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Cost and Commercial Viability: Financial Modelling Input Costs Update

Airports Commission

July 2015

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Contents

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Report updates

The 13. Cost and Commercial: Financial Modelling Input Costs report was originally published in November 2014. Following the consultation period, which concluded in February 2015, this report is being updated to reflect changes made in response to consultation responses. At a high level, these updates include:

- Revised optimism bias assumptions (scheme capex, core capex, asset replacement and opex);
- Updates to HAL and HHL core and surface access costs (Southern Road Tunnel project moved from surface access to core costs);
- HAL and HHL core and asset replacement costs adjusted to a revised base date (Q1 2014);
- Updates to scheme capex across all schemes in response to consultation comments;
- Minor updates to opex (all schemes) to rectify minor errors identified;
- The November 2014 version of this report included both the AC's view of costs and the scheme promoters' view of costs. Following consultation the Commission has received multiple responses to these costs. It is not considered practical to compare the AC's view of costs with all these additional views and so this comparison has been removed from this updated report.

The updated costs presented 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 on the costs and changes made following consultation is provided in the following updated reports:

- Cost and Commercial Viability: Cost and Revenue Identification Update Gatwick Airport Second Runway ("the Cost and Revenue Identification Update LGW 2R report");
- Cost and Commercial Viability: Cost and Revenue Identification Update Heathrow Airport Northwest Runway ("the Cost and Revenue Identification Update LHR NWR report"); and
- Cost and Commercial Viability: Cost and Revenue Identification Update Heathrow Airport Extended Runway ("the Cost and Revenue Identification Update LHR ENR report").

[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 licence-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, 'Economics Regulation at Gatwick from April 2014: notice of the proposed licence, CAP1139' for more information on GAL's regulatory requirements.

Scope and context

The Airports Commission (AC), 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 AC has considered and evaluated a variety of options for meeting the UK's international connectivity needs, the results of which were outlined in the AC'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 AC, with a decision made in September 2014 to not include this in the short list. The AC published its consultation report in November 2014 and a first version of this report was issued as part of that process.

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 updated analysis presented in this report has been 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 Cost and Commercial Viability: Funding and Financing Update report ("the Funding and Financing Update report")); or
- Review delivery risks associated with the costs identified (this review forms part of the Cost and Commercial Viability: Literature Review Update report ("the Literature Review Update report")) and, where it relates to financing, as part of the Funding and Financing Update report).

This report forms part of a wider body of work which PwC was commissioned to undertake to support the AC in its commercial, financial and economic appraisal of the schemes.

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 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:

- Cost and Revenue Identification Update LGW 2R report;
- Cost and Revenue Identification Update LHR NWR report; and
- Cost and Revenue Identification Update LHR ENR report.

Sections 1 to 3 have been drafted so that they can be read independently of each other resulting in a level of duplication 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 Cost (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 Limited (LF) or Jacobs UK Limited (Jacobs) who are providing technical advice to the AC;
- The assumptions and approach underlying the narrative explaining the AC's approach to cost calculations 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 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 review period	1 January 2014	Current year applied.

Parameter	Assumption	Basis for assumption
End of the cost review period	31 December 2050	As set out in the Airports Commission Interim Report, it is expected that a second additional runway may be required by 2050. This has formed the end date of the assessment period.
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)[5].

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

- Cost and Revenue Identification Update LGW 2R report;
- Cost and Revenue Identification Update LHR NWR report; and
- Cost and Revenue Identification Update LHR ENR report.

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
  - **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.

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

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[6]
Equipment	
Land	
Rail	
Airfield Ancillary	
Car Parks	
Third Party land users[7]	
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.

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

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

[7] 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).

have a tendency to cost more than forecast. The application of OB to project appraisals is required by the HMT Green Book[8].

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[9] (the AC's view of costs)**; and
- Case 3: Base Cost + Risk + Full Optimism Bias[10] (high end of the range).

Case 2 represents the AC's view of costs and has been used as an input to the Funding and Financing Update 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:

- Cost and Revenue Identification Update LGW 2R report;
- Cost and Revenue Identification Update LHR NWR report; and
- Cost and Revenue Identification Update LHR ENR report.

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.	15% premium (MOB15)	Developed using the Green Book approach to OB on civil engineering works.	45% premium (FOB45)	Developed using the Green Book approach to OB on civil engineering works[11].
Core capex	No risk applied (R0)	Core capex was adopted from the SPs' costs, which already include an adjustment for risk. No further risk adjustment was considered necessary.	10% premium (MOB10)	Developed using the Green Book approach to OB on civil engineering works. As these costs are considered to be more understood than others, greater mitigation was considered appropriate.	15% premium (FOB15)	Developed using the Green Book approach to OB on civil engineering works. As these costs are considered to be more understood than others, greater mitigation was considered appropriate and a lower application of full OB was

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

[9] 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.

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

[11] 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
						considered appropriate.
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.	15% premium (MOB15)	Developed using the Green Book approach to OB on civil engineering works.	45% premium (FOB45)	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.	15% premium (MOB15)	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 road schemes[12].	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[13].

[12] 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.

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

	Risk	Basis	Mitigated OB (MOB)	Basis	Full OB (FOB)	Basis
Asset replacement	No risk applied (Ro)	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 (Ro)	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, MOB41 - 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 41% premium for rail (FOB44 - road, FOB41 - rail)	DfT's WebTAG guidance.

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. Each demand scenario has two variants, 'Carbon Capped' and 'Carbon Traded'. These scenarios are reflected in the AC's passenger demand forecasts, and are used to inform the assessments undertaken. By considering each scheme in relation to multiple potential futures, the AC has aimed to stress-test the robustness of its analysis.

The AC's scenarios broadly follow the approach taken in the early phases 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 Commission 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.

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[14]. For the avoidance of doubt, the version of costs under the AoN-CC scenario should not be considered as a central case.

The funding and financing of alternative demand scenarios, and sensitivities around key variables are considered in the separately published Funding and Financing Update report.

[14]Future demand under different scenarios is detailed in Strategic Fit: Updated Forecasts.

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 the Funding and Financing Update report. Information on the detailed costs used in the financial modelling work for all scenarios/sensitivities is provided in the Cost and Revenue Identification Update LGW 2R report.

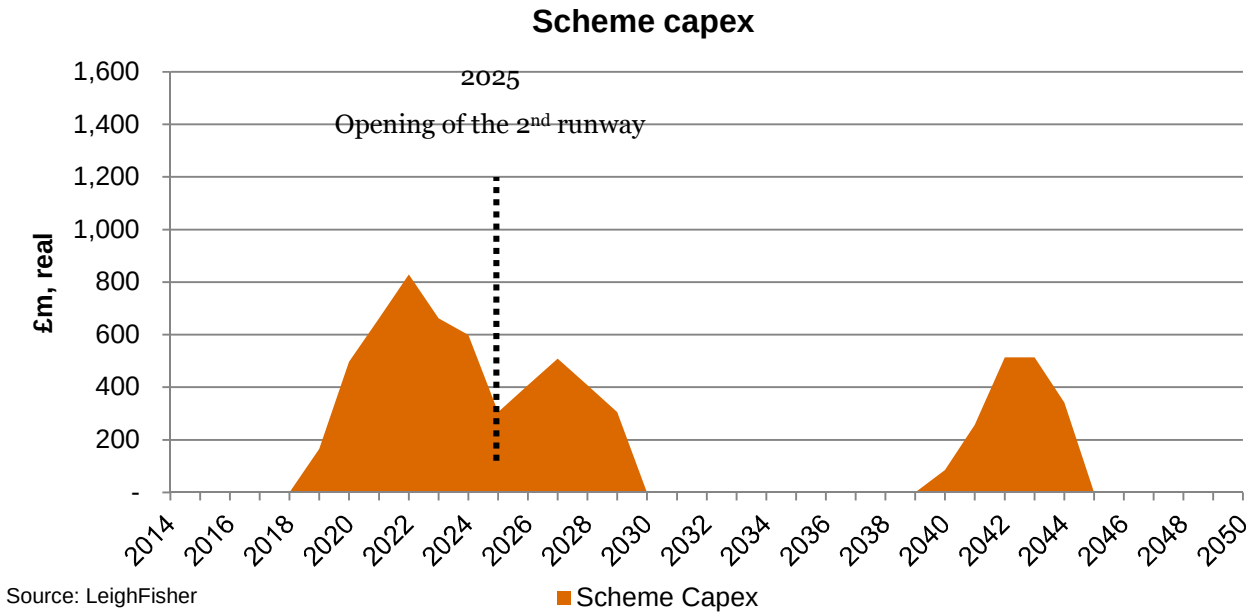
It should be noted that the AC's view of costs in the AoN-CC scenario does not include the final phase of the scheme development proposed by GAL in their submission (as the phases are linked to demand and this would take place after the end of the cost review period under the AoN-CC demand forecast). 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 **£7,060m** 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



Source: LeighFisher

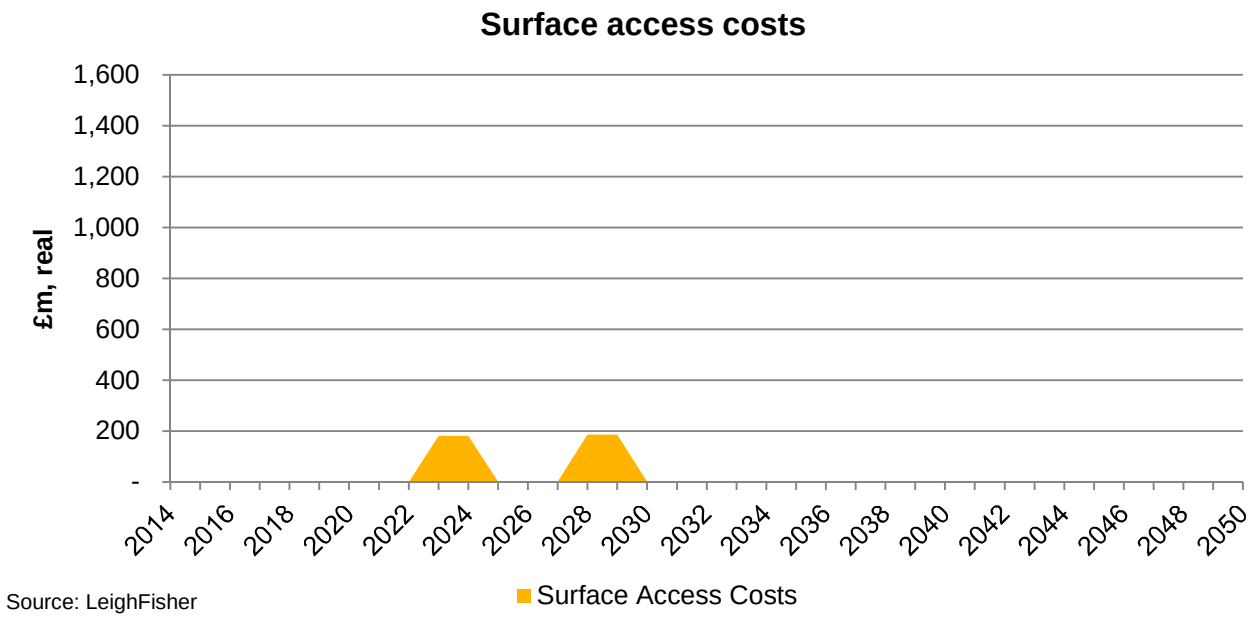
1.2.2 Surface access costs

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[15].

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 the Funding and Financing Update report.

[15] 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



Source: LeighFisher

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, MOB15)	7,060	90.0%
Surface access costs (R0, MOB44 – roads, MOB66 – rail capex and surface access, MOB41 – rail opex)	787	10.0%
Total	**7,847**	**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 **£21,737m** 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

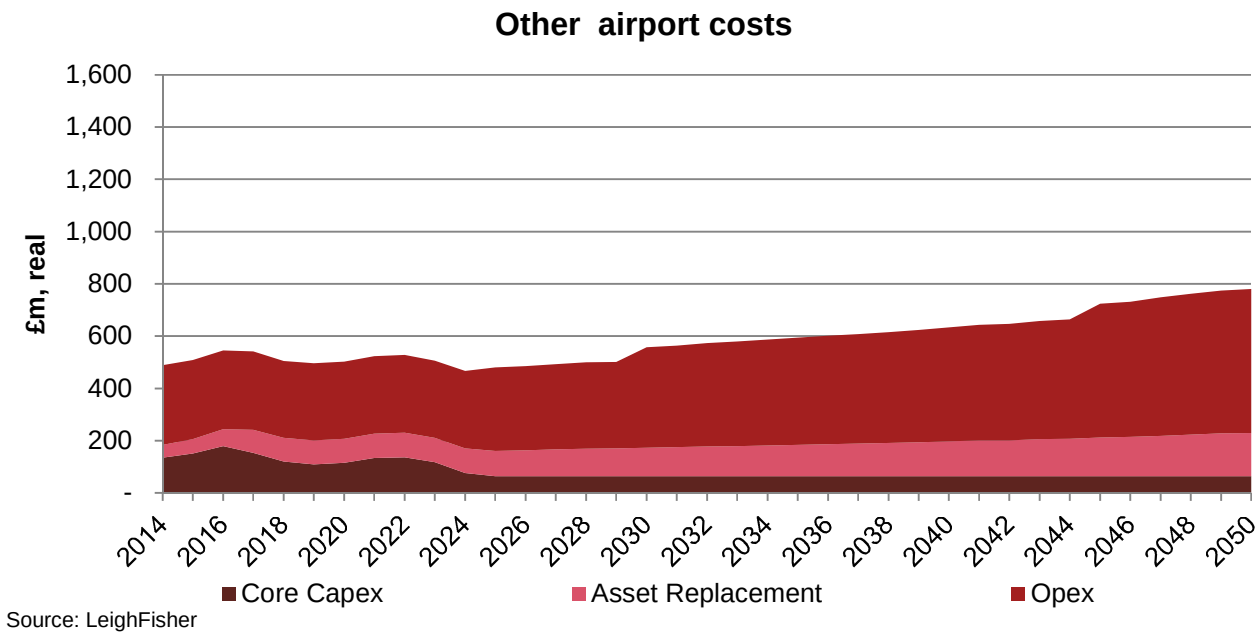


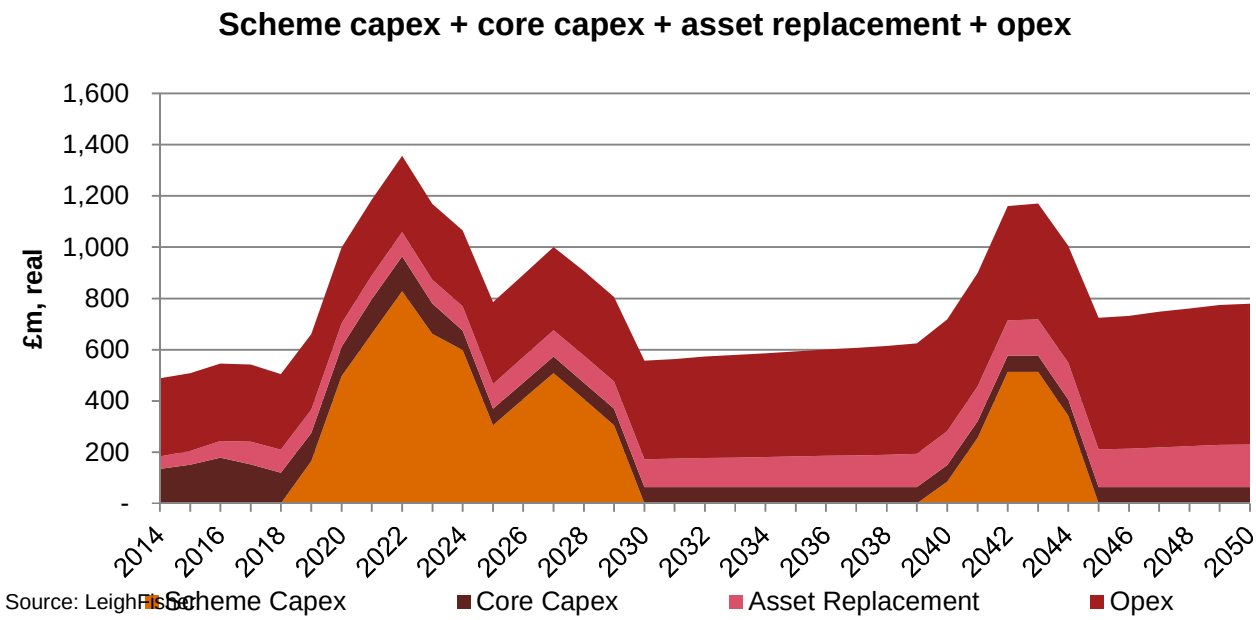
Table 5: Other airport costs

Cost item	Cost (£m, real)	%
Core capex (R0, MOB10)	3,104	14.3%
Asset replacement (R20, MOB15)	4,231	19.5%
Opex (R0.5 per annum, MOB15)	14,402	66.3%
Total	**21,737**	**100.0%**

1.2.4 Financial modelling costs

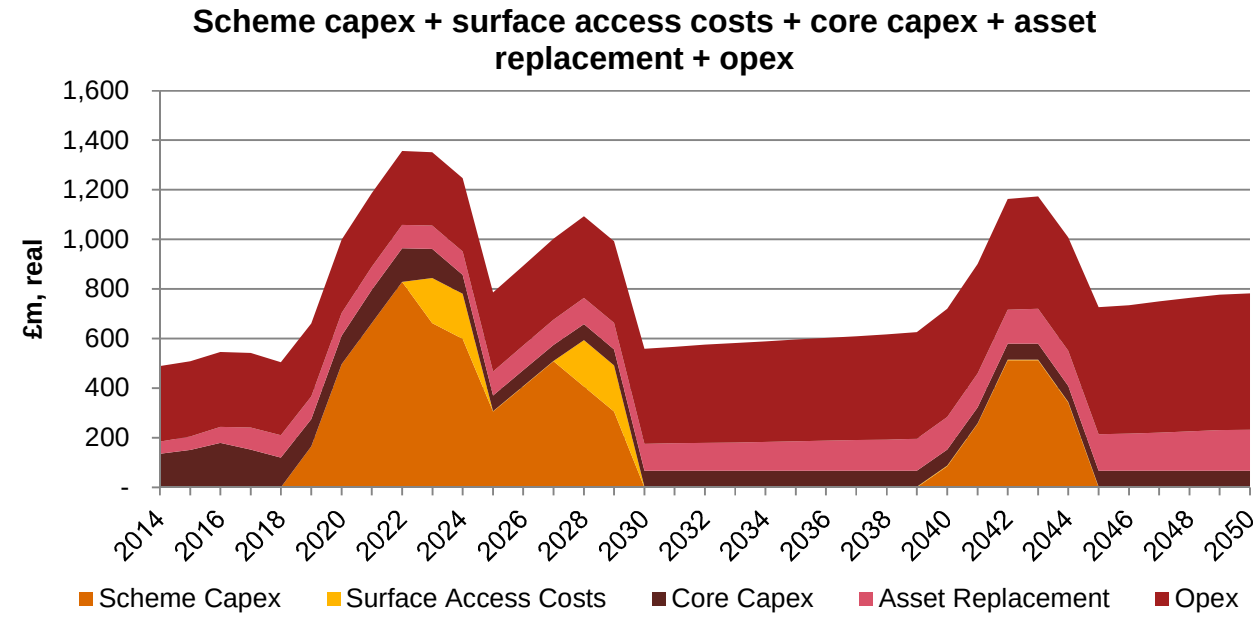
As noted, in order to assess the level of aeronautical charges, the AC has developed a financial model for the airport as a whole, combining the costs identified in sections 1.2.1, 1.2.2 (under certain model sensitivities) and 1.2.3 of this report. The combined impact of these costs over the cost review 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



Source: LeighFisher

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



Source: LeighFisher

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 subsequent regulation looked to re-introduce a RAB-based approach. 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 Literature Review Update report.

