional allowance for risk is required in addition to adjusting for optimism bias. The same approach has been followed for road schemes.	Same as full OB (MOB44 - road, MOB66 - rail)	It is not considered appropriate to use a mitigated OB level that is less than the full OB level, given the early stage of development of the surface access plans.	44% premium for roads 66% premium for rail (FOB44 - road, FOB66 - rail)	DfT's WebTAG guidance.

It should be noted that the SPs' submissions include risk provisions but do not consider OB. The SPs' risk assumptions are as follows:

- GAL has assumed a 25% risk contingency which has been applied as a premium to their costs with the exception of costs allocated for railway station works, levies and highway surface access;
- HAL has applied a 15% risk contingency to their costs; and
- HHL has assumed a range of risk premiums varying between 15% - 50% depending on the cost item.

The AC has not been provided with full details on how these risk premiums have been applied by the SPs in their view of costs.

[11] https://www.gov.uk/transport-analysis-guidance-webtag

[10] The WebTAG guidance suggests that a quantified risk assessment be undertaken for each non-Highways Agency scheme. Due to the difficulties in understanding the full scope of works required at this stage, in addition to many of these schemes involving Highways Agency works, a separate risk premium is not considered appropriate, given that the upper bound of optimism bias has also been applied for road schemes.

Demand scenarios

An important aspect of the AC's appraisals is that they are not based on one potential view of the future. This is because the future development of the aviation sector is inherently difficult to predict.

Therefore, rather than base its analysis on one likely pattern of future demand, the AC has constructed five future scenarios. These scenarios are reflected in the AC's passenger demand forecasts, and are used to inform the assessments undertaken in this consultation. By considering each scheme in relation to multiple potential futures, the AC aims to stress-test the robustness of its analysis, and ultimately its final recommendations to Government.

The AC's scenarios broadly follow the approach taken in the first phase of its work, in which a set of scenarios were developed to test the overall assessment of the need for new capacity set out in the Airports Commision Interim Report. They reflect different potential outcomes in respect of the development of the global economy and the international aviation sector, including consideration of ongoing liberalisation or more protectionist policies, shifts in the balance between full-service and low-cost carriers and varying rates of long-term economic growth, including at the global level or in specific regions.

Five possible scenarios of future demand have been considered by the AC. For illustrative purposes, it should be noted that the costs presented by the AC in sections 1, 2 and 3 of this report are based on the **Assessment of Need Carbon Capped (AoN-CC)** demand scenario. This scenario is consistent with the forecasts underpinning the AC's Assessment of Need and based on a scenario where carbon is 'capped' to a specific target rather than 'traded' as part of an emissions trading scheme[12]. For the avoidance of doubt, the version of costs under the AoN-CC scenario should not be considered as a central case.

This report also presents the costs as submitted by the SPs and these are based on their own demand forecasts.

The funding and financing of alternative demand scenarios, and sensitivities around key variables are considered in the separately published Module 13. Cost and Commercial Viability: Funding and Financing report.

[12]Future demand under different scenarios is detailed in Module 1. Strategic Fit: Forecasts report.

1 Gatwick Airport Second Runway

1.1 The Gatwick Airport Second Runway Scheme

The Gatwick Airport Second Runway (LGW 2R) scheme, proposed by Gatwick Airport Limited (GAL), is made up of a second runway to the south of the existing runway at Gatwick Airport with a separation of 1,045m which allows independent mixed mode operations (i.e. one could be used for arrivals and the other for departures at the same time).

The LGW 2R scheme also includes works to increase passenger terminal space, infrastructure to accommodate heightened airport traffic (e.g. taxiways, aprons and transit systems), the acquisition and preparation of land for the new airport infrastructure and various other items to support a new second runway.

1.2 The costs

This section of the report provides an overview of the AC's view of costs based on development of the LGW 2R scheme. The AC has considered a range of different cases/scenarios/sensitivities depending on the levels of risk and OB (cost cases), levels of demand (demand scenarios), and sensitivities around other key variables (for example contribution to surface access costs). For the purposes of illustrating the cost of the scheme proposals this report presents the following version of the costs:

- Cost case: Base Cost + Risk + Mitigated Optimism Bias;
- Demand scenario: Assessment of Need – Carbon Capped; and
- Key sensitivities: None in this document.

For the avoidance of doubt, this version of costs should not be considered as a central case. A more detailed overview of the ranges of costs for different cost cases is provided in section 1.3 of this report. The impact of different demand scenarios and sensitivities modelled is covered in Module 13. Cost and Commercial Viability: Funding and Financing. Information on the detailed costs used in the financial modelling work for all scenarios/sensitivities is provided in Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway.

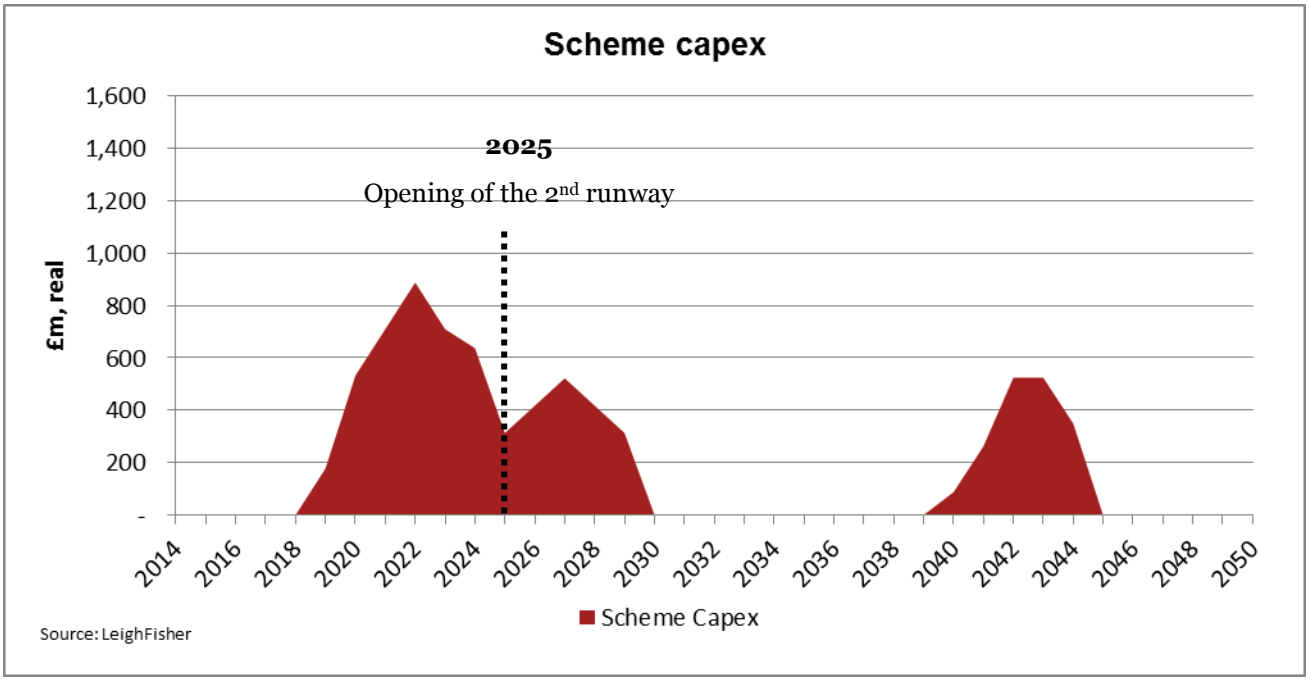
It should be noted that the AC's view of costs does not include the final phase of the scheme development proposed by GAL in their submission (as the phases are linked to demand and this would take place after the end of the cost review period under the AoN-CC demand forecast). Refer to Appendix 2 for further explanation and details on the AC's view of costs under an alternative demand forecast where the final phase is developed within the cost review period.

1.2.1 The LGW 2R scheme cost

The AC's view of the cost of the LGW 2R scheme is **£7,387m** in real terms. This cost relates to the capex required to build out the LGW 2R scheme (excluding GAL's proposed phase 3 development (see Appendix 2)) but does not take into account the related surface access cost.

The profile of this expenditure is presented in figure 1.

Figure 1: Scheme capex



1.2.2 Surface access costs

The AC has also considered the cost of incremental surface access works to accommodate the heightened traffic at Gatwick Airport following the implementation of the LGW 2R scheme. The AC's view of the total surface access costs is **£787m** in real terms. The profile of this expenditure is given in figure 2[13].

There are well established precedents for private sector entities making contributions to transport schemes from which they directly benefit. The level and timing of any contribution to surface access costs would ultimately be made following discussions between the airport and the relevant public sector bodies. The AC has not taken a view on what this level of contribution would be but has considered a range of possible outcomes in its sensitivity analysis. This has involved looking at a 0% and 100% contribution to surface access costs by GAL. The impact of this sensitivity is covered in Module 13. Cost and Commercial Viability: Funding and Financing.

[13] These costs primarily relate to the capex required to deliver the surface access works but a percentage of this total relates to asset replacement (4%) and opex (2%) over the cost review period. The asset replacement and opex are small relative to the capex so do not show up clearly in figure 2.

Figure 2: Surface access costs

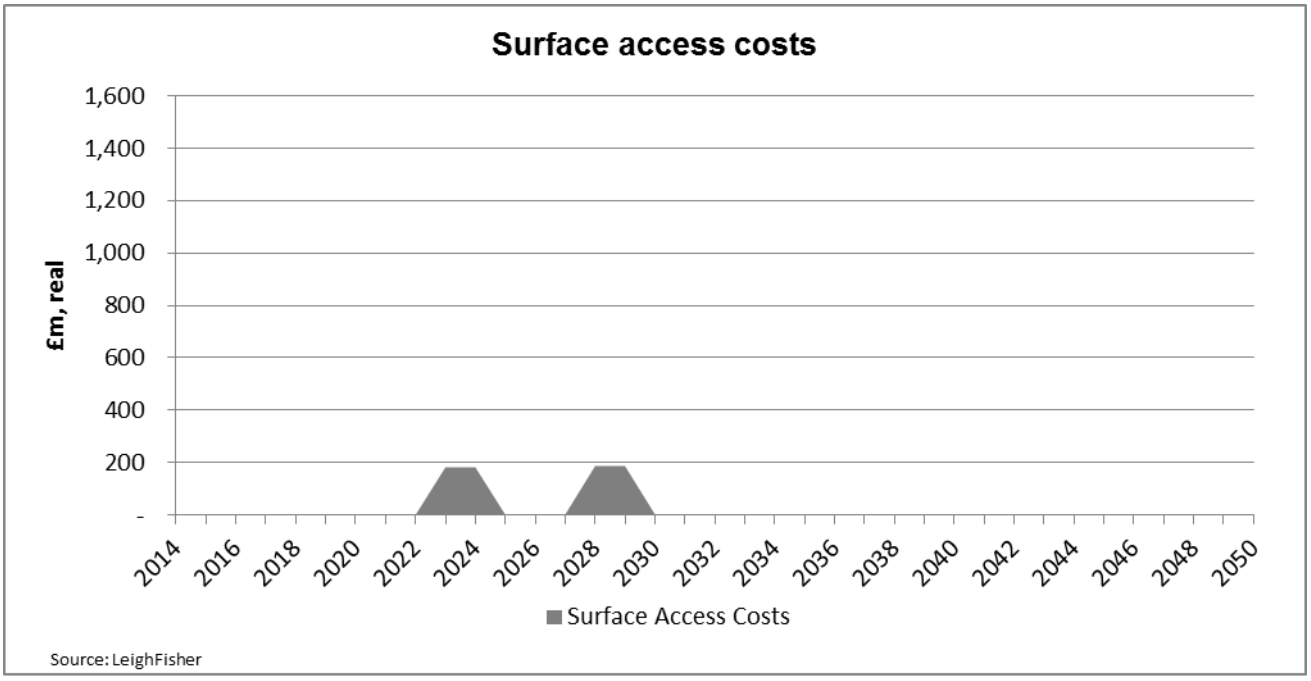


Table 4 presents the AC's view of the overall cost of the LGW 2R scheme including the associated surface access costs.

Table 4: Scheme and surface access costs

Cost item	Cost (£m, real)	%
Scheme capex (R20, MOB20)	7,387	90.4%
Surface access costs (R0, MOB44 – roads, MOB66 – rail)	787	9.6%
Total	**8,173**	**100.0%**

1.2.3 Other airport costs

A key part of the evaluation carried out by the AC is to assess the level of increase of aeronautical charges required to develop the scheme. The AC has looked to do this by developing a financial model that considers the whole airport. To undertake this analysis, the AC has needed to calculate the total costs that would be incurred by GAL during the cost review period. In addition to the scheme capex and surface access costs, these costs include the 'other airport costs' incurred by GAL. These are costs associated with the running and development of the airport and include:

- Core capex – expenditure that could be expected to take place regardless of whether new runway capacity is developed at the airport (these costs are separate and distinct from the scheme capex);
- Asset replacement – for the whole airport including the proposed scheme; and
- Opex – also for the whole airport including the proposed scheme.

The AC's view of the total 'other airport costs' is **£22,153m** in real terms for the cost review period. The profile for this expenditure is given in figure 3 and table 5.

Figure 3: Other airport costs

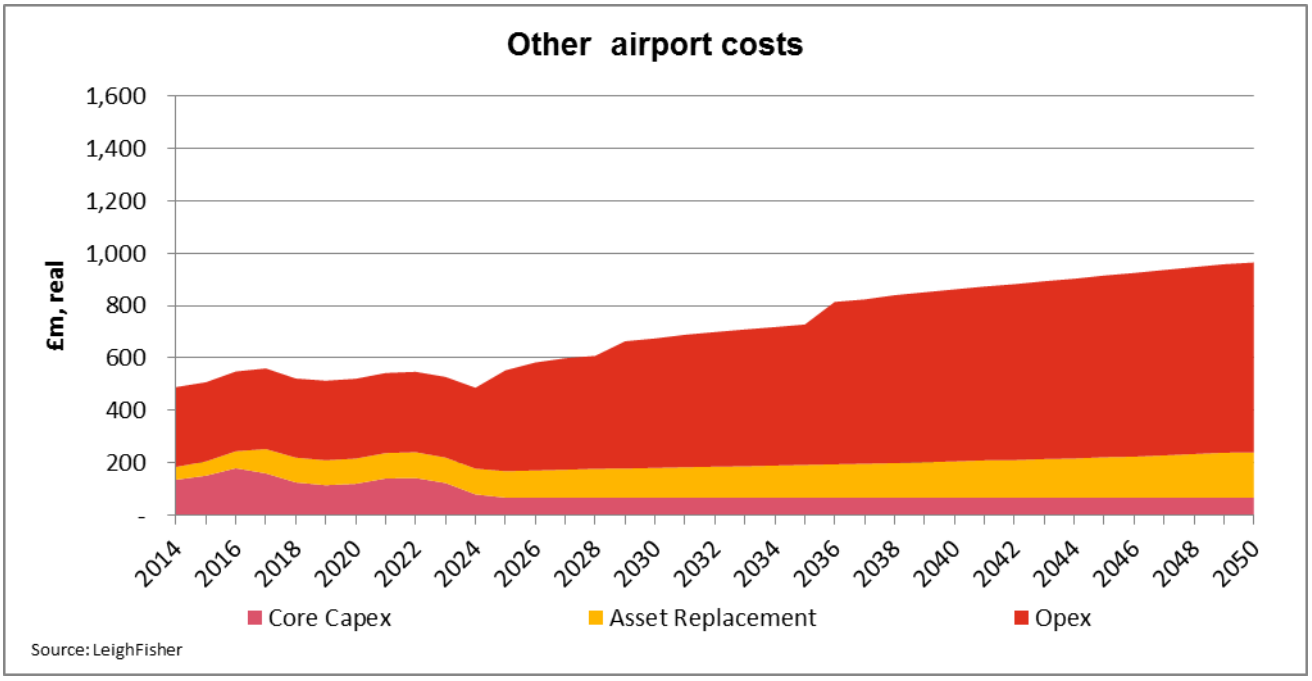


Table 5: Other airport costs

Cost item	Cost (£m, real)	%
Core capex (R0, MOB15)	3,224	14.6%
Asset replacement (R20, MOB20)	4,408	19.9%
Opex (R0.5 per annum, MOB20)	14,521	65.5%
Total	**22,153**	**100.0%**

1.2.4 Financial modelling costs

As noted, in order to assess the level of aeronautical charges, the AC has developed a financial model for the airport as a whole, combining the costs identified in sections 1.2.1, 1.2.2 (under certain model sensitivities) and 1.2.3 of this report. The combined impact of these costs over the cost review period is given in figure 4 (no contribution to surface access costs) and figure 5 (full contribution to surface access costs).

Figure 4: Financial modelling costs with 'no contribution' to surface access costs

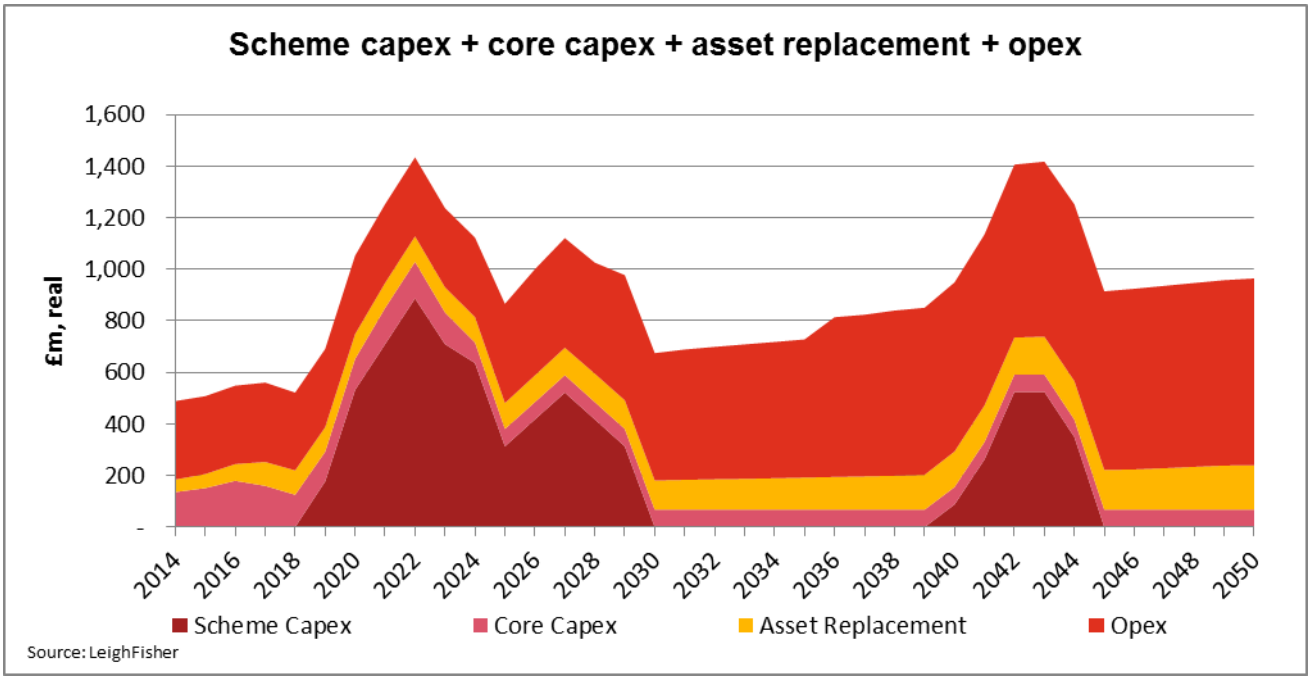
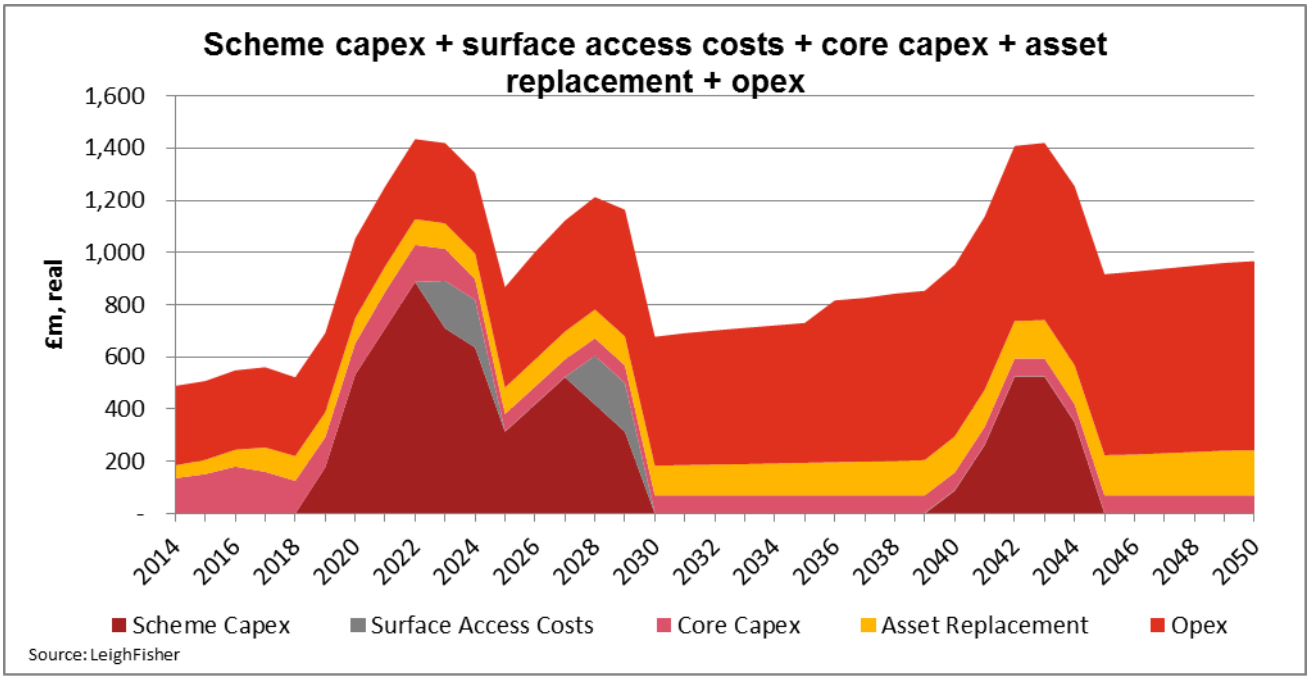


Figure 5: Financial modelling costs with 'full contribution' to surface access costs



1.2.5 Regulated Asset Base

The CAA uses the Regulated Asset Base (RAB) as a key factor in determining the average aeronautical charges which can be charged by a regulated airport on a per passenger basis. Since April 2014, GAL has been regulated by the Civil Aviation Authority (CAA) on a license based approach which allows GAL some flexibility in setting airport charges. However, the CAA also requires GAL to undertake a shadow RAB calculation in case tighter regulation needs to be re-introduced. In light of the requirement to undertake a shadow RAB calculation, the following analysis is still considered relevant for GAL. For more information on the RAB and its implication on

aeronautical charges, please see the separately published Module 13. Cost and Commercial Viability: Literature Review.

The RAB is calculated each year by taking the opening RAB, adding forecast capex, and deducting regulatory forecast depreciation. The RAB takes into account both scheme and core capex and the associated asset replacement costs. The AC has assumed straight line depreciation for all of the capital assets listed in table 6 and applied a blended asset life for all asset replacement costs.

Table 6: Asset life assumptions

Asset	Depreciation assumption (Years) [14]
Terminal buildings	40
Plant	20
Transit systems	50
Runways	100 (base)
Taxiways and aprons	50
Equipment	20
Environment	0
Asset replacement	30
Airfield ancillary items	40
Tunnels and bridges	50
Car parks	40
Third party land user costs	30
Items currently on the RAB (as of 1 January 2014)	15
Risk[15]	34
Mitigated OB[15]	34

Figure 6 and table 7 illustrate the development of the RAB balance over the cost review period. Note that the average RAB balance is the average of the opening and closing balances over an annual period.

[14] The depreciation assumptions on these cost items, with the exception of environment, third party land user costs, and items currently on the RAB, risk and mitigated OB were extracted from GAL's most recent annual report.

[15] The depreciation assumption for risk and mitigated OB were estimated by taking the weighted average of the cost items listed in table 6. Depreciation needs to be applied to risk and OB as these costs, when added to the base costs reflect the AC's view of the actual costs incurred by the airport and which would therefore be added to the RAB. Risk and OB costs have been modelled as separate line items from the base costs and therefore require the application of a blended depreciation assumption.

Figure 6: Cost additions and changes to the RAB

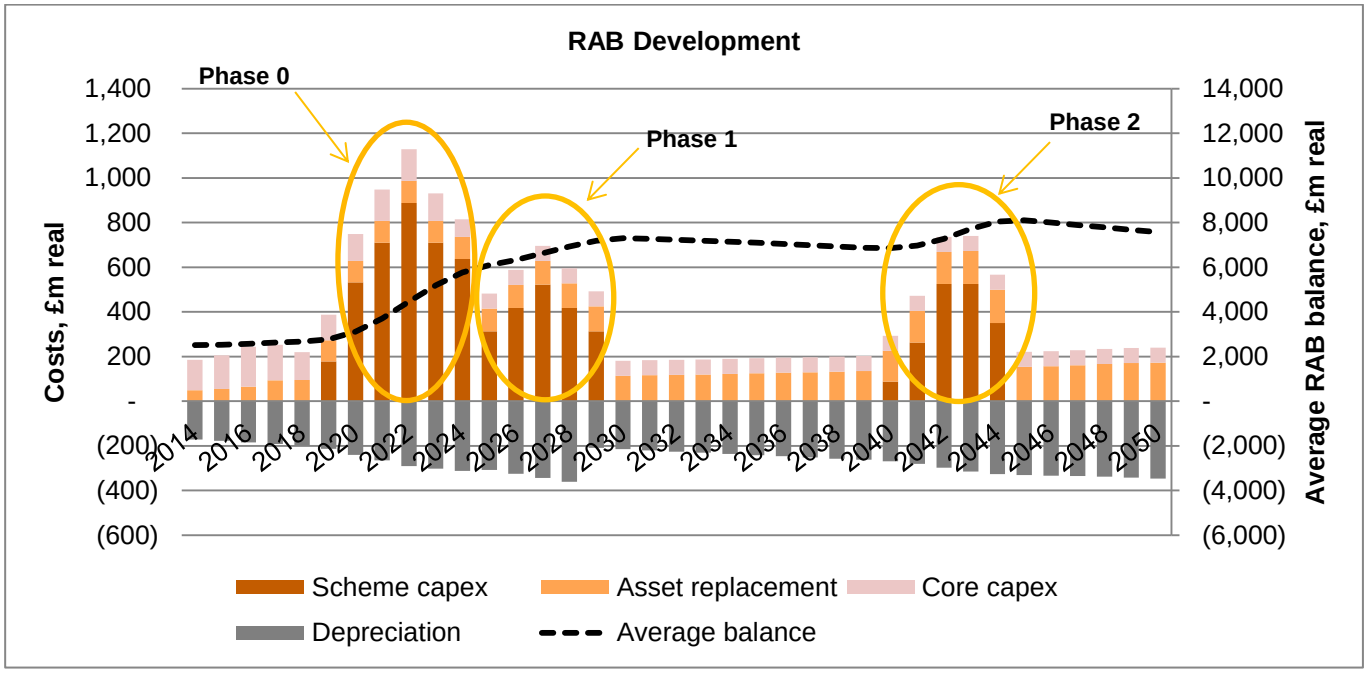


Table 7: RAB changes and peak information

	RAB information (£m, real)	RAB information (£m, nominal)
Opening RAB as of 2014	2,502	2,502
Indexation effect	n/a	16,327
Additions	15,018	27,883
Depreciation	(10,002)	(20,771)
Closing RAB as of 2050	7,518	25,941
Peak (average RAB balance)	8,104	26,125
Peak Year	2045	2050

The costs presented above the x axis in figure 6 represent additions to the RAB over the cost review period while the costs below the x axis represent depreciation which reduces the RAB value. The net impact of these additions and reductions each year causes the average RAB balance to increase (where the net impact is positive) or decrease (where the net impact is negative) and this net impact is illustrated by the dashed black line in figure 6.

Figure 6 shows that the average RAB balance increases significantly from 2020 to 2030 as phase 0 and phase 1 of the LGW 2R scheme are built out, reaching an initial peak of £7.3bn in 2030. The RAB then remains relatively stable before peaking again at £8.1bn in 2045 following the build out of phase 2. The RAB then starts to decrease as the depreciation costs exceed additions to the RAB.

1.3 Developing the costs

Section 1.2 presents the AC's view of the scheme capex, surface access costs and 'other airport costs' (core capex, asset replacement and opex) for the LGW 2R scheme, however the AC recognises that there are a range of possible outcomes for these costs. This section provides an overview of this range of costs and summarises the methodologies and assumptions used in deriving these costs.

Cost case

In developing the costs, the AC has considered various risk and optimism bias assumptions to account for the tendency for actual project costs to be higher than those forecast[16]. To generate a range of potential costs, the following cost cases have been considered:

- Case 1: Base Cost +Risk (low end of the range);
- **Case 2: Base Cost + Risk + Mitigated Optimism Bias (the AC's view of costs)**; and
- Case 3: Base Cost + Risk + Full Optimism Bias (high end of the range).

Case 2 represents the AC's view of costs and has been used as an input to the Module 13. Cost and Commercial Viability: Funding and Financing report to evaluate the funding and financing implications of the scheme.

Demand scenario

It should be noted that all the costs presented by the AC in section 1.3 are based on the AoN-CC passenger profile (unless stated otherwise). Alternative demand scenarios and sensitivities are considered in the separately published Module 13. Cost and Commercial Viability: Funding and Financing report.

This section also presents the costs as submitted by the scheme promoter, GAL, based on their own demand forecast.

It should be noted that the AC's view of costs does not include the final phase of the scheme development proposed by GAL in their submission (as the phases are linked to demand and this would take place after the end of the cost review period under the AoN-CC demand forecast). Refer to Appendix 2 for further explanation and details on the AC's view of costs under an alternative demand forecast where the final phase is developed within the cost review period.

Structure

Table 8, summarises the content presented in section 1.3.

Table 8: Content of section 1.3

Section	Content
1.3.1 – 1.3.3	• Details on the methodology and assumptions employed in generating the costs. • Presentation of the range of costs calculated by the AC. • Presentation of GAL's view on costs. • Commentary on the difference between the AC's and GAL's view of costs.

1.3.1 Scheme capex

The scheme capex relates to the capex required to build out the LGW 2R scheme (excluding GAL's proposed phase 3 development (see Appendix 2)) but does not take into account the related surface access costs. Scheme capex does not include the costs of operating or maintaining the new runway or associated new terminal facilities and equipment.