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

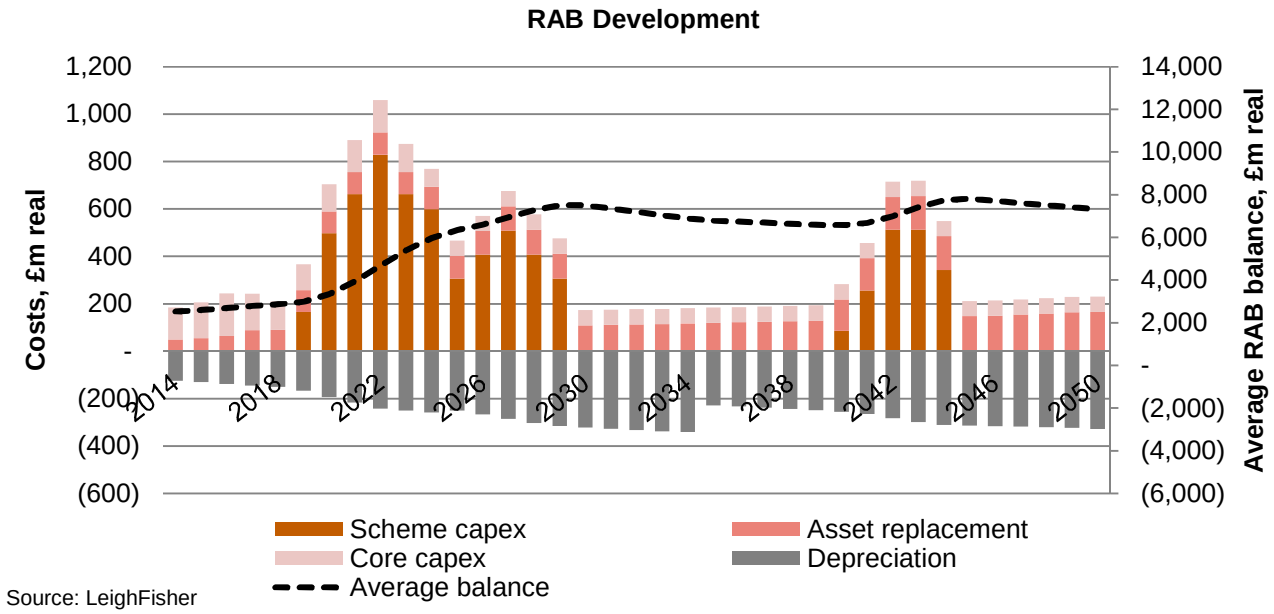
Asset	Depreciation assumption (Years) [16]
Terminal buildings	40
Plant	20
Transit systems	50
Runways	100 (base)
Taxiways and aprons	50
Equipment	20
Environment	0
Asset replacement	30
Airfield ancillary items	40
Tunnels and bridges	50
Car parks	40
Third party land user costs	30
Items currently on the RAB (as of 1 January 2014)	21
Risk[17]	34
Mitigated OB[17]	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.

[16] 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.

[17] 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



Source: LeighFisher

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	16,091
Additions	14,396	26,770
Depreciation	(9,618)	(20,246)
Closing RAB as of 2050	7,280	25,117
Peak (average RAB balance)	7,822	25,286
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 £7.5bn in 2030. The RAB then remains relatively stable before peaking again at £7.8bn 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[18]. 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 Funding and Financing Update 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 Funding and Financing Update report.

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.

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.

[18] 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).

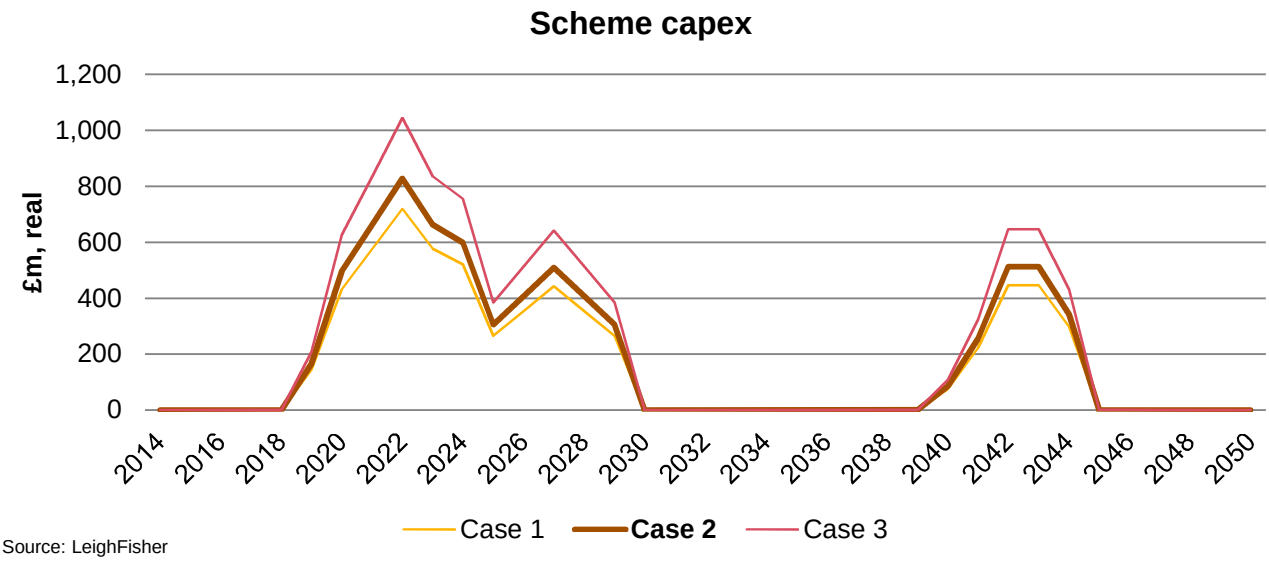
Table 9: Scheme phases and capex

Phase	Passenger capacity (mppa)	Opening year	Works	Scheme capex, (£m, real)	%
0	Not applicable[19]	2025	• Full length runway • Associated airfield works	3,313	47%
1	60	2030	• First phase of terminal works • Expansion of the airfield as required to serve the terminals	2,036	29%
2	75	2045	• Second phase of terminal works • Incremental airfield works	1,710	24%
Total Cost (R20, MOB15)				**7,060**	**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[20].

The AC has calculated a range of costs for the LGW 2R scheme (see Figure 7 and Table 10).

Figure 7: Scheme capex profiles



Source: LeighFisher

[19] Phase 1 is triggered when ATM movements will be in excess of 280,000 per year, not on passenger numbers.

[20] See the assessment of delivery published as part of the consultation documentation in November 2014.

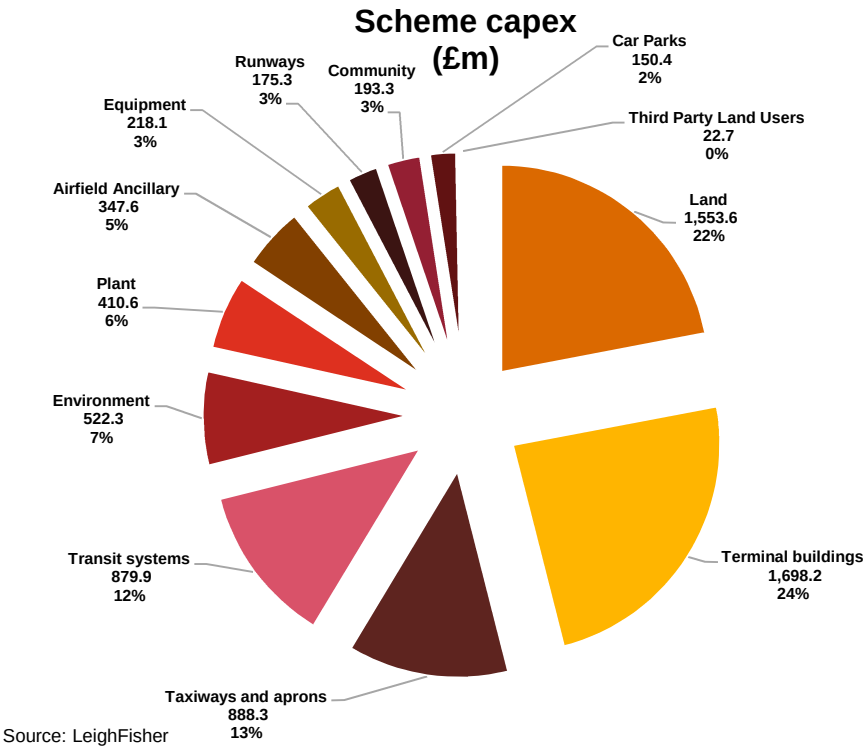
Table 10: Total scheme capex

Source	Cost scenarios	LGW 2R scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	6,140	10,498	3,901
	Case 2 (R20, MOB15)	**7,060**	**12,073**	**4,486**
	Case 3 (R20, FOB45)	8,902	15,223	5,656

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 14. Operational Efficiency: Ground-Infrastructure Gatwick Airport Second Runway report. 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[21]. Phase 1 construction is proposed to take place from 2024 to 2029 with facilities opening in 2030 and a second phase of terminal development and associated works would commence in 2040, 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 £1,911m[22].

Figure 8 presents a breakdown of the AC's view of scheme capex by the cost categories given in Table 2 (total £7,061m).

Figure 8: Scheme capex breakdown



Source: LeighFisher

Together, the cost of terminal buildings and land make up 46% of the total scheme capex costs. Taxiways and aprons are the next largest cost at 13% of the total, followed by transit systems at 12%. The remaining costs, in

[21] See the assessment of delivery published as part of the consultation documentation in November 2014.

[22] 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.

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).

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.

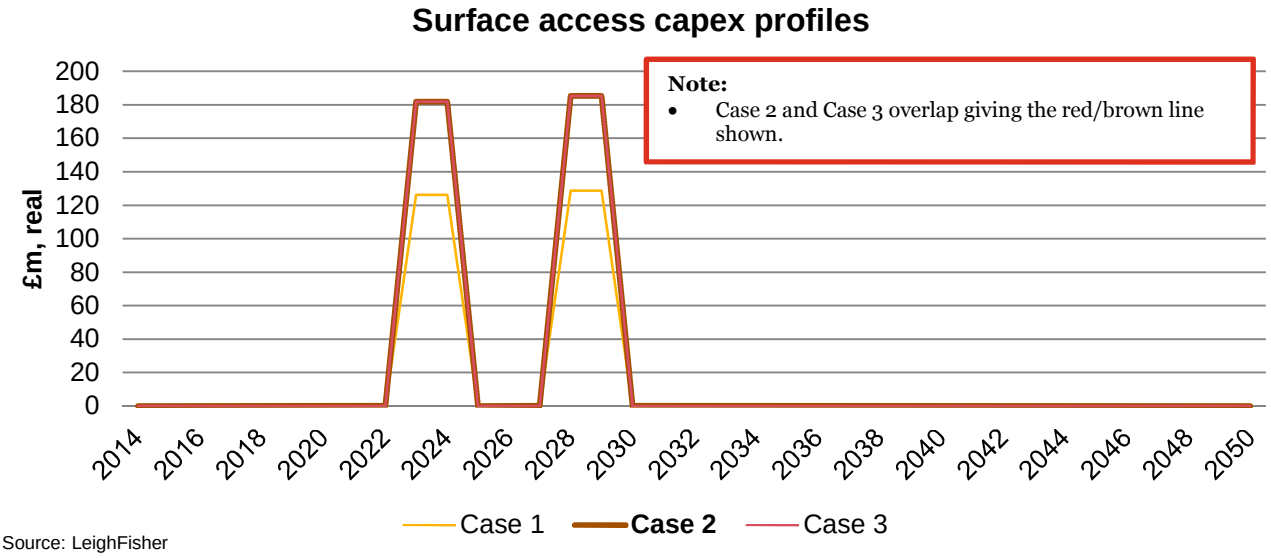
Table 11: Surface access capex breakdown

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%

Route	Type	Proposed works	Road/Highway length (km)	Capex, real (£m)	%
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 (Ro, 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.

Figure 9: Surface access capex profiles[23]



Source: LeighFisher

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

Table 12: Total surface access capex

Source	Case	Total surface access capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	510	774	339
	Case 2 (Ro, MOB44 - roads, MOB66 - rail)	**734**	**1,115**	**487**
	Case 3 (Ro, FOB44 - roads, FOB66 - rail)	734	1,115	487

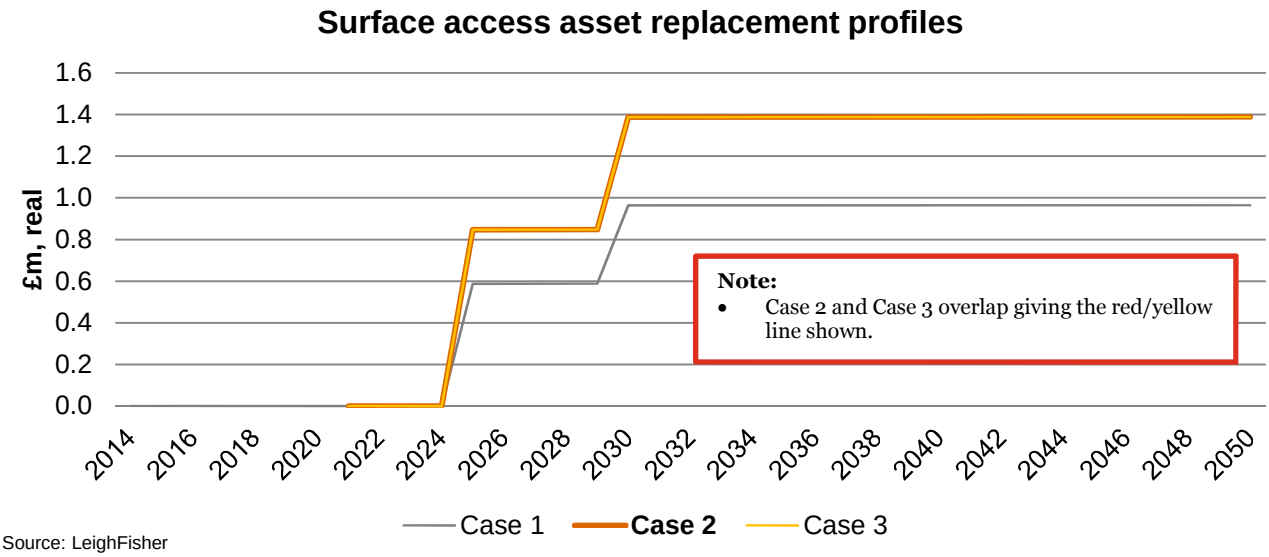
As seen in Figure 9, the surface access works would need to commence by 2023 at the latest. These are works for the re-alignment of the A23, and works to Gatwick Road (addition of a roundabout and approaches) and Balcombe Road (the re-provision of the existing road). These schemes would open just ahead 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.

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 the Cost and Revenue Identification Update LGW 2R report.

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]



Source: LeighFisher

[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.

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 (Ro)	23	55	10
	Case 2 (Ro, MOB44 - roads, MOB66 - rail)	**33**	**79**	**15**
	Case 3 (Ro, FOB44 - roads, FOB66 - rail)	33	79	15

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 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 the Cost and Revenue Identification Update LGW 2R report for further detail on the approach taken in calculating these costs.

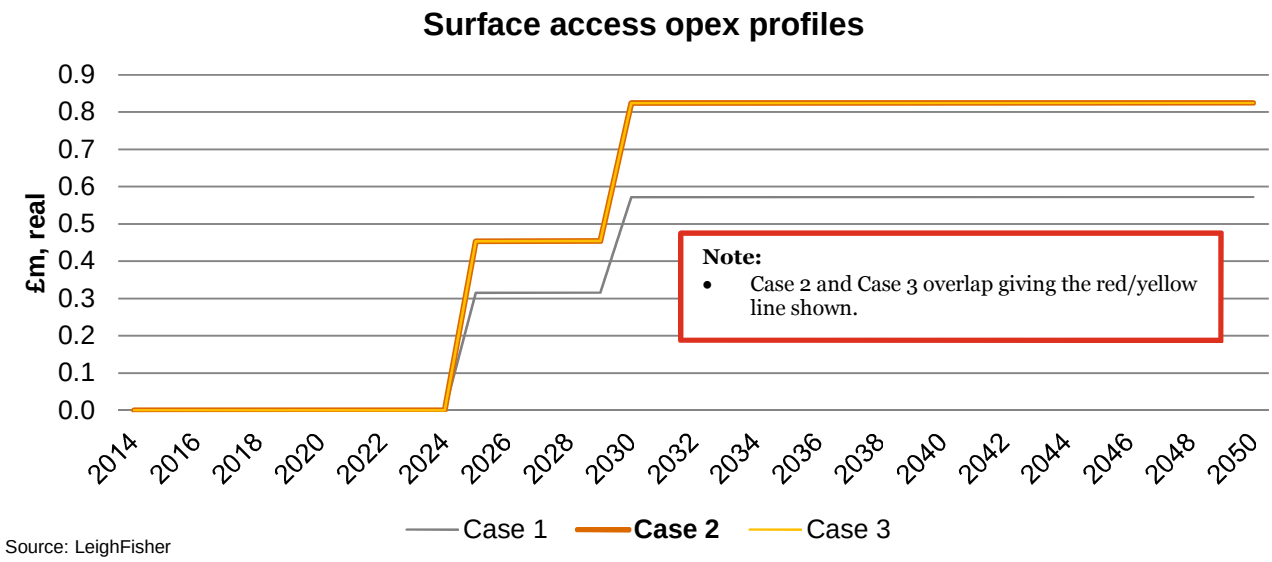
Surface access opex

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.

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

Figure 11: Surface access opex profiles[27]



Source: LeighFisher

Table 14: Total surface access opex

Source	Case	Total surface access opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	14	29	6
	Case 2 (Ro, MOB44 - roads, MOB41 - rail)	**20**	**41**	**9**
	Case 3 (Ro, FOB44 - roads, FOB41 - rail)	20	41	9

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.

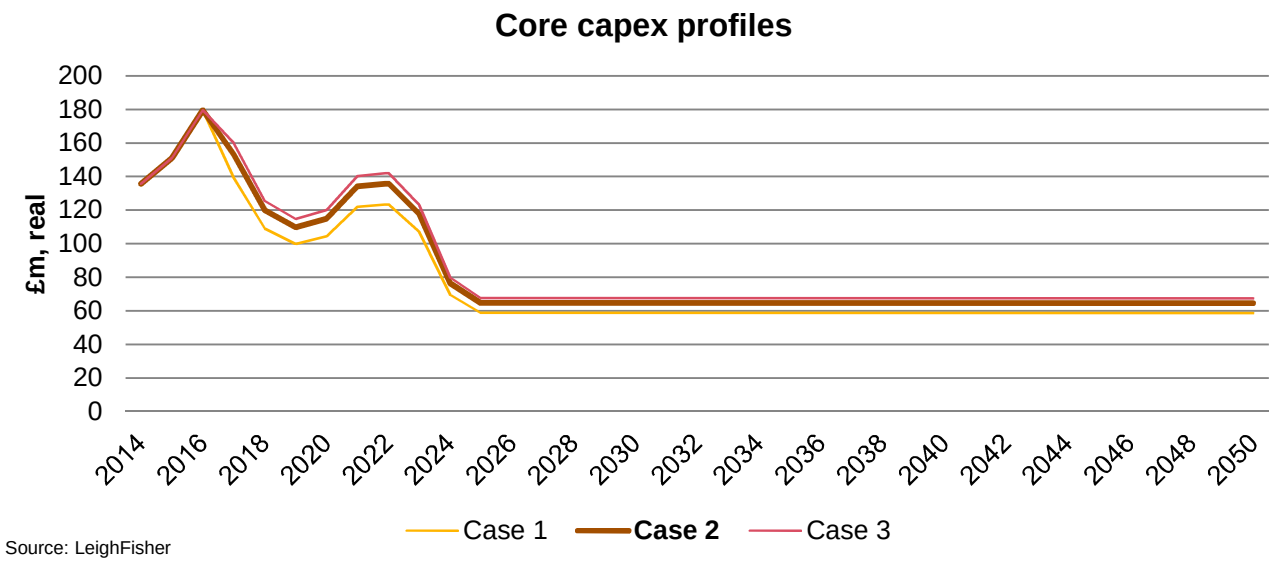
[27] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

[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).

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).

Figure 12: Core capex profiles



Source: LeighFisher

Table 15: Core capex

Source	Cost scenarios	Core capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	2,864	5,107	1,860
	Case 2 (Ro, MOB10)	**3,104**	**5,569**	**2,001**
	Case 3 (Ro, FOB15)	3,224	5,800	2,071

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.

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.

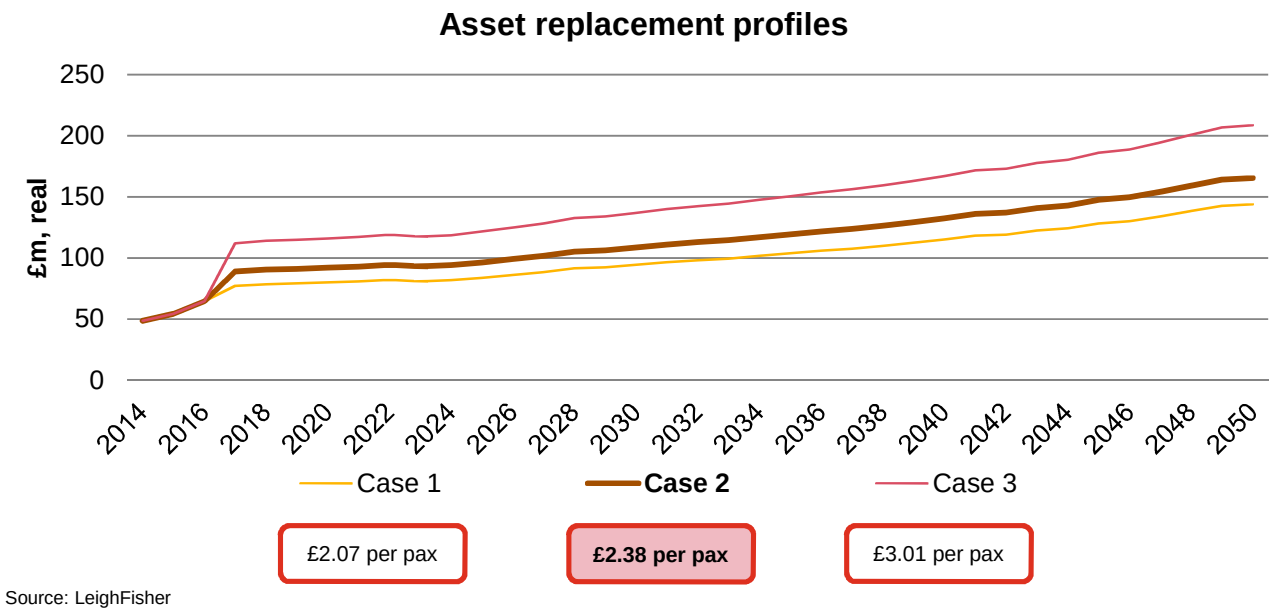
[29] Note that GAL submitted a core capex profile for the period of April 2016 – March 2050 to a total of £2,479m. The AC has only included £2,339m of this total in its estimation of core capex as the remaining £140m does not relate to full years of cost in 2016 and 2050. The AC has therefore used the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

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.

The AC has derived the expenditure rate per passenger from GAL's submitted total asset replacement cost of £4.02bn[31] 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.

Figure 13: Asset replacement profiles



Source: LeighFisher

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, MOB15)	**4,231**	**9,127**	**2,229**
	Case 3 (R20, FOB45)	5,291	11,462	2,768

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[32]. 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

[31] The AC has assumed that GAL's submitted £4.02bn asset replacement cost does not include any risk contingency and therefore risk has been added to this value.

[32] 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[33]. This generates a step up in costs from 2016 to 2017 where costs up to 2016 were generated from the Q6 regulatory settlement.

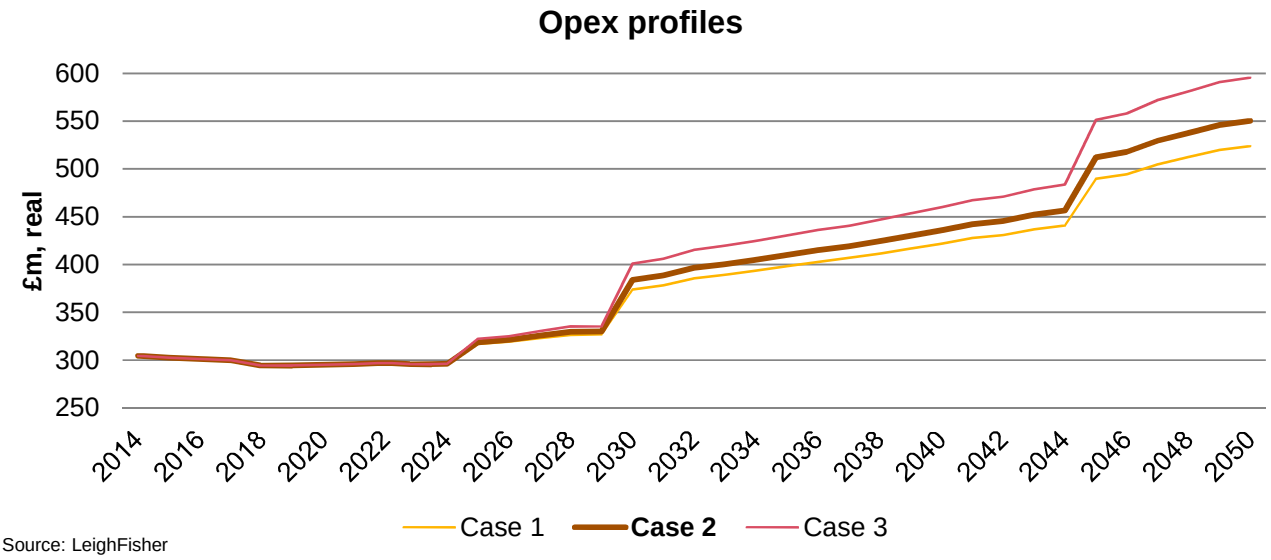
Opex

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[34]:

- In the short term up to 2025, the AC has used the opex breakdown and elasticities[35] (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[36] 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.

Figure 14: Opex profiles



Source: LeighFisher

[33] A detailed explanation of the AC's methodology is available in the separately published the Cost and Revenue Identification Update LGW 2R report.

[34] A detailed explanation of the AC's methodology is available in the separately published Cost and Revenue Identification Update LGW 2R report.

[35] **'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.

[36] 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.

Table 17: Total opex

Source	Cost scenarios	Total opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0.5 per annum)	14,051	26,650	7,570
	Case 2 (R0.5 per annum, MOB15)	**14,402**	**27,453**	**7,711**
	Case 3 (R0.5 per annum, FOB41)	15,010	28,846	7,956

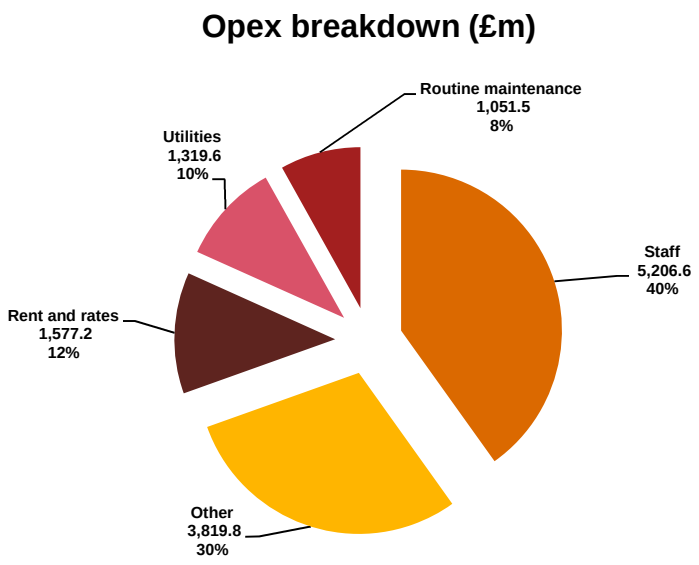
The AC's forecast opex shows stepped increases in line with:

- 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.

Figure 15 presents a breakdown of the AC's view of opex by cost category (total of £12,975m). This excludes risk and OB of £1,427m.

Figure 15: Opex breakdown



Source: LeighFisher

'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.

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:

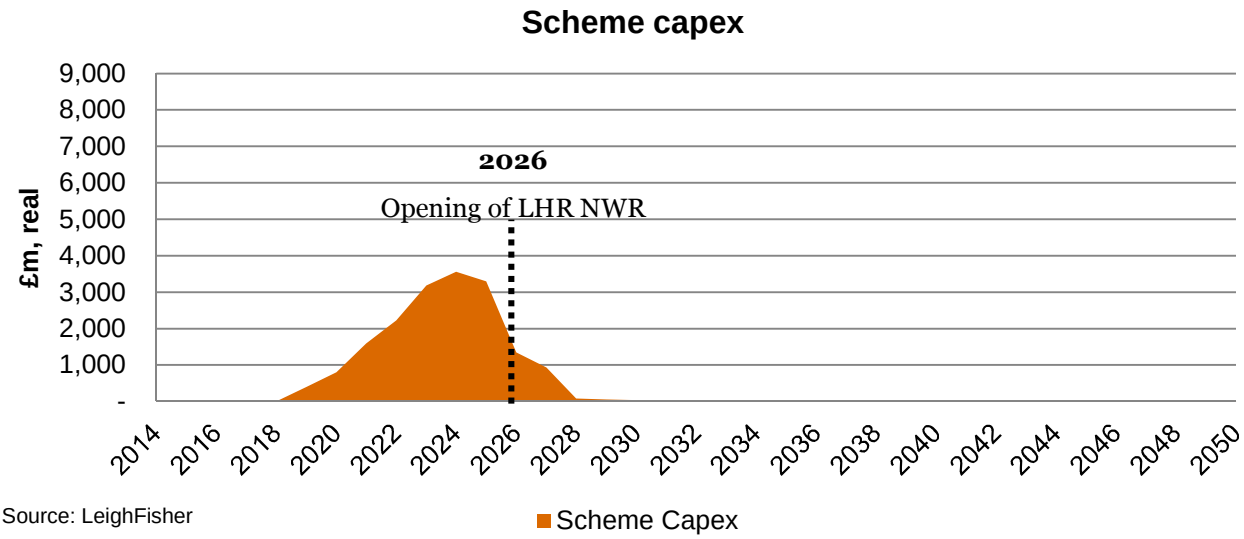
- Cost case: Base Cost + Risk + Mitigated Optimism Bias;
- Demand scenario: Assessment of Need – Carbon Capped; and
- Key sensitivities: None in this document.

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 the Funding and Financing Update report. Information on the detailed costs used in the financial modelling work for all scenarios/sensitivities is provided in the Cost and Revenue Identification Update LHR NWR report.

2.2.1 The LHR NWR scheme capex

The AC's view of the cost of the LHR NWR scheme is **£17,644m** 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



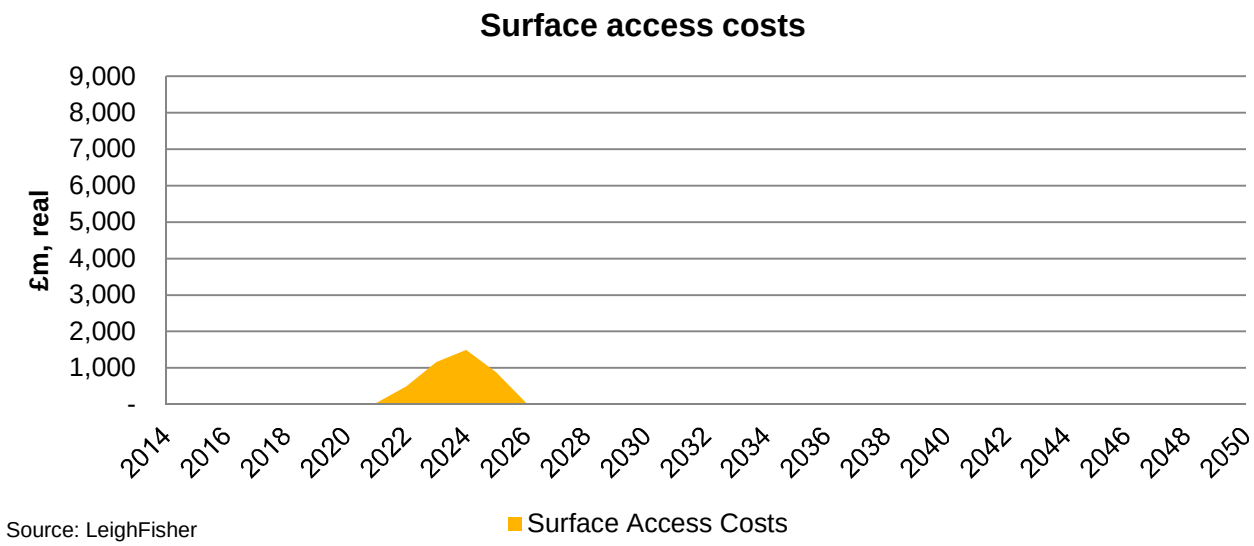
Source: LeighFisher

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 **£4,962m** in real terms. The profile of this expenditure is given in Figure 17 [37].

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 the Funding and Financing Update report.

Figure 17: Surface access costs



Source: LeighFisher

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, MOB15)	17,644	78.1%
Surface access costs (R0, MOB44 – roads, MOB66 – rail capex and surface access, MOB41 – rail opex)	4,962	21.9%
Total	**22,605**	**100%**

[37] 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 (16%) 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.