[16] Please refer to the Introduction and methodology section of this report for further details on risk and OB and the assumptions used.

In deriving the scheme capex for the LGW 2R scheme, the AC has independently developed a phased construction plan and calculated base costs for each phase of the development. Risk and OB assumptions have then been applied to the base costs (see table 9).

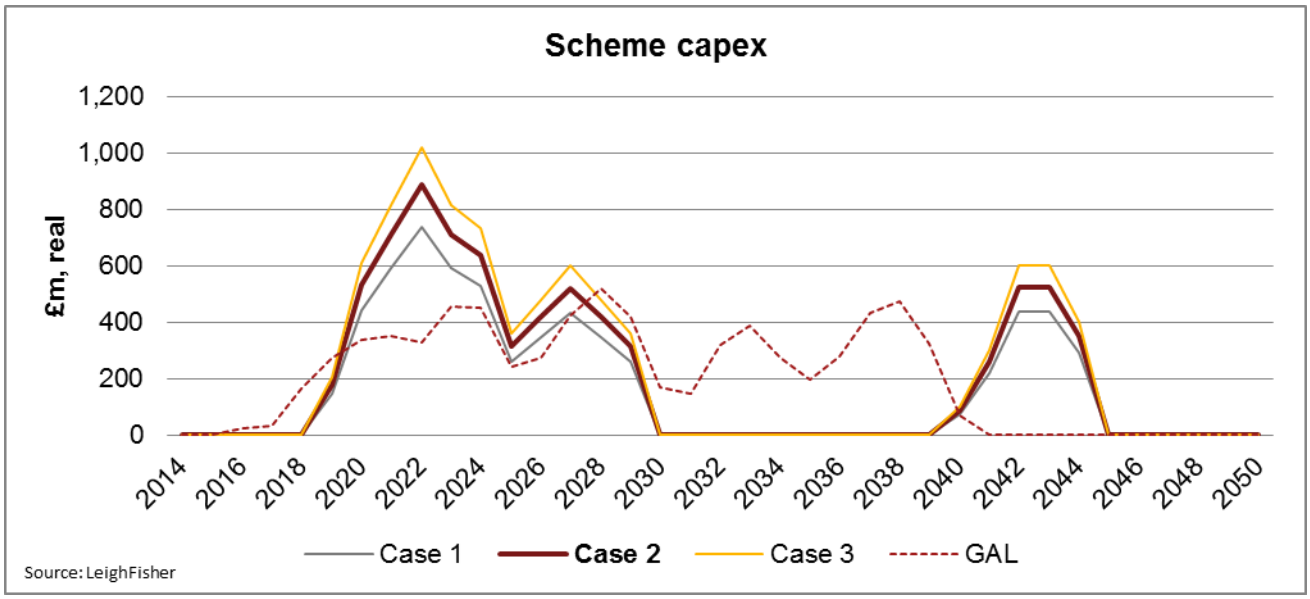
Table 9: Scheme phases and capex

Phase	Passenger capacity (mppa)	Opening year	Works	Scheme capex, (£m, real)	%
0	Not applicable[17]	2025	• Full length runway • Associated airfield works	3,549	48%
1	60	2030	• First phase of terminal works • Expansion of the airfield as required to serve the terminals	2,088	28%
2	75	2045	• Second phase of terminal works • Incremental airfield works	1,749	24%
Total Cost (R20, MOB20)				**7,387**	**100%**

As presented in table 9 the AC's view, based on the AoN-CC demand forecast is that 3 phases of work will be required in the cost review period. The build out of each phase is triggered by certain passenger demand or ATM milestones being met. The passenger capacity numbers presented in table 9 reflect the airport capacity once that phase of the development has been completed[18].

The AC has calculated a range of costs for the LGW 2R scheme (see figure 7 and table 10). GAL's view of scheme costs is also presented[19].

Figure 7: Scheme capex profiles



[17] Phase 0 is triggered when ATM movements will be in excess of 280,000 per year, not on passenger numbers.

[18] It is recognised in the delivery paper that construction is scheduled to commence around 2020 (for further details refer to Module 16: Delivery – Risk Assessment and Mitigation).

[19] Note that the AC's cost calculations relate to the period from January 2014-December 2050. GAL's view of costs relates to the period from April 2016 to March 2050 and is based on their own demand forecast.

Table 10: Total scheme capex

Source	Cost scenarios	LGW 2R scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	6,155	10,472	3,928
	Case 2 (R20, MOB20)	**7,387**	**12,566**	**4,714**
	Case 3 (R20, FOB38)	8,495	14,451	5,421
GAL	Scheme Promoter cost	7,389	12,541	4,569

The AC's view is that three major phases of work will be required. For full detail of the work underpinning this assessment, refer to Module 14. Operational Efficiency: Ground-Infrastructure Gatwick Airport Second Runway. In summary for this report, Phase 0 construction includes the build out of the new runway from 2019 to 2024 with the runway opening in 2025[20]. Phase 1 construction is proposed to take place from 2025 to 2029 with facilities opening in 2030 and a second phase of terminal development and associated works would commence in 2041, opening in 2045. The AC's view of costs in this, the AoN-CC scenario, does not include the final phase of the scheme development proposed by GAL in their submission as this would be developed after the end of the cost review period at a cost of £1,952m[21].

The AC's view of scheme capex, £7,387m when compared to GAL's view of £7,389m is broadly the same. However, it should be noted that there are a number of key factors, underlying these costs, which result in the costs being more closely aligned than they otherwise would be. These include:

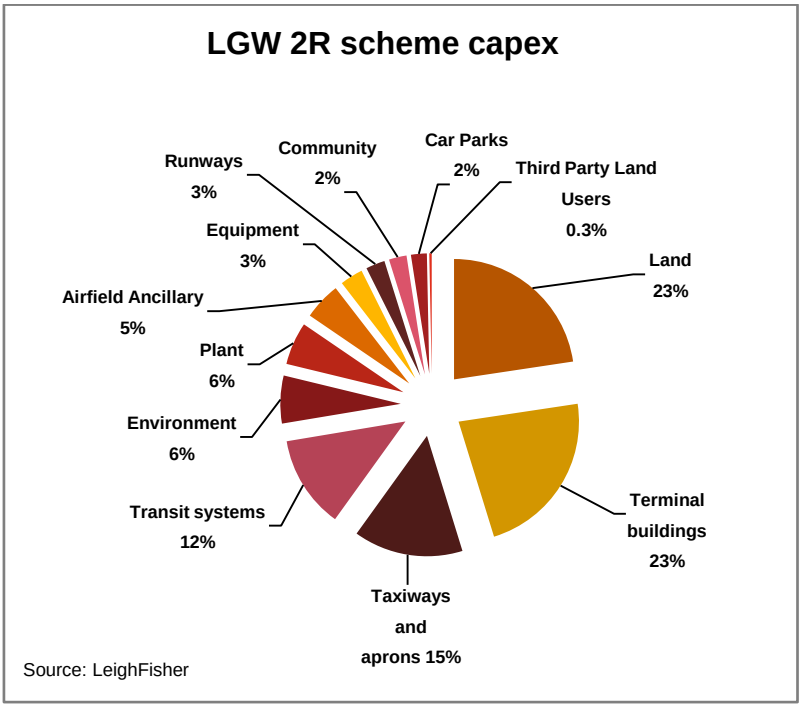
- **The exclusion of the final phase of development from the AC's view of costs (-£1,952m)**;
- The AC's inclusion of OB in their view of costs (+£1,232m);
- The difference in risk assumptions applied by the AC and GAL; and
- Differences in approach to calculating scheme capex.

Figure 8 presents a breakdown of the AC's view of scheme capex by the cost categories given in table 2.

[20] It is recognised in the delivery paper that construction is scheduled to commence around 2020 (for further details refer to Module 16: Delivery – Risk Assessment and Mitigation).

[21] Refer to Appendix 2 for further explanation and details on the AC's view of costs under an alternative passenger forecast where the final phase is developed within the cost review period.

Figure 8: Scheme capex breakdown



Together, the cost of terminal buildings and land make up 46% of the total scheme capex costs (23% each). Taxiways and aprons are the next largest cost at 15% of the total, followed by transit systems at 12%. The remaining costs, in order of magnitude, relate to environmental, plant, ancillary airfield, equipment, runways, community, car parks and third party land user costs respectively.

1.3.2 Surface access costs

The AC has also considered the cost of incremental surface access works to accommodate the heightened traffic at Gatwick Airport following the implementation of the LGW 2R scheme. The surface access costs relate to the building and operating of transport links (e.g. railway and road links) and include the links which would be built only if the LGW 2R scheme is selected. Committed plans around Gatwick Airport such as the widening of the M23 and the implementation of a smart motorway scheme are not considered in the AC's forecast of surface access costs. No rail surface access costs are currently considered to be required. For further details on the schemes considered within the surface access baseline, refer to the AC's Discussion Paper 10: Surface Access: Process Overview.

The AC has calculated a range of costs, considering various risk and OB assumptions for the surface access works but it should be noted that unlike some cost categories it is not considered appropriate to use a mitigated OB level that is less than the full OB level, given the early stage of development of the surface access plans. As a result, the mitigated OB costs that the AC is considering in the financial modelling work for surface access are the same as the full OB costs (i.e. Case 2 is equal to Case 3, at 44% OB for roads and 66% OB for rail).

As discussed in section 1.2.2, while a level of contribution to surface access costs would be expected, the AC has not taken a view on what this may be but has considered the range of possible outcomes from a 0% to 100% contribution by GAL.

Surface access capex

The AC has considered the incremental highway and local road costs in evaluating surface access capex. Table 11 presents the AC's view of the works required and the associated capex.

Table 11: Surface access capex breakdown

Route	Type	Proposed works	Road/Highway length (km)	Capex, real (£m)	%
M23	Highway	Junction 9 slip road widening	1.00	61	8.3%
		Junction 9 grade-separated flyover	1.00	50	6.9%
		Junction 9 to 9a road widening	0.75	32	4.4%
Airport Way	Local Road	Lane widening	1.25	54	7.4%
A23 realignment	Local Road	Provision of a new section of A23	5.50	198	27.0%
		Grade separation	1.75	88	12.0%
Long term parking	Local Road	New high capacity roundabout and approaches	n/a	7	1.0%
Industrial zone	Local Road	New roundabout and approaches	n/a	7	1.0%
North terminal access	Local Road	New high capacity roundabout and approaches	n/a	7	1.0%
		A23 to Airport Way grade-separated flyover	0.6	30	4.1%
New terminal access	Local Road	Provision of new D2 connecting M23 to new terminal	1.30	47	6.4%
				66	8.9%
		Grade-separated section of new D2 access to new terminal	1.30		
South terminal access	Local Road	New high capacity roundabout and approaches	n/a	7	1.0%
Longbridge roundabout	Local Road	Capacity enhancements	n/a	1	0.2%
Gatwick road	Local Road	New roundabout and approaches	n/a	7	1.0%
Balcombe road	Local Road	Re-provision of the existing road	3.25	70	9.6%
Total			**n/a**	**734**	**100%**
Total for Highways			*2.75*	*144*	*19.6%*
Total for Local Roads			*14.95*	*590*	*80.4%*
Total (R0, MOB44 – roads, MOB66 – rail)			***n/a***	***734***	***100%***

The AC has calculated a range of capex for the surface access works required for the LGW 2R scheme and these are presented in figure 9 and table 12. GAL's view of surface access costs is also presented[22].

[22] Note that the AC's cost calculations relate to the period from 2014-2050. GAL's view of costs relates to the period from April 2016 to March 2050.

Figure 9: Surface access capex profiles[23]

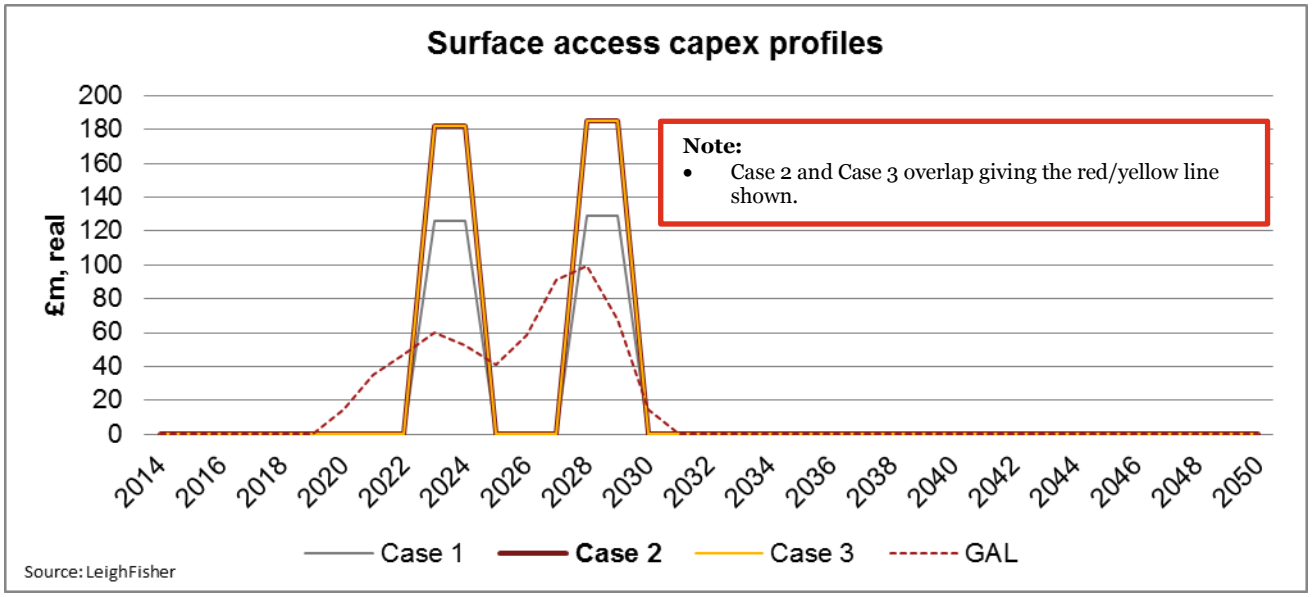


Table 12: Total surface access capex

Source	Case	Total surface access capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	510	774	339
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**734**	**1,115**	**487**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	734	1,115	487
GAL	Scheme promoter cost	582	872	392

As seen in figure 9, the surface access works would need to commence by 2023 at the latest. These are works for the re-alignment of the A23, and works to Gatwick Road (addition of a roundabout and approaches) and Balcombe Road (the re-provision of the existing road). These schemes would open just ahead of the new runway at Gatwick Airport in 2025. All the other works listed in table 11 are phased over 2028-2029. These later schemes will be operational in 2030, coinciding with the opening of the Phase 1 infrastructure of the LGW 2R scheme.

GAL's costs include highway works from M23 Junction 9 through the North terminal, realignment of the A23, works to a local road network and a railway station upgrade.

The difference of £152m between the AC's view of surface access capex, £734m, when compared to GAL's view of £582m, is due to factors that include:

- The AC's inclusion of OB in their assessment of cost (+£224m);
- The difference in risk assumptions applied by the AC and GAL; and
- GAL's inclusion of costs to make improvements to the railway station which have not been included in the AC's estimate at this stage.

[23] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

Surface access asset replacement

The AC has calculated road asset replacement costs using Highways Agency (HA) published data[24]. The HA figure of £46k per lane mile has been used for highways, while the South East cost of £56k per lane mile was used for local roads. The AC has based its calculations on 2.75km of highway and 14.95km of local roads requiring maintenance (see table 11). For further details of this analysis, refer to Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway.

The AC has calculated a range of costs for the surface access asset replacement works required for the LGW 2R scheme and these are presented in figure 10 and table 13.

Figure 10: Surface access asset replacement profiles[25]

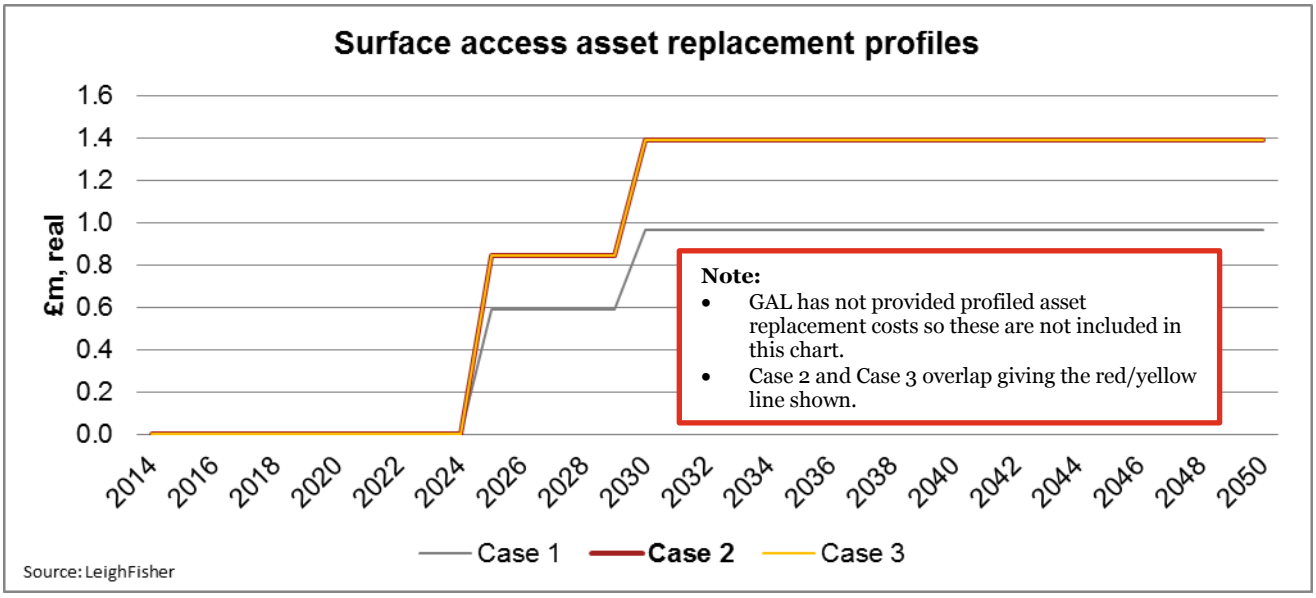


Table 13: Total surface access asset replacement costs

Source	Case	Total surface access asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	23	55	10
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**33**	**79**	**15**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	33	79	15
GAL	Scheme promoter cost	Not provided	Not provided	Not provided

Road asset replacement costs are assumed to be annual costs which commence once the planned road schemes are completed. As the A4, Gatwick Road and Balcombe Road schemes become operational, it is assumed annual costs of £0.85m are incurred. Following the opening of the remaining road schemes, the full annual asset replacement costs of £1.39m are incurred starting from 2030. Road asset replacement costs have been calculated on the basis of latest available HA data, which includes: "*all renewal of roads and structures expenditure; proportion of the managing agent contractor's routine and winter maintenance expenditure; a*

[24] https://www.gov.uk/government/publications/cost-of-maintaining-the-highways-agency-s-motorway-and-a-road-network-per-lane-mile

[25] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

proportion of the PFI/DBFO service payments calculated from contract data; and all technology maintenance and renewals expenditure".

It is not possible at this stage of the analysis to determine when various maintenance activities would need to take place so it has been assumed that an annual contribution of £0.85m from 2025 to 2029 and £1.39m from 2030 onwards is put towards "a fund" for asset replacement costs. See Module 13 Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway for further detail on the approach taken in calculating these costs.

Surface access opex

Road opex includes costs for activities such as lighting, drainage and landscaping. The AC has calculated annual road opex using the DfT Cost and Benefit Analysis guidance (2006) [26]. Following a similar approach to the surface access asset replacement costs, the DfT figure of £45k per lane km was used for highways, while the South East cost of £30k per lane km was used for local roads. The AC has again based its calculations on 2.75km of highway and 14.95km of local roads.

The AC has calculated a range of costs for the surface access opex required for the LGW 2R scheme and these are presented in figure 11 and table 14.

Figure 11: Surface access opex profiles[27]

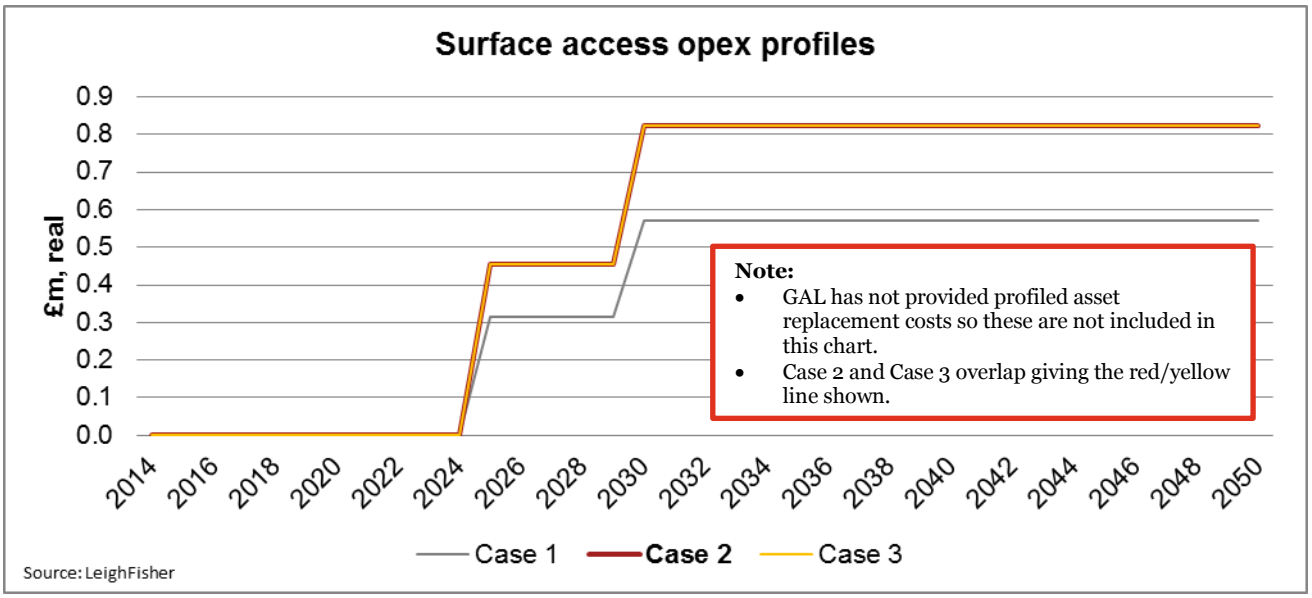


Table 14: Total surface access opex

Source	Case	Total surface access opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	14	29	6
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**20**	**41**	**9**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	20	41	9
GAL	Scheme promoter cost	Not provided	Not provided	Not provided

[26] http://www.dft.gov.uk/ha/standards/ghost/dmrb/vol13/index.htm

[27] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

Road opex for a particular road scheme is assumed to commence the year after the scheme has been completely built out. Road opex starts in 2025 (as road schemes become operational) at a total annual contribution of £0.45m, ramping up to a full road opex of £0.82m per annum from 2030[28].

1.3.3 Other airport costs

As described in section 1.2.3, this section presents the different views of 'other airport costs' that would be incurred by GAL (in addition to scheme capex and surface access costs) and provides an overview of the AC's assumptions and methodologies applied in deriving these costs.

Core capex

Core capex relates to expenditure that could be expected to take place regardless of whether new runway capacity is developed at Gatwick. These costs are separate and distinct from the scheme capex.

The AC has derived the core capex profiles presented in figure 12 by adopting GAL's submitted total core capex (from 1 April 2016 to 31 March 2050) of £2,479m[29]. As GAL's submitted costs do not span the full cost review period the AC has applied the core capex identified in the Q6 regulatory settlement for the years 2014 to 2016, and the AC has extrapolated the core capex amount for 2049 to accommodate a full year of costs for 2050[30].

The AC has calculated a range of costs based on GAL's submitted core capex (see figure 12 and table 15). GAL's view of core capex is also presented[31].

[28] In real terms, it is assumed that opex remains constant for the life of the road and rail schemes. There is no publically available information on operating cost trends; therefore it is assumed costs would increase in line with inflation (see inflated costs in the 'nominal' column of table 14).

[29] Note that GAL submitted a core capex profile for the period of April 2016 – March 2050 to a total of £2,479m. The AC has only included £2,339m of this total in its estimation of core capex as the remaining £140m does not relate to full years of cost in 2016 and 2050. The AC has therefore used the Q6 settlement figure for 2016 and has extrapolated GAL's 2049 figure, £58.6m to replace the partial 2050 year figure submitted by GAL.

[30] The AC has based their calculation of core capex for the Q6 period based on information from the following source: http://www.caa.co.uk/docs/33/CAP1152LGW.pdf

[31] Note that the AC's cost calculations relate to the period from 2014 to 2050. GAL's view of costs relates to the period from April 2016 to March 2050.

Figure 12: Core capex profiles[32]

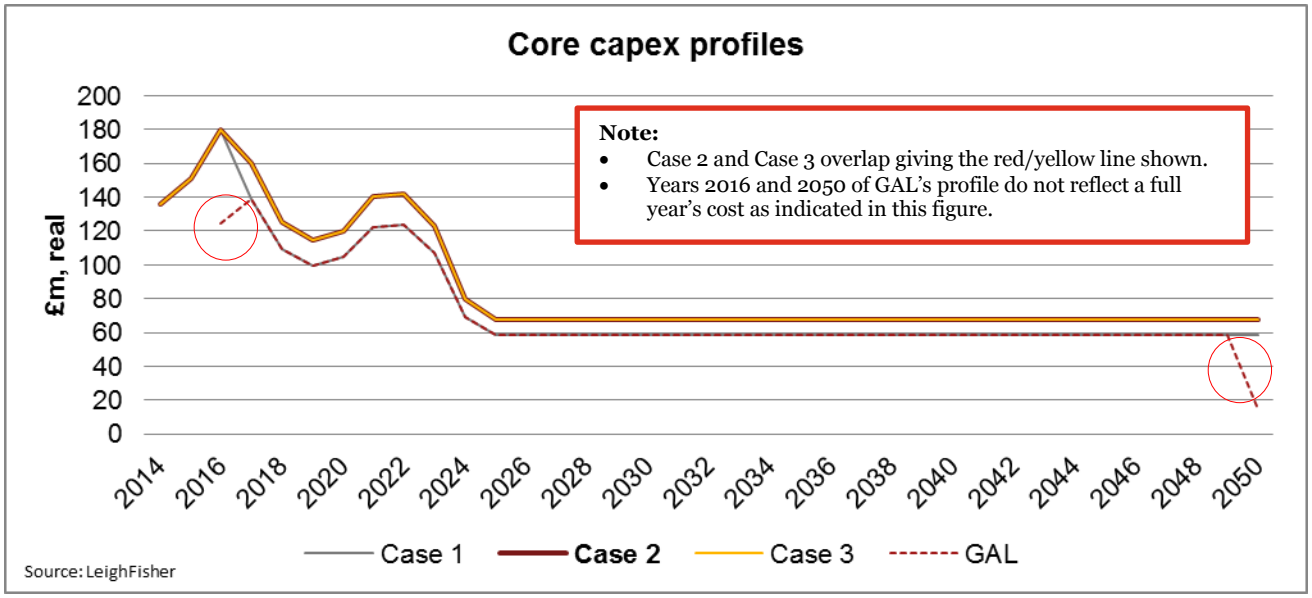


Table 15: Core capex

Source	Cost scenarios	Core capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	2,864	5,107	1,860
	Case 2 (R0, MOB15)	**3,224**	**5,800**	**2,071**
	Case 3 (R0, FOB15)	3,224	5,800	2,071
GAL	Scheme promoter cost	2,479	4,604	1,514

The AC is not able to comment on the components of GAL's core capex profile as the works to which this investment relates have not been made available.

The difference of £745m between the AC's view of core capex, £3,224m, when compared to GAL's view of £2,479m is due to:

- The AC's adoption of Q6 derived core capex for years 2014 – 2016 and adjustments(from GAL's submitted figures) to include full year costs in 2016 and 2050 (+£385m); and
- The AC's inclusion of OB in their assessment of cost (+£360m).

Asset replacement

Asset replacement costs relate to the investment required to maintain or replace the capital assets of the airport as well as to update infrastructure to maintain the assets as a modern airport. At this point in time it is not known what specific asset replacement will be required, however precedent informs us that these costs will need to be incurred as part of operating an airport.

The AC has calculated asset replacement costs for the whole airport, including costs associated with the LGW 2R scheme. Because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has calculated these costs by assuming an expenditure rate per passenger, where passenger 'foot fall' equates to the 'wear and tear' of the assets, which is used to model the overall investment required for asset replacement.

[32] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

The AC has derived the expenditure rate per passenger from GAL's submitted total asset replacement cost of £4.02bn[33] for the period from 2016/2017 to 2049/2050. A per passenger figure was calculated by dividing this £4.02bn by the total number of passengers in the same period based on the GAL demand profile. This per passenger expenditure rate can then be applied to the different demand scenarios modelled to develop the AC's asset replacement cost profiles. The AC has also applied risk and OB to expenditure rates to create the rates given in Figure 13 and table 16. GAL's view of asset replacement costs is also presented in table 16[34].

Figure 13: Asset replacement profiles

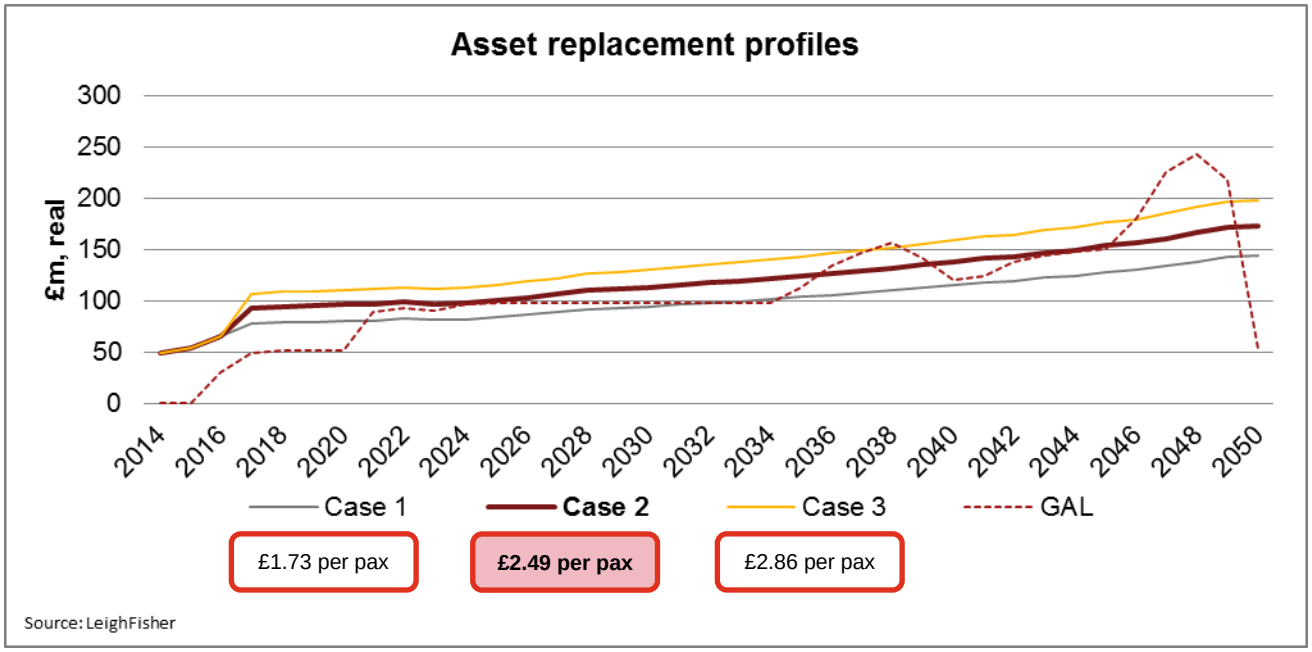


Table 16: Total asset replacement costs

Source	Cost scenarios	Total asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	3,701	7,959	1,959
	Case 2 (R20, MOB20)	**4,408**	**9,516**	**2,319**
	Case 3 (R20, FOB 38)	5,044	10,918	2,642
GAL	Scheme promoter cost	4,020	9,127	1,971

The AC's view of costs increases in line with the AoN-CC demand profile from 2017 to 2050 (as the expenditure rate per passenger is applied to the demand forecast). Costs from 2014 to 2016, are based on costs extracted from Gatwick's Q6 regulatory settlement[35]. The annual expenditure costs have been allocated between core capex and asset replacement in line with the proportions stated in the settlement for 2017 and 2018. As noted, because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has derived

[33] The AC has assumed that GAL's submitted £4.02bn asset replacement cost does not include any risk contingency and therefore the cost could be used without any adjustment.

[34] Note that the AC's cost calculations relate to the period from 2014-2050. GAL's view of costs relates to the period from April 2016 to March 2050 and are based on their own demand forecast.

[35] http://www.caa.co.uk/docs/33/CAP1152.pdf

its per passenger cost from GAL's submitted total asset replacement cost of £4.02bn for the period from 2016/2017 to 2049/2050[36]. This generates a step up in costs from 2016 to 2017 where costs up to 2016 were generated from the Q6 regulatory settlement.

The difference of £388m between the AC's view of asset replacement costs, £4,408m, when compared to GAL's view of £4,020m is due to factors that include:

- The AC's inclusion of OB in their assessment of cost (+£707m);
- The time period over which costs are considered (the AC's estimate includes costs for the whole cost review period whereas GAL's costs span 1 April 2016 to 31 March 2050);
- The difference between the AoN-CC forecast used by the AC to build up costs and GAL's demand forecast which it has been assumed was used to build up the GAL cost; and
- The difference in risk assumptions applied by the AC and GAL.

Opex

Opex includes costs such as staff, facilities management and utilities. The AC has calculated opex for the whole airport, including costs associated with the LGW 2R scheme. The AC's calculation of opex was independently derived using the following summarised methodology[37]:

- In the short term up to 2025, the AC has used the opex breakdown and elasticities[38] (adjusted against comparable benchmarks) supplied by GAL;
- In the long term (2025 onwards), the AC has modelled total opex based on a range of elasticities related to passenger increase, gross floor area increase and airfield increase; and
- An efficiency frontier[39] of -1% was applied until 2030, following which no efficiencies are assumed (the AC's modelling approach assumes that the opening of significant additional infrastructure by 2030 would deliver the opportunity to make substantial cost efficiencies and that other than the efficiencies implicit in the elasticity based approach, no efficiency frontier should be applied for the remainder of the forecasting period).

The AC has calculated a range of opex cases for GAL which are presented in figure 14 and table 17. GAL's view of opex is also presented based on its own demand forecast.

[36] A detailed explanation of the AC's methodology is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway.

[37] A detailed explanation of the AC's methodology is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway.

[38] **'Elasticity'** in this context refers to how costs are affected by demand drivers. Costs are said to be highly elastic when a small change in a demand driver, for instance passenger numbers, results in a large change in cost.

[39] An **'efficiency frontier'** refers to the airport's ability to improve operational performance while at the same time reducing costs, in line with trends among other airport comparators.

Figure 14: Opex profiles

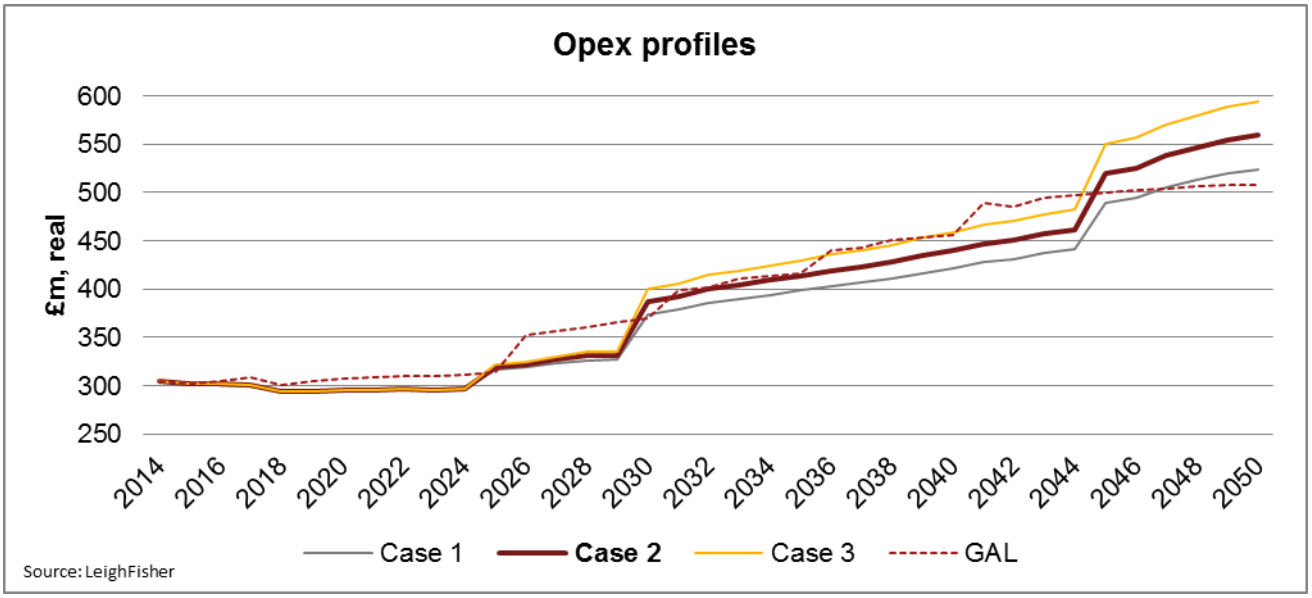


Table 17: Total opex

Source	Cost scenarios	Total opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0.5 per annum)	14,052	26,651	7,571
	Case 2 (R0.5 per annum, MOB20)	**14,521**	**27,724**	**7,760**
	Case 3 (R0.5 per annum, FOB41)	14,990	28,796	7,949
GAL	Scheme promoter cost	**14,765**[40]	**22,427**	**7,939**

The AC's forecast opex shows stepped increases in line with:

- The opening of new terminal infrastructure (resulting in larger floor space);
- The opening of expanded airfield and apron facilities; and
- Growth in passenger numbers.

These stepped increases are partially offset by the efficiency gains applied in the earlier years of the cost review period.

GAL's forecast is based on similar elasticities to passenger numbers to those assumed by the AC but lower elasticities to terminal floor space. This is illustrated by the comparatively small stepped increases when new terminal infrastructure opens from 2030 onwards. GAL assumed a stepped increase in costs in 2025 in line with the opening of its temporary passenger facility. The AC's view does not include this temporary facility and instead the first phase of permanent terminal expansion would open in 2030 resulting in a stepped increase in opex at that time.

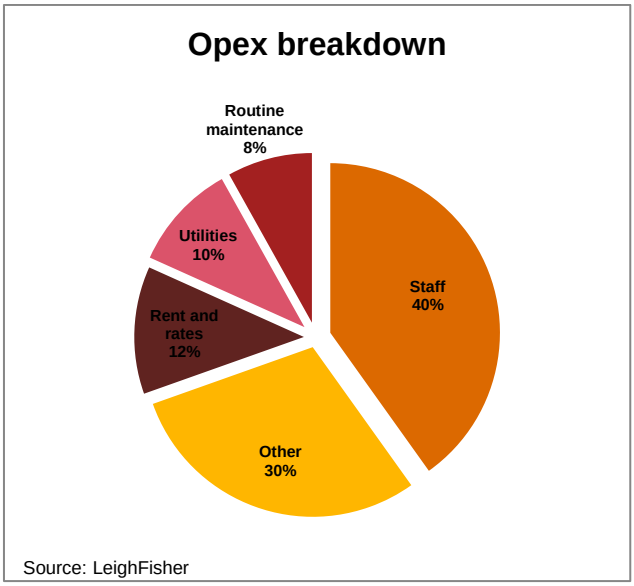
The difference of £244m between the AC's view of opex, £14,521m, when compared to GAL's view of £14,765m is due to factors that include:

[40] Note that GAL only provided opex from April 2016 to March 2050 (where 2016 and 2019 are not full years), based on their own demand forecast. The AC has calculated opex for GAL for 2014 to 2016, and 2050 based on GAL's assumptions.

- The AC's inclusion of OB in their assessment of cost (£469m);
- The difference in elasticity assumptions applied[41];
- The difference in cost efficiency assumptions applied[42];
- The difference in demand profiles which were assumed by the AC and GAL; and
- The difference in risk assumptions applied by the AC and GAL.

Figure 15 presents a breakdown of the AC's view of opex by cost category.

Figure 15: Opex breakdown



'Staff' costs form the largest component of opex for GAL as they are relatively elastic to both passenger numbers and floor area increases (elasticities of 40% have been applied).

Together, 22% of the total opex are made up of 'utilities' and 'rent and rates' which are both considered to be highly sensitive to floor space increases. Respectively, elasticities of 70% and 80% were applied to these costs in relation to floor space, causing pronounced increases in opex as new terminal building space is developed.

The 'other' costs which make up 30% of total opex include costs for IT & Telecoms, policing, NATS, cleaning, insurance, uniforms and payroll.

'Routine maintenance', which forms 8% of opex includes materials for maintenance activities undertaken in-house by airport employees as well as contract costs for servicing and repair systems such as escalators and air conditioning.

[41] The AC applied elasticities similar to GAL's up until 2025 and independently derived assumptions thereafter. A detailed explanation of the AC's elasticity assumptions is available in the separately published 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway.

[42] The AC assumes flat rate efficiencies (-1% up to 2030 and no efficiency gains thereafter) whereas GAL assumes improvements in efficiency modelled using elasticities and an annual efficiency factor.

2 Heathrow Airport Northwest Runway

2.1 The Heathrow Airport Northwest Runway

The Heathrow Airport Northwest Runway (LHR NWR) scheme, proposed by Heathrow Airport Limited (HAL), is made up of a new 3,500m runway constructed further to the west of the existing airport, linking to the west of the current north runway. The new runway would be Heathrow Airport's third runway and would have the ability to be operated independently from the existing runways.

The LHR NWR scheme also includes the expansion of existing terminals plus a new Terminal 6 to the west of Terminal 5. The scheme also sets out plans for a satellite building to the north of T5 and T6.

2.2 The costs

This section of the report provides an overview of the AC's view of costs based on development of the LHR NWR scheme. The AC has considered a range of different cases/scenarios/sensitivities depending on the levels of risk and OB (cost cases), levels of demand (demand scenarios), and sensitivities around other key variables (for example contribution to surface access costs). For the purposes of illustrating the cost of the LHR NWR scheme, this report presents the following version of the costs:

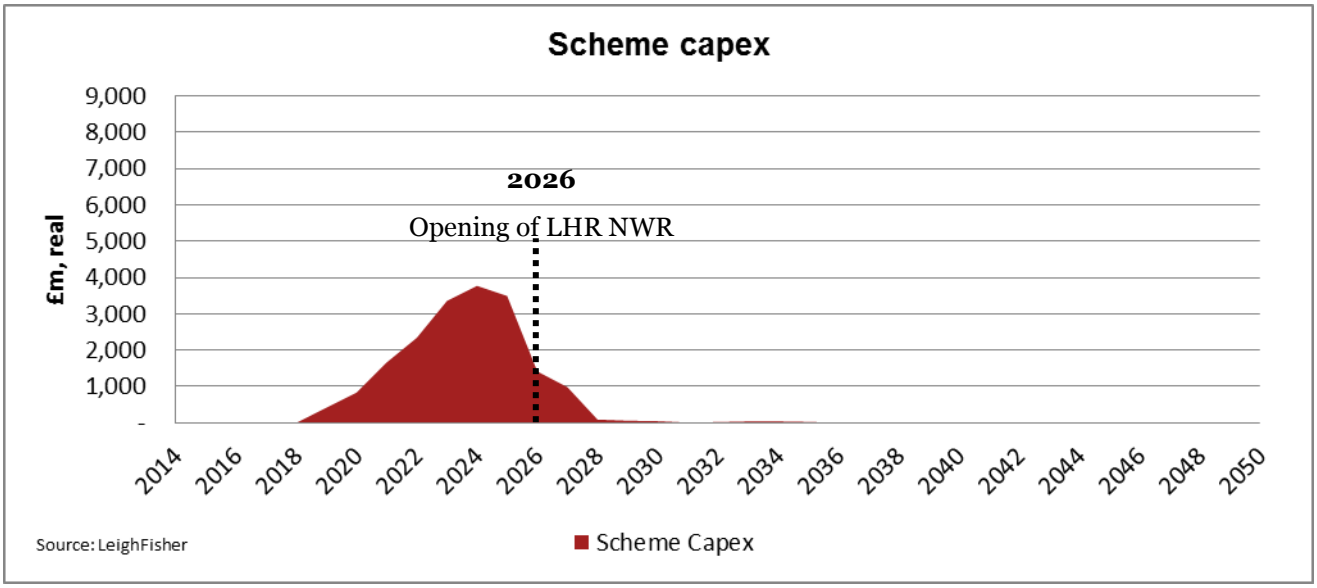
- Cost case: Base Cost + Risk + Mitigated Optimism Bias;
- Demand scenario: Assessment of Need – Carbon Capped; and
- Key sensitivities: None in this document.

For the avoidance of doubt, this version of costs should not be considered as a central case. A more detailed overview of the ranges of costs for different cost cases is provided in section 2.3 of this report. The impact of different demand scenarios and sensitivities modelled is covered in Module 13. Cost and Commercial Viability: Funding and Financing. Information on the detailed costs used in the financial modelling work for all scenarios/sensitivities is provided in Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway.

2.2.1 The LHR NWR scheme capex

The AC's view of the cost of the LHR NWR scheme is **£18,583m** in real terms. This cost relates to the capex required to build out the LHR NWR scheme in its entirety but does not take into account the related surface access costs. The profile of this expenditure is presented in figure 16.

Figure 16: Scheme capex



2.2.2 Surface access costs

The AC has also considered the cost of incremental surface access works to accommodate the heightened traffic at Heathrow Airport following the implementation of the LHR NWR scheme. The AC's view of the total surface access costs is **£5,728m** in real terms. The profile of this expenditure is given in figure 17 [43].

There are well established precedents for private sector entities making contributions to transport schemes from which they directly benefit. The level and timing of any contribution to surface access costs would ultimately be made following discussions between the airport and the relevant public sector bodies. The AC has not taken a view on what this level of contribution would be but has considered a range of possible outcomes in its sensitivity analysis. This has involved looking at a 0% and 100% contribution to surface access costs by HAL. The impact of this sensitivity is covered in Module 13. Cost and Commercial Viability: Funding and Financing.

Figure 17: Surface access costs

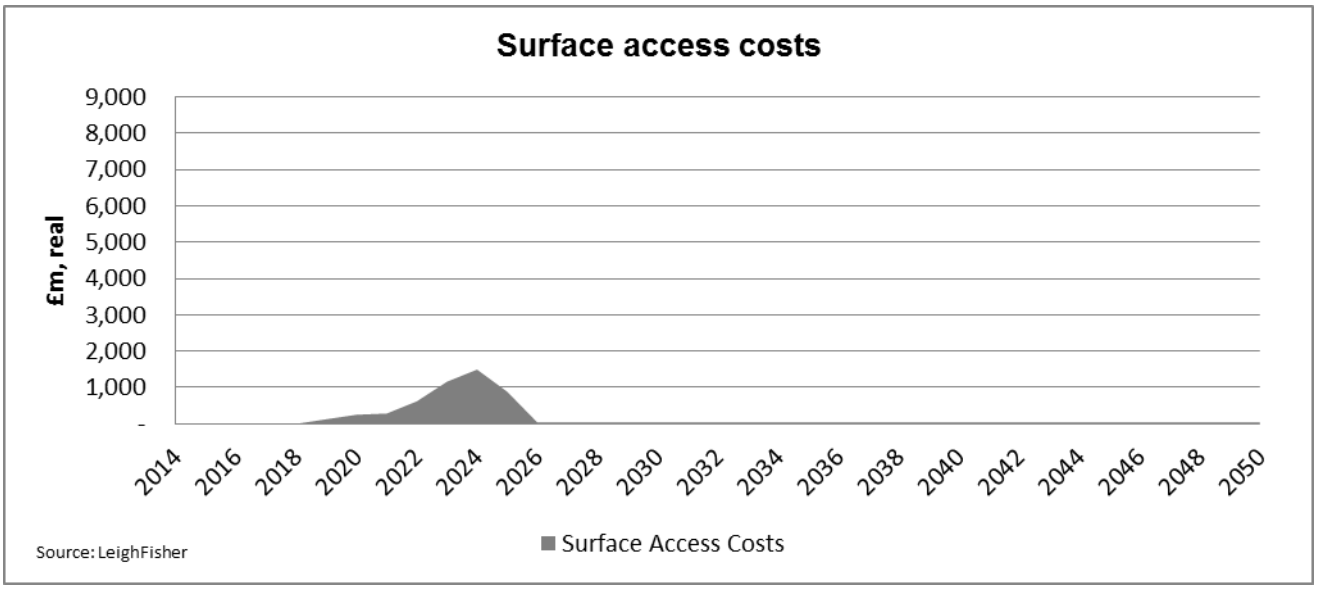


Table 18 presents the AC's view of the overall cost of the LHR NWR scheme including the associated surface access costs.

Table 18: Scheme and surface access costs

Cost item	Cost £m, real	%
Scheme capex (R20, MOB20)	18,583	76.4%
Surface access costs (R0, MOB44 – roads, MOB66 – rail)	5,728	23.6%
Total	**24,311**	**100%**

2.2.3 Other airport costs

A key part of the evaluation carried out by the AC is to assess the level of increase of aeronautical charges required to develop the scheme. The AC has looked to do this by developing a financial model that considers the

[43] These costs primarily relate to the capex required to deliver the surface access works but a percentage of this total relates to asset replacement (3%) and opex (14%) over the cost review period. The asset replacement and opex are small relative to the capex so do not show up clearly in figure 17.

whole airport. To undertake this analysis, the AC has needed to calculate the total costs that would be incurred by HAL during the cost review period. In addition to the scheme capex and surface access costs, these costs include the 'other airport costs' incurred by HAL. These are costs associated with the running and development of the airport and include:

- Core capex – expenditure that could be expected to take place regardless of whether new runway capacity is developed at the airport (these costs are separate and distinct from the scheme capex);
- Asset replacement – for the whole airport including the proposed scheme; and
- Opex – also for the whole airport including the proposed scheme.

The AC's view of the total 'other airport costs' is **£79,737m** in real terms for the cost review period. The profile for this expenditure is given in figure 18 and table 19.

Figure 18: Other airport costs

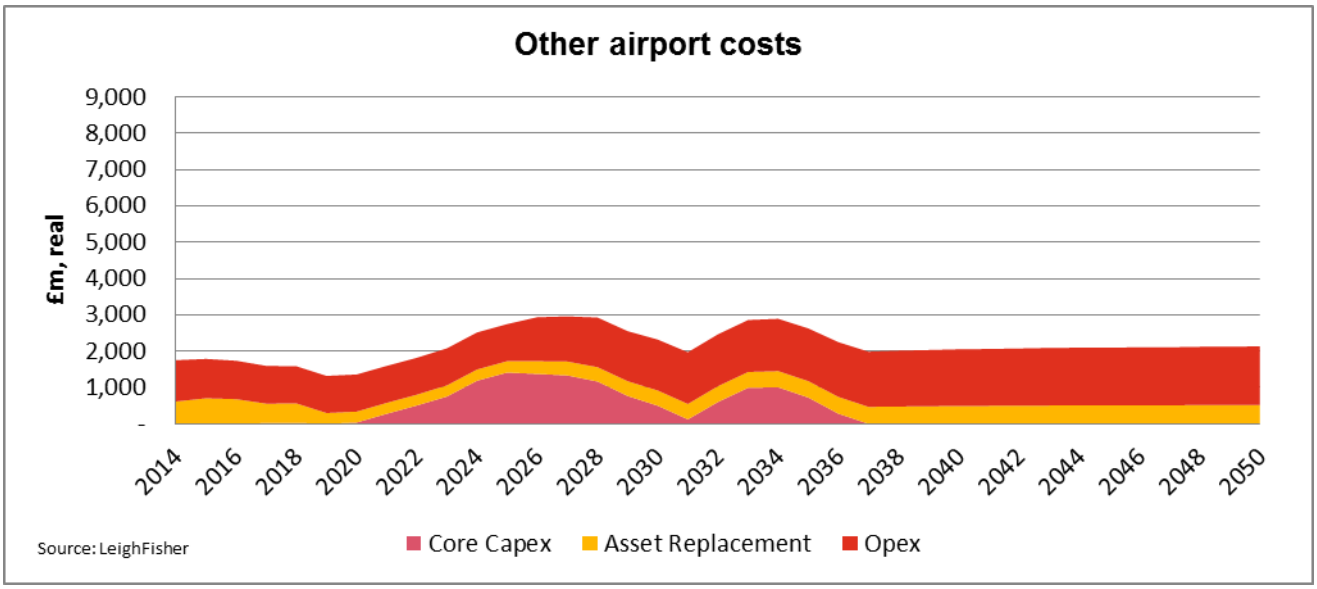


Table 19: Other airport costs

Cost item	Cost (£m, real)	%
Core capex (R0, MOB15)	13,069	16.4%
Asset replacement (R20, MOB20)	16,784	21.0%
Opex (R0.5 per annum, MOB20)	49,884	62.6%
Total	**79,737**	**100.0%**

2.2.4 Financial modelling costs

As noted, in order to assess the level of aeronautical charges, the AC has developed a financial model for the airport as a whole, combining the costs identified in sections 2.2.1, 2.2.2 (under certain model sensitivities) and 2.2.3 of this report. The combined impact of these costs over the cost review period is given in figures 19 (no contribution to surface access costs) and figure 20 (full contribution to surface access costs).

Figure 19: Financial modelling costs with 'no contribution' to surface access costs

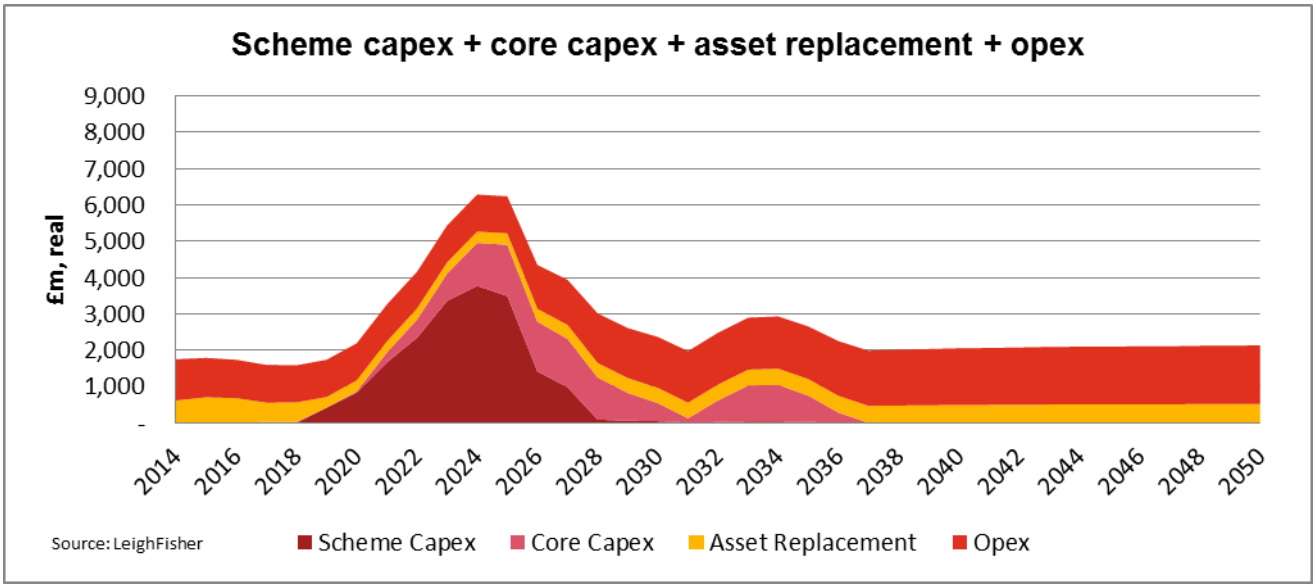
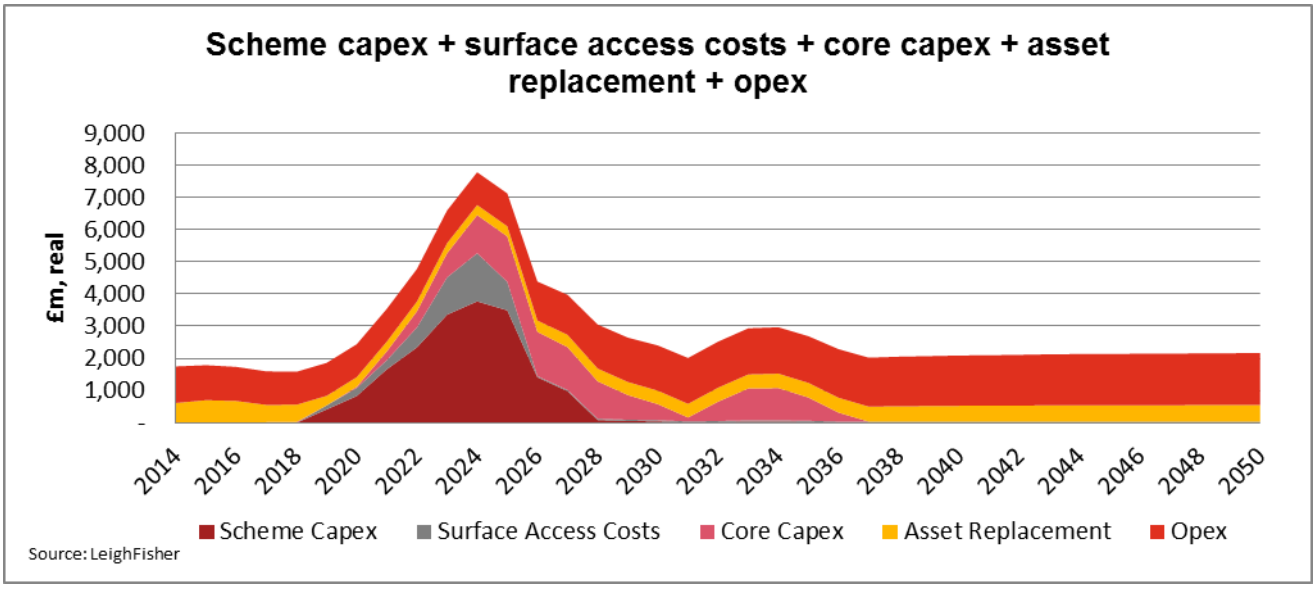


Figure 20: Financial modelling costs with 'full contribution' to surface access costs



2.2.5 Regulated Asset Base

The CAA uses the Regulated Asset Base (RAB) as a key factor in determining the average aeronautical charges which can be charged by a regulated airport on a per passenger basis. HAL is currently subject to regulation by the CAA and as such it is important to understand the impact of the proposed costs and their timing on HAL's RAB balance. For more information on the RAB and its implication on aeronautical charges, please see Module 13. Cost and Commercial Viability: Literature Review.

The RAB is calculated each year by taking the opening RAB, adding forecast capex, and deducting regulatory forecast depreciation. The RAB takes into account both scheme and core capex and the associated asset replacement costs. The AC has assumed straight line depreciation for all of the capital assets listed in table 20 below and applied a blended asset life for all asset replacement.

Table 20: Asset life assumptions

Asset	Depreciation assumption (Years)[44]
Terminal buildings	40
Plant	20
Transit systems	50
Runways	100 (base)
Taxiways and aprons	50
Equipment	20
Environment	0
Asset replacement	30
Airfield Ancillary	40
Tunnels and bridges	50
Car parks	40
Third party land user costs	30
Items currently on the RAB (as of 1 January 2014)	15
Risk[45]	31
Mitigated OB[45]	31

[44] The depreciation assumptions on these cost items, with the exception of environment, third party land user costs, items currently on the RAB, risk and mitigated OB were extracted from HAL's most recent annual report.

[45] The depreciation assumption for risk and mitigated OB were estimated by taking the weighted average of the cost items listed in table 20. Depreciation needs to be applied to risk and OB as these costs, when added to the base costs reflect the AC's view of the actual costs incurred by the airport and which would therefore be added to the RAB. Risk and OB costs have been modelled as separate line items from the base costs and therefore require the application of a blended depreciation assumption.

Figure 21 and table 21 illustrate the development of the RAB balance over the cost review period. Note that the average RAB balance is the average of the opening and closing balances over an annual period.