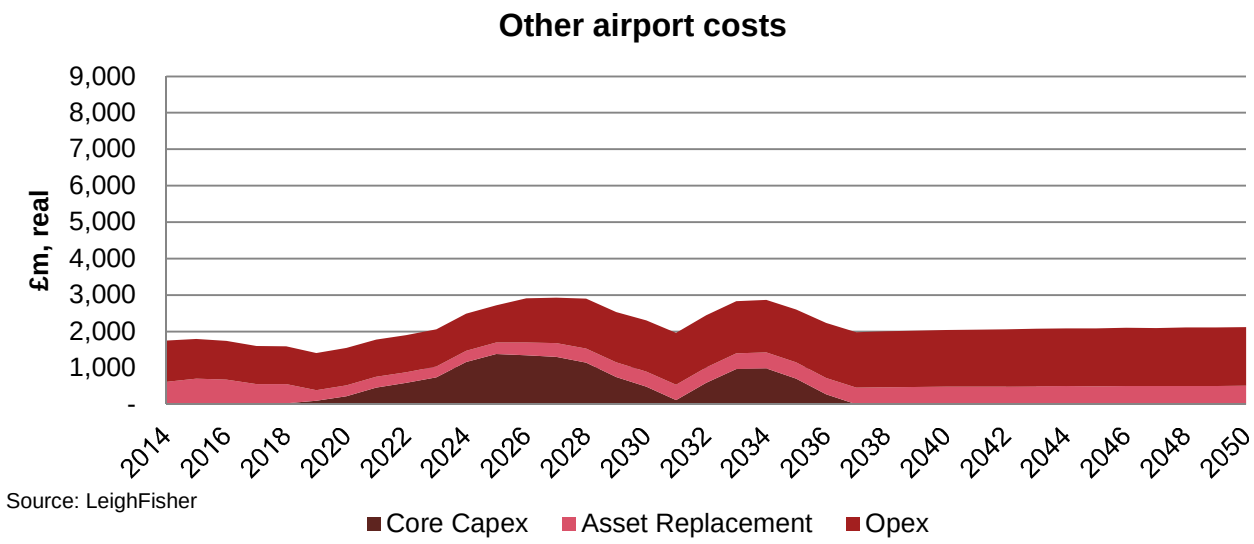
2.2.3 Other airport costs

A key part of the evaluation carried out by the AC is to assess the level 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 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 **£79,819m** 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



Source: LeighFisher

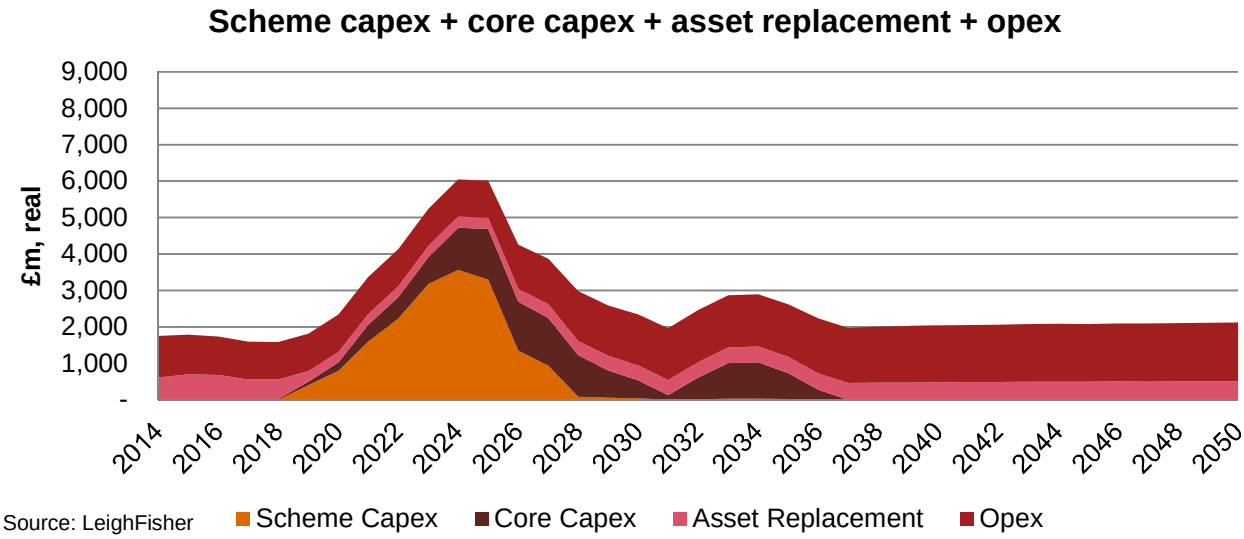
Table 19: Other airport costs

Cost item	Cost (£m, real)	%
Core capex (R0, MOB10)	13,394	16.8%
Asset replacement (R20, MOB15)	16,547	20.7%
Opex (R0.5 per annum, MOB15)	49,878	62.5%
Total	**79,819**	**100.0%**

2.2.4 Financial modelling costs

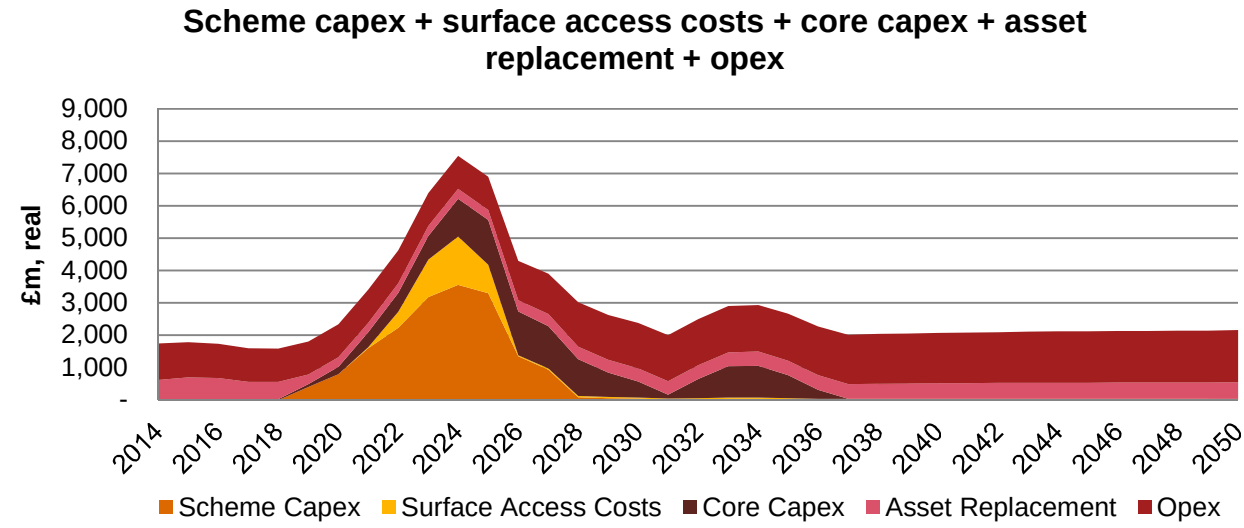
As noted, in order to assess the level of aeronautical charges, the AC has developed a financial model for the airport as a whole, combining the costs identified in sections 2.2.1, 2.2.2 (under certain model sensitivities) and 2.2.3 of this report. The combined impact of these costs over the cost review 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



Source: LeighFisher

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



Source: LeighFisher

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 this approach 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 the Literature Review Update report.

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

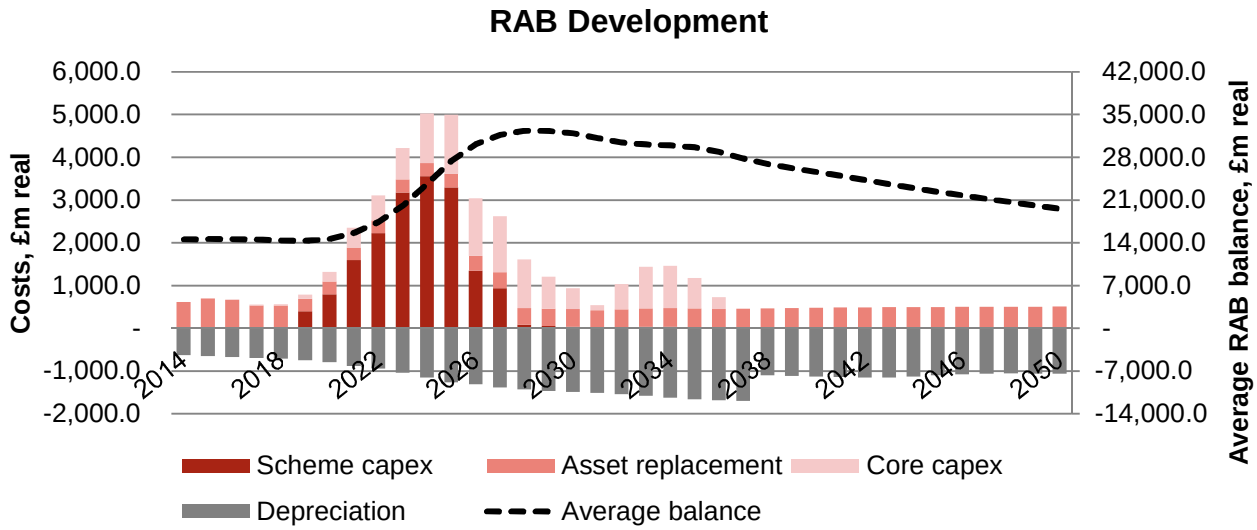
Asset	Depreciation assumption (Years)[38]
Terminal buildings	40
Plant	20
Transit systems	50
Runways	100 (base)
Taxiways and aprons	50
Equipment	20
Environment	0
Asset replacement	30
Airfield Ancillary	40
Tunnels and bridges	50
Car parks	40
Third party land user costs	30
Items currently on the RAB (as of 1 January 2014)	24
Risk[39]	31
Mitigated OB[39]	31

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.

[38] 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.

[39] 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: Cost additions and changes to the RAB



Source: LeighFisher

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	59,410
Additions	47,584	79,801
Depreciation	(42,878)	(87,236)
Closing RAB as of 2050	19,291	66,560
Average RAB balance peak	32,385	67,512
Year average RAB balance peaks	2028	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 average RAB balance increases significantly from 2020 to 2028, reaching its peak of £32.4bn in 2028. This is due to high capital expenditure on major terminal and LHR NWR works in the period. The RAB balance then starts to decrease due to the net impact of depreciation of the capital assets particularly during the final phases of core capex development which include car park and satellite development 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[40]. 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 Funding and Financing Update 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 Funding and Financing Update report.

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.

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).

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.	7,976	45%

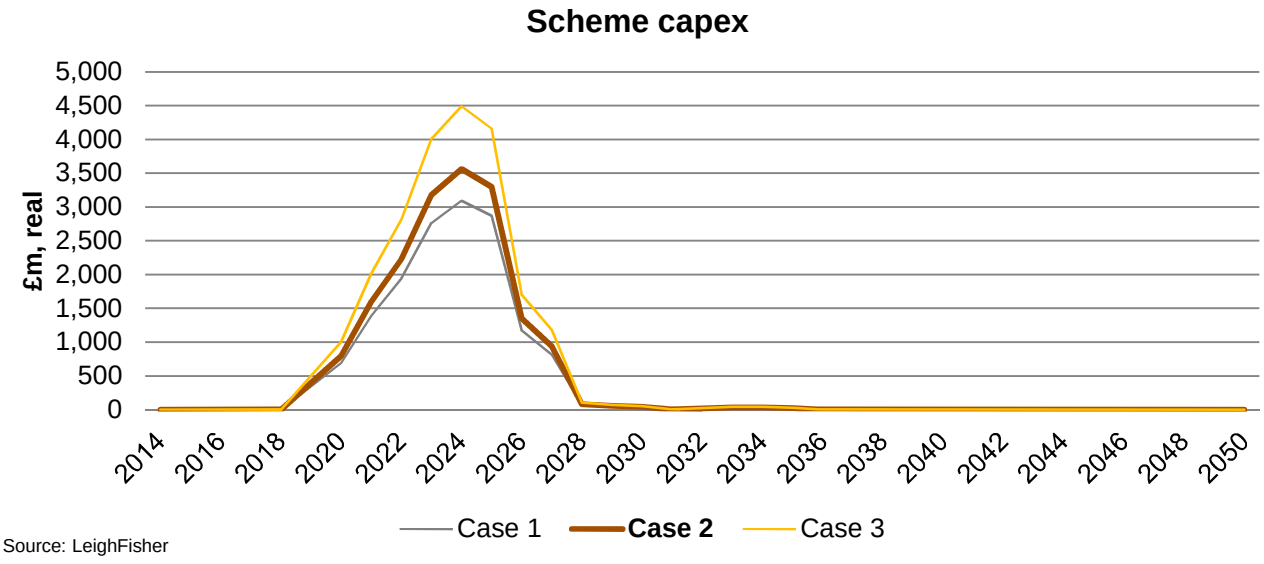
[40] Please refer to the Introduction and methodology of this report for further details on risk and OB and the assumptions used.

2	2026	Additional aircraft stands, Terminal 6 and satellite substructures, superstructures and fit-out, baggage tunnels and Tracked Transit System (TTS) tunnels, car parks	6,334	36%
3	2028	Additional aircraft stands, T2E satellite, baggage tunnels and TTS tunnels, car parks	2,937	17%
4	2031	Car parks	278	2%
5	2036	Car parks	119	1%
Total (R20, MOB15)			**17,644**	**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[41]. 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 phase 2 works would be concurrent with phase 1. Phase 1 starts in 2019 and continues through 2025; Phase 2 starts in 2022 and continues through 2027.

The AC has calculated a range of costs for the LHR NWR scheme (see Figure 22 and Table 24).

Figure 22: Scheme capex profiles



Source: LeighFisher

Table 24: Total scheme capex

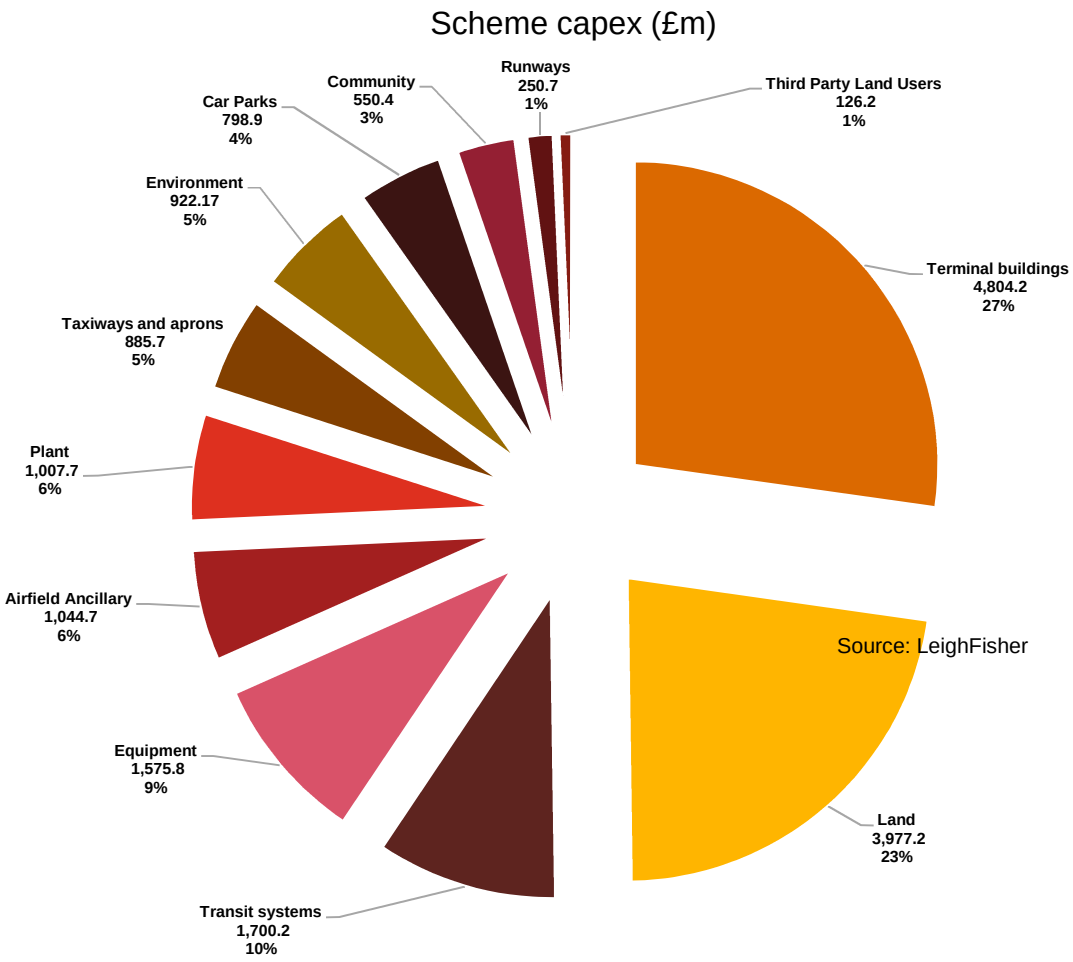
Source	Cost scenarios	LHR NWR scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	15,342	21,414	11,051
	Case 2 (R20, MOB15)	**17,644**	**24,626**	**12,708**
	Case 3 (R20, FOB45)	22,246	31,050	16,023

[41] See the assessment of delivery published as part of the consultation documentation in November 2014.

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.

Figure 23 presents a breakdown of the AC's view of scheme capex by cost category (total £17,644m).

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, £4,804.2m, would be incurred in Phase 2 of the scheme works, between the years 2022 to 2027. Land costs, £3,977.2m, 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).

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 in Table 25.

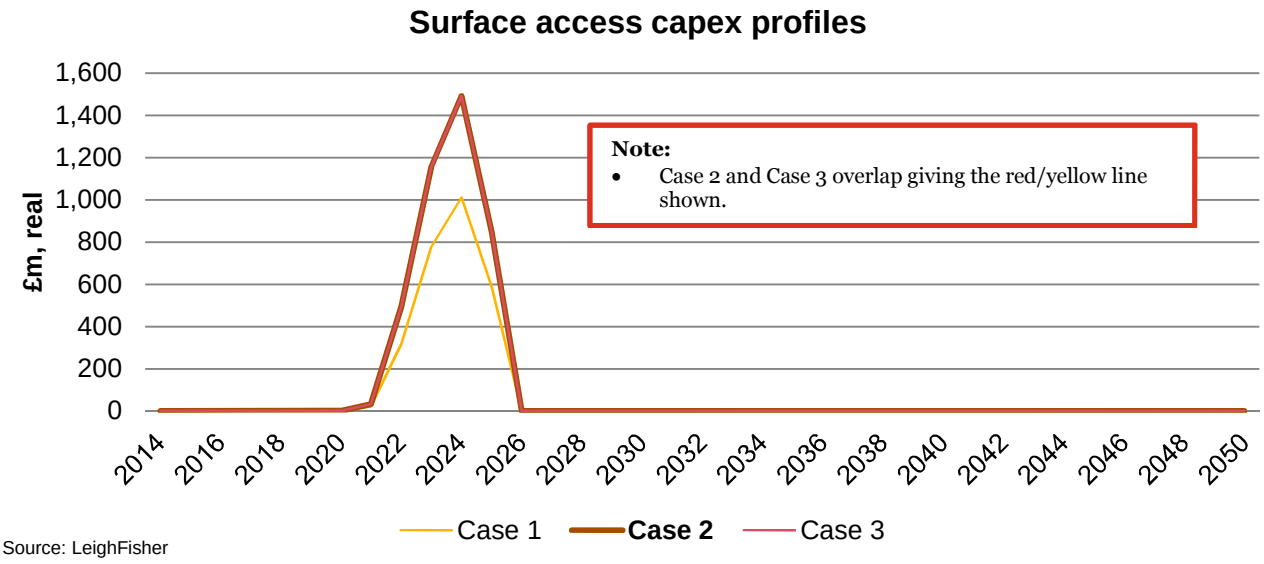
Table 25: Surface access capex breakdown

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	6.8%
M4 Airport Spur	Highway	Road widening in both directions	2.8	202	5.0%
M4 J2 to J3	Highway	Road widening in both directions	17.6	1,267	31.5%
M4 J4 and J4B	Highway	Additional road widening in both directions	4.7	338	8.4%
M4	Highway	Large M4 junction, J4b replacement	n/a	216	5.4%
M4	Highway	Implementation of higher capacity at the M4 junction, J4a	n/a	58	1.4%
M4	Highway	Capacity improvements to existing main airport tunnel	n/a	58	1.4%
M25	Highway	M25 tunnelling costs (south of junction 15)	4.0	576	14.3%
A4	Local Road	Diversion of the A4 road alignment, dual carriageway	3.5	126	3.1%
A3044	Local Road	Diversion of A3044 Road alignment, dual carriageway	1.0	36	0.9%
Airport Way/Southern Perimeter Road Interchange	Local Road	Grade separated junction and flyover/bridge structures	1.0	50	1.3%
Southern Road Tunnel/Southern Perimeter Road Interchange	Local Road	Works for an interchange	1.0	14	0.4%
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	20.1%
Total			**n/a**	**4,027**	**100%**

Route/ Rail project	Type	Works	Road/Highway length (km)	Capex, real (£m)	%
Total for Highways			*32.9*	*2,988*	*74.2%*
Total for Local Roads			*7.5*	*230*	*5.7%*
Total for Rail schemes			*n/a*	*809*	*20.1%*
Total (Ro, MOB44 – roads, MOB66 – rail)			***n/a***	***4,027***	***100%***

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.

Figure 24: Surface access capex profiles[42]



Source: LeighFisher

Table 26: Total surface access capex

Source	Case	Total surface access capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	2,722	3,799	1,953
	Case 2 (Ro, MOB44 - roads, MOB66 - rail)	**4,027**	**5,616**	**2,891**
	Case 3 (Ro, FOB44 - roads, FOB66 - rail)	4,027	5,616	2,891

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 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.

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

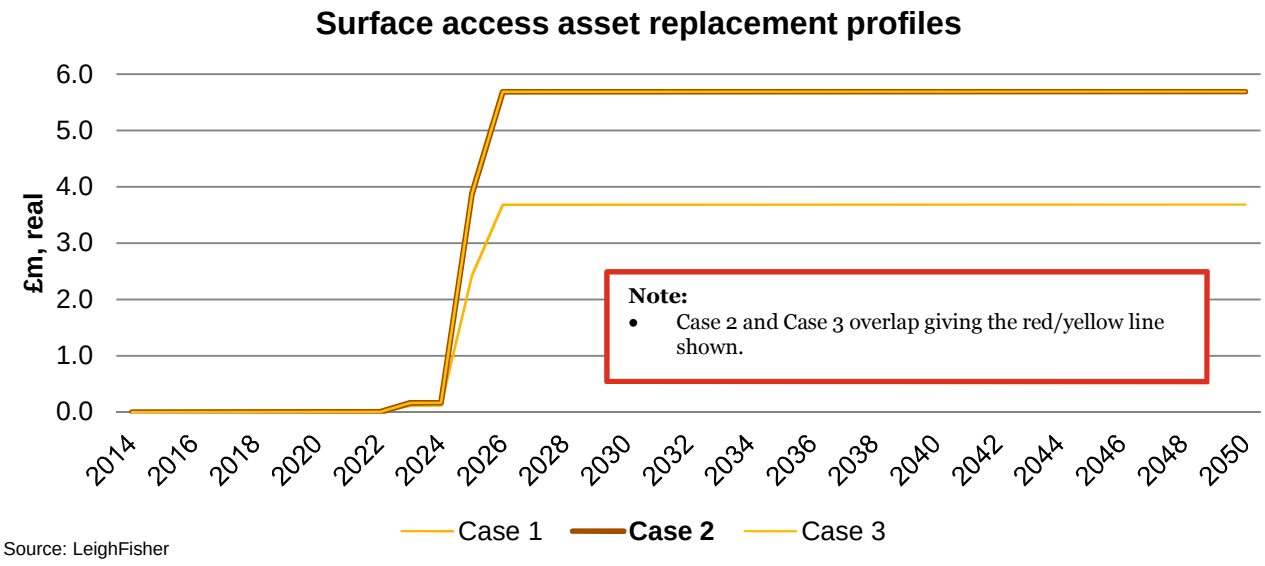
Surface access asset replacement

The AC has calculated road asset replacement costs using Highways Agency (HA) published data[43]. 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 7.5km of local roads requiring maintenance (see Table 25). For further details of this analysis, refer to the Cost and Revenue Identification Update LHR NWR report.

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[44] on per route mile charges paid to Network Rail by existing franchise operators and amounts to £2.9m 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.

Figure 25: Surface access asset replacement profiles[45]



Source: LeighFisher

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 (Ro)	95	221	44
	Case 2 (Ro, MOB44 - roads, MOB66 - rail)	**146**	**341**	**67**
	Case 3 (Ro, FOB44 - roads, FOB66 - rail)	146	341	67

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 £0.2m from 2023 to 2024. Following the completion of the second phase of road schemes in 2025, the annual

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

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

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

asset replacement cost then increases to £1.0m. The annual expenditure then increases following the build out of the third phase and remains at £2.8m 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 £2.9m 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 £5.7m is put towards "a fund" for both road and rail asset replacement costs, reflecting the combined asset replacement costs of £2.8m and £2.9m for road and rail respectively. See the Cost and Revenue Identification Update LHR NWR report for further detail on the approach taken in calculating these costs.

Surface access opex

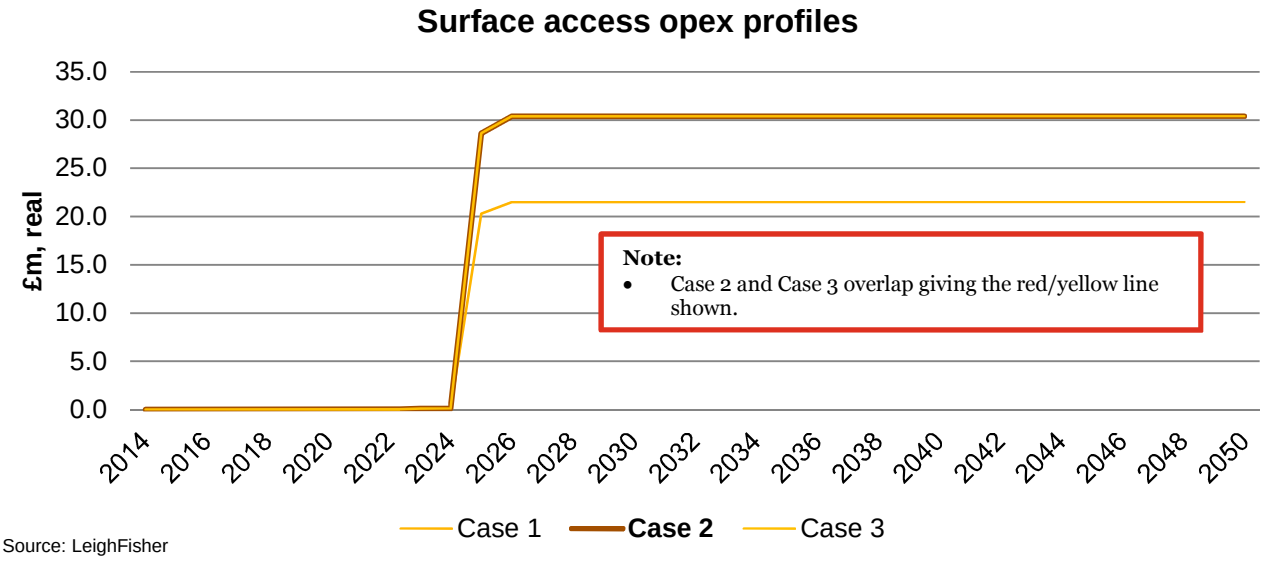
Road opex includes costs for activities such as lighting, drainage and landscaping. The AC has calculated annual road opex using the DfT Cost and Benefit Analysis guidance (2006)[46]. Following a similar approach to the surface access asset replacement costs, the DfT figure of £45k per lane km was used 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 7.5km 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.

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

Figure 26: Surface access opex profiles[47]



Source: LeighFisher

Table 28: Total surface access opex

Source	Case	Total surface access opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	558	1,146	257
	Case 2 (Ro, MOB44 - roads, MOB41 - rail)	**788**	**1,619**	**364**
	Case 3 (Ro, FOB44 - roads, FOB41 - rail)	788	1,619	364

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 £0.1m per annum, ramping up to £0.7m per annum in 2025 to reach the full road opex amount of £2.5m 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 £27.9m per annum.

In total, the full annual spend for opex is £30.4m per annum from 2026, including road and rail schemes[48,49].

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.

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

[48] 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).

[49] 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.

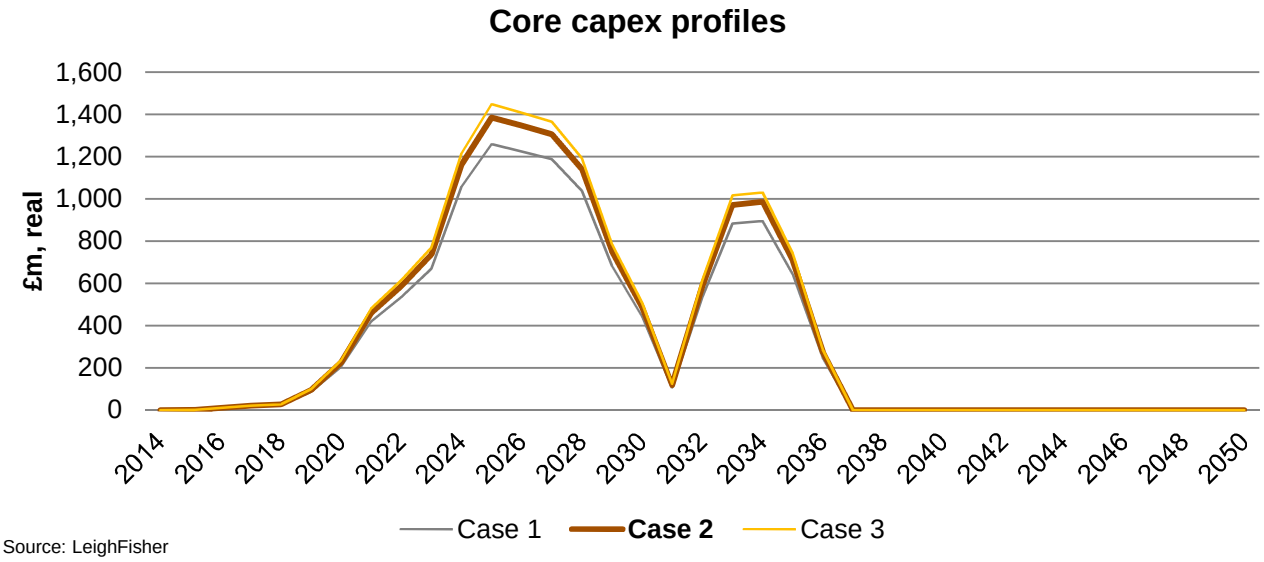
Core capex

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 adjusting for inflation, adopting the surface access cost assessment of the southern road tunnel project (previously included in surface access costs in the November 2014 Financial Modelling Input Costs report), 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).

Figure 27: Core capex profiles[50]



Source: LeighFisher

Table 29: Core capex

Source	Cost scenarios	Core capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	12,181	19,727	7,692
	Case 2 (Ro, MOB10)	**13,394**	**21,694**	**8,456**
	Case 3 (Ro, FOB15)	14,000	22,677	8,838

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.

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

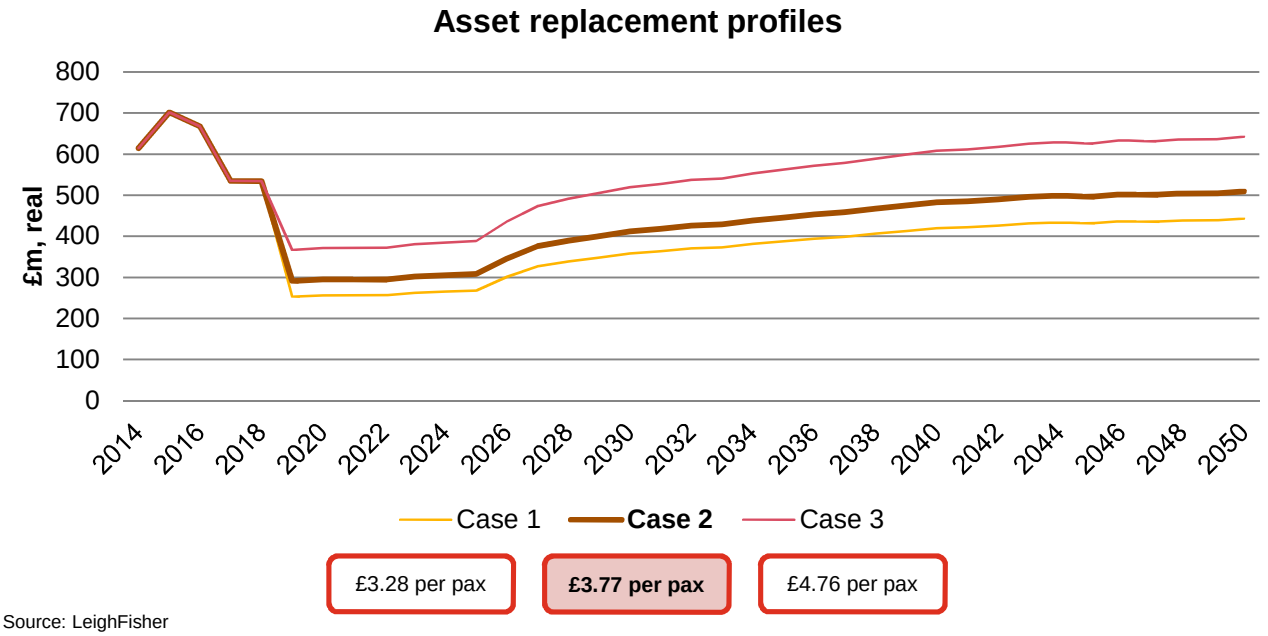
[50] Table 3 of the Introduction and methodology section explains why Case 2 (MOB) and Case 3 (FOB) overlap.

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 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 £9.68bn[51] for the period from 2019 to 2050. A per passenger figure was calculated by dividing this £9.68bn 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.

Figure 28: Asset replacement profiles



Source: LeighFisher

Table 30: Total asset replacement costs

Source	Cost scenarios	Total asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	14,787	29,540	8,629
	Case 2 (R20, MOB15)	**16,547**	**33,482**	**9,494**
	Case 3 (R20, FOB 45)	20,067	41,366	11,223

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

[51] The AC has assumed that HAL's submitted £9.68bn asset replacement cost does not include any risk contingency and therefore risk has been added to this value.

from Heathrow's Q6 regulatory settlement, £3,054m[52]. 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 £9.68n for the period from 2019 to 2050. This generates a significant decrease in the annual asset replacement costs from 2018 to 2019[53].

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[54]:

- 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[55] 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[56] 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.

[52] The Q6 regulatory settlement total is £3,108m (adjusted to 2014 prices) of which £56m 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

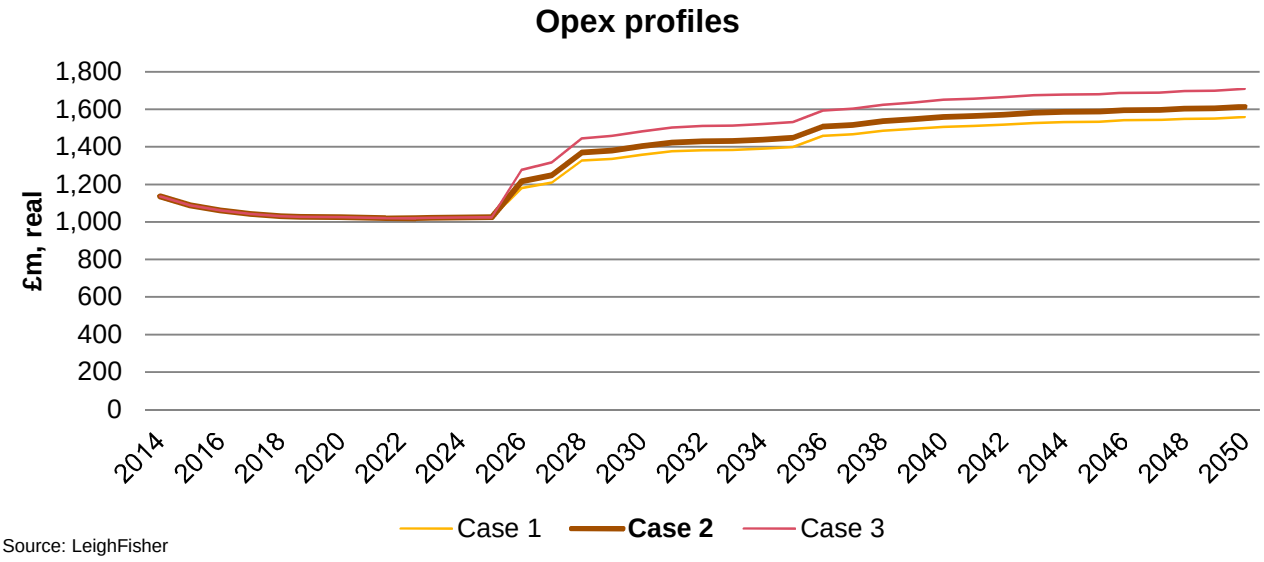
[53] A detailed explanation of the AC's methodology is available in the separately published Cost and Revenue Identification Update LHR NWR report.

[54] A detailed explanation of the AC's methodology is available in the separately published Cost and Revenue Identification Update LHR NWR report.

[55] **'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.

[56] 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 29: Opex profiles



Source: LeighFisher

Table 31: Total opex

Source	Cost scenarios	Total opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro.5 per annum)	48,638	90,904	26,548
	Case 2 (Ro.5 per annum, MOB15)	**49,878**	**93,532**	**27,097**
	Case 3 (Ro.5 per annum, FOB41)	**52,029**	**98,088**	**28,048**

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 a stepped increase in opex, following the opening of the runway in 2026 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[57].

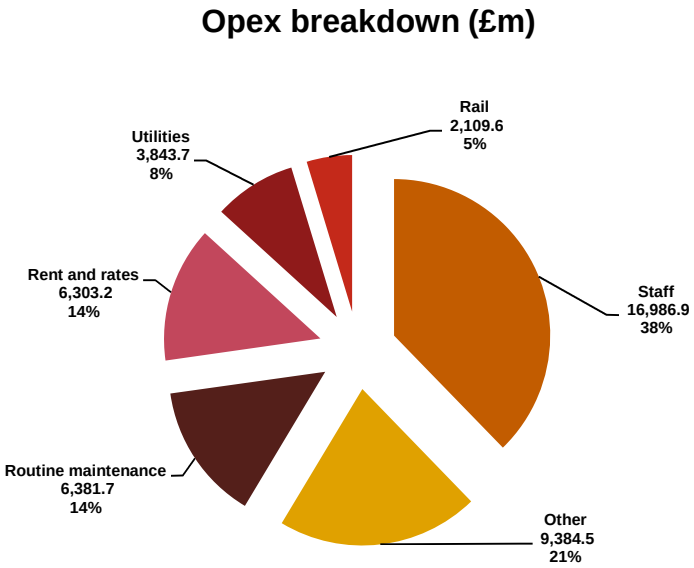
Although some of these cost increases would typically be offset by decreases in costs brought about by efficiency gains in the existing terminals, the step up in fixed costs are in line with the scale of airport expansion that can be expected as a result of the new runway and terminal capacity.