Figure 21: Cost additions and changes to the RAB

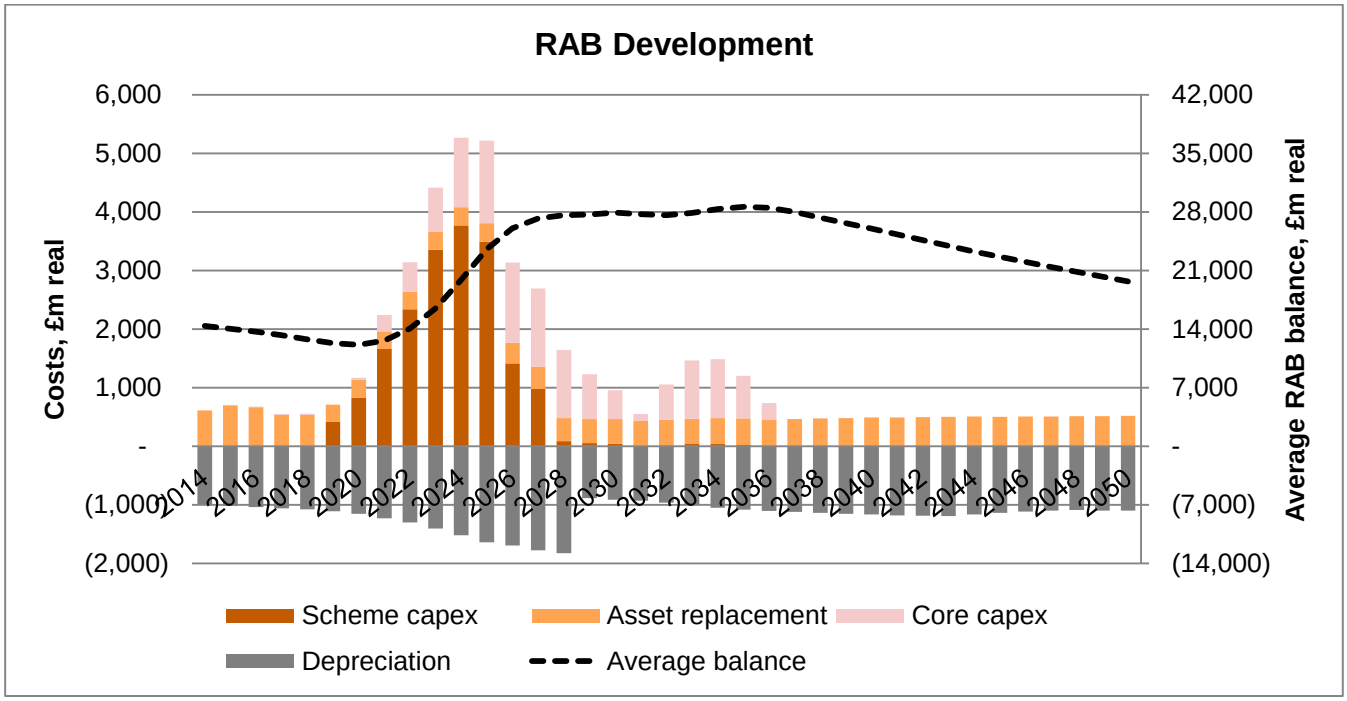


Table 21: RAB changes and peak information

	RAB information (£m, real)	RAB information (£m, nominal)
Opening RAB as of 2014	14,585	14,585
Indexation effect	n/a	56,557
Additions	48,436	81,335
Depreciation	(43,625)	(85,555)
Closing RAB as of 2050	19,396	66,923
Average RAB balance peak	28,608	67,920
Year average RAB balance peaks	2035	2050

The costs presented above the x axis in figure 21 represent additions to the RAB over the cost review period while the costs below the x axis represent depreciation which reduces the RAB value. The net impact of these additions and reductions each year causes the average RAB balance to increase (where the net impact is positive) or decrease (where the net impact is negative) and this net impact is illustrated by the dashed black line in figure 21.

Figure 21 shows that the RAB balance increases significantly from 2024 to 2030, reaching an initial peak of £27.9bn in 2030. This is due to high capital expenditure on major terminal and LHR NWR works in the period. The RAB balance subsequently peaks again at £28.6bn in 2035 following the final phases of core capex development which include car park works and satellite development. The RAB balance then starts to decrease

due to the net impact of depreciation of the capital assets and lower annual capital expenditure. Table 21 summarises the opening and closing RAB balances for the cost review period.

2.3 Developing the costs

Section 2.2 presents the AC's view of the scheme capex, surface access costs and 'other airport costs' (core capex, asset replacement and opex) for the LHR NWR scheme, however the AC recognises that there are a range of possible outcomes for these costs. This section provides an overview of this range of costs and summarises the methodologies and assumptions used in deriving these costs.

Cost case

In developing the costs, the AC has considered various risk and optimism bias assumptions to account for the tendency for actual project costs to be higher than those forecast[46]. To generate a range of potential costs, the following cost cases have been considered:

- Case 1: Base Cost +Risk (low end of the range);
- **Case 2: Base Cost + Risk + Mitigated Optimism Bias (the AC's view of costs)**; and
- Case 3: Base Cost + Risk + Full Optimism Bias (high end of the range).

Case 2 represents the AC's view of costs and has been used as an input to the Module 13. Cost and Commercial Viability: Funding and Financing report to evaluate the funding and financing implications of the scheme.

Demand scenario

It should be noted that all the costs presented by the AC in section 2.3 are based on the AoN-CC demand profile (unless stated otherwise). Alternative demand scenarios and sensitivities are considered in the separately published Module 13. Cost and Commercial Viability: Funding and Financing report.

This section also presents the costs as submitted by the scheme promoter, HAL, based on their own demand forecast.

Structure

Table 22, summarises the content presented in section 2.3.

Table 22: Content of section 2.3

Section	Content
2.3.1 – 2.3.3	• Details on the methodology and assumptions employed in generating the costs. • Presentation of the range of costs calculated by the AC. • Presentation of HAL's view on costs. • Commentary on the difference between the AC's and HAL's view of costs.

2.3.1 Scheme capex

The scheme capex relates to the cost required to build out the LHR NWR scheme in its entirety but does not take into account the related surface access costs. Scheme capex does not include the costs of operating or maintaining the new runway or associated new terminal facilities and equipment.

In deriving the scheme capex for the LHR NWR scheme, the AC has independently developed a phased construction plan and calculated base costs for each phase of the development. Risk and OB assumptions have then been applied to the base costs (see table 23).

[46] Please refer to the Introduction and methodology of this report for further details on risk and OB and the assumptions used.

Table 23: Scheme phases and capex

Phase	Opening Year	Works	Scheme capex, (£m, real)	%
1	2026	Enabling works, runway, taxiways and stands, various airfield ancillary facilities (e.g. Air Traffic Control tower, fire station), airside access roads.	8,322	44.8%
2	2026	Additional aircraft stands, Terminal 6 and satellite substructures, superstructures and fit-out, baggage tunnels and Tracked Transit System (TTS) tunnels, car parks	6,770	36.4%
3	2028	Additional aircraft stands, T2E satellite, baggage tunnels and TTS tunnels, car parks	3,076	16.6%
4	2031	Car parks	290	1.6%
5	2036	Car parks	124	0.7%
Total (R20, MOB20)			**18,583**	**100.0%**

The AC's view is that the third runway would be built between 2019 and 2025 as part of the phase 1 works to be operational in 2026[47]. This would be followed by the development of the Western and Eastern Campus facilities which consist of changes to terminals 1, 2, 3 and 5, a new terminal 6 and satellite additions.

The AC has calculated a range of costs for the LHR NWR scheme (see figure 22 and table 24). HAL's view of scheme costs is also presented[48].

[47] It is recognised in the delivery paper that construction is scheduled to commence around 2020 (for further details refer to Module 16: Delivery – Risk Assessment and Mitigation).

[48] Note that the AC's cost calculations relate to the period from 2014-2050. HAL's view of costs relates to the period from 2019 to 2050 and is based on their own demand forecast.

Figure 22: Scheme capex profiles

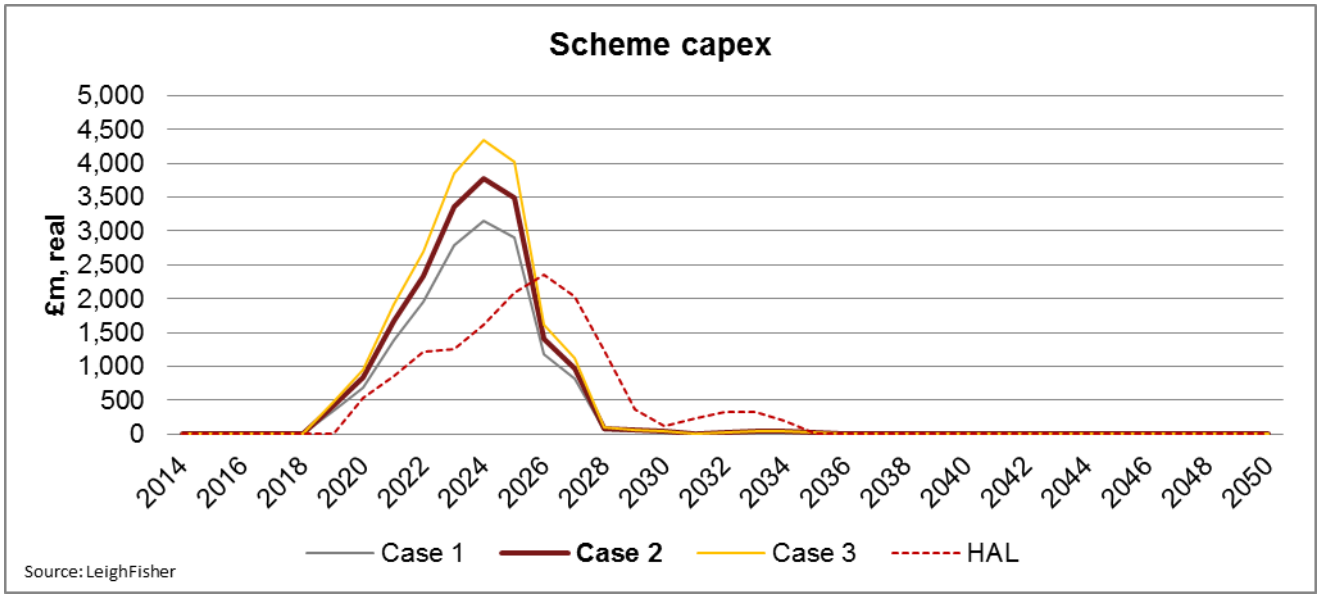


Table 24: Total scheme capex

Source	Cost scenarios	LHR NWR scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	15,486	21,616	11,152
	Case 2 (R20, MOB20)	**18,583**	**25,939**	**13,383**
	Case 3 (R20, FOB38)	21,371	29,830	15,390
HAL	Scheme Promoter cost	14,762	21,994	10,015

The AC's view is that the various phases of the scheme development (described in table 23) need to be largely concurrent to meet the forecast growth in passenger demand. This is reflected in the AC's scheme capex profiles presented in figure 22 where the majority of costs are incurred between 2018 and 2028.

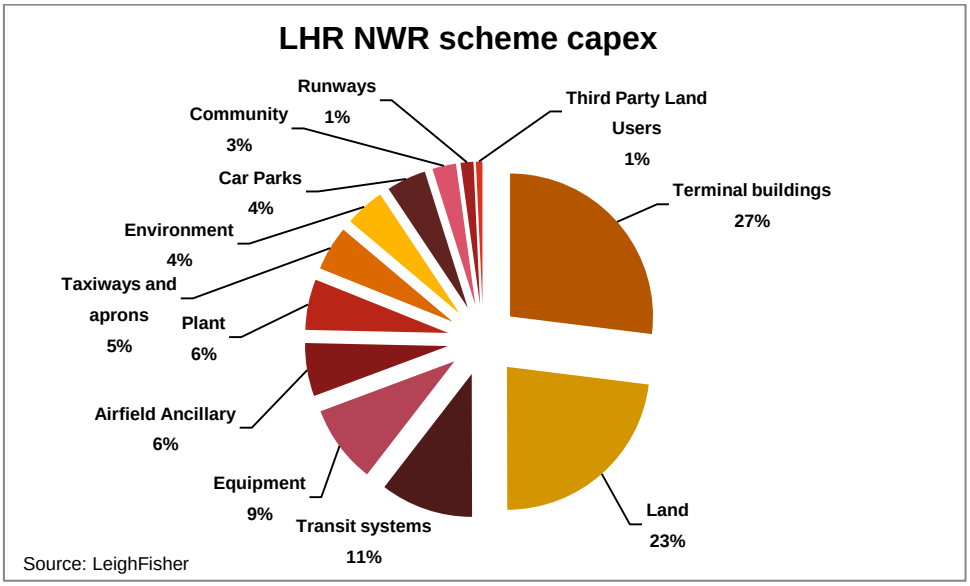
The difference of £3,821m between the AC's view of scheme capex, £18,583m when compared to HAL's view of £14,762m is due to factors that include:

- The AC's inclusion of OB in their view of costs (+£3,097m);
- The difference in risk assumptions applied by the AC and HAL; and
- Differences in approach to calculating scheme capex[49].

Figure 23 presents a breakdown of the AC's view of scheme capex by cost category.

[49] These assumptions are discussed in further detail in Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway report.

Figure 23: Scheme capex breakdown



Together, the cost of terminal buildings and land make up 50% of the total scheme capex. The AC's view is that the cost of terminal buildings, £3,481m, would be incurred in Phase 2 of the scheme works, between the years 2022 to 2027. Land costs, £2,967m, are considered to be incurred concurrently with runway and taxiway works between the years 2019 to 2025.

2.3.2 Surface access costs

The AC has also considered the cost of incremental surface access works to accommodate the heightened traffic at Heathrow Airport following the implementation of the LHR NWR scheme. The surface access costs relate to the building and operating of transport links (e.g. railway and road links) and only includes the links which would be built in addition to committed plans around Heathrow Airport such as the Crossrail scheme and the Old Oak Common Interchange with HS2. For further details on the schemes considered within the surface access baseline, refer to the AC's Discussion Paper 10: Surface Access: Process Overview.

The AC has calculated a range of costs, considering various risk and OB assumptions for the surface access works but it should be noted that unlike some cost categories, it is not considered appropriate to use a mitigated OB level that is less than the full OB level, given the early stage of development of the surface access plans. As a result, the mitigated OB costs the AC is considering in the financial modelling work for surface access are the same as the full OB costs (i.e. Case 2 is equal to Case 3, at 44% OB for roads and 66% OB for rail).

As discussed in section 2.2.2, while a level of contribution to surface access costs would be expected, the AC has not taken a view on what this may be but has considered the range of possible outcomes from a 0% to 100% contribution by HAL.

Surface access capex

The AC has considered the incremental highway, local road and rail costs in evaluating surface access capex. Table 25 presents the AC's view of the works required and the associated capex.

Table 25: Surface access capex breakdown

Route/ Rail project	Type	Works	Road/Highway length (km)	Capex, real (£m)	%
M4 J3 to J4	Highway	Hard shoulder running in both directions + additional road widening	3.8	274	5.7%
M4 Airport Spur	Highway	Road widening in both directions	2.8	202	4.2%
M4 J2 to J3	Highway	Road widening in both directions	17.6	1,267	26.5%
M4 J4 and J4B	Highway	Additional road widening in both directions	4.7	338	7.1%
M4	Highway	Large M4 junction, J4b replacement	n/a	216	4.5%
M4	Highway	Implementation of higher capacity at the M4 junction, J4a	n/a	58	1.2%
M4	Highway	Capacity improvements to existing main airport tunnel	n/a	58	1.2%
M25	Highway	M25 tunnelling costs (south of junction 15)	4.0	576	12.1%
A4	Local Road	Diversion of the A4 road alignment, dual carriageway	3.5	126	2.6%
A3044	Local Road	Diversion of A3044 Road alignment, dual carriageway	1.0	36	0.8%
Southern Road Tunnel	On-Airport Road[50]	Southern Road Tunnel from the Central Terminal Area (CTA) to the Southern Perimeter Road	5.2	749	15.7%
Airport Way/Southern Perimeter Road Interchange	Local Road	Grade separated junction and flyover/bridge structures	1.0	50	1.1%
Southern Road Tunnel/Southern Perimeter Road Interchange	Local Road	Works for an interchange	1.0	14	0.3%
One way system for western campus	Local Road	Implementation of a one way system	1.0	3	0.1%
Southern Rail Access (SRA) to Staines (Rail)	Rail	New southern access	n/a	809	16.9%
Total			**n/a**	**4,776**	**100%**
Total for Highways			*32.9*	*2,988*	*62.6%*
Total for Local Roads			*12.7*	*978*	*20.5%*
Total for Rail schemes			*n/a*	*809*	*16.9%*
Total (R0, MOB44 – roads, MOB66 – rail)			***n/a***	***4,776***	***100%***

[50] Treated as a local road for the purpose of opex and asset replacement calculation.

The AC has calculated a range of capex for the surface access works required for the LHR NWR scheme and these are presented in figure 24 and table 26. HAL's view of surface access costs is also presented[51].

Figure 24: Surface access capex profiles[52]

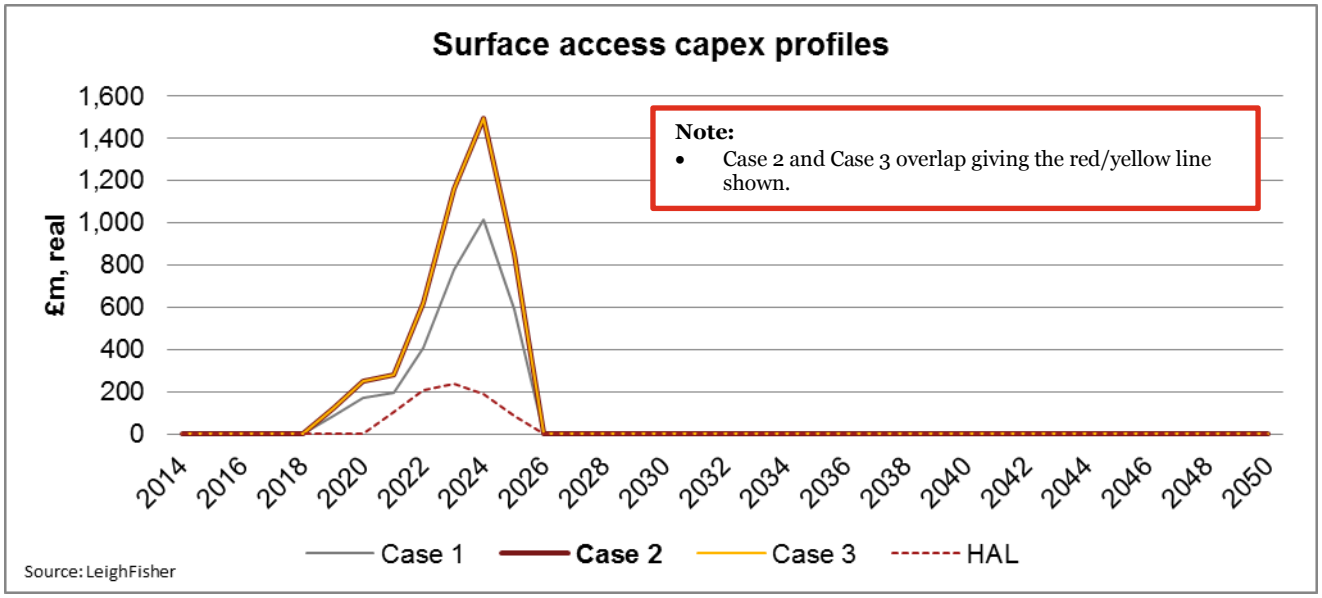


Table 26: Total surface access capex

Source	Case	Total surface access capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	3,242	4,449	2,369
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**4,776**	**6,553**	**3,490**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	4,776	6,553	3,490
HAL[53]	Scheme promoter cost	831	1,132	611

As seen in figure 24, the initial surface access works would need to commence by 2019 at the latest. These are works for a Southern Road Tunnel, which would connect the CTA to the Southern Perimeter Road and cost £749m to construct. The AC has assumed that the M25 tunnelling costs would need to begin in 2022 and be completed in 2024 for the opening of the runway in 2026. The large M4 schemes are phased over 3 years and would be scheduled to commence in 2023. The other highways and local road schemes would commence in 2024 and are phased over 2 years.

[51] Note that the AC's cost calculations relate to the period from 2014-2050. HAL's view of costs relates to the period from 2019 to 2050.

[52] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

[53] HAL's submitted costs are made up of:

- M25 Landside Road Diversion, £601m;
- Bath Road (A4) Landside Road Diversion, £226m; and
- T5 Landside Road Connections, £4m (separate to the £430m mentioned below).

Note that in HAL's submission, a further surface access cost of £430m for T5 Landside Road Connections was included. The AC has omitted this from the HAL view of surface access costs as it is included as part of HAL's core capex total in section 2.3.3.

The AC has derived rail capex by adopting an estimate of £809m for the Southern Rail Access to Staines scheme. This figure is phased over 3 years and the works are scheduled to be completed in advance of the start of operation for the LHR NWR scheme in 2026.

The difference of £3,945m between the AC's view of surface access capex, £4,776m, when compared to HAL's view of £831m, is due to factors that include:

- The AC's inclusion of OB in their assessment of cost (+£1,534m);
- The AC's consideration of more / different surface access schemes (the AC considers 15 schemes, relative to HAL's 4 schemes);
- The difference in approach to calculating costs[54]; and
- The difference in risk assumptions assumed by the AC and by HAL.

Surface access asset replacement

The AC has calculated road asset replacement costs using Highways Agency (HA) published data[55]. The HA figure of £46k per lane mile has been used for highways, while the South East cost of £56k per lane mile was used for local roads. The AC has based its calculations on 32.9km of highway and 12.7km of local roads requiring maintenance (see table 25). For further details of this analysis, refer to 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway.

The AC has calculated the rail portion of the asset replacement costs by assuming an infrastructure fee, payable by the train operator to Network Rail for track maintenance and renewals. This fee has been derived from industry data[56] on per route mile charges paid to Network Rail by existing franchise operators and amounts to £1.75m per annum for the SRA rail scheme.

The AC has calculated a range of costs for the surface access asset replacement works required for the LHR NWR scheme and these are presented in figure 25 and table 27.

[54] The AC's approach includes costs for the entirety of the works required to complete the surface access schemes, whereas HAL's costs appear to include only the level of contribution it has assumed it would make to the surface access schemes and not the full cost of the schemes.

[55] https://www.gov.uk/government/publications/cost-of-maintaining-the-highways-agency-s-motorway-and-a-road-network-per-lane-mile

[56] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275128/webtag-tag-unit-a1-2-scheme-costs.pdf

Figure 25: Surface access asset replacement profiles[57]

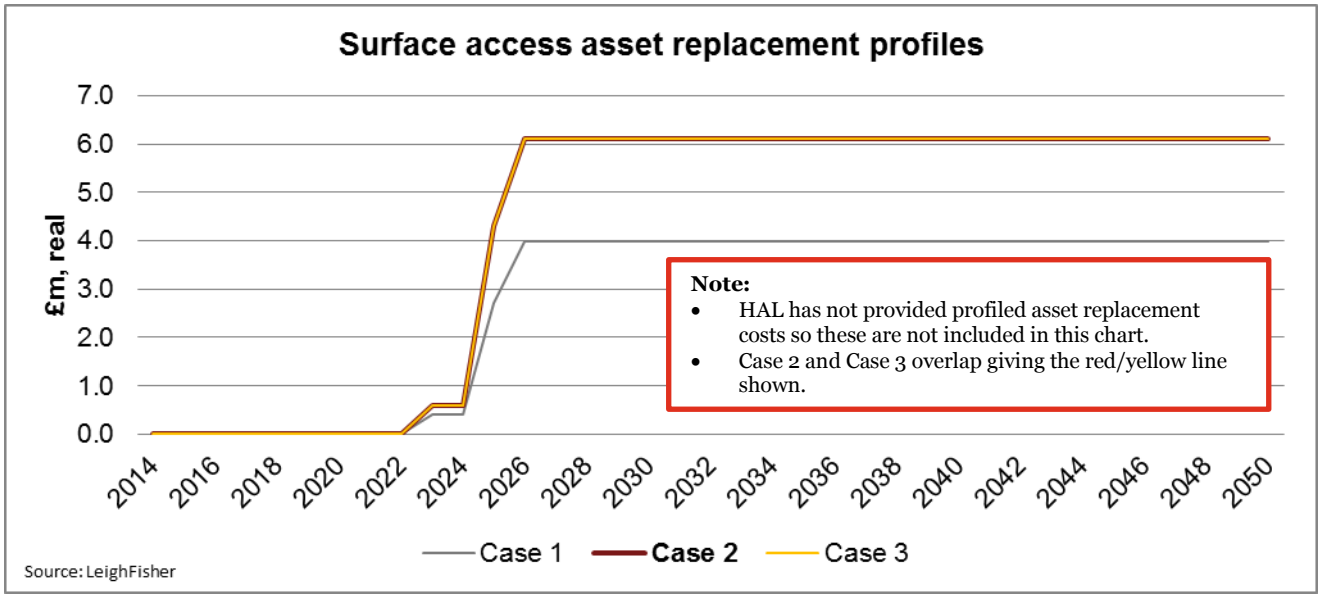


Table 27: Total surface access asset replacement costs

Source	Case	Total surface access asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	103	239	47
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**158**	**367**	**73**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	158	367	73
HAL	Scheme promoter estimate	Not provided	Not provided	Not provided

Road asset replacement costs are assumed to be annual costs which commence once the planned road schemes are completed. The AC assumes that roads will be built in three phases where the end of each phase corresponds to an increase in asset replacement costs. The first phase of road schemes incurs an annual cost of £0.58m between 2023 to 2024. Following the completion of the second phase of road schemes in 2025, the annual asset replacement cost then increases to £1.39m. The annual expenditure then increases following the build out of the third phase and remains at £3.2m for the life of the roads.

Road asset replacement costs have been calculated on the basis of the latest available HA data, which includes: "*all renewal of roads and structures expenditure; proportion of the managing agent contractor's routine and winter maintenance expenditure; a proportion of the PFI/DBFO service payments calculated from contract data; and all technology maintenance and renewals expenditure*".

The annual rail asset replacement costs of £2.91m begin in 2025 following the build out of the rail scheme.

It is not possible at this stage of the analysis to determine when various maintenance activities would need to take place so it has been assumed that an annual contribution of £6.11m is put towards "a fund" for both road and rail asset replacement costs, reflecting the combined asset replacement costs of £3.2m and £2.91 for road and rail respectively. See Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway for further detail on the approach taken in calculating these costs.

[57] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

Surface access opex

Road opex includes costs for activities such as lighting, drainage and landscaping. The AC has calculated annual road opex using the DfT Cost and Benefit Analysis guidance (2006)[58]. Following a similar approach to the surface access asset replacement costs, the DfT figure of £45k per lane km was used for highways, while the South East cost of £30k per lane km was used for local roads. The AC has again based its calculations on 32.9km of highway and 12.7km of local roads.

The AC has calculated opex for the SRA scheme based on an assumption of an additional 4 trains per hour between Heathrow and Waterloo. The total rail opex also reflects an increased Crossrail service of an additional 2 trains per hour. Note that while Crossrail has not been considered as a part of capex since it is a committed scheme that would be built out regardless of a 3rd Heathrow runway being developed; the increased service that would be required as a result of an airport expansion has been reflected in the opex.

The AC has calculated a range of costs for the surface access opex required for the LHR NWR scheme and these are presented in figure 26 and table 28.

Figure 26: Surface access opex profiles[59]

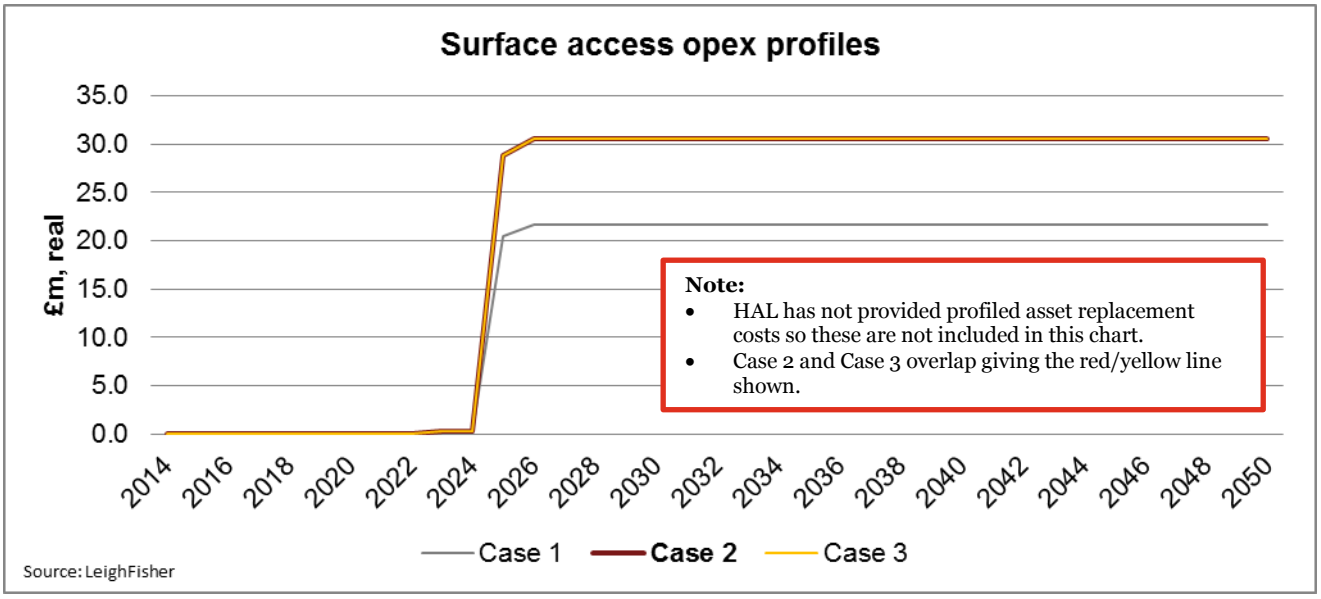


Table 28: Total surface access opex

Source	Case	Total surface access opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	562	1,155	260
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**794**	**1,631**	**367**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	794	1,631	367
HAL	Scheme promoter estimate	Not provided	Not provided	Not provided

Road opex for a particular road scheme is assumed to commence the year after the scheme has been completely built out. Road opex costs start in 2023 as road schemes become operational at a total contribution of £0.31m

[58] http://www.dft.gov.uk/ha/standards/ghost/dmrb/vol13/index.htm

[59] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

per annum, ramping up to £0.95m per annum in 2025 to reach the full road opex amount of £2.68m per annum from 2026.

Similarly, opex for rail schemes commences post the full build out of the schemes and in the case of Crossrail, when the additional services start. Rail opex costs start in 2025 and remain constant throughout the cost period at £27.92m per annum.

In total, the full annual spend for opex is £30.6m per annum from 2026, including road and rail schemes[60],[61].

2.3.3 Other airport costs

As described in section 2.2.3, this section presents the different views of 'other airport costs' that would be incurred by HAL (in addition to scheme capex and surface access) and provides an overview of the AC's assumptions and methodologies applied in deriving these costs.