Figure 30 presents a breakdown of the AC's view of opex by cost category (total of £45,010m). This excludes risk and OB of £4,868m.

[57] 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.

Figure 30: Opex breakdown



Source: LeighFisher

'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.

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 has been 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:

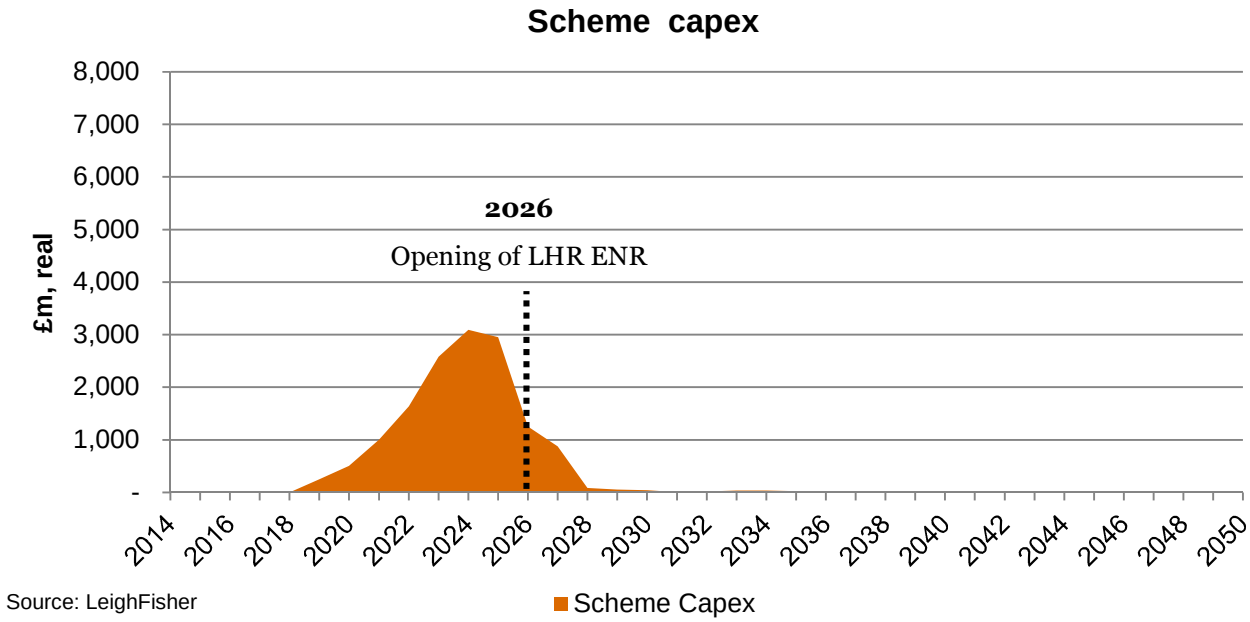
- Cost case: Base Cost + Risk + Mitigated Optimism Bias;
- Demand scenario: Assessment of Need – Carbon Capped; and
- Key sensitivities: None in this document.

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 the Funding and Financing Update report. Information on the detailed costs used in the financial modelling work for all scenarios/sensitivities is provided in the Cost and Revenue Identification Update LHR ENR report.

3.2.1 The LHR ENR scheme capex

The AC's view of the cost of the LHR ENR scheme is **£14,435m** 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



Source: LeighFisher

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 **£5,515m** in real terms. The profile of this expenditure is given in Figure 32[58].

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[59]. The impact of this sensitivity is covered in the Funding and Financing Update report.

[58] 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 32.

[59] 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

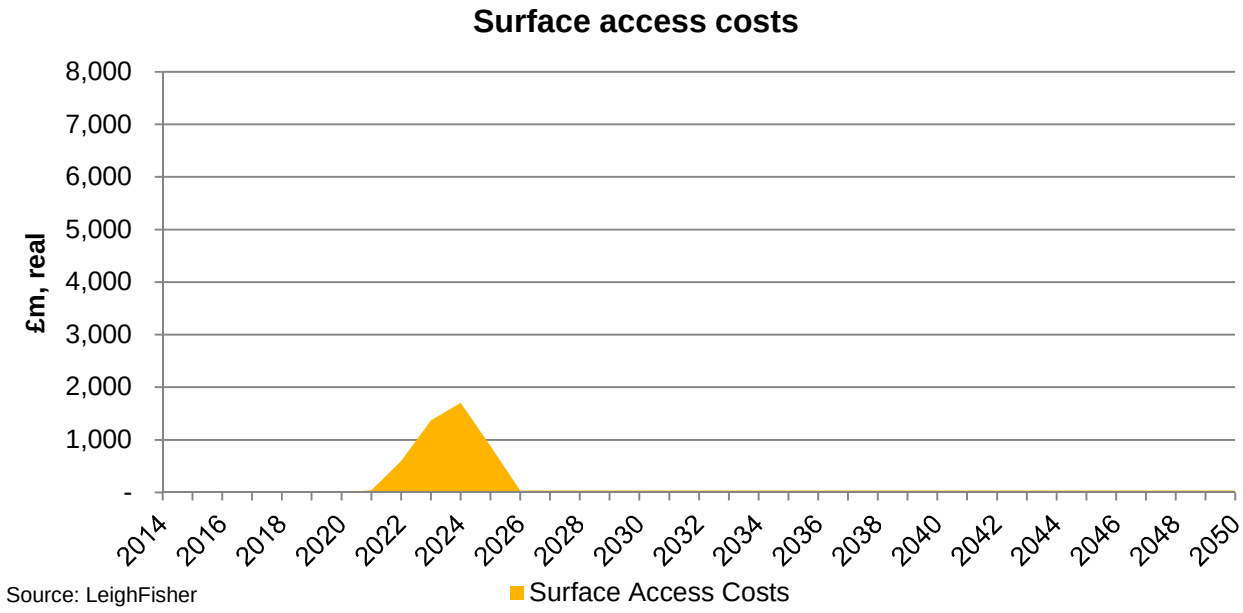


Table 32 presents the AC's view of the overall cost of the LHR ENR scheme including the associated surface access costs.

Table 32: Scheme and surface access costs

Cost item	Cost (£m, real)	%
Scheme capex (R20, MOB15)	14,435	72.4%
Surface access costs (R0, MOB44 – roads, MOB66 – rail capex and surface access, MOB41 – rail opex)	5,515	27.6%
Total	**19,950**	**100.0%**

3.2.3 Other airport costs

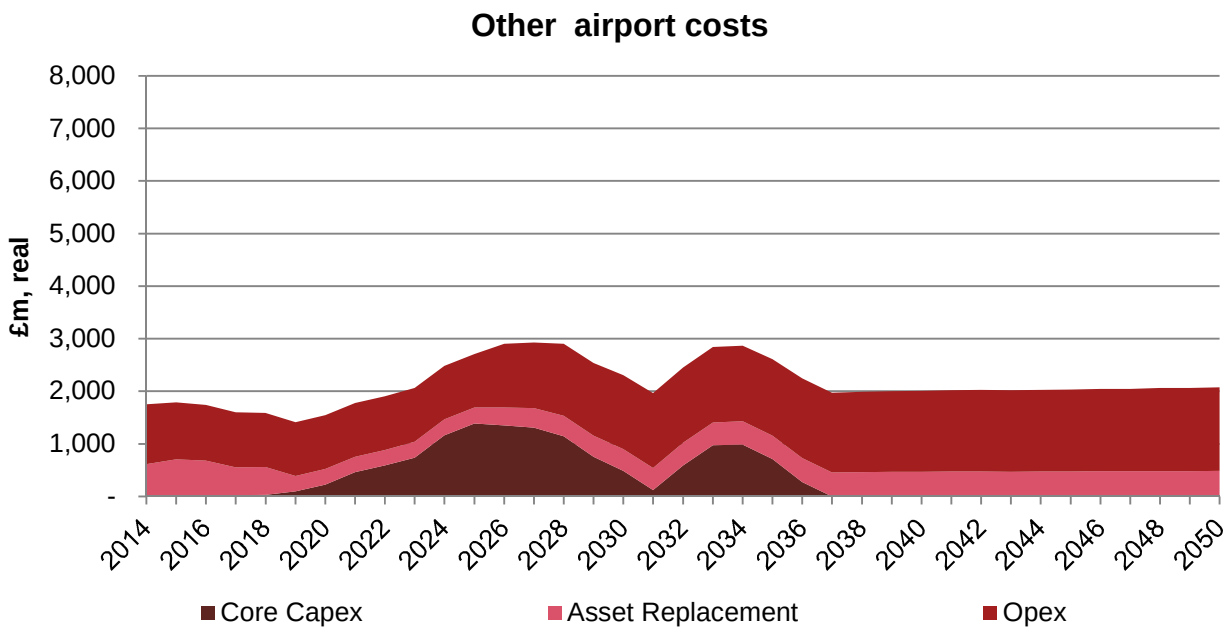
A key part of the evaluation carried out by the AC is to assess the level of aeronautical charges required to develop the scheme. The AC has looked to do this by developing a financial model that considers the entirety of Heathrow Airport[60]. To undertake this analysis, the AC has needed to calculate 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.

[60] 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 **£79,307m** in real terms for the cost review period. The profile for this expenditure is given in Figure 33 and Table 33.

Figure 33: Other airport costs



Source: LeighFisher

Table 33: Other airport costs

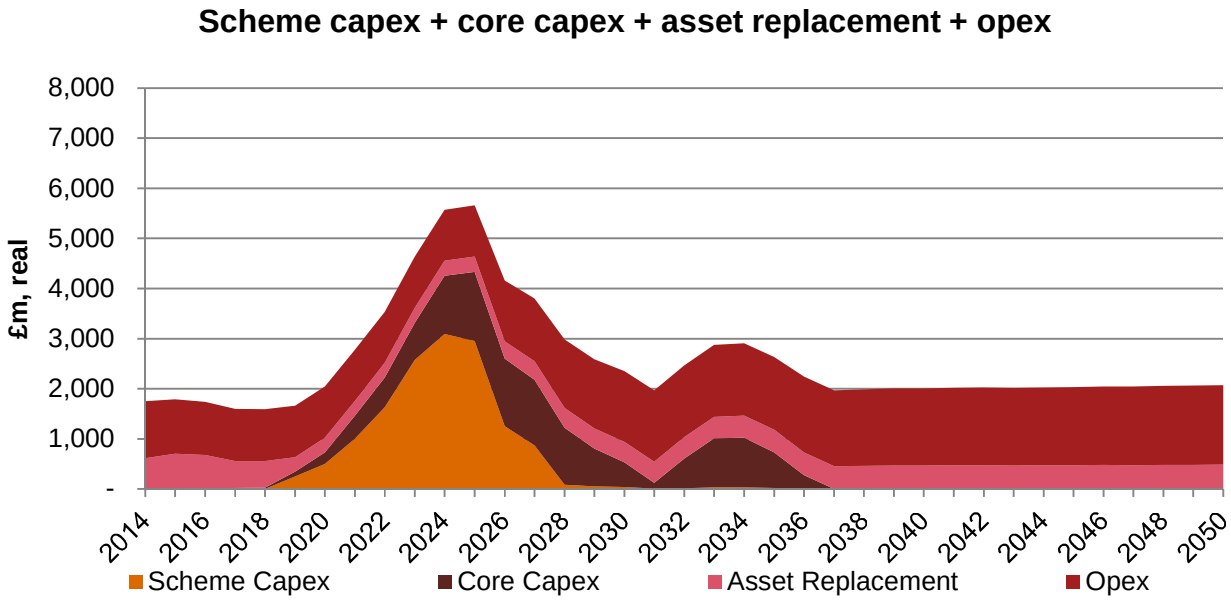
Cost item	Cost (£m, real)	%
Core capex (R0, MOB10)	13,394	16.9%
Asset replacement (R20, MOB15)	16,301	20.6%
Opex (R0.5 per annum, MOB15)	49,612	62.6%
Total	**79,307**	**100.0%**

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[61], 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).

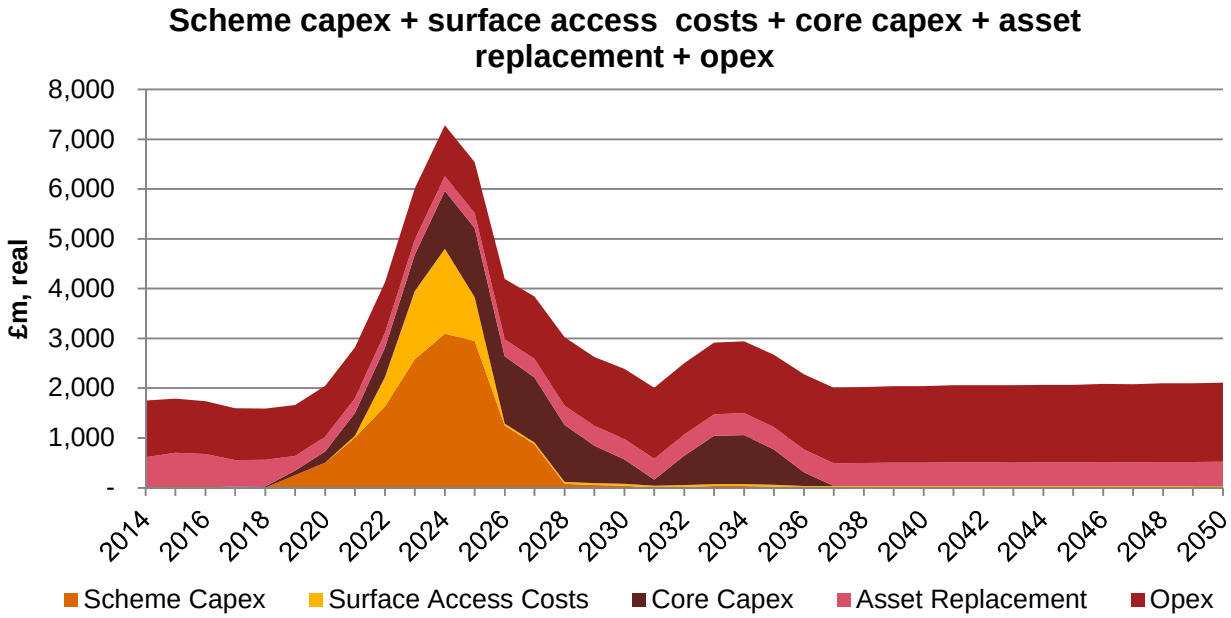
[61] As noted before, it is assumed that HAL, the current operator of Heathrow Airport would implement the LHR ENR scheme if selected. Therefore it is necessary to consider the cost of the LHR ENR scheme as part of Heathrow airport to assess the aeronautical charges.

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



Source: LeighFisher

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



Source: LeighFisher

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 this approach 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[62]. For more information on the RAB and its implication on aeronautical charges, please see the Literature Review Update report.

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

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

replacement costs. The AC has assumed straight line depreciation for all of the capital assets listed in Table 34 below and applied a blended asset life for all asset replacement costs.

Table 34: Asset life assumptions

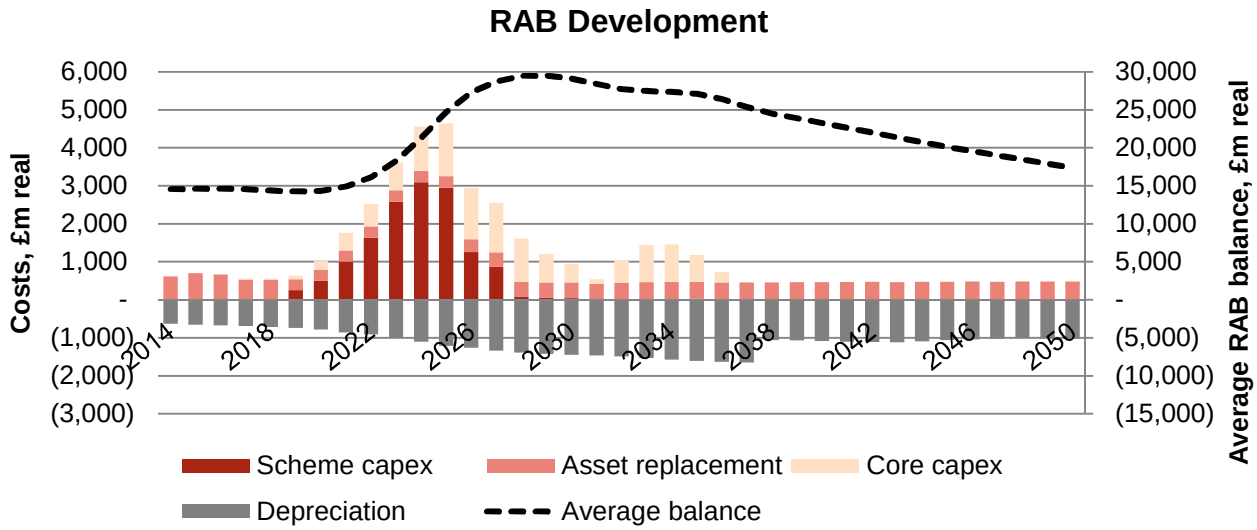
Asset	Depreciation assumption (years)[63]
Terminal buildings	40
Plant	20
Transit systems	50
Runways	100 (base)
Taxiways and aprons	50
Equipment	20
Environment	0
Asset replacement	30
Airfield Ancillary	40
Tunnels and bridges	50
Car parks	40
Third party land user costs	30
Items currently on the RAB (as of 1 January 2014)	24
Risk[64]	31
Mitigated OB[64]	31

Figure 36 and Table 35 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.

[63] 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.

[64] 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: Cost additions and changes to the RAB



Source: LeighFisher

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	54,191
Additions	44,130	74,766
Depreciation	(41,589)	(84,453)
Closing RAB as of 2050	17,126	59,089
Average RAB balance peak	29,499	60,015
Year average RAB balance peaks	2029	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 average RAB balance increases significantly from 2021 to 2029, reaching its peak of £29.5bn in 2029. This is due to high capital expenditure on major terminal and LHR ENR works in the period. The RAB balance then starts to decrease due to the net impact of depreciation of the capital assets particularly during the final phases of core capex development which include car park and satellite development and lower annual capital expenditure. Table 35 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[65]. 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 Funding and Financing Update 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 Funding and Financing Update report.

Structure

Table 36 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.

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 37).

[65] 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

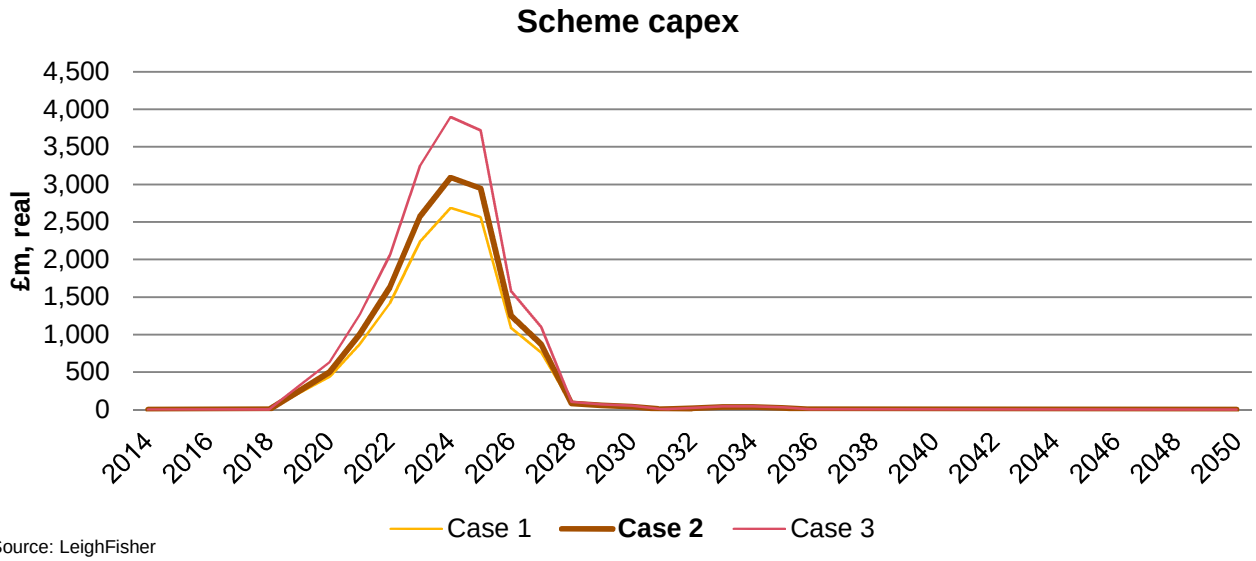
Phase	Opening Year	Works	Scheme Capex, (£m, real)	%
1	2026	Enabling works, runway, taxiways and stands, various airfield ancillary facilities (e.g. Air Traffic Control tower, fire station), airside access roads.	5,018	35%
2	2026	Additional aircraft stands, Terminal 6 and satellite substructures, superstructures and fit-out, baggage tunnels and Tracked Transit System (TTS) tunnels, car parks	6,298	44%
3	2028	Additional aircraft stands, T2E satellite, baggage tunnels and TTS tunnels, car parks	2,722	19%
4	2031	Car parks	278	2%
5	2036	Car parks	119	1%
Total (R20, MOB15)			**14,435**	**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[66]. 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 phase 2 works would be concurrent with phase 1. Phase 1 starts in 2019 and continues through 2025; Phase 2 starts in 2022 and continues through 2027.

The AC has calculated a range of costs for the LHR ENR (see Figure 37 and Table 38).

[66] See the assessment of delivery published as part of the consultation documentation in November 2014.

Figure 37: Scheme capex profiles



Source: LeighFisher

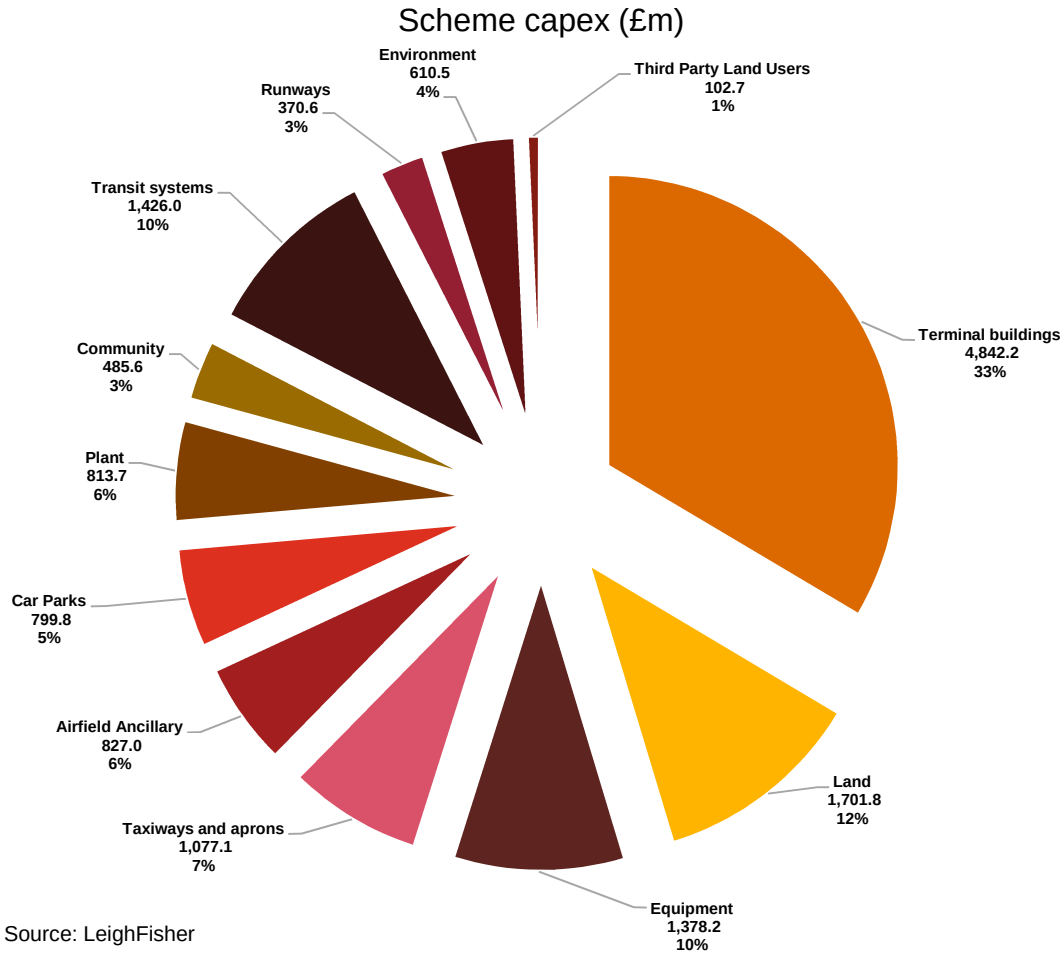
Table 38: Total scheme capex

Source	Cost scenarios	LHR ENR scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	12,552	17,666	8,965
	Case 2 (R20, MOB15)	**14,435**	**20,316**	**10,310**
	Case 3 (R20, FOB45)	18,201	25,616	13,000

The AC's view is that the various phases of the scheme development (described in Table 37) 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.

Figure 38 presents a breakdown of the AC's view of scheme capex by cost category (total of £14,435m).

Figure 38: Scheme capex breakdown



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 £4,842.2m and would be incurred between years 2022 to 2027. Land costs (£1,701.8m) 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).

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[67].

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 in Table 39.

Table 39: Surface access capex breakdown

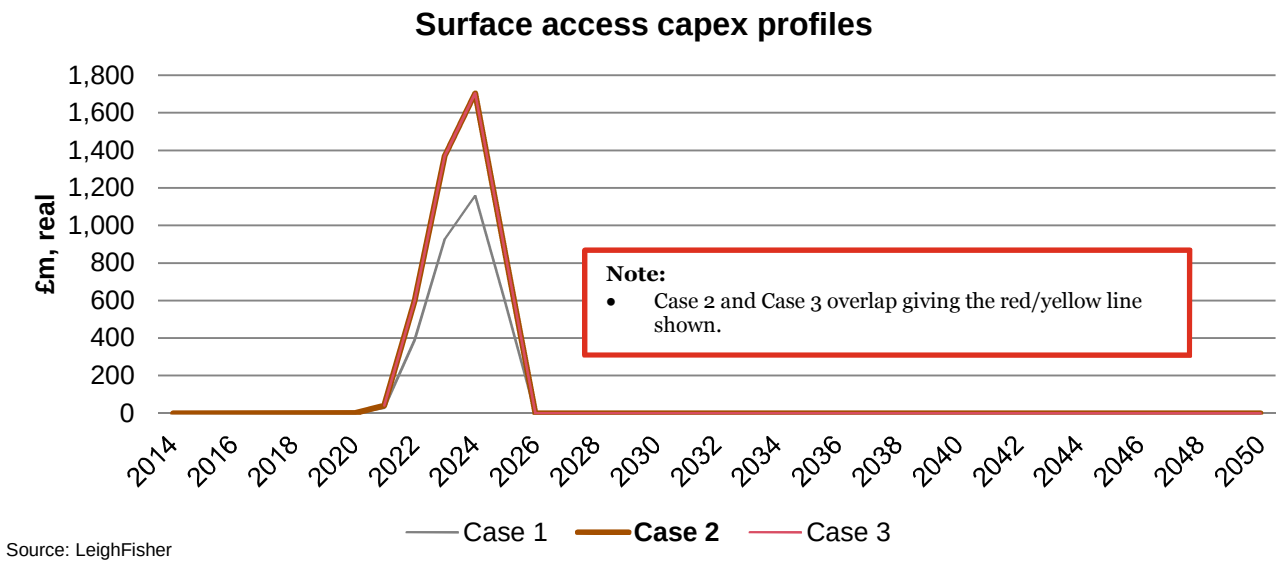
Route/ Rail project	Type	Proposed works	Road/Highway length (km)	Capex, real (£m)	%
M4 J3 to J4	Highway	Hard shoulder running in both directions + additional road widening	3.8	274	6.0%
M4 Airport Spur	Highway	Road widening in both directions	2.8	202	4.4%
M4 J2 to J3	Highway	Road widening in both directions	17.6	1,267	27.8%
M4 J4 and J4B	Highway	Additional road widening in both directions	4.7	338	7.4%
M4	Highway	Large M4 junction, J4b replacement	n/a	216	4.7%
M4	Highway	Implementation of higher capacity at the M4 junction, J4a	n/a	58	1.3%
M4	Highway	Capacity improvements to existing main airport tunnel	n/a	58	1.3%
M25	Highway	M25 tunnelling costs (south of junction 15)	4.0	864	18.9%
Tunnel from A4 to T5	Local Road	Tunnel from A4 to T5	2.1	60	1.3%
Western Tunnel	Local Road	Tunnel running parallel to M25 - expected to have light traffic	3.0	86	1.9%
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	Southern Road Tunnel/Southern Perimeter Road Interchange	1.0	29	0.6%
M25 J13 (A13) D2	Local Road	New D2 link from junction 13	3.9	140	3.1%
M25 J13 (A13)	Local Road	Providing new spur access	n/a	50	1.1%
A4 Access	Local Road	Single lane widening	2.7	58	1.3%

[67] 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)	%
Southern Rail Access (SRA) to Staines	Rail	New Southern Access	n/a	809	17.7%
Total			**n/a**	**4,560**	**100%**
Total for Highways			*32.9*	*3,276*	*71.8%*
Total for Local Roads			*13.7*	*475*	*10.4%*
Total for Rail schemes			*n/a*	*809*	*17.7%*
Total (Ro, MOB44 - roads, MOB66 - rail)			***n/a***	***4,560***	***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 40.

Figure 39: Surface access capex profiles[68]



Source: LeighFisher

Table 40: Total surface access capex

Source	Case	Total surface access capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	3,093	4,307	2,223
	Case 2 (Ro, MOB44 - roads, MOB66 - rail)	**4,560**	**6,348**	**3,280**
	Case 3 (Ro, FOB44 - roads, FOB66 - rail)	4,560	6,348	3,280

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

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 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.

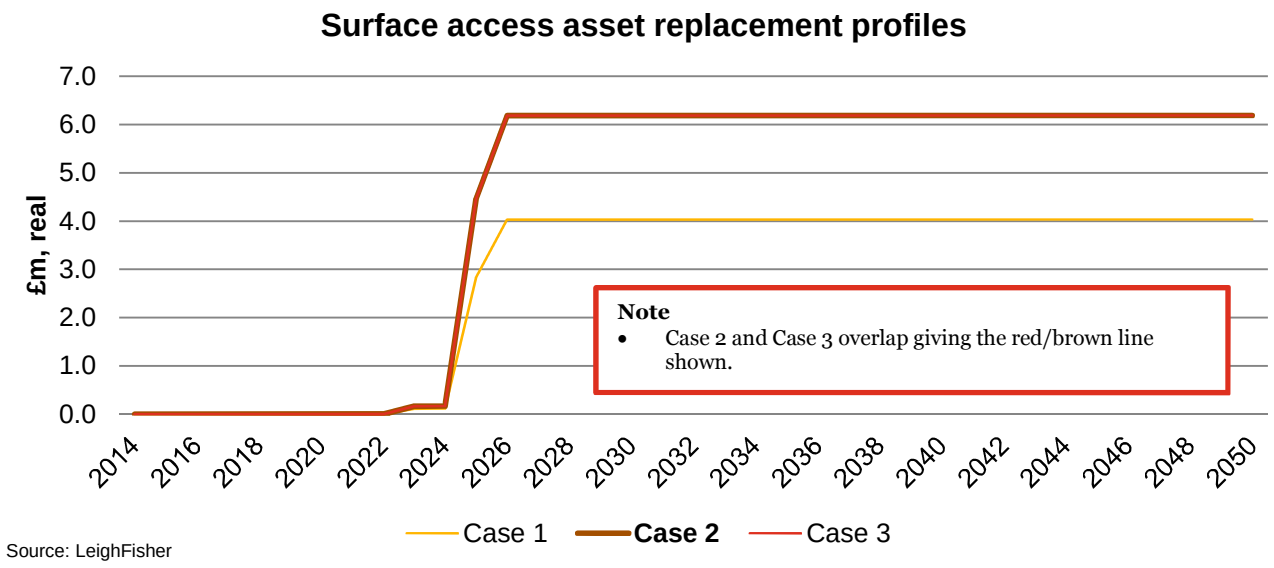
Surface access asset replacement

The AC has calculated road asset replacement costs using Highways Agency (HA) published data[69]. 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 13.7km of local roads requiring maintenance (see Table 39). For further details of this analysis, refer to the Cost and Revenue Identification Update LHR ENR report.

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[70] on per route mile charges paid to Network Rail by existing franchise operators and amounts to £2.9m 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 41.

Figure 40: Surface access asset replacement profiles[71]



Source: LeighFisher

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

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

[71] 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 opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	104	242	48
	Case 2 (Ro, MOB44 - roads, MOB41 - rail)	**160**	**371**	**73**
	Case 3 (Ro, FOB44 - roads, FOB41 - rail)	160	371	73

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 £0.2m from 2023 to 2024. Following the completion of the second phase of road schemes in 2025, the annual asset replacement cost then increases to £1.6m. The annual expenditure then increases following the build out of the third phase and remains at £3.3m 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 £2.9m 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 £6.2m is put towards "a fund" for both road and rail asset replacement costs, reflecting the combined asset replacement costs of £3.3m and £2.9m for roads and rail respectively. See the Cost and Revenue Identification Update LHR ENR report for further detail on the approach taken in calculating these costs.

Surface access opex

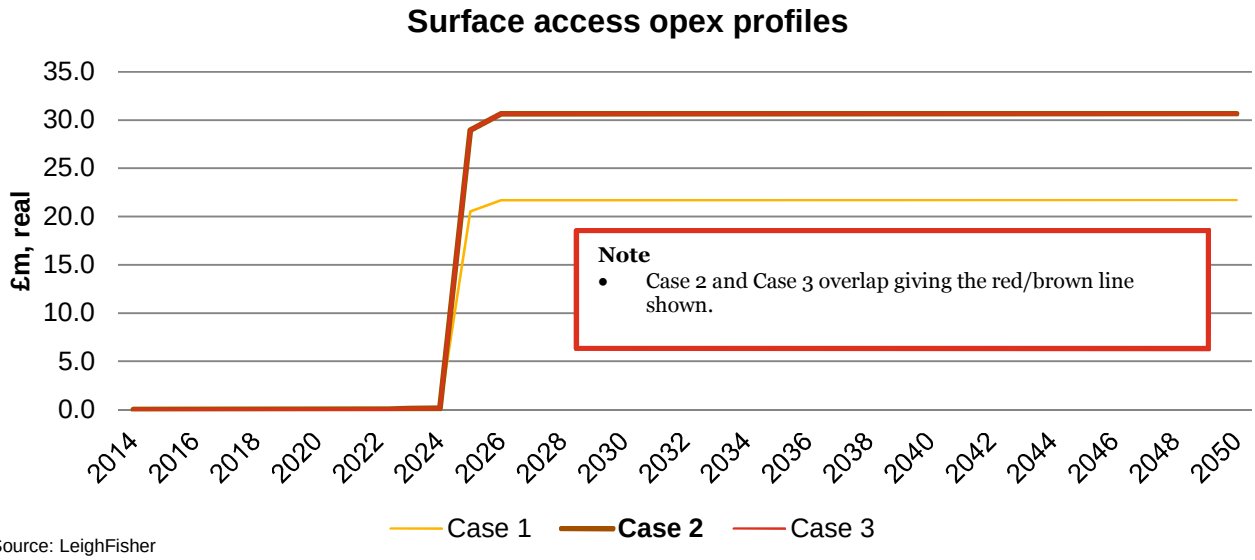
Road opex include activities such as lighting, drainage and landscaping. The AC has calculated annual road opex using the DfT Cost and Benefit Analysis guidance (2006)[72]. Following a similar approach to the surface access asset replacement costs, the DfT figure of £45k per lane km was used for highways, 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 13.7km 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 ENR scheme and these are presented in Figure 41 and Table 42.

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

Figure 41: Surface access opex profiles[73]



Source: LeighFisher

Table 42: Total surface access opex

Source	Case	Total surface access opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro)	563	1,156	260
	Case 2 (Ro, MOB44 - roads, MOB41 - rail)	**795**	**1,633**	**367**
	Case 3 (Ro, FOB44 - roads, FOB41 - rail)	795	1,633	367

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 £0.09m per annum, ramping up to £1.03m per annum in 2025 to reach the full road opex amount of £2.72m 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 from 2026, including road and rail schemes[74,75].