Core capex

Core capex relates to expenditure that could be expected to take place regardless of whether new runway capacity is developed at Heathrow. These costs are separate and distinct from the scheme capex.

The AC has derived the core capex profiles presented in figure 27 by adopting HAL's submitted total core capex cost of £11,801m. The AC has decided to make no changes to HAL's submitted core capex of £11,801m in deriving the AC's view, apart from the removal of 'Terminal 5 Landside roads' costs, £430m (which is considered a committed surface access cost), and adjusting the phasing of costs according to the AoN-CC demand profile.

The AC has produced a range of costs based on HAL's submitted core capex (see figure 27 and table 29). HAL's view of core capex is also presented[62].

[60] In real terms, it is assumed that opex remains constant for the life of the road and rail schemes. There is no publically available information on operating cost trends; therefore it is assumed costs would increase in line with inflation (see inflated costs in the 'nominal' column of table 28).

[61] The costs for Heathrow Express services are considered as part of the airport's operating expenses in section 2.3.3 given that it is owned by HAL.

[62] Note that the AC's cost calculations relate to the period from 2014-2050. HAL's view of costs relates to the period from 2019 to 2050.

Figure 27: Core capex profiles[63]

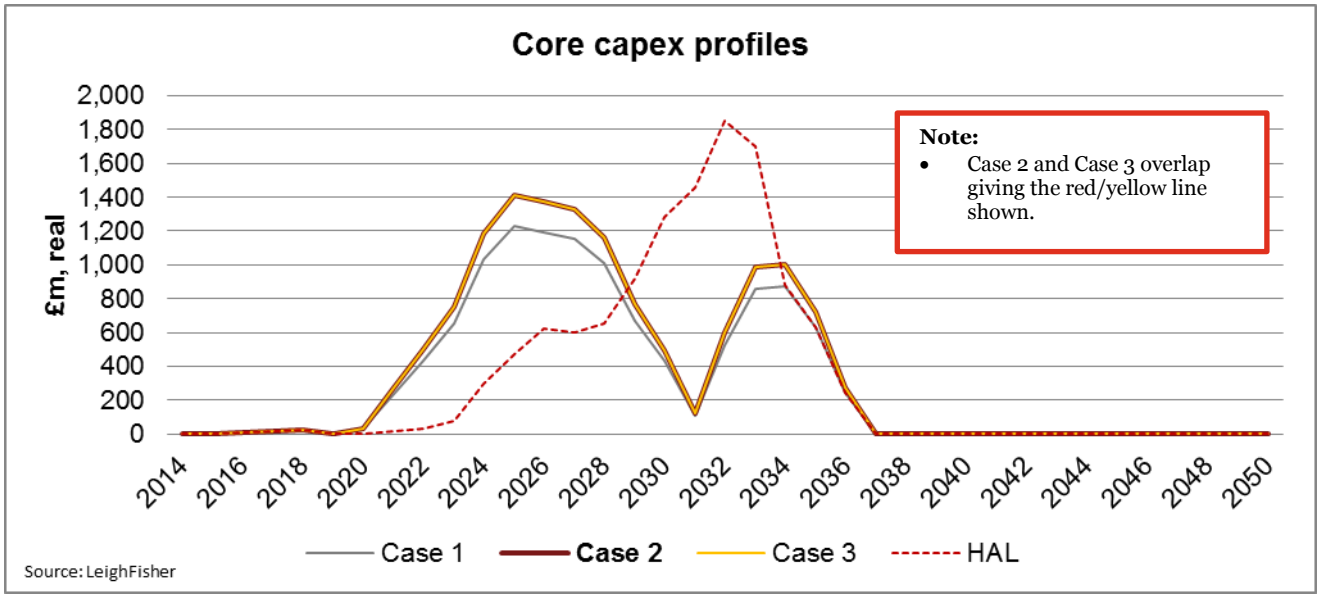


Table 29: Core capex

Source	Cost scenarios	Core capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	11,371	18,602	7,095
	Case 2 (R0, MOB15)	**13,069**	**21,383**	**8,151**
	Case 3 (R0, FOB15)	13,069	21,383	8,151
HAL	Scheme promoter cost	11,801	20,947	6,727

The AoN-CC forecast assumes a faster rate of passenger growth which warrants certain additional terminal space and taxiway works to accommodate growth, as compared to HAL's profile. This is reflected in the figure 27 where the AC's view is that core capex would need to begin sooner, with major works starting in 2021, as compared to HAL's view which shows costs ramping up in 2023. The major components to these works include the expansion of Terminal 5, followed by the expansion of Terminal 2 and the cost of additional T2 satellites.

The difference of £1,268m between the AC's view of core capex, £13,069m, when compared to HAL's view of £11,801m is due to:

- The AC's inclusion of OB in their assessment of cost (+£1,698m); and
- HAL's inclusion of surface access costs for 'Terminal 5 Landside roads' (-£430m).

Asset replacement

Asset replacement costs relate to the investment required to maintain or replace the capital assets of the airport as well as to update infrastructure to maintain the assets as a modern airport. At this point in time it is not known what specific asset replacement will be required, however precedent informs us that these costs will need to be incurred as part of operating an airport.

[63] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

The AC has calculated asset replacement costs for the whole airport, including costs associated with the LHR NWR scheme. Because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has calculated these costs by assuming an expenditure rate per passenger, where passenger 'foot fall' equates to the 'wear and tear' of the assets, which is used to model the overall investment required for asset replacement.

The AC has derived the expenditure rate per passenger from HAL's submitted total asset replacement cost of £9.44bn[64] for the period from 2019 to 2050. A per passenger figure was calculated by dividing this £9.44bn by the total number of passengers in the same period based on the HAL demand profile. This per passenger expenditure rate can then be applied to the different demand scenarios modelled to develop the AC's asset replacement cost profiles. The AC has also applied risk and OB to expenditure rates to create the rates given in Figure 28 and table 30. HAL's view of asset replacement costs is also presented in table 30[65].

Figure 28: Asset replacement profiles

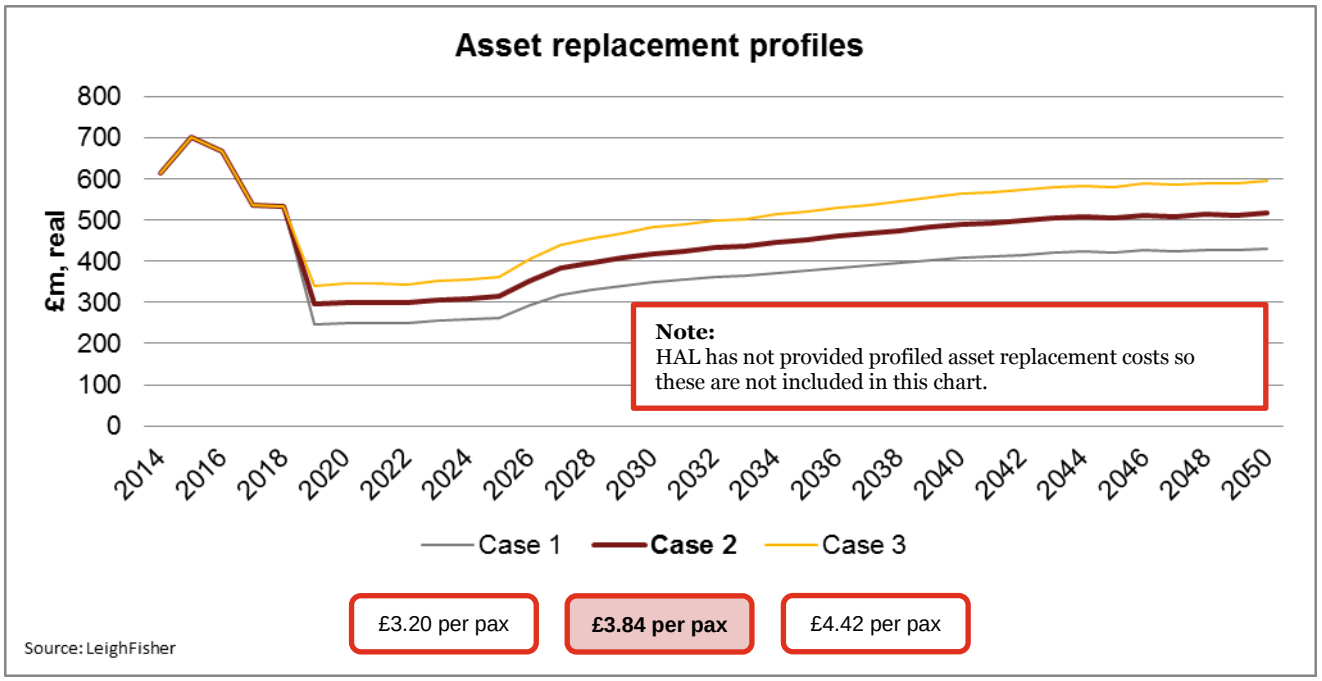


Table 30: Total asset replacement costs

Source	Cost scenarios	Total asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	14,496	28,888	8,487
	Case 2 (R20, MOB20)	**16,784**	**34,013**	**9,611**
	Case 3 (R20, FOB 38)	18,844	38,625	10,623
HAL	Scheme promoter cost	9,440	Not provided	Not provided

[64] The AC has assumed that HAL's submitted £9.44bn asset replacement cost does not include any risk contingency and therefore the cost could be used without any adjustment.

[65] Note that the AC's cost calculations relate to the period from 2014-2050. HAL's view of costs relates to the period from 2019 to 2050.

The AC's view of costs increases in line with the AoN-CC demand profile from 2019 to 2050 (as the expenditure rate per passenger is applied to the demand forecast). Costs from 2014 to 2018, are based on costs extracted from Heathrow's Q6 regulatory settlement, £3,054m[66]. As noted, because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has derived its per passenger cost from HAL's submitted total asset replacement cost of £9.44bn for the period from 2019 to 2050. This generates a significant decrease in the annual asset replacement costs from 2018 to 2019[67].

The difference of £7,344m between the AC's view of asset replacement costs, £16,784m, when compared to HAL's view of £9,440m is due to:

- The time period over which costs are considered (the AC's estimate includes costs incurred in the Q6 period, whereas HAL's costs begin after the Q6 period in 2019) (+£3,053m);
- The AC's inclusion of OB in their assessment of cost (+£2,288m);
- The difference in risk assumptions applied by the AC and HAL; and
- The difference between the AoN-CC forecast used by the AC to build up costs and HAL's demand forecast which it has been assumed was used to build up the HAL cost.

Opex

Opex includes costs such as staff, facilities management and utilities. The AC has calculated opex for the whole airport, including costs associated with the LHR NWR scheme. The AC's calculation of opex was independently derived using the following summarised methodology[68]:

- In the short term (up to 2025), the AC calculated its estimates for each opex category based on HAL's latest annual reports. The AC then adopted elasticities[69] of 40% to passenger numbers for most categories (this is in line with HAL's approach). The AC also assumed increases in relation to terminal size and airfield size to drive stepped increases in cost (also in line with HAL's approach);
- In the long term (2025 onwards), the AC has modelled total opex based on a range of elasticities related to passenger increase, gross floor area increase and airfield increase; and
- An efficiency frontier[70] of -1% was applied until 2035 following which a -0.5% efficiency was applied (the AC's modelling approach assumed that while the additional infrastructure delivered by the scheme would be substantial, the existing facilities within the core airport, parts of which opened in 1986, are extensive and would afford further efficiencies to be made until 2035 and at a lower rate thereafter).

The AC has calculated a range of opex costs for HAL which are presented in figure 29 and table 31. HAL's view of opex is also presented based on its own demand forecast[71].

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[66] The Q6 regulatory settlement total is £3,108m (adjusted to 2014 prices) of which £55m was removed as it has been included in HAL's core capex amount (see 'Core capex' section). Source of Q6 figure: http://www.caa.co.uk/docs/33/CAP1151.pdf

[67] A detailed explanation of the AC's methodology is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway.

[68] A detailed explanation of the AC's methodology is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway.

[69] **'Elasticity'** in this context refers to how costs are affected by demand drivers. Costs are said to be highly elastic when a small change in a demand driver, for instance passenger numbers, results in a large change in cost.

[70] An **'efficiency frontier'** refers to the airport's ability to improve operational performance while at the same time reducing costs, in line with trends among other airport comparators.

[71] Note that since the AC's view of opex was calculated there has been a small adjustment to the AoN-CC passenger forecast applied from 2014 to 2018 inclusive. This does not have a material impact on the cost presented.

Figure 29: Opex profiles

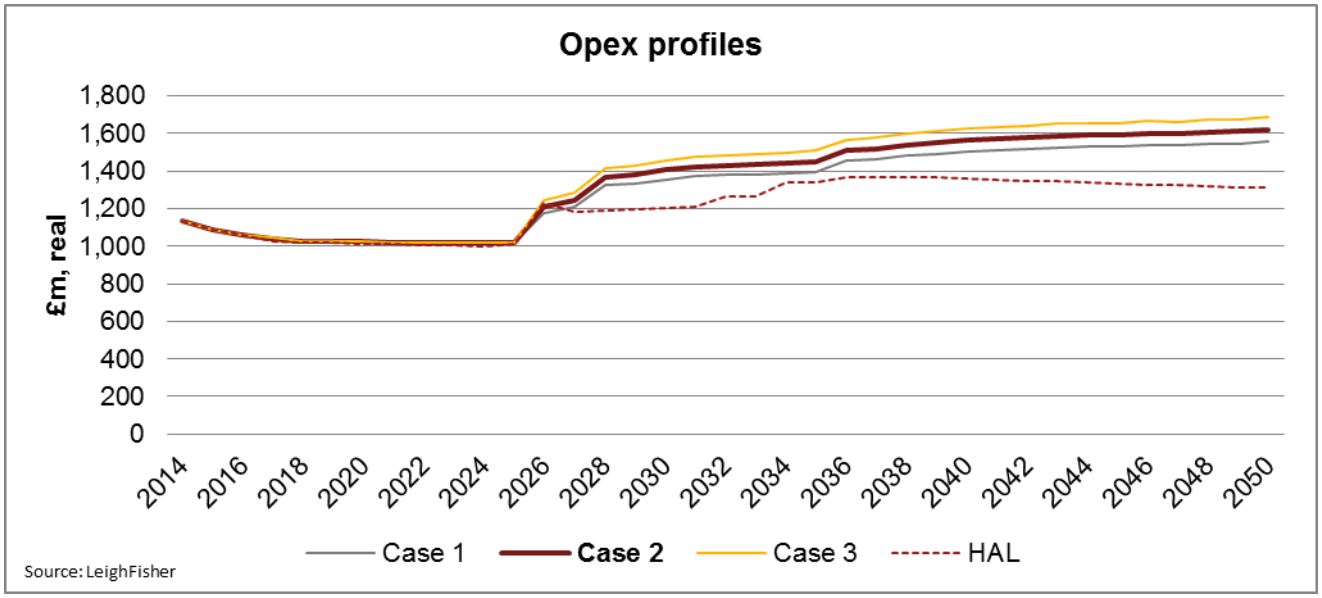


Table 31: Total opex

Source	Cost scenarios	Total opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0.5 per annum)	48,505	90,655	26,476
	Case 2 (R0.5 per annum, MOB20)	**49,884**	**93,596**	**27,081**
	Case 3 (R0.5 per annum, FOB41)	51,332	96,685	27,715
HAL	Scheme promoter cost	44,928[72]	66,922	24,972

The AC's view is that opex would decrease overall from 2014 to 2025 as the AC assumes efficiency gains (or an efficiency frontier) of -1%. The AC then forecasts opex to increase with more pronounced steps than those assumed by HAL, following the opening of the runway in 2025 and the opening of new terminal capacity. This is due to the opening of new infrastructure giving rise to opex in categories such as utilities, cleaning, first line maintenance and certain staff functions[73].

Although some of these cost increases would typically be offset by decreases in costs brought about by efficiency gains in the existing terminals, the step up in fixed costs are in line with the scale of airport expansion that can be expected as a result of the new runway and terminal capacity. HAL forecasts continued improvements in efficiency resulting in annual net decreases in operating costs from 2035 onwards.

The difference of £4,956m between the AC's view of opex, £49,884m, when compared to HAL's view of £44,928m is due to factors that include:

[72] Note that HAL only provided opex from 2019 to the end of the cost review period, based on its own demand forecast. The AC has calculated opex for HAL for 2014 to 2018 based on HAL's assumptions.

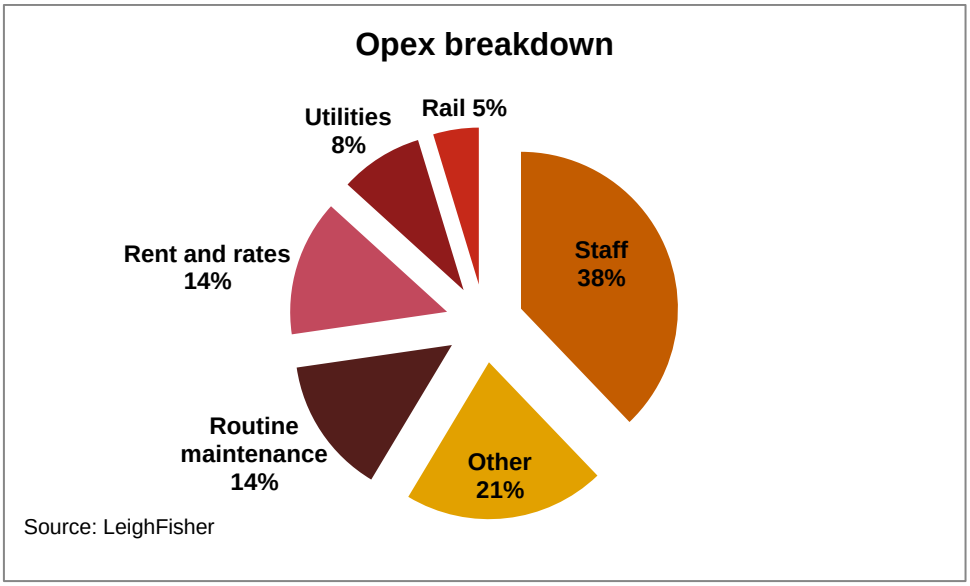
[73] The steps in the AC's opex profile in figure 29 are explained by the following statements.

- The step in 2026 is due to the opening of the 3rd runway and new terminal facilities, coinciding with a significant increase in passenger numbers.
- The next step up occurs in 2028 in line with the next phase of expansion of terminal facilities.
- A further step up in opex occurs in 2036 in line with the final phase of expansion of terminal facilities.

- The AC's inclusion of OB in their assessment of cost (+£1,379m);
- The difference in elasticity assumptions applied[74];
- The difference in cost efficiency assumptions applied[75];
- The difference in demand profiles which were assumed by the AC and HAL; and
- The difference in risk assumptions applied by the AC and HAL.

Figure 30 presents a breakdown of the AC's view of opex by cost category.

Figure 30: Opex breakdown



'Staff' costs form the largest component of opex for HAL as they are relatively elastic to both passenger numbers and floor area increases (elasticities of 40% have been applied). Since the AoN-CC demand forecast predicts a relatively fast rate of passenger growth following the opening of a third runway at Heathrow and new terminal space would increase overall floor areas, increased numbers of airport staff would be required which contributes to increased opex at Heathrow.

Together, 22% of the total opex is made up of 'utilities' and 'rent and rates' which are both considered to be highly sensitive to floor space increases. Respectively, elasticities of 70% and 80% were applied to these costs in relation to floor space causing pronounced increases in opex as new terminal building space is built.

The 'other' costs which make up 21% of total opex include costs for IT & Telecoms, policing, NATS, cleaning, insurance, uniforms and payroll.

'Rail' costs refer solely to the costs associated with operating the Heathrow Express owned by HAL.

'Routine maintenance', which forms 14% of opex includes materials for maintenance activities undertaken in-house by airport employees as well as contract costs for servicing and repair systems such as escalators and air conditioning.

[74] The AC applied elasticities similar to HAL's up until 2025 and independently derived assumptions thereafter. In contrast, HAL applies the same elasticities throughout the cost review period. A detailed explanation of the AC's elasticity assumptions is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Northwest Runway.

[75] The AC assumes flat rate efficiencies (-1% up to 2035 and -0.5% up to 2050) whereas HAL assumes ongoing efficiency gains.

3 Heathrow Airport Extended Northern Runway

3.1 The Heathrow Airport Extended Northern Runway

The Heathrow Airport Extended Northern Runway (LHR ENR) scheme, proposed by Runway Innovations Limited and Heathrow Hub Limited (HHL), is made up of an extension of Heathrow's northern runway to the west, to a combined length of at least 6,500m enabling the northern runway to operate as two in-line runways.

This scheme also considers other major infrastructure construction such as additional works for a new terminal building, satellites and associated airfield ancillary infrastructure which will be required to add capacity to the airport and accommodate the extended runway operations.

The 'Heathrow Hub', the multi-modal and passenger terminal, which was previously part of the LHR ENR scheme will now be reviewed separately, as a detachable element of the scheme and hence is not considered in this report.

While HHL is the scheme promoter for the LHR ENR scheme, it is assumed that the LHR ENR scheme would be implemented by HAL, the current operator of Heathrow Airport. The AC has therefore assumed that all core capex, asset replacement and opex (i.e. costs relating to the underlying operations of Heathrow Airport) calculated for the LHR ENR scheme are derived using the same methodology as the costs calculated for HAL.

3.2 The costs

This section of the report provides an overview of the AC's view of costs based on development of the LHR ENR scheme. The AC has considered a range of different cases/scenarios/sensitivities depending on the levels of risk and OB (cost cases), levels of demand (demand scenarios), and sensitivities around other key variables (for example contribution to surface access costs). For the purposes of illustrating the cost of the LHR ENR scheme this report presents the following version of the costs:

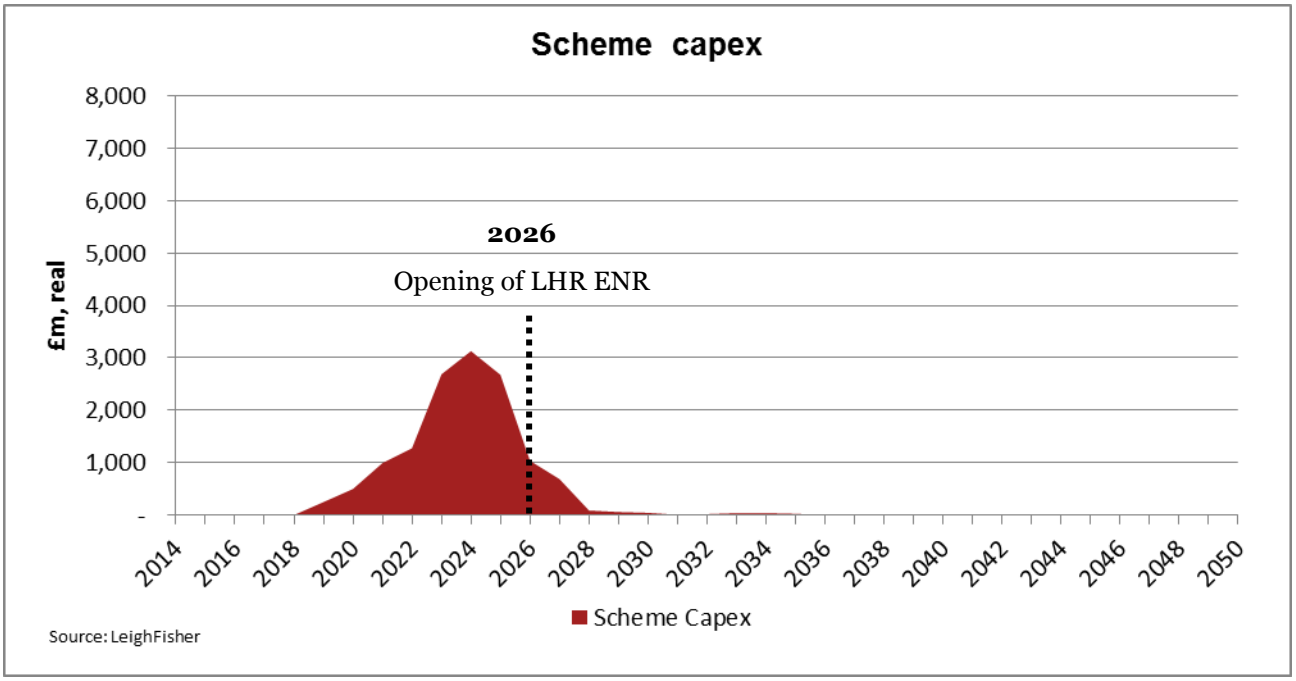
- Cost case: Base Cost + Risk + Mitigated Optimism Bias;
- Demand scenario: Assessment of Need – Carbon Capped; and
- Key sensitivities: None in this document.

For the avoidance of doubt, this version of costs should not be considered as a central case. A more detailed overview of the ranges of costs for different cost cases is provided in section 3.3 of this report. The impact of different demand scenarios and sensitivities modelled is covered in Module 13. Cost and Commercial Viability: Funding and Financing. Information on the detailed costs used in the financial modelling work for all scenarios/sensitivities is provided in Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway.

3.2.1 The LHR ENR scheme capex

The AC's view of the cost of the LHR ENR scheme is **£13,539m** in real terms. This cost relates to the capex required to build out the LHR ENR scheme in its entirety but does not take into account the related surface access costs. The profile of this expenditure is presented in figure 31.

Figure 31: Scheme capex



3.2.2 Surface access costs

The AC has also considered the cost of incremental surface access works to accommodate the heightened traffic at Heathrow Airport following the implementation of the LHR ENR scheme. The AC's view of the total surface access costs is **£6,282m** in real terms. The profile of this expenditure is given in figure 32[76].

There are well established precedents for private sector entities making contributions to transport schemes from which they directly benefit. The level and timing of any contribution to surface access costs would ultimately be made following discussions between the airport and the relevant public sector bodies. The AC has not taken a view on what this level of contribution would be but has considered a range of possible outcomes in its sensitivity analysis. This has involved looking at a 0% and 100% contribution to surface access costs by HAL[77]. The impact of this sensitivity is covered in Module 13. Cost and Commercial Viability: Funding and Financing.

[76] These costs primarily relate to the capex required to deliver the surface access works but a percentage of this total relates to asset replacement (3%) and opex (13%) over the cost review period. The asset replacement and opex are small relative to the capex so do not show up clearly in figure 32.

[77] Note that it is assumed that the LHR ENR scheme would be implemented by HAL, the current operator of Heathrow Airport, so any contribution to surface access would be payable by HAL.

Figure 32: Surface access costs

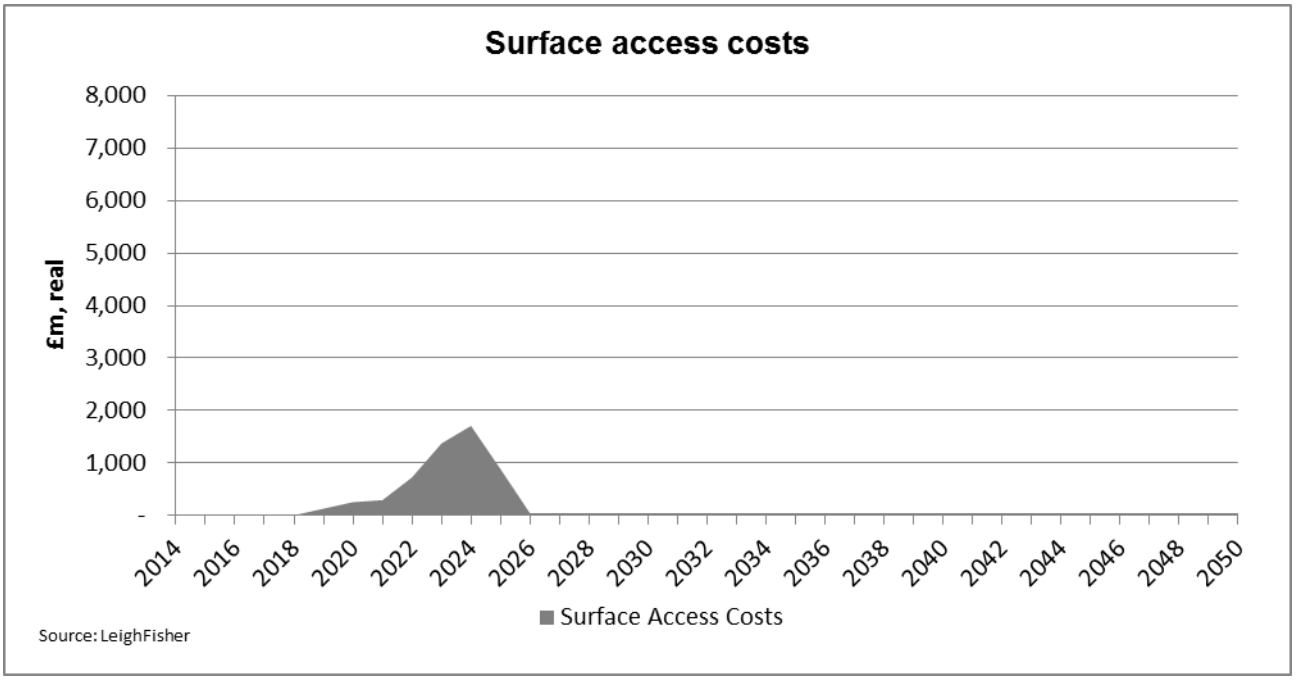


Table 32 presents the AC's view of the overall cost of the LHR ENR scheme including the associated surface access costs.

Table 32: Scheme and surface access costs

Cost item	Cost (£m, real)	%
Scheme capex (R20, MOB20)	13,539	68.3%
Surface access costs (R0, MOB44 – roads, MOB66 – rail)	6,282	31.7%
Total	**19,821**	**100.0%**

3.2.3 Other airport costs

A key part of the evaluation carried out by the AC is to assess the level of increase of aeronautical charges required to develop the scheme. The AC has looked to do this by developing a financial model that considers the entirety of Heathrow Airport[78]. To undertake this analysis, the AC has needed to calculate the total costs that would be incurred by HAL during the cost review period. In addition to the LHR ENR scheme capex and surface access costs, these costs include the 'other airport costs' incurred by HAL. These are costs associated with the running and development of the airport and include:

- Core capex – expenditure that could be expected to take place regardless of whether new runway capacity is developed at the airport (these costs are separate and distinct from the scheme capex);
- Asset replacement – for the whole airport including the proposed scheme; and
- Opex – also for the whole airport including the proposed scheme.

[78] As noted before, it is assumed that HAL, the current operator of Heathrow Airport would implement the LHR ENR scheme if selected. Therefore it is necessary to consider the cost of the LHR ENR scheme as part of the airport.

The AC's view of the total 'other airport costs' is **£79,234m** in real terms for the cost review period. The profile for this expenditure is given in figure 33 and table 34.

Figure 33: Other airport costs

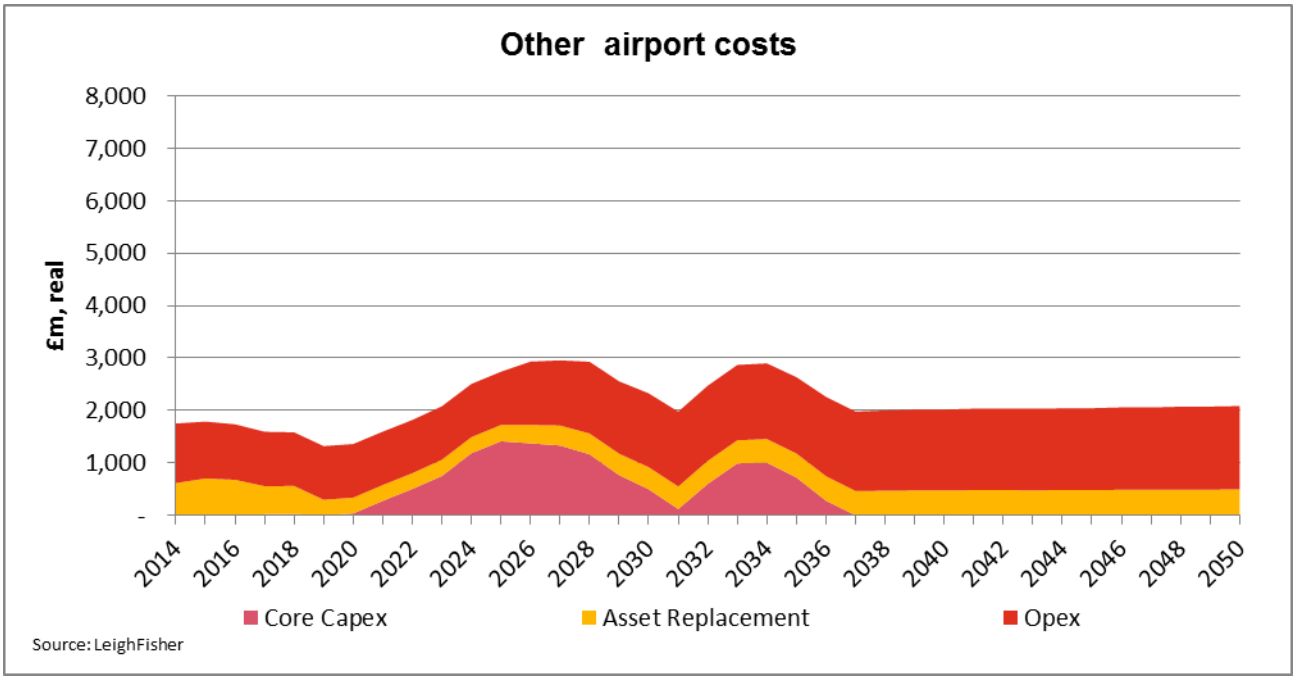


Table 33: Other airport costs

Cost item	Cost (£m, real)	%
Core capex (R0, MOB15)	13,069	16.5%
Asset replacement (R20, MOB20)	16,535	20.9%
Opex (R0.5 per annum, MOB20)	49,631	62.6%
Total	**79,234**	**100.0%**

3.2.4 Financial modelling costs

As noted, in order to assess the level of aeronautical charges, the AC has developed a financial model for the airport as a whole[79], combining the costs identified in sections 3.2.1, 3.2.2 (under certain model sensitivities) and 3.2.3 of this report. The combined impact of these costs over the cost review period is given in figures 34 (no contribution to surface access costs) and figure 35 (full contribution to surface access costs).

[79] As noted before, it is assumed that HAL, the current operator of Heathrow Airport would implement the LHR ENR scheme if selected. Therefore it is necessary to consider the cost of the LHR ENR scheme as part of Heathrow airport to assess the aeronautical charges.

Figure 34: Financial modelling costs with 'no contribution' to surface access costs

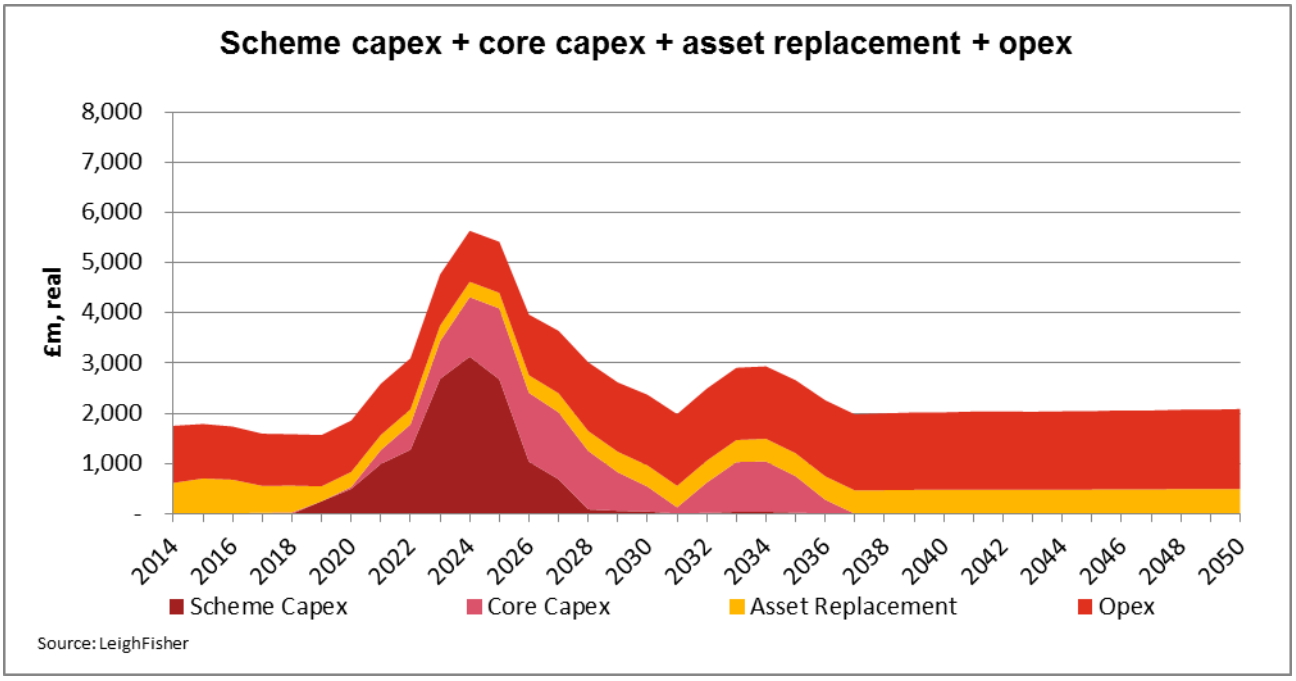
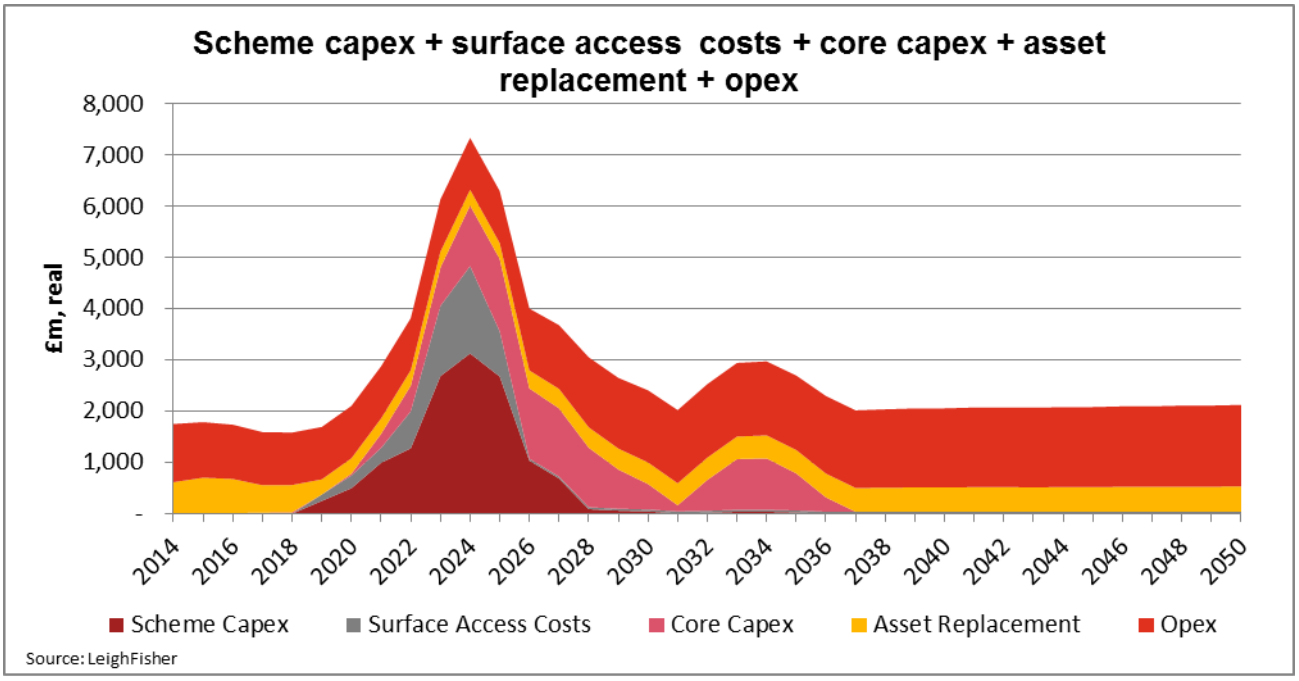


Figure 35: Financial modelling costs with 'full contribution' to surface access costs



3.2.5 Regulated Asset Base

The CAA uses the Regulated Asset base (RAB) as a key factor in determining the average aeronautical charges which can be charged by a regulated airport on a per passenger basis. HAL is currently subject to regulation by the CAA and as such it is important to understand the impact of the proposed LHR ENR costs and their timing

on HAL's RAB balance[80]. For more information on the RAB and its implication on aeronautical charges, please see 13. Cost and Commercial Viability: Literature Review.

The RAB is calculated each year by taking the opening RAB, adding forecast capex, and deducting regulatory forecast depreciation. The RAB takes into account both scheme and core capex and the associated asset replacement costs. The AC has assumed straight line depreciation for all of the capital assets listed in table 35 below and applied a blended asset life for all asset replacement costs.

Table 34: Asset life assumptions

Asset	Depreciation assumption (Years)[81]
Terminal buildings	40
Plant	20
Transit systems	50
Runways	100 (base)
Taxiways and aprons	50
Equipment	20
Environment	0
Asset replacement	30
Airfield Ancillary	40
Tunnels and bridges	50
Car parks	40
Third party land user costs	30
Items currently on the RAB (as of 1 January 2014)	15
Risk[82]	31
Mitigated OB[82]	31

[80] As noted before, it is assumed that HAL, the current operator of Heathrow Airport would implement the LHR ENR scheme if selected.

[81] The depreciation assumptions on these cost items, with the exception of environment, third party land user costs, items currently on the RAB, risk and mitigated OB were extracted from HAL's most recent annual report.

[82] The depreciation assumption for risk and mitigated OB were estimated by taking the weighted average of the cost items listed in table 35. Depreciation needs to be applied to risk and OB as these costs, when added to the base costs reflect the AC's view of the actual costs incurred by the airport and which would therefore be added to the RAB. Risk and OB costs have been modelled as separate line items from the base costs and therefore require the application of a blended depreciation assumption.

Figure 36 and table 36 illustrate the development of the RAB balance over the cost review period. Note that the average RAB balance is the average of the opening and closing balances over an annual period.

Figure 36: Cost additions and changes to the RAB

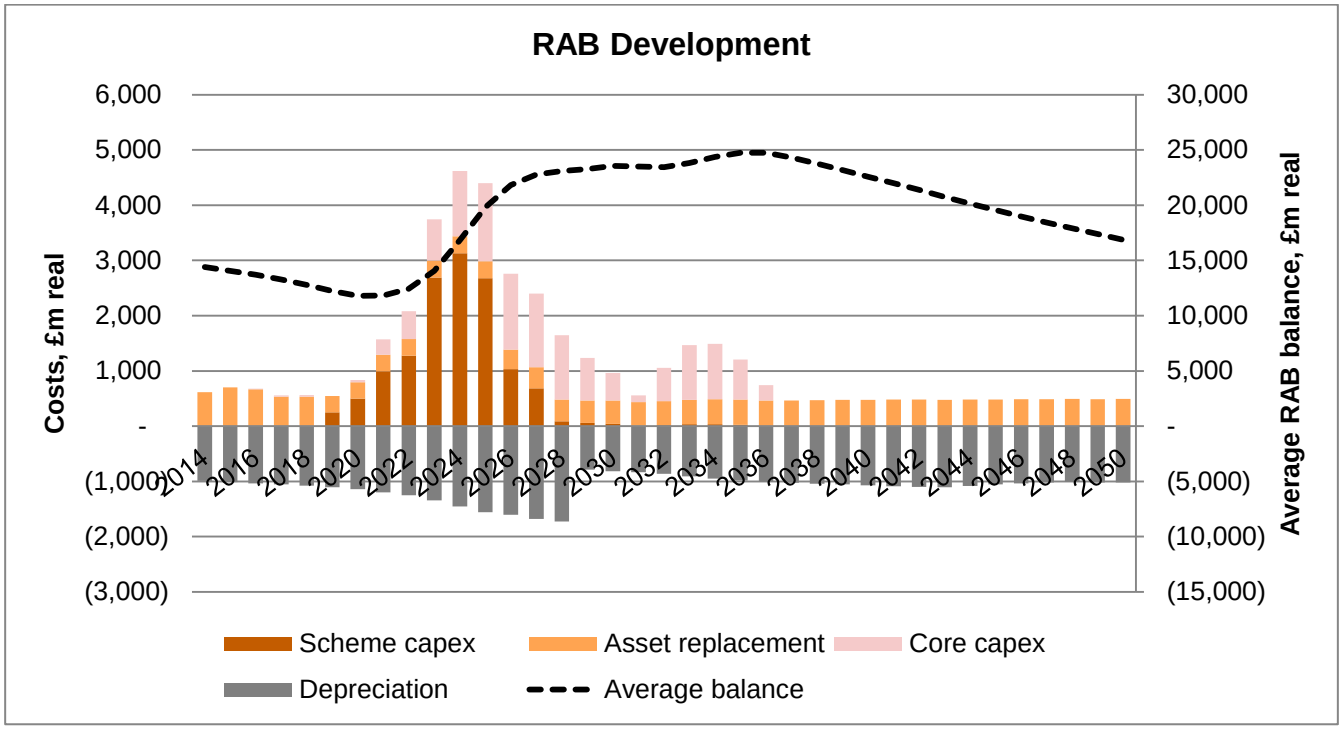


Table 35: RAB changes and peak information

	RAB information (£m, real)	RAB information (£m, nominal)
Opening RAB as of 2014	14,585	14,585
Indexation effect	n/a	49,066
Additions	43,143	73,682
Depreciation	(41,124)	(80,047)
Closing RAB as of 2050	16,603	57,286
Average RAB balance peak	24,758	58,193
Year average RAB balance peaks	2035	2050

The costs presented above the x axis in figure 36 represent additions to the RAB over the cost review period while the costs below the x axis represent depreciation which reduces the RAB value. The net impact of these additions and reductions each year causes the average RAB balance to increase (where the net impact is positive) or decrease (where the net impact is negative) and this net impact is illustrated by the dashed black line in figure 36.

Figure 36 shows that the RAB balance increases significantly from 2024 to 2030 as the LHR ENR scheme is built out, reaching an initial peak of £23.6bn in 2030. This is due to high capital expenditure on major terminal and LHR ENR works in the period. The RAB balance subsequently peaks again at £24.8bn in 2035 following

the final phases of core capex development which include car park works and satellite development. The RAB balance then starts to decrease due to the net impact of depreciation of the capital assets and lower annual capital expenditure. Table 36 summarises the opening and closing RAB balances for the cost review period.

3.3 Developing the costs

Section 3.2 presents the AC's view of the scheme capex, surface access costs and 'other airport costs' (core capex, asset replacement and opex) for the LHR ENR scheme, however the AC recognises that there are a range of possible outcomes for these costs. This section provides an overview of this range of costs and summarises the methodologies and assumptions used in deriving these costs.

Cost case

In developing the costs, the AC has considered various risk and optimism bias assumptions to account for the tendency for actual project costs to be higher than those forecast[83]. To generate a range of potential costs, the following cost cases have been considered:

- Case 1: Base Cost +Risk (low end of the range);
- **Case 2: Base Cost + Risk + Mitigated Optimism Bias (the AC's view of costs)**; and
- Case 3: Base Cost + Risk + Full Optimism Bias (high end of the range).

Case 2 represents the AC's view of costs and has been used as an input to the Module 13. Cost and Commercial Viability: Funding and Financing report to evaluate the funding and financing implications of the scheme.

Demand scenario

It should be noted that all the costs calculated by the AC in section 3.3 are based on the AoN-CC demand profile unless stated otherwise. Alternative demand scenarios and sensitivities are considered in the separately published Module 13. Cost and Commercial Viability: Funding and Financing report.

This section also presents the costs as submitted by the scheme promoter, HHL, based on its own demand forecast.

Structure

Table 37 summarises the content presented in section 3.3.

Table 36: Content of section 3.3

Section	Content
3.3.1 – 3.3.3	• Details on the methodology and assumptions employed in generating the costs. • Presentation of the range of costs calculated by the AC. • Presentation of HHL's view on costs. • Commentary on the difference between the AC's and HHL's view of costs.

3.3.1 Scheme capex

The scheme capex relates to the cost required to build out the LHR ENR scheme in its entirety but does not take into account the related surface access costs. Scheme capex does not include the costs of operating or maintaining the new runway or associated new terminal facilities and equipment.

In deriving the scheme capex for the LHR ENR scheme, the AC has independently developed a phased construction plan and calculated base costs for each phase of the development. Risk and OB assumptions have then been applied to the base costs (see table 38).

[83] Please refer to the Introduction and methodology of this report for further details on risk and OB and the assumptions used.

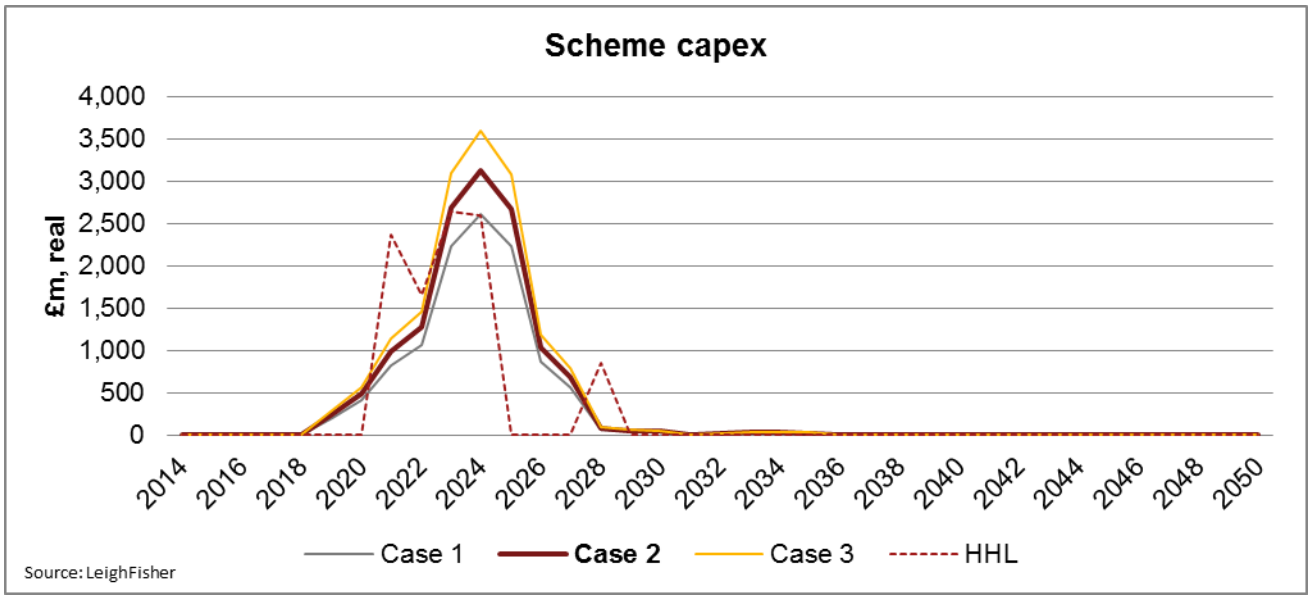
Table 37: Scheme phases and costs

Phase	Opening Year	Works	Scheme Capex, (£m, real)	%
1	2026	Enabling works, runway, taxiways and stands, various airfield ancillary facilities (e.g. Air Traffic Control tower, fire station), airside access roads.	4,965	36.7%
2	2026	Additional aircraft stands, Terminal 6 and satellite substructures, superstructures and fit-out, baggage tunnels and Tracked Transit System (TTS) tunnels, car parks	5,645	41.7%
3	2028	Additional aircraft stands, T2E satellite, baggage tunnels and TTS tunnels, car parks	2,515	18.6%
4	2031	Car parks	290	2.1%
5	2036	Car parks	124	0.9%
Total (R20, MOB20)			**13,539**	**100.0%**

The AC's view is that the runway extension would be built between 2019 and 2025 as part of the phase 1 works to be operational in 2026[84]. This would be followed by the development of the Western and Eastern Campus facilities which consist of changes to terminals 1, 2, 3 and 5, a new terminal 6 and satellite additions.

The AC has calculated a range of costs for the LHR ENR (see figure 37 and table 39). HHL's view of scheme costs is also presented[85].

Figure 37: Scheme capex profiles



[84] It is recognised in the delivery paper that construction is scheduled to commence around 2020 (for further details refer to Module 16: Delivery – Risk Assessment and Mitigation).

[85] Note that the AC's cost calculations relate to the period from 2014-2050. HHL's view of costs relates to the period from 2018 to 2041 and is based on its own demand profile.

Table 38: Total scheme capex

Source	Cost scenarios	LHR ENR scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	11,283	15,854	8,071
	Case 2 (R20, MOB20)	**13,539**	**19,025**	**9,686**
	Case 3 (R20, FOB38)	15,570	21,878	11,138
HHL	Scheme Promoter cost	10,121	13,845	7,430

The AC's view is that the various phases of the scheme development (described in table 39) need to be largely concurrent to meet the forecast growth in passenger demand. This is reflected in the AC's scheme capex profiles presented in figure 37 where the majority of costs are incurred between 2018 and 2028.

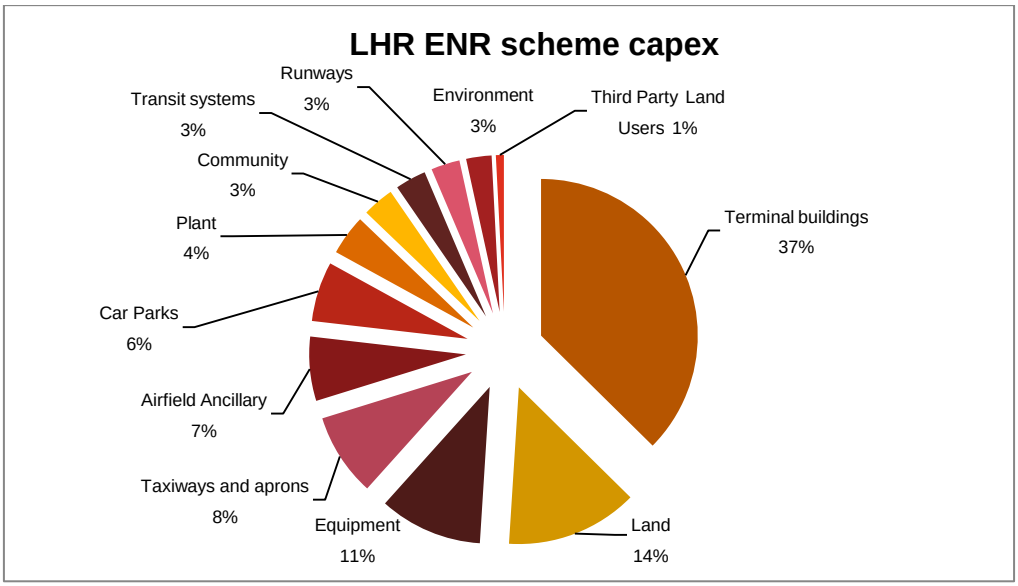
HHL's forecast assumes that land acquisition and site preparation works take place in 2021 and construction of the new terminal and runway commences in 2022 with the majority of the work taking place in 2023 and 2024. HHL's forecast also assumes a second satellite building is constructed in 2028.

The difference of £3,418m between the AC's view of scheme costs, £13,539m, when compared to HHL's view of £10,121m is due to factors that include:

- The AC's inclusion of OB in their view of costs (+£2,256m);
- The difference in risk assumptions applied by the AC and HHL; and
- Small differences in a large number of assumptions that were used to calculate scheme capex[86].

Figure 38 presents a breakdown of the AC's view of scheme capex by cost category.

Figure 38: Scheme capex breakdown



[86] For instance, the AC has assumed that more car park space will be required relative to HHL's assumptions; therefore the AC's forecast of capex for car parks is higher than that estimated by HHL. These assumptions and the approach are documented in Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway report.

The costs for terminal buildings form the largest component of the AC's estimate of scheme capex. The AC's view is that terminal building works will cost £3,515m (base cost) and would be incurred between years 2022 to 2027. Land costs (£1,280m) are considered to be incurred concurrently with runway and taxiway works, from 2019 to 2025.

3.3.2 Surface access costs

The AC has also considered the cost of incremental surface access works to accommodate the heightened traffic at Heathrow Airport following the implementation of the LHR ENR scheme. The surface access costs relate to the building and operating of transport links (e.g. railway and road links) and include the links which would be built only if the LHR ENR scheme is selected: Committed plans around Heathrow Airport such as the Crossrail scheme and the Old Oak Common Interchange with HS2 works are not considered in the AC's forecast of surface access costs. For further details on the schemes considered within the surface access baseline, refer to the AC's Discussion Paper 10: Surface Access: Process Overview.

The AC has calculated a range of costs, considering various risk and OB assumptions for the surface access works but it should be noted that unlike some cost categories, it is not considered appropriate to use a mitigated OB level that is less than the full OB level given the early stage of development of the surface access plans. As a result, the mitigated OB costs the AC is considering in the financial modelling work for surface access are the same as the full OB costs (i.e. Case 2 is equal to Case 3, at 44% OB for roads and 66% OB for rail).

As discussed in section 3.2.2, while a level of contribution to surface access costs would be expected, the AC has not taken a view on what this may be but has considered the range of possible outcomes from a 0% to 100% contribution by HAL[87].

Surface access capex

The AC has considered the incremental highway, local road and rail costs in evaluating surface access capex. Table 40 presents the AC's view of the works required and the associated capex.

Table 39: Surface access capex breakdown

Route/ Rail project	Type	Proposed works	Road/Highway length (km)	Capex, real (£m)	%
M4 J3 to J4	Highway	Hard shoulder running in both directions + additional road widening	3.8	274	5.2%
M4 Airport Spur	Highway	Road widening in both directions	2.8	202	3.8%
M4 J2 to J3	Highway	Road widening in both directions	17.6	1,267	23.9%
M4 J4 and J4B	Highway	Additional road widening in both directions	4.7	338	6.4%
M4	Highway	Large M4 junction, J4b replacement	n/a	216	4.1%
M4	Highway	Implementation of higher capacity at the M4 junction, J4a	n/a	58	1.1%
M4	Highway	Capacity improvements to existing main airport tunnel	n/a	58	1.1%
M25	Highway	M25 tunnelling costs (south of junction 15)	4.0	864	16.3%
Tunnel from A4 to T5	Local Road	Tunnel from A4 to T5	2.1	60	1.1%

[87] Note that it is assumed that the LHR ENR scheme would be implemented by HAL, the current operator of Heathrow Airport, so any contribution to surface access would be payable by HAL.

Route/ Rail project	Type	Proposed works	Road/Highway length (km)	Capex, real (£m)	%
Western Tunnel	Local Road	Tunnel running parallel to M25 - expected to have light traffic	3.0	86	1.6%
Southern Road Tunnel	On-Airport Road[88]	Southern Road Tunnel from the Central Terminal Area (CTA) to the Southern Perimeter Road	5.2	749	14.1%
Airport Way/Southern Perimeter Road Interchange	Local Road	Grade separated junction and flyover/bridge structures	1.0	50	0.9%
Southern Road Tunnel/Southern Perimeter Road Interchange	Local Road	Southern Road Tunnel/Southern Perimeter Road Interchange	1.0	29	0.5%
M25 J13 (A13) D2	Local Road	New D2 link from junction 13	3.9	140	2.6%
M25 J13 (A13)	Local Road	Providing new spur access	n/a	50	0.9%
A4 Access	Local Road	Single lane widening	2.7	58	1.1%
Southern Rail Access (SRA) to Staines	Rail	New Southern Access	n/a	809	15.2%
Total			**n/a**	**5,309**	**100%**
Total for Highways			*32.9*	*3,276*	*61.7%*
Total for Local Roads			*18.9*	*1,224*	*23.1%*
Total for Rail schemes			*n/a*	*809*	*15.2%*
Total (R0, MOB44 - roads, MOB66 - rail)			***n/a***	***5,309***	***100%***

The AC has calculated a range of capex for the surface access works for the LHR ENR scheme and these are presented in figure 39 and table 41. HHL's view of surface access costs is also presented[89]. Note this does not include their preferred surface access proposal which is being reviewed separately.

[88] Treated as a local road for the purpose of opex and asset replacement calculation.

[89] Note that the AC's cost calculations relate to the period from 2014-2050. HHL's view of costs relates to the period from 2018 to 2041.

Figure 39: Surface access capex profiles[90]

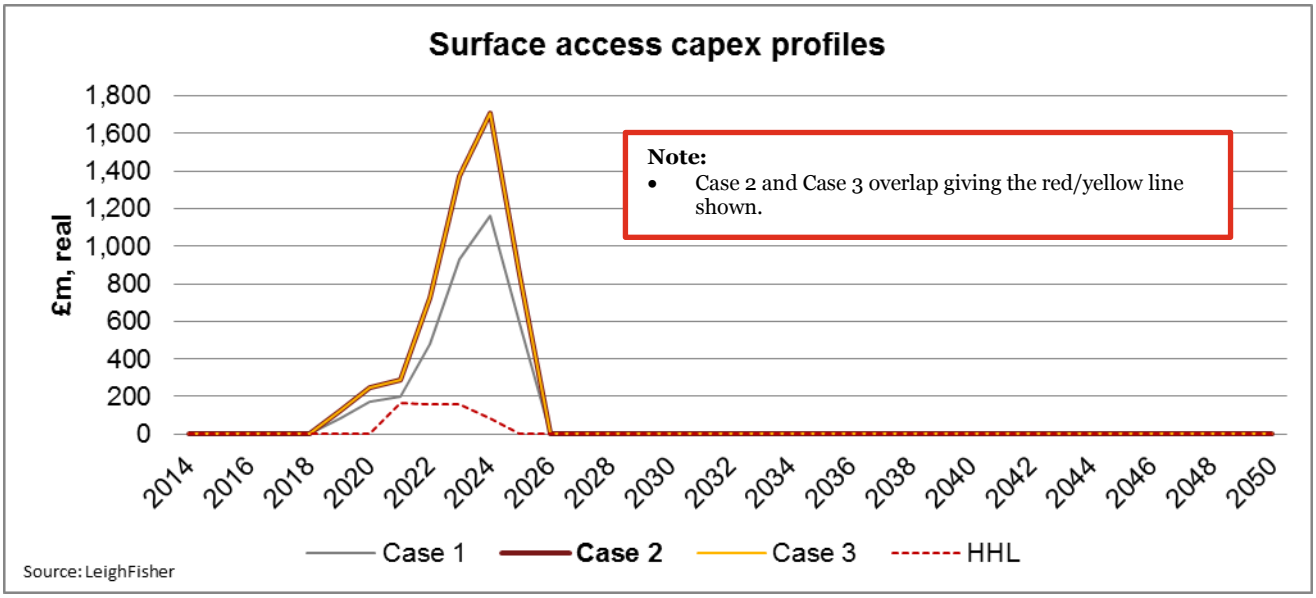


Table 40: Total surface access capex

Source	Case	Total surface access capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	3,613	4,957	2,639
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**5,309**	**7,285**	**3,879**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	5,309	7,285	3,879
HHL[91]	Scheme promoter cost	566	754	426

As seen in figure 39, the initial surface access works would need to commence by 2019 at the latest. These are works for a Southern Road Tunnel, which would connect the CTA to the Southern Perimeter Road and cost £749m to construct. The AC has assumed that the M25 tunnelling costs would need to begin in 2022 and be completed in 2024 for the opening of the runway in 2026. The large M4 schemes are phased over 3 years and would be scheduled to commence in 2023. The other highway and local road schemes would commence in 2024 and are phased over 2 years.

The AC has derived rail capex by adopting an estimate of £809m for the Southern Rail Access to Staines scheme. This figure is phased over 3 years and is scheduled to be completed in advance of the start of operation for the LHR ENR scheme in 2026.

The difference of £4,743m between the AC's view of surface access capex, £5,309m, when compared to HHL's view of £566m, is due to factors that include:

[90] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

[91] The AC's costs are based on a revised master plan which does not include the HUB and surface access arrangements have been determined accordingly. HHL's costs assume that the Hub itself is built and include surface access works for Southern Rail Access, M25 tunnelling, upgrades to M25 J13 and a new southern link road, local road modifications to the northwest of the airfield, and the decommissioning of M25 J14.

- The AC's inclusion of OB in their assessment of cost (+£1,696m);
- The AC's consideration of more / different surface access schemes; and
- The difference in approach to calculating costs[92].

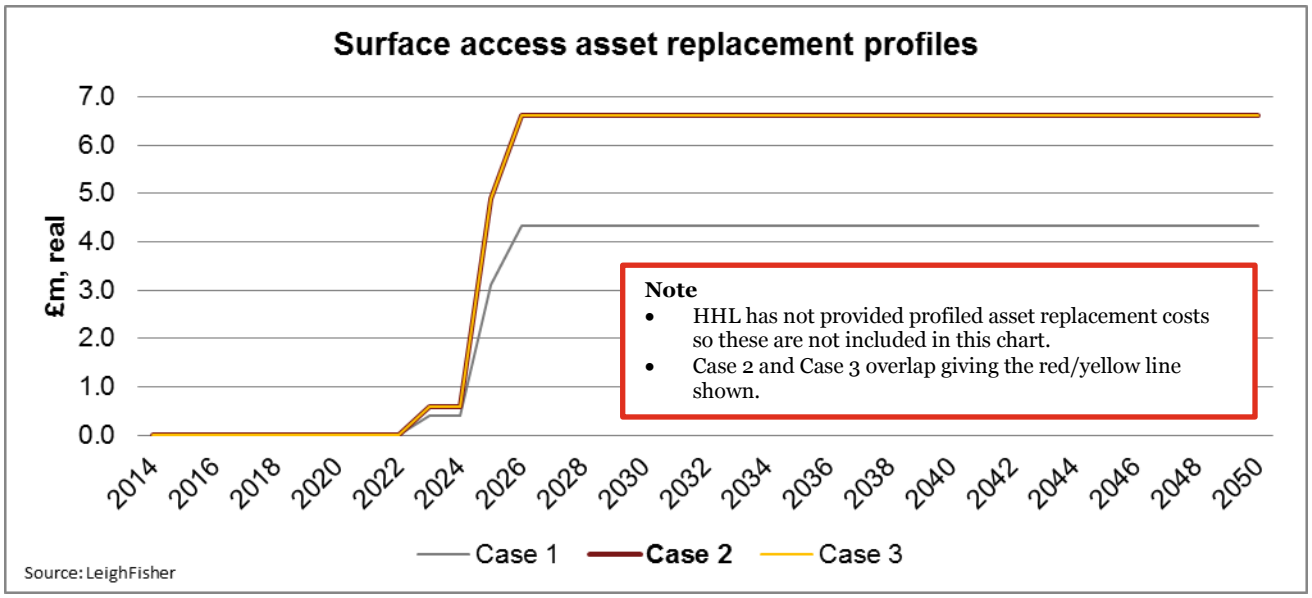
Surface access asset replacement

The AC has calculated road asset replacement costs using Highways Agency (HA) published data[93]. The HA figure of £46k per lane mile has been used for highways, while the South East cost of £56k per lane mile was used for local roads. The AC has based its calculations on 32.9km of highway and 18.9km of local roads requiring maintenance (see table 40). For further details of this analysis, refer to Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Runway.

The AC has calculated the rail portion of the asset replacement costs by assuming an infrastructure fee, payable by the train operator to Network Rail for track maintenance and renewals. This fee has been derived from industry data[94] on per route mile charges paid to Network Rail by existing franchise operators and amounts to £1.75m per annum for the SRA rail scheme.

The AC has calculated a range of costs for the surface access asset replacement works required for the LHR ENR scheme and these are presented in figure 40 and table 42.

Figure 40: Surface access asset replacement profiles[95]



[92] The AC's approach includes costs for the entirety of the works required to complete the surface access schemes, whereas HHL's costs appear to include only the level of contribution it has assumed HAL (as the operator of the scheme) would make to the surface access schemes and not the full cost of the schemes.

[93] https://www.gov.uk/government/publications/cost-of-maintaining-the-highways-agency-s-motorway-and-a-road-network-per-lane-mile

[94] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275128/webtag-tag-unit-a1-2-scheme-costs.pdf

[95] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

Table 41: Total surface access asset replacement costs

Source	Case	Total surface access asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	112	260	52
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**171**	**398**	**79**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	171	398	79
HHL	Scheme promoter estimate	Not provided	Not provided	Not provided

Road asset replacement costs are assumed to be annual costs which commence once the planned road schemes are completed. The AC assumes that roads will be built in three phases where the end of each phase corresponds to an increase in asset replacement costs. The first phase of road schemes incurs an annual cost of £0.58m between 2023 to 2024. Following the completion of the second phase of road schemes in 2025, the annual asset replacement cost then increases to £1.97m. The annual expenditure then increases following the build out of the third phase and remains at £3.7m for the life of the roads.

Road asset replacement costs have been calculated on the basis of the latest available HA data, which includes: "*all renewal of roads and structures expenditure; proportion of the managing agent contractor's routine and winter maintenance expenditure; a proportion of the PFI/DBFO service payments calculated from contract data; and all technology maintenance and renewals expenditure*".

The annual rail asset replacement costs of £2.91m begins in 2025 following the build out of the rail scheme.

It is not possible at this stage of the analysis to determine when various maintenance activities would need to take place so it has been assumed that an annual contribution of £6.6m is put towards "a fund" for both road and rail asset replacement costs, reflecting the combined asset replacement costs of £3.7m and £2.91m for roads and rail respectively. See Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway for further detail on the approach taken in calculating these costs.

Surface access opex

Road opex include activities such as lighting, drainage and landscaping. The AC has calculated annual road opex using the DfT Cost and Benefit Analysis guidance (2006) [96]. Following a similar approach to the surface access asset replacement costs, the DfT figure of £45k per lane km was used for highways, while the South East cost of £30k per lane km was used for local roads. The AC has again based its calculations on 32.9km of highway and 18.9km of local roads.

The AC has calculated opex for the SRA scheme based on an assumption of an additional 4 trains per hour between Heathrow and Waterloo. The total rail opex also reflects an increased Crossrail service of an additional 2 trains per hour. Note that while Crossrail has not been considered as a part of capex since it is a committed scheme that would be built out regardless of a 3rd Heathrow runway being developed; the increased service that would be required as a result of an airport expansion has been reflected in the opex.

The AC has calculated a range of costs for the surface access opex required for the LHR ENR scheme and these are presented in figure 41 and table 43.

[96] http://www.dft.gov.uk/ha/standards/ghost/dmrb/vol13/index.htm

Figure 41: Surface access opex profiles[97]

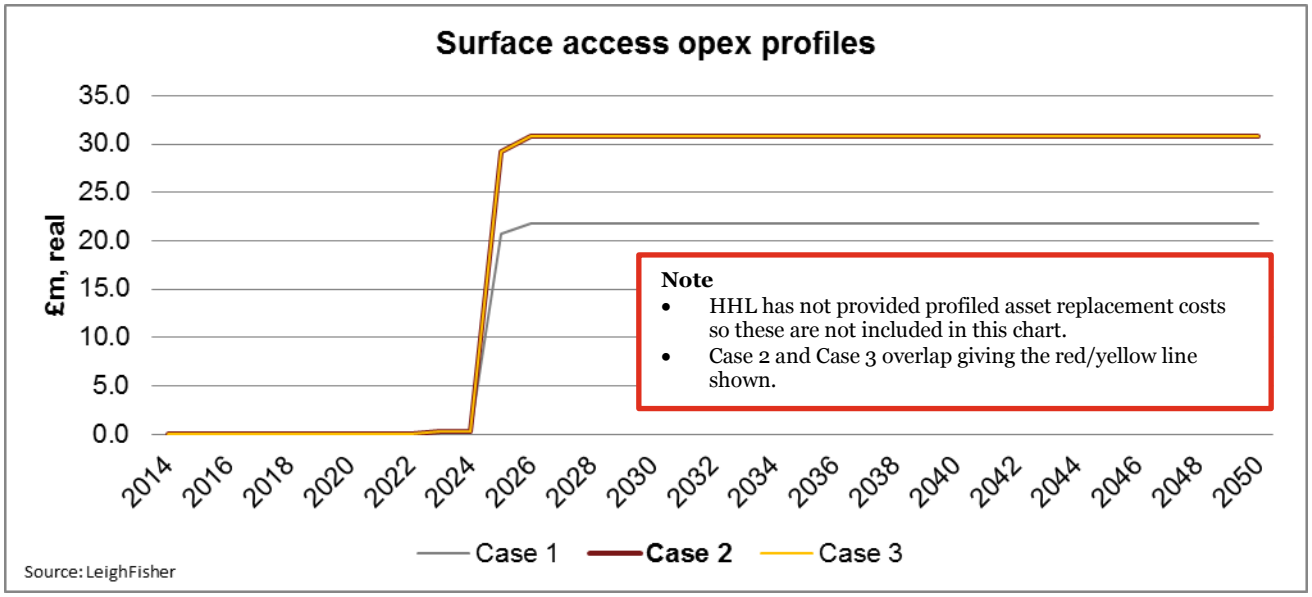


Table 42: Total surface access opex

Source	Case	Total surface access opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	567	1,165	262
	Case 2 (R0, MOB44 - roads, MOB66 - rail)	**801**	**1,646**	**370**
	Case 3 (R0, FOB44 - roads, FOB66 - rail)	801	1,646	370
HHL	Scheme promoter estimate	Not provided	Not provided	Not provided

Road opex for a particular scheme is assumed to commence the year after the scheme has been completely built out. Road opex costs start in 2023 as road schemes become operational at a total contribution of £0.31m per annum, ramping up to £1.26m per annum in 2025 to reach the full road opex amount of £2.95m per annum from 2026.

Similarly, opex for rail schemes commences post the full build out of the schemes and in the case of Crossrail, when the additional services start. Rail opex costs start in 2025 and remain constant throughout the cost period at £27.92m per annum.

In total, the full annual spend for opex is £30.87m from 2026, including road and rail schemes[98,99].

[97] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

[98] In real terms, it is assumed that opex remains constant for the life of the road and rail schemes. There is no publically available information on operating cost trends; therefore it is assumed costs would increase in line with inflation (see inflated costs in the 'nominal' column of table 43).

[99] The costs for Heathrow Express services are considered as part of the airport's operating expenses in section 3.3.3 given that it is owned by HAL.

3.3.3 Other airport costs

As described in section 3.2.3, this section presents the different views of 'other airport costs' that would be incurred by HAL (in addition to scheme capex and surface access costs) and provides an overview of the AC's assumptions and methodologies applied in deriving these costs.

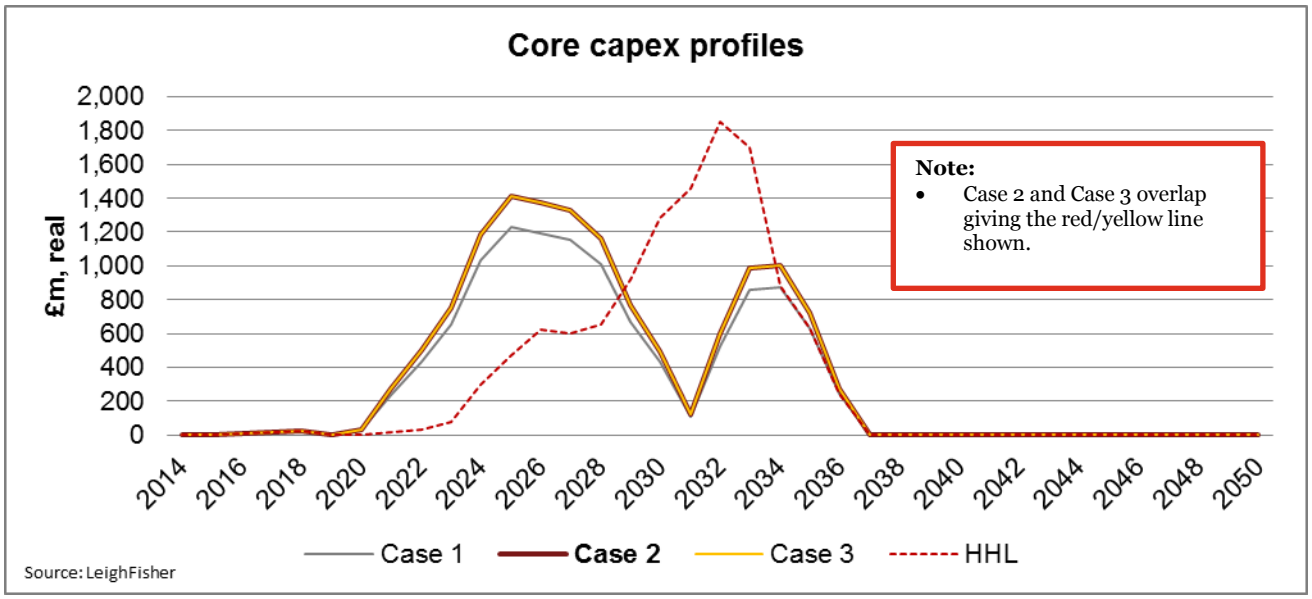
Core capex

Core capex relates to expenditure that could be expected to take place regardless of whether new runway capacity is developed at Heathrow. These costs are separate and distinct from the scheme capex.

The AC has derived the core capex profiles for HHL presented in figure 42 by adopting HAL's submitted total core capex cost of £11,801m[100]. The AC has decided to make no changes to HAL's submitted core capex of £11,801m in deriving the AC's view, apart from the removal of 'Terminal 5 Landside roads' costs, £430m (which is considered a committed surface access cost), and adjusting the phasing of costs according to the AoN-CC demand profile.

The AC has produced a range of costs for HHL based on HAL's submitted core capex (see figure 42 and table 44). HHL's view of core capex is also presented[101].

Figure 42: Core capex profiles[102]



[100] While HHL is the scheme promoter for the LHR ENR scheme, it is assumed that the LHR ENR scheme would be implemented by HAL, the current operator of Heathrow Airport. The AC has therefore assumed that all core capex, calculated for the LHR ENR scheme are derived using the same methodology as the costs calculated for HAL.

[101] Note that the AC's cost calculations relate to the period from 2014-2050. HHL's view of costs relates to the period from 2018 to 2041 and is based on HAL's assessment of core capex.

[102] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

Table 43: Core capex

Source	Cost scenarios	Core capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	11,371	18,602	7,095
	Case 2 (R0, MOB15)	**13,069**	**21,383**	**8,151**
	Case 3 (R0, FOB15)	13,069	21,383	8,151
HAL (used by HHL)	Scheme promoter cost	11,801	20,947	6,727

The AoN-CC forecast assumes a faster rate of passenger growth which warrants certain additional terminal space and taxiway works to accommodate growth, as compared to HHL's profile. This is reflected in figure 42 where the AC's view is that core capex would need to begin sooner, with major works starting in 2021, as compared to HHL's view which shows costs ramping up in 2023. The major components to these works include the expansion of Terminal 5, followed by the expansion of Terminal 2 and the cost of additional T2 satellites.

The difference of £1,268m between the AC's view of core capex, £13,069m, when compared to HHL's view of £11,801m is due to:

- The AC's inclusion of OB in their assessment of cost (+£1,698m); and
- HAL's and by extension, HHL's inclusion of surface access costs for 'Terminal 5 Landside roads' (-£430m).

Asset replacement

Asset replacement costs relate to the investment required to maintain or replace the capital assets of the airport as well as to update infrastructure to maintain the assets as a modern airport. At this point in time it is not known what specific asset replacement will be required, however precedent informs us that these costs will need to be incurred as part of operating an airport.

The AC has calculated asset replacement costs for the whole airport, including costs associated with the LHR ENR scheme. Because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has calculated these costs by assuming an expenditure rate per passenger, where passenger 'foot fall' equates to the 'wear and tear' of the assets, which is used to model the overall investment required for asset replacement.

The AC has calculated the expenditure rate per passenger for the LHR ENR scheme from HAL's submitted total asset replacement cost of £9.44bn for the period from 2019 to 2050. A per passenger figure was calculated by dividing this £9.44bn by the total number of passengers in the same period based on the HHL demand profile[103,104]. This per passenger expenditure rate can then be applied to the different demand scenarios modelled to develop the AC's asset replacement cost profiles. The AC has also applied risk and OB to expenditure rates to create the rates given in figure 43 and table 45. HHL's view of asset replacement costs is also presented in table 45[105].

[103] The AC has assumed that HAL's submitted £9.44bn asset replacement cost does not include any risk contingency and therefore the cost could be used without any adjustment.

[104] While HHL has provided asset replacement costs, the AC has taken a view that HAL's asset replacement cost of £9.44bn should be used to calculate the expenditure rate per passenger, given that HAL are the current operators of Heathrow airport and are best placed to assess ongoing and planned works. Further discussion of the approach taken is given in Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Northern Runway.

[105] Note that the AC's cost calculations relate to the period from 2014-2050. HHL's view of costs relates to the period from 2018 to 2041.

Figure 43: Asset replacement profiles

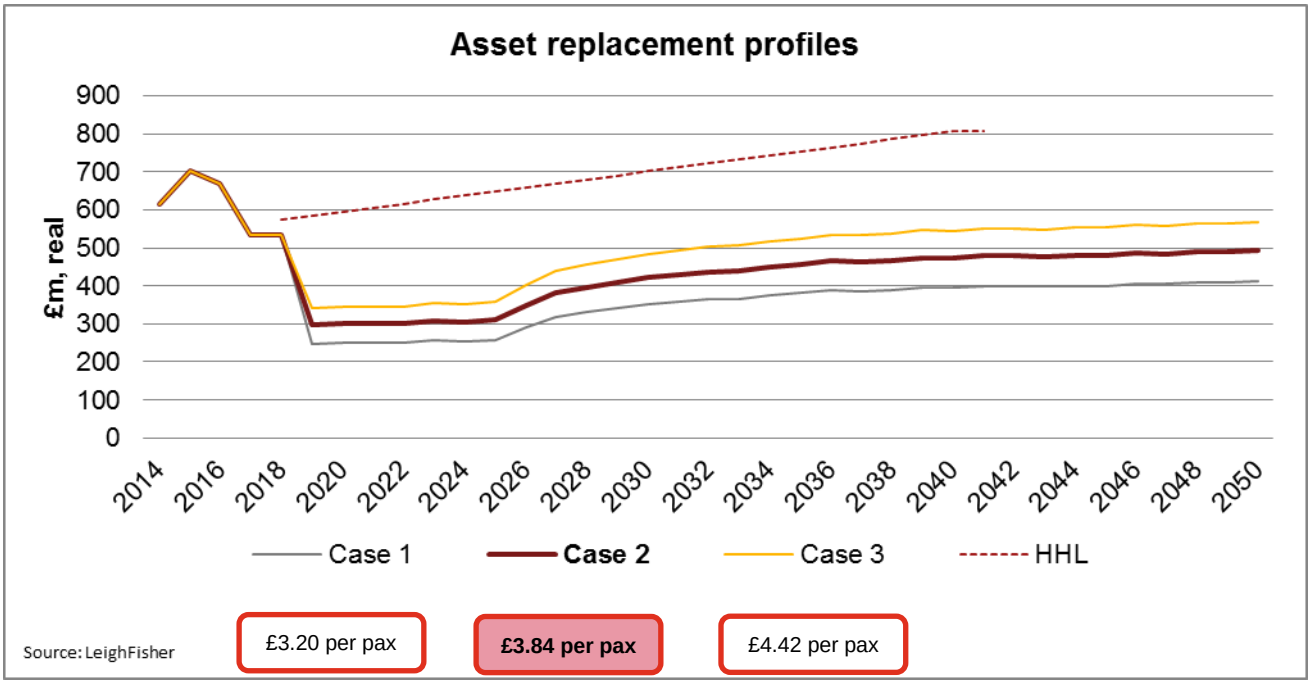


Table 44: Total asset replacement costs

Source	Cost scenarios	Total asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	14,288	28,272	8,415
	Case 2 (R20, MOB20)	**16,535**	**33,274**	**9,525**
	Case 3 (R20, FOB 38)	18,557	37,776	10,524
HHL[106,107]	Scheme promoter cost	16,685	29,968	9,822

The AC's view of cost increases in line with the AoN-CC demand profile increasing from 2019 – 2050 (as the expenditure rate per passenger is applied to the passenger forecast). Costs from 2014 to 2018, are based on costs extracted from Heathrow's Q6 regulatory settlement, £3,054m[108]. As noted, because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has derived its per passenger cost for HHL from HAL's submitted total asset replacement cost of £9.44bn for the period from 2019 to 2050. This generates a significant decrease in costs from 2018 to 2019.

It should be noted that HHL's estimate of £16,685m is based on costs incurred from 2018-2041 and was derived using the HHL demand profile.

[106] Note that the AC's cost calculations relate to the period from 2014-2050. HHL's view of costs relates to the period from 2018 to 2041

[107] In contrast to the AC's method, HHL has estimated asset replacement costs by assuming growth of asset replacement costs from the Q6-CAA 2018 capex of £ 0.5billion to a long term average capex of £0.75billion per annum by 2040.

[108] The Q6 regulatory settlement total is £3,108m (adjusted to 2014 prices) of which £55m was removed as it has been included in HAL's core capex amount (see 'Core capex' section). Source of Q6 figure: http://www.caa.co.uk/docs/33/CAP1151.pdf

The difference of £150m between the AC's view of asset replacement costs, £16,535m, when compared to HHL's view of £16,685m is due to factors that include:

- The different calculation methods and assumptions used in deriving the costs (the AC has derived an expenditure rate per passenger based on HAL's asset replacement costs and applied it to HHL's demand forecast, whereas HHL have assumed a steady annual increase in costs starting from Heathrow airport's Q6 capex settlement);
- The time period over which costs are considered (the AC's estimate includes costs incurred from 2014 to 2050. The HHL estimate includes costs from 2018 to 2041) (+£6,882);
- The AC's inclusion of OB in their assessment of cost (+£2,247m);
- The difference in risk assumptions applied by the AC and HHL; and
- The difference between the AoN-CC forecast used by the AC to build up costs and HHL's demand forecast which has been assumed was used to build up the HHL cost.

Opex

Opex includes costs such as staff, facilities management and utilities. The AC has calculated opex for the whole airport, including costs associated with the LHR ENR scheme. The AC's calculation of opex was independently derived using the following summarised methodology[109]:

- In the short term up to 2025, the AC adopted a general elasticity[110] applied across the opex categories of 0.3x to passenger growth, with an efficiency saving of 0.5% per year;
- In the long term (2025 onwards), the AC has modelled total opex based on a range of elasticities related to passenger increase, gross floor area increase and airfield increase; and
- An efficiency frontier[111] of -1% was applied until 2035 following which a -0.5% efficiency was applied (the AC's modelling approach assumed that while the additional infrastructure delivered by the scheme would be substantial, the existing facilities within the core airport, parts of which opened in 1986, are extensive and would afford further efficiencies to be made until 2035 and at a lower rate thereafter).

The AC has calculated a range of opex cases for HHL which are presented in figure 44 and table 46. HHL's view of opex is also presented based on their demand forecast[112].

[109] A detailed explanation of the AC's methodology is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Heathrow Airport Extended Runway.

[110] **'Elasticity'** in this context refers to how costs are affected by demand drivers. Costs are said to be highly elastic when a small change in a demand driver, for instance passenger numbers, results in a large change in cost.

[111] An **'efficiency frontier'** refers to the airport's ability to improve operational performance while at the same time reducing costs, in line with trends among other airport comparators.

[112] Note that since the AC's view of opex was calculated there has been a small adjustment to the AoN-CC demand forecast applied from 2014 to 2018 inclusive. This does not have a material impact on the cost presented.

Figure 44: Opex profiles

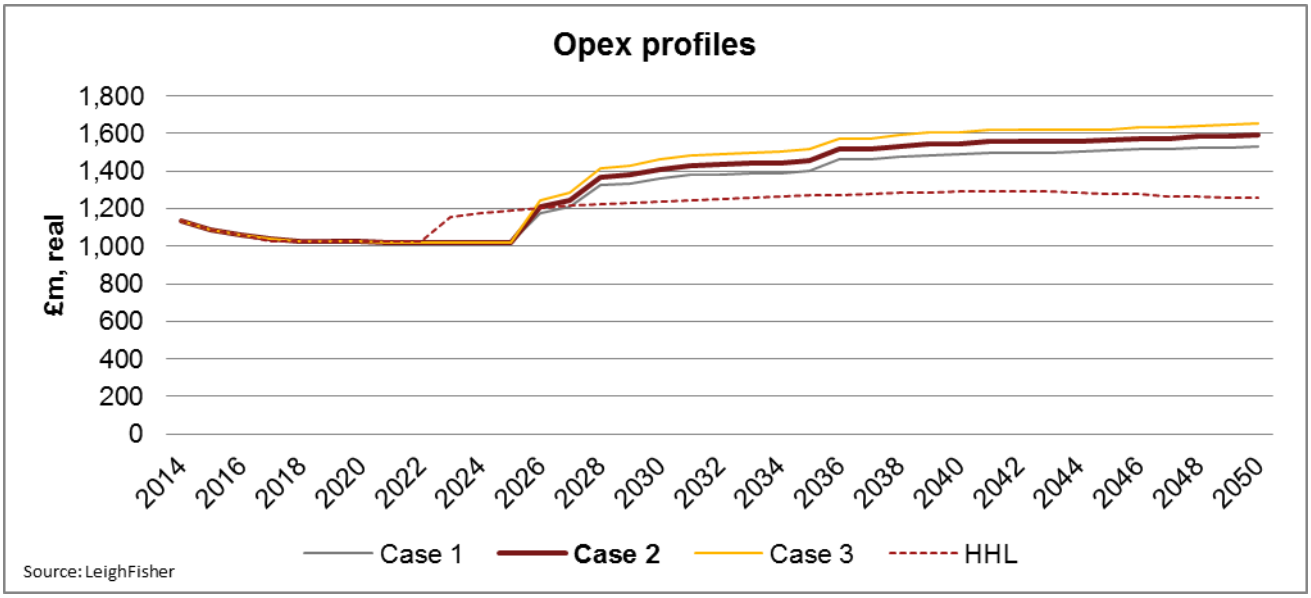


Table 45: Total opex

Source	Cost scenarios	Total Opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0.5 per annum)	48,295	90,111	26,406
	Case 2 (R0.5 per annum, MOB20)	**49,631**	**92,943**	**26,995**
	Case 3 (R0.5 per annum, FOB41)	51,033	95,916	27,614
HHL	Scheme promoter cost	44,525[113]	65,885	25,019

The AC's view is that opex would decrease overall from 2014 to 2025 as the AC assumes efficiency gains (or an efficiency frontier) of -1%. The AC then forecasts opex to increase with more pronounced steps than those assumed by HHL, following the opening of the runway in 2025 and the opening of new terminal capacity. This is due to the opening of new infrastructure giving rise to opex costs in categories such as utilities, cleaning, first line maintenance and certain staff functions.

Although some of these cost increases would typically be offset by decreases in costs brought about by efficiency gains in the existing terminals, the step up in fixed costs are in line with the scale of airport expansion that can be expected as a result of the new runway and terminal capacity.

In contrast, HHL forecasts a 10% stepped increase in costs in 2023 and apply 30% elasticity to passenger growth throughout the period in addition to a 1% efficiency frontier. HHL's modelling assumptions were extrapolated to infer a forecast from 2042 to 2050. During this period, any increases in costs associated with passenger growth are offset by efficiency gains, resulting in a net decrease in costs.

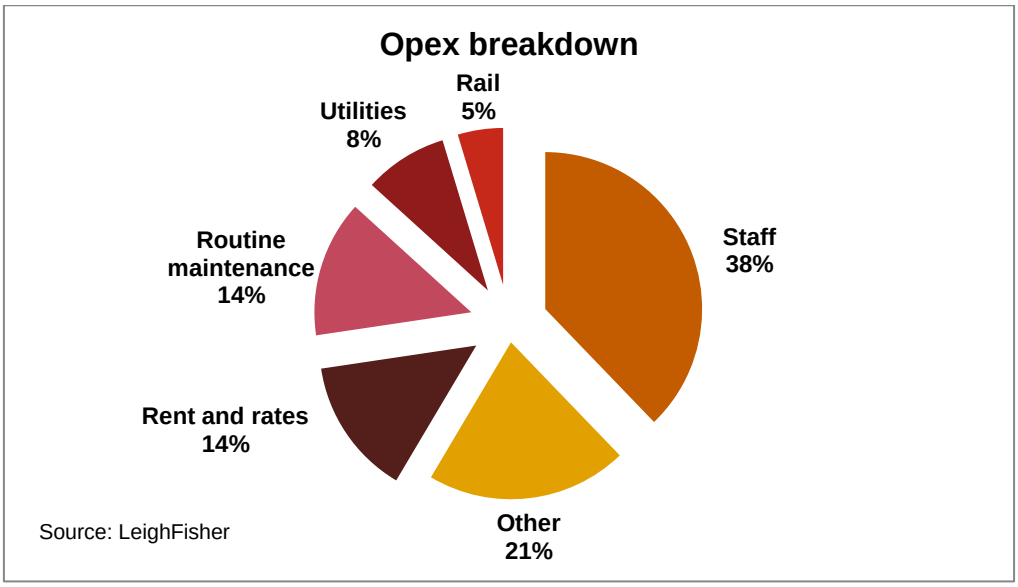
The difference of £5,106m between the AC's view of opex, £49,631m, when compared to HHL's view of £44,525m is due to factors that include:

[113] Note that HHL only provided opex from 2018-2041. The AC has calculated opex for HHL for years 2014to 2017, and 2042 to 2050 based on HHL's assumptions.

- The AC's inclusion of OB in their assessment of cost (+£1,336m);
- The difference in growth and cost efficiency assumptions[114];
- The difference in demand profiles assumed by the AC and HHL; and
- The difference in risk assumptions applied by the AC and HHL.

Figure 45 presents a breakdown of the AC's view of opex by cost category.

Figure 45: Opex breakdown



'Staff' costs form the largest component of opex for Heathrow airport (based on the AC's estimate of opex for HHL) as staff costs are relatively elastic to passenger and floor area increases (elasticities of 40% have been applied). Since the AoN-CC demand forecast predicts a relatively fast rate of passenger growth following the opening of the runway extension at Heathrow and new terminal space would increase overall floor areas, increased numbers of airport staff would be required, which contributes to increased opex at Heathrow.

Together, 22% of the total opex is made up of 'utilities' and 'rent and rates' which are both assumed to be highly sensitive to floor space increases. Respectively, elasticities of 70% and 80% were applied to these costs in relation to floor space causing pronounced increases in opex as new terminal building space is built.

The 'other' costs which make up 21% of total opex include costs for IT & Telecoms, police, NATS, cleaning, insurance, uniforms and payroll.

'Rail' costs refer solely to the costs associated with operating the Heathrow Express owned by HAL.

'Routine maintenance', which forms 14% of opex includes materials for maintenance activities undertaken in-house by airport employees as well as contract costs for servicing and repair systems such as escalators and air conditioning.

[114] Where HHL have applied general growth drivers across all categories, coupled with an efficiency frontier of 1%, through the forecasting period to 2050, the AC have applied separate drivers to each cost line and flat rate efficiencies (-1% up to 2035 and -0.5% up to 2050).

Appendices

Appendix 1: References and sources

Websites

Footnote reference (where relevant)	Link
3	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf
6, 9	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf
11	https://www.gov.uk/transport-analysis-guidance-webtag
30, 35	http://www.caa.co.uk/docs/33/CAP1152LGW.pdf
24, 55, 93	https://www.gov.uk/government/publications/cost-of-maintaining-the-highways-agency-s-motorway-and-a-road-network-per-lane-mile
66	http://www.caa.co.uk/docs/33/CAP1151.pdf
56, 94	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275128/webtag-tag-unit-a1-2-scheme-costs.pdf
26, 58, 96	http://www.dft.gov.uk/ha/standards/ghost/dmrb/vol13/index.htm

Data references

The inputs for each scheme and scenario have been sourced from the following LF files.

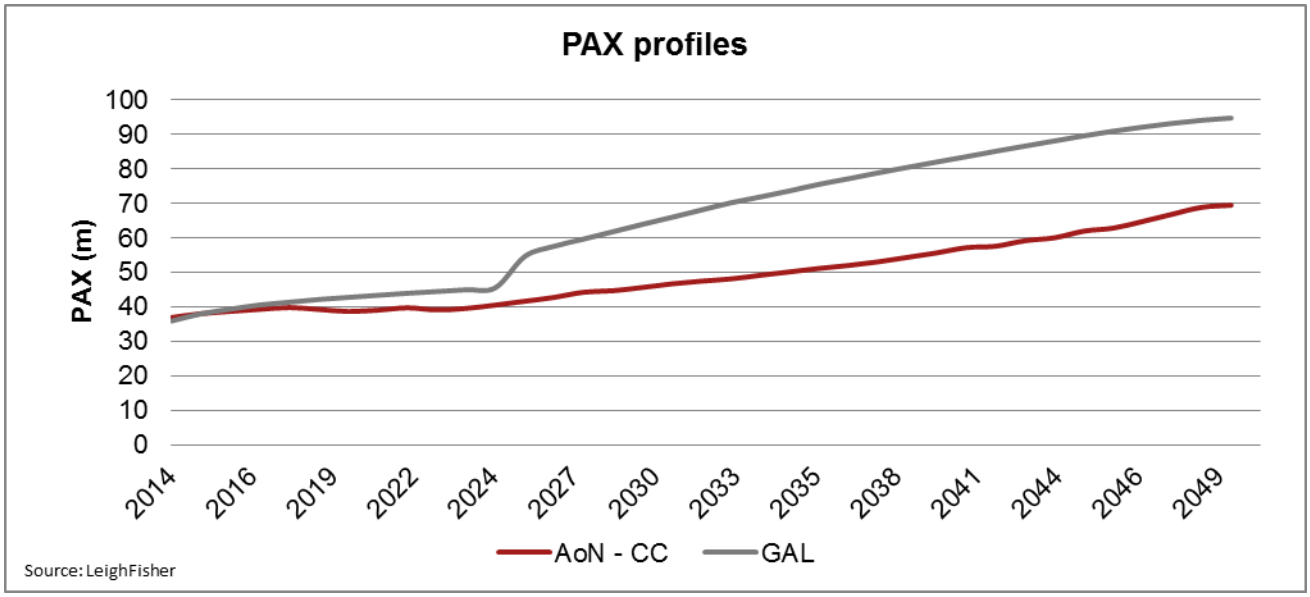
	GAL	HAL	HHL
AC scenario name	AoN Carbon Capped (AoN-CC)	AoN Carbon Capped (AoN-CC)	AoN Carbon Capped (AoN-CC)
Capex & Asset Replacement	20141014 – Gatwick Airport v1.xlsx	20141006 – Heathrow Airport v1 – Issued to PwC.xlsx	20141006 – Heathrow Hub v1.xlsx
Opex	141016 LF Airport Schemes Opex v18 – AoN Carbon Capped.xlsx	141014 LF Airport Schemes Opex v17 – AoN Carbon Capped.xlsx	141014 LF Airport Schemes Opex v17 – AoN Carbon Capped.xlsx

Appendix 2: AC view of GAL costs based on the GAL passenger forecast

As described in section 1.3, the AC's view of costs for the LGW 2R scheme does not include the final phase of the scheme development proposed by GAL in their submission. This is because the build out of the scheme's phases are linked to demand and under the AoN-CC demand scenario presented in this report, the final phase would not be required until after the end of the cost review period.

The AoN-CC demand scenario forecasts a slower increase in passenger numbers at Gatwick as compared to GAL's demand forecast. Both forecasts assume the LGW 2R scheme is developed. GAL has assumed a sharp increase in passenger numbers as a result of the opening of the new runway in 2025, whereas the AC predicts a more gradual increase and lower overall passenger numbers. These passenger forecasts are presented in figure 46.

Figure 46: Passenger (PAX) profiles for Gatwick Airport



Section 1 of this report presents the AC's view of costs for the LGW 2R scheme under the AoN-CC demand scenario. **This Appendix presents the AC's view of costs based on GAL's own passenger forecast to provide a view that includes the final phase of development**[115]**.**

Scheme capex

See section 1.3.1 for costs based on AoN-CC demand scenario

In deriving the scheme capex for the LGW 2R scheme, the AC has independently developed a phased construction plan and calculated base costs for each phase of the development based on the GAL passenger forecast. Risk and OB assumptions have then been applied to the base costs (see table 47).

[115] The impact of further different demand scenarios and sensitivities modelled is covered in Module 13. Cost and Commercial Viability: Funding and Financing

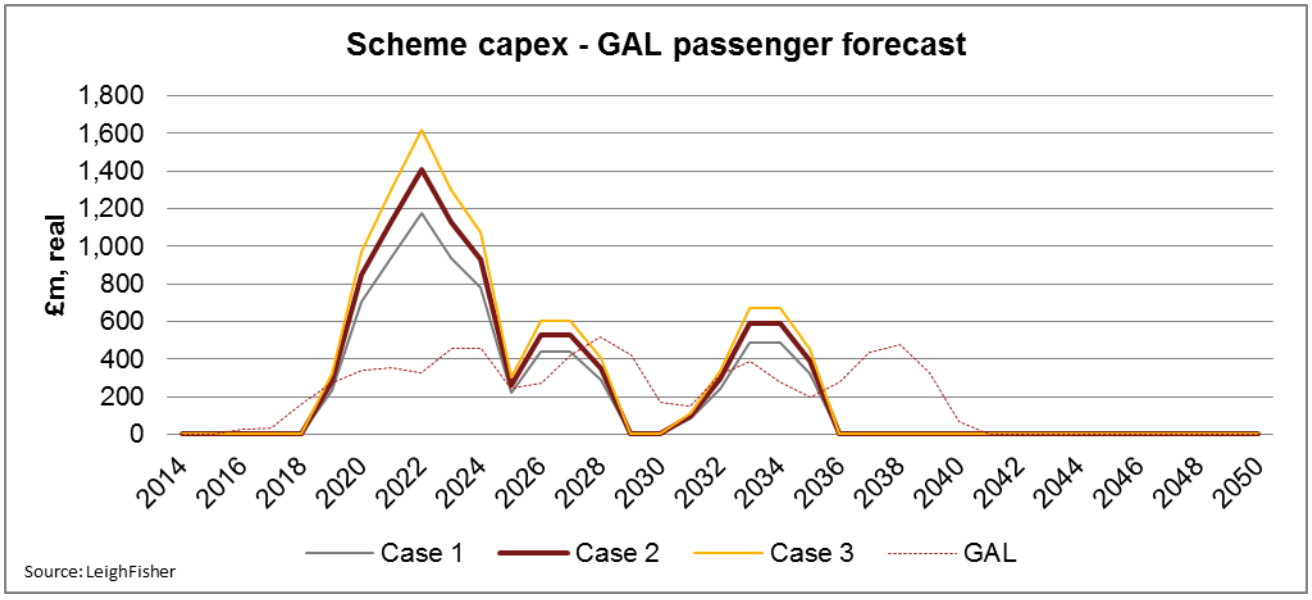
Table 46: Scheme phases and capex

Phase	Passenger capacity (mppa)	Opening year	Works	Scheme capex, (£m, real)	%
0	Not applicable	2025	• Full length runway • Associated airfield works	3,549	38.0%
1	60	2025	• First phase of terminal works • Expansion of the airfield as required to serve the terminals	2,088	22.4%
2	75	2029	• Second phase of terminal works • Incremental airfield works	1,749	18.7%
3	95	2036	• Final fit-out of all terminal infrastructure • Expansion of the airfield as required to serve the terminals	1,953	20.9%
Total Cost (R20, MOB20)				**9,340**	**100.0%**

The AC's view, based on the GAL passenger forecast is that 4 phases of work will be required to deliver the LGW 2R scheme (versus 3 based on the AoN-CC passenger profile). This is because GAL's passenger profile predicts faster growth in passenger demand, which triggers the final phase of development within the cost review period. The passenger capacity numbers presented in table 47 reflect the airport capacity once that phase of the development has been completed.

The AC has calculated a range of costs for the LGW 2R scheme (see figure 47 and table 48). GAL's view of scheme costs is also presented[116].

Figure 47: Scheme capex profiles based on the GAL passenger forecast



[116] Note that the AC's cost calculations relate to the period from January 2014-December 2050. GAL's view of costs relates to the period from April 2016 to March 2050.

Table 48: Total scheme capex based on the GAL passenger forecast

Source	Cost scenarios	LGW 2R scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	7,783	11,580	5,375
	Case 2 (R20, MOB20)	**9,340**	**13,896**	**6,450**
	Case 3 (R20, FOB38)	10,741	15,981	7,418
GAL	Scheme Promoter cost	7,389	12,541	4,569

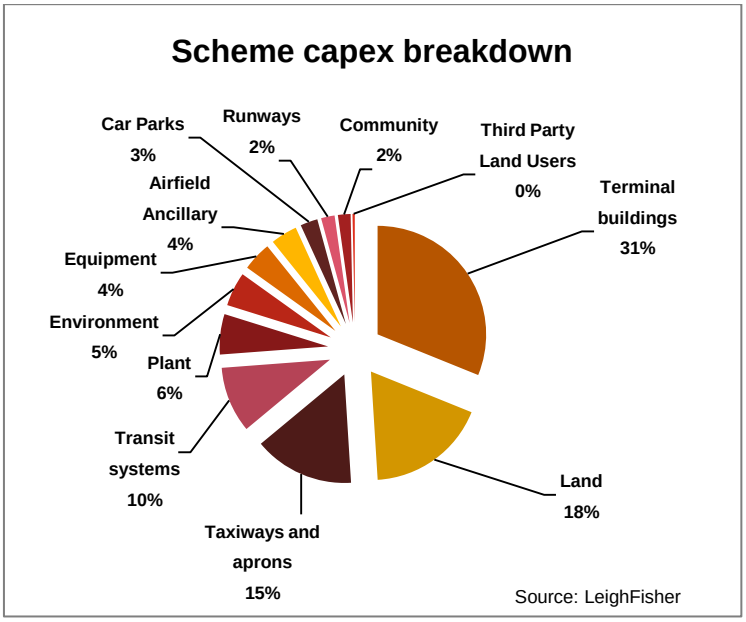
The AC's view, based on GAL's passenger forecast, includes the construction of Phase 0 and Phase 1 works commencing in 2019 and opening in 2025. Phase 2 of development would need to be completed by 2029 in order to meet demand, with works commencing in 2026. Phase 3 would commence in 2033 and open in 2036. The AC's view of the development shows construction concluding in 2037 – earlier than under GAL's construction plan which concludes in 2040. This is due to the AC's view that Phase 0 and phase 1 will be built concurrently, bringing forward the development of phases 2 and 3. For further details on the analysis behind this assessment, refer to Module 14. Operational Efficiency: Ground-Infrastructure Gatwick Airport Second Runway.

The difference of £1,951m between the AC's view of scheme capex, £9,340m, when compared to GAL's view of £7,389m is due to:

- The AC's inclusion of OB in their view of costs (+£1,557m);
- The difference in risk assumptions applied by the AC and GAL; and
- Differences in approach to calculating scheme capex.

Figure 49 presents a breakdown of the AC's view of scheme capex by cost category.

Figure 49: Scheme capex breakdown based on the GAL passenger profile



Together, the cost of terminal buildings and land make up 49% of the total scheme capex (31% and 18% respectively). Taxiways and aprons are the next largest cost at 15% of the total, followed by transit systems at 10%. The remaining costs, in order of magnitude, relate to plant, environmental, equipment, ancillary airfield, car parks, runways, community and third party land user costs respectively.

The AC's view of the relative breakdown of costs by cost category is different under the GAL passenger profile as compared to the AoN-CC passenger profile (see figure 8) since the AC's view of costs under the AoN-CC passenger profile does not include the final phase of the scheme development proposed by GAL in their submission. The difference is most notable in the relative cost of terminal buildings where these form 23% of scheme capex under the AoN-CC passenger profile as compared to 31% of scheme capex according to the GAL passenger profile. This is due to the inclusion of phase 3 terminal costs under the GAL passenger scenario.

Surface access costs

The AC's view of surface access costs is the same based on the AoN-CC and GAL passenger profiles as these are considered to be independent of different demand scenarios. These costs are discussed in section 1.3.2.

Other airport costs

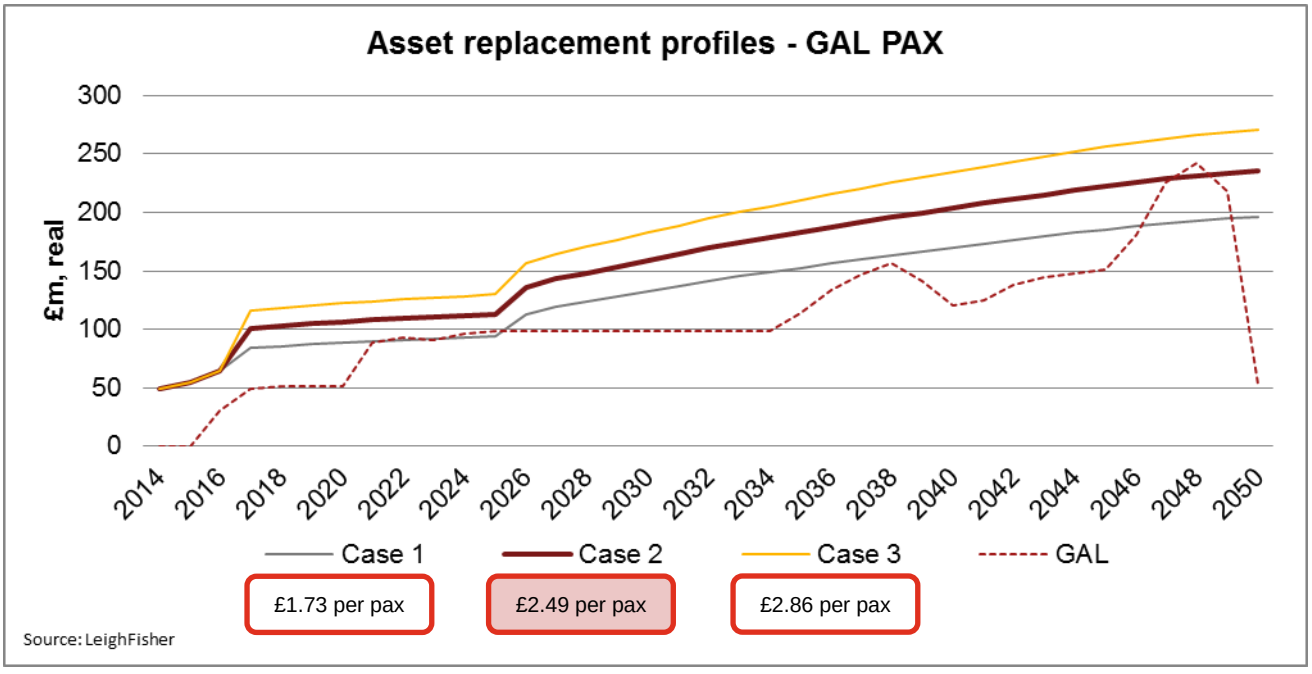
Core capex

The AC's view of core capex costs is the same based on the AoN-CC and GAL demand profiles as these are considered to be independent of different demand scenarios. These costs are discussed in section 1.3.3.

Asset replacement

The same methodology as that used in section 1.3.3 has been used to calculate asset replacement costs based on the GAL passenger profile. The AC then applied risk and OB to expenditure rates to create the rates given in figure 50 and table 48. GAL's view of asset replacement costs is also presented [117].

Figure 50: Asset replacement costs based on the GAL passenger (PAX) forecast



[117] Note that the AC's cost calculations relate to the period from 2014-2050. GAL's view of costs relates to the period from April 2016 to March 2050.

Table 47: Total asset replacement costs based on the GAL passenger forecast

Source	Cost scenarios	Total asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	4,992	11,023	2,546
	Case 2 (R20, MOB20)	**5,957**	**13,193**	**3,023**
	Case 3 (R20, FOB 38)	6,825	15,145	3,452
GAL	Scheme promoter cost	4,020	9,127	1,971

The difference of £1,937m between the AC's view of asset replacement costs, £5,957m, when compared to GAL's view of £4,020m is due to factors that include:

- The AC's inclusion of OB in their assessment of cost (+£965m);
- The time period over which costs are considered (the AC's estimate includes costs for the whole cost review period whereas GAL's costs span 1 April 2016 to 31 March 2050); and
- The difference in risk assumptions applied by the AC and GAL.

Opex

The same methodology as that used in section 1.3.3 has been used to calculate opex based on the GAL passenger profile. The AC then applied risk and OB to expenditure rates to create the rates given in figure 51 and table 49. GAL's view of opex costs is also presented.

Figure 51: Opex profiles based on the GAL passenger (PAX) forecast

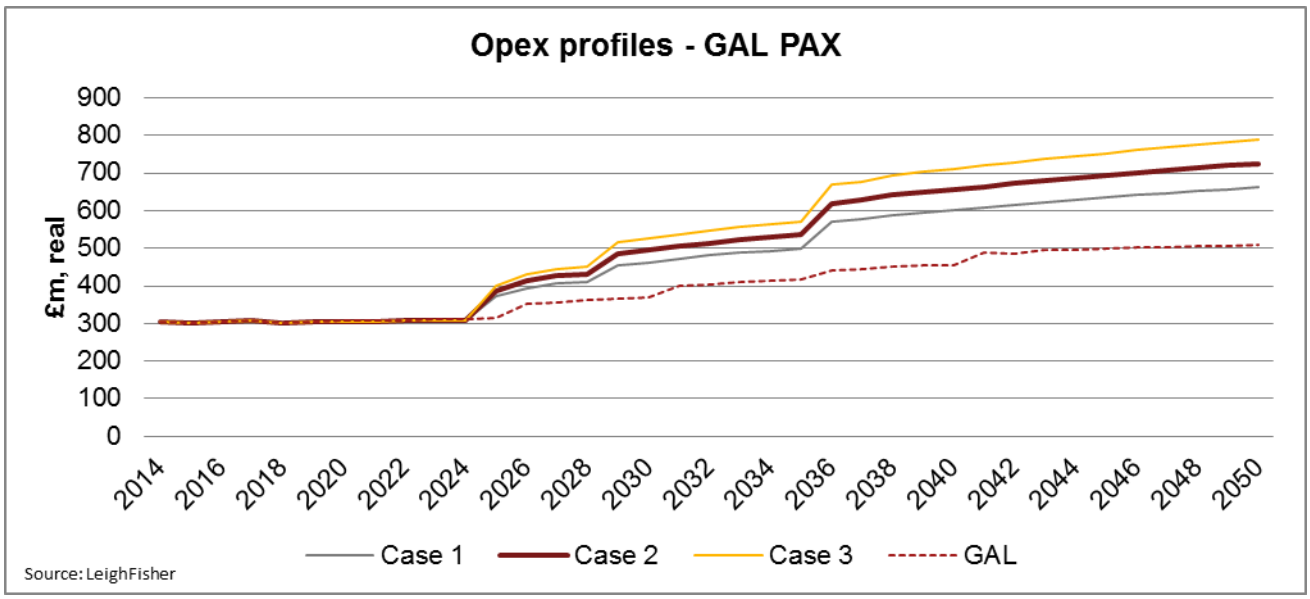


Table 48: Total opex base on the GAL passenger forecast

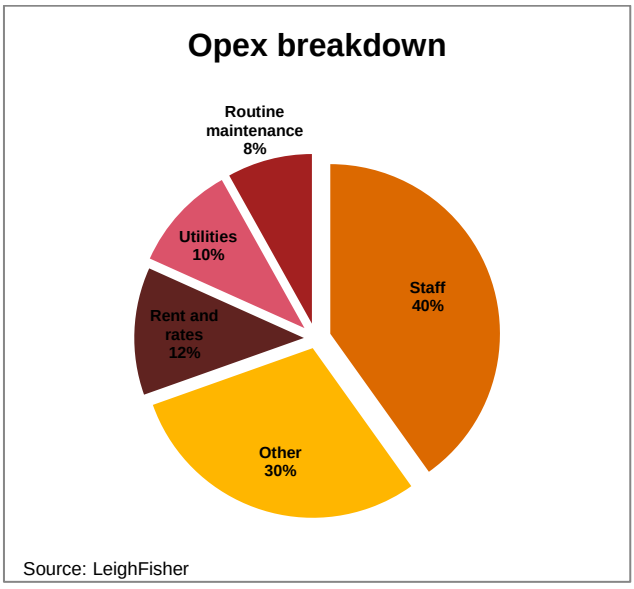
Source	Cost scenarios	Total Opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0.5 per annum)	17,591	34,152	9,140
	Case 2 (R0.5 per annum, MOB20)	**18,751**	**36,705**	**9,629**
	Case 3 (R0.5 per annum, FOB41)	19,911	39,257	10,118
GAL	Scheme promoter cost	14,765	22,427	7,939

The difference of £3,986m between the AC's view of opex, £18,751m, when compared to GAL's view of £14,765m is due to factors that include:

- The AC's inclusion of OB in their assessment of cost (£1,160m);
- The difference in phasing assumptions applied[118];
- The difference in elasticity assumptions applied[119];
- The difference in cost efficiency assumptions applied[120]; and
- The difference in risk assumptions applied by the AC and GAL.

Figure 52 presents a breakdown of the AC's view of opex by cost category.

Figure 52: Opex breakdown based on the GAL passenger profile



[118] The AC has assumed that a full terminal will be built and operational earlier in the cost review period, whereas GAL has assumed a temporary facility will initially be built instead, opening in 2025, with comparatively smaller floor space. This results in larger stepped increases in opex according to AC estimates as driven by larger floor area becoming operational at an earlier point in time.

[119] The AC applied elasticities similar to GAL's up until 2025 and independently derived assumptions thereafter. A detailed explanation of the AC's elasticity assumptions is available in the separately published Module 13. Cost and Commercial Viability: Cost and Revenue Identification Gatwick Airport Second Runway.

[120] The AC assumes flat rate efficiencies (-1% up to 2030 and no efficiency gains thereafter) whereas GAL assumes improvements in efficiency modelled using elasticities and an annual efficiency factor.

Regulated Asset Base

See section 1.2.5 for RAB based on AoN-CC demand scenario

Figure 53 and table 50 illustrate the development of the RAB balance over the cost review period, based on the GAL passenger forecast. Note that the average RAB balance is the average of the opening and closing balances over an annual period.

Figure 53: Cost additions and changes to the RAB under the GAL passenger forecast

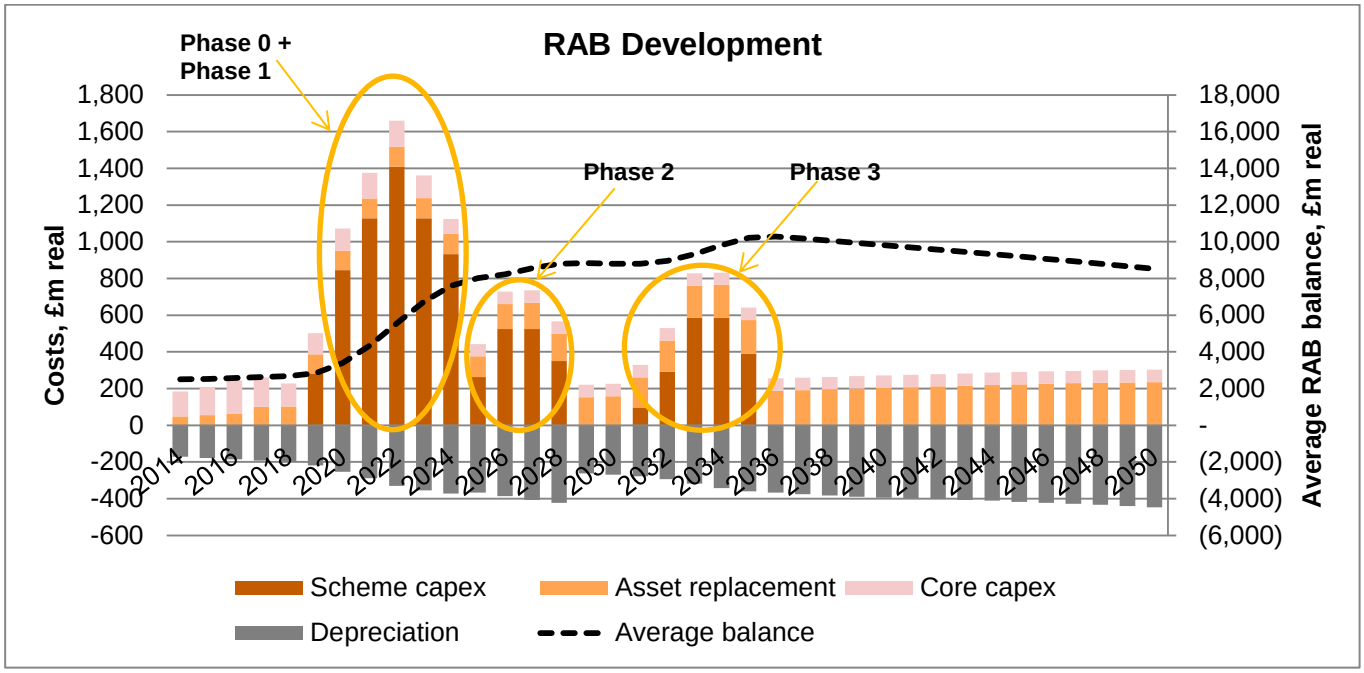


Table 49: RAB changes and peak information under the GAL passenger forecast

	RAB changes (£m, real)	RAB changes (£m, nominal)
Opening RAB as of 2014	2,502	2,502
Indexation effect	N/a	20,496
Additions	18,520	32,889
Depreciation	(12,565)	(26,707)
Closing RAB as of 2050	8,457	29,180
Average RAB balance peak	10,292	29,428
Year average RAB balance peaks	2036	2050

The average RAB balance peaks at £10.3bn in 2036. The peak in RAB balance is higher in value and occurs earlier with the AC's view of costs based on the GAL passenger profile because:

- Higher capital costs are incurred earlier;
- Capital costs are incurred in closer succession, reducing the time for depreciation of capital assets; and
- The final phase of construction is realised under this passenger profile.