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

[74] 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).

[75] 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.

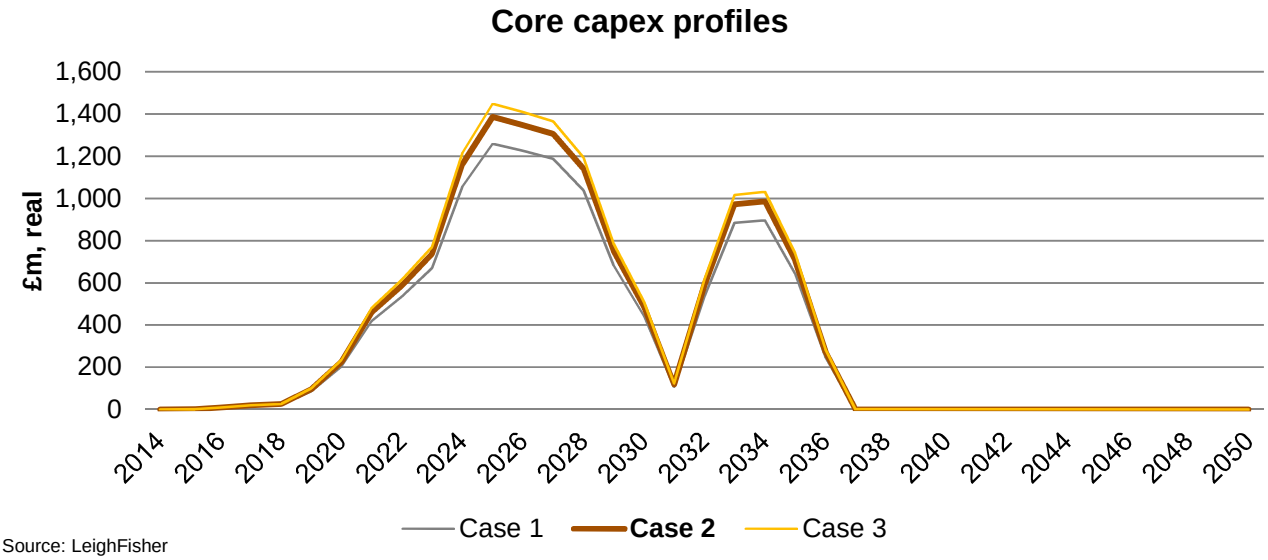
Core capex

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[76]. 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 adjusting for inflation, adopting the surface access cost assessment of the southern road tunnel project (previously included in surface access costs), 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 43).

Figure 42: Core capex profiles



Source: LeighFisher

Table 43: Core capex

Source	Cost scenarios	Core capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0)	12,181	19,727	7,692
	Case 2 (R0, MOB10)	**13,394**	**21,694**	**8,456**
	Case 3 (R0, FOB15)	14,000	22,677	8,838

[76] 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.

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.

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.

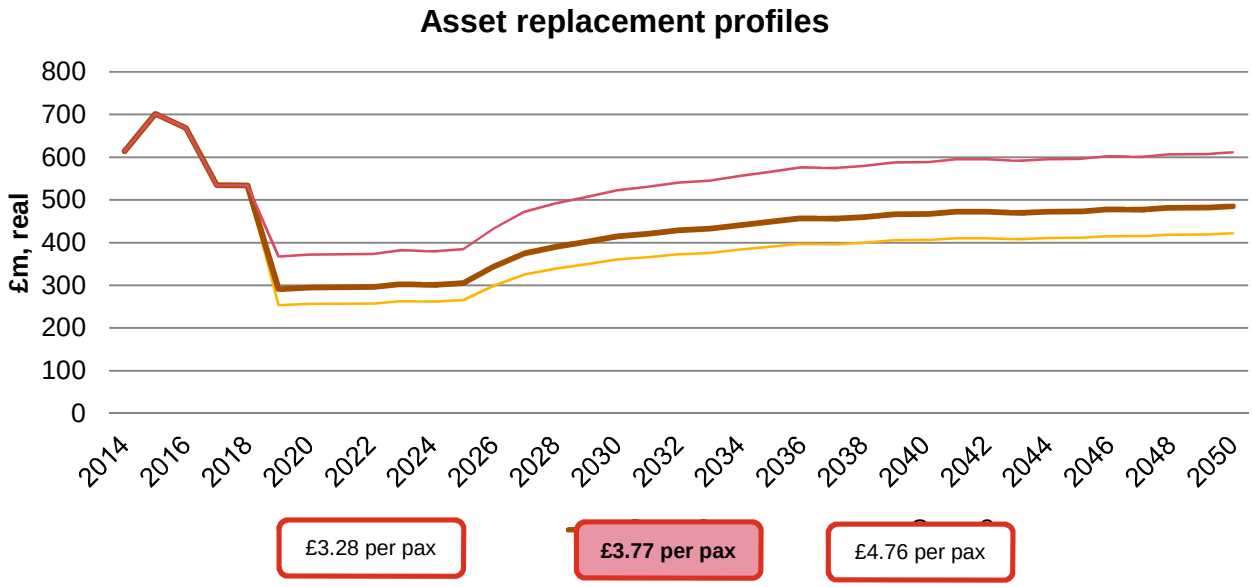
The AC has calculated asset replacement costs for the whole airport, including costs associated with the LHR ENR scheme. Because it is not possible to identify specific assets that will be built/refurbished at this time, the AC has calculated these costs by assuming an expenditure rate per passenger, 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 derived the expenditure rate per passenger for the LHR ENR scheme from HAL's submitted total asset replacement cost of £9.68bn for the period from 2019 to 2050. A per passenger figure was calculated by dividing this £9.68bn by the total number of passengers in the same period based on the HHL demand profile[77,78]. 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 44.

[77] The AC has assumed that HAL's submitted £9.68bn asset replacement cost does not include any risk contingency and therefore risk has been added to this value.

[78] While HHL has provided asset replacement costs, the AC has taken a view that HAL's asset replacement cost of £9.68bn 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 the Cost and Revenue Identification Update LHR ENR report.

Figure 43: Asset replacement profiles



Source: LeighFisher

Table 44: Total asset replacement costs

Source	Cost scenarios	Total asset replacement costs		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	14,573	28,909	8,555
	Case 2 (R20, MOB15)	**16,301**	**32,756**	**9,409**
	Case 3 (R20, FOB45)	19,757	40,450	11,117

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[79]. 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 £9.68bn for the period from 2019 to 2050. This generates a significant decrease in costs from 2018 to 2019.

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[80]:

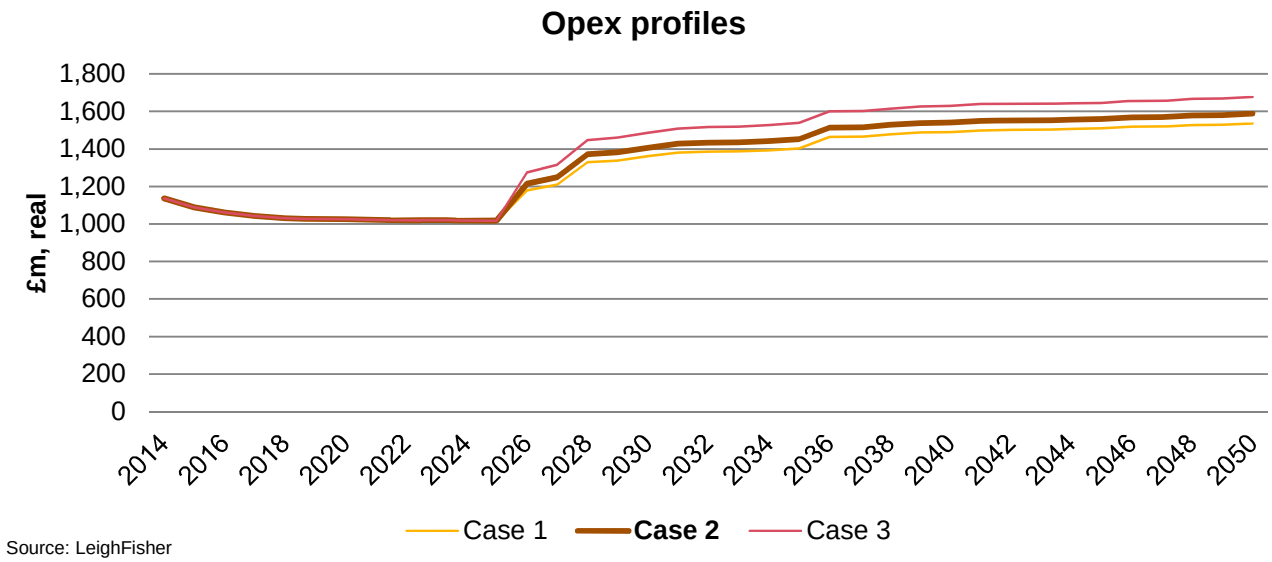
[79] The Q6 regulatory settlement total is £3,108m (adjusted to 2014 prices) of which £56m was removed as it has been included in HAL's core capex amount (see 'Core capex' section). Source of Q6 figure: http://www.caa.co.uk/docs/33/CAP1151.pdf

[80] A detailed explanation of the AC's methodology is available in the separately published Cost and Revenue Identification Update LHR ENR report.

- In the short term up to 2025, the AC adopted a general elasticity[81] 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[82] 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 45.

Figure 44: Opex profiles



Source: LeighFisher

Table 45: Total opex

Source	Cost scenarios	Total Opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R0.5 per annum)	48,405	90,314	26,467
	Case 2 (R0.5 per annum, MOB15)	**49,612**	**92,856**	**27,004**
	Case 3 (R0.5 per annum, FOB41)	51,705	97,262	27,936

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 in steps following the opening of the runway in 2026 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.

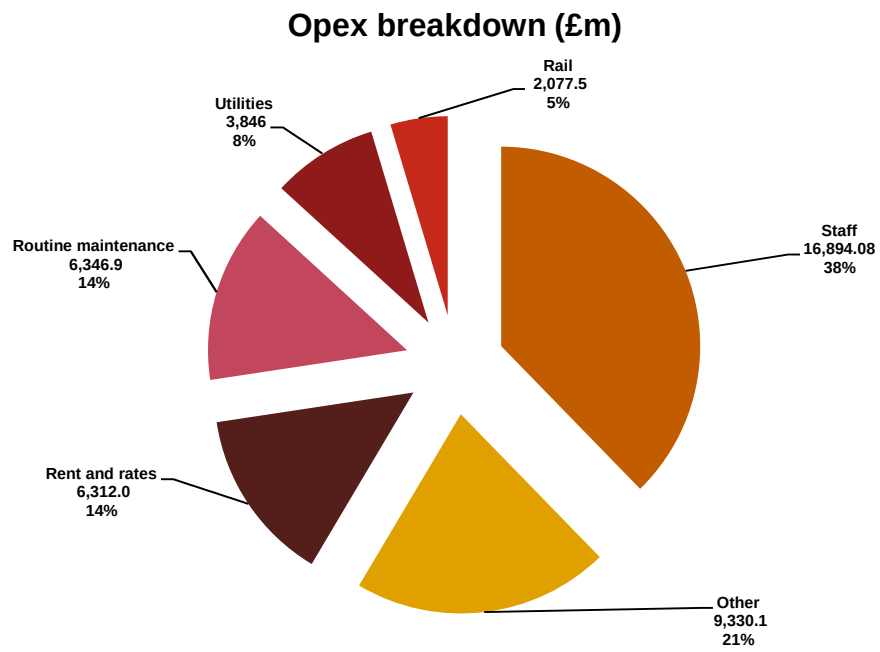
[81] **'Elasticity'** in this context refers to how costs are affected by demand drivers. Costs are said to be highly elastic when a small change in a demand driver, for instance passenger numbers, results in a large change in cost.

[82] 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.

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.

Figure 45 presents a breakdown of the AC's view of opex by cost category (total of £44,806m). This excludes risk and OB of £4,806m.

Figure 45: Opex breakdown



Source: LeighFisher

'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.

Appendices

Appendix 1: References and sources

Websites

Footnote reference (where relevant)	Link
5	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf
8, 11	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf
13	https://www.gov.uk/transport-analysis-guidance-webtag
24, 43, 69	https://www.gov.uk/government/publications/cost-of-maintaining-the-highways-agency-s-motorway-and-a-road-network-per-lane-mile
26, 46, 72	http://www.dft.gov.uk/ha/standards/ghost/dmrb/vol13/index.htm
30, 32	http://www.caa.co.uk/docs/33/CAP1152LGW.pdf
44, 70	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275128/webtag-tag-unit-a1-2-scheme-costs.pdf
52, 79	http://www.caa.co.uk/docs/33/CAP1151.pdf

Data references

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

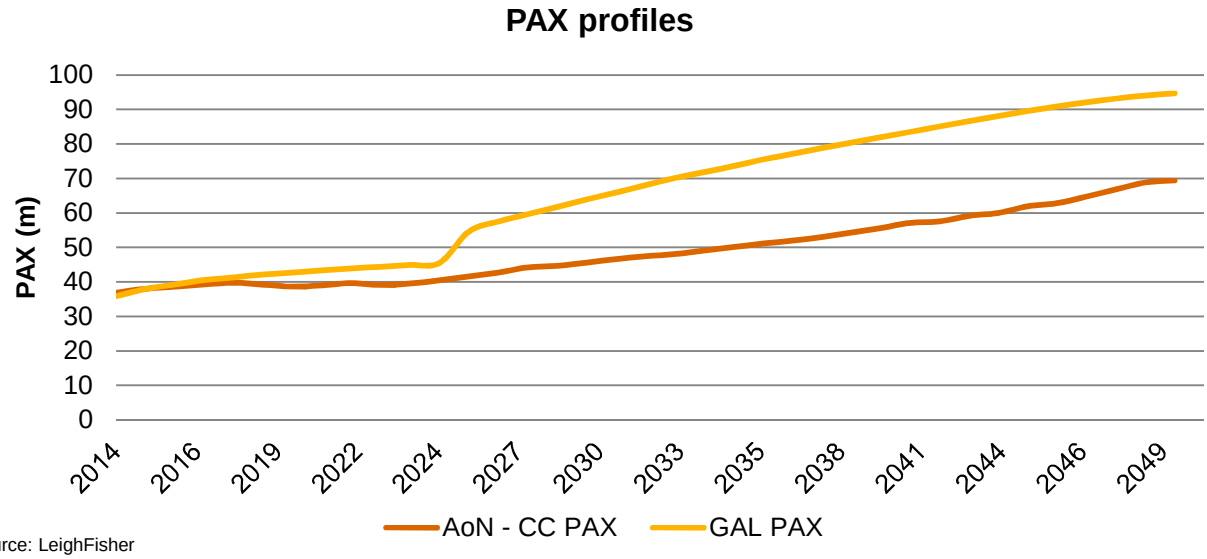
	GAL	HAL	HHL
AC scenario name	AoN Carbon Capped (AoN-CC)	AoN Carbon Capped (AoN-CC)	AoN Carbon Capped (AoN-CC)
Capex, Opex and Non-aero revenue	150506 Cost Model Outputs for NWR_ENR_2R_hardcoded.xlsx	150506 Cost Model Outputs for NWR_ENR_2R_hardcoded.xlsx	150506 Cost Model Outputs for NWR_ENR_2R_hardcoded.xlsx
Surface access	150422 Jacobs Surface Access Cost summary v12 - hardcoded output.xlsx	150422 Jacobs Surface Access Cost summary v12 - hardcoded output.xlsx	150422 Jacobs Surface Access Cost summary v12 - hardcoded output.xlsx

Appendix 2: AC view of costs for the LGW2R scheme 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



Source: LeighFisher

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 scheme development**[83]**.**

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 46).

[83] The impact of further different demand scenarios and sensitivities modelled is covered the Funding and Financing Update report.

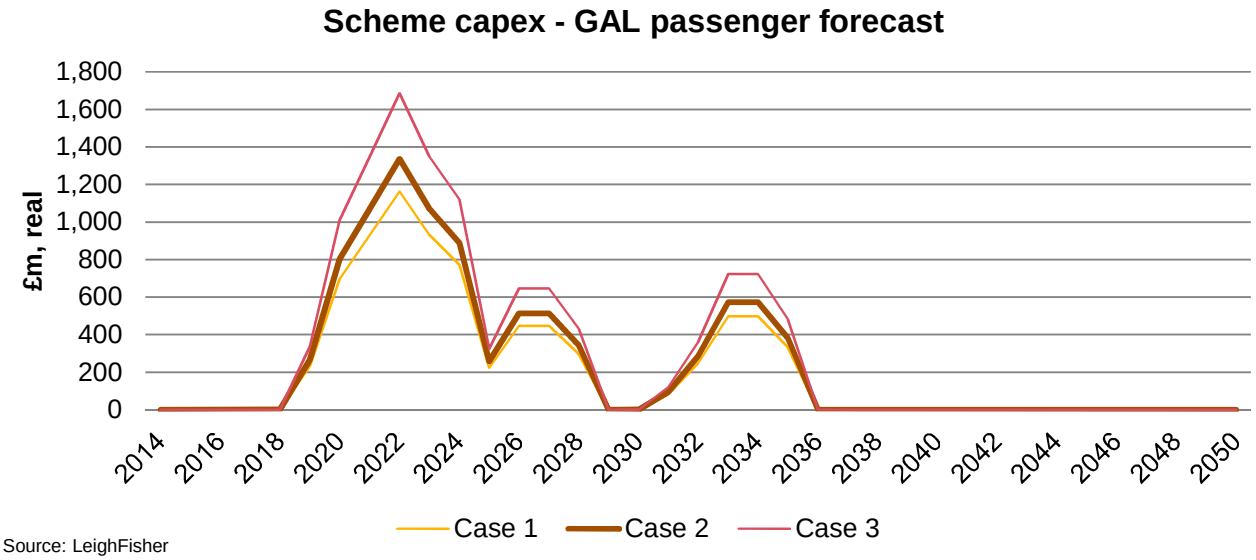
Table 46: Scheme phases and capex

Phase	Passenger capacity (mppa)	Opening year	Works	Scheme capex, (£m, real)	%
0	Not applicable	2025	• Full length runway • Associated airfield works	3,313	37%
1	60	2025	• First phase of terminal works • Expansion of the airfield as required to serve the terminals	2,036	23%
2	75	2029	• Second phase of terminal works • Incremental airfield works	1,710	19%
3	95	2036	• Final fit-out of all terminal infrastructure • Expansion of the airfield as required to serve the terminals	1,911	21%
Total Cost (R20, MOB15)				**8,971**	**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 46 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 47).

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



Source: LeighFisher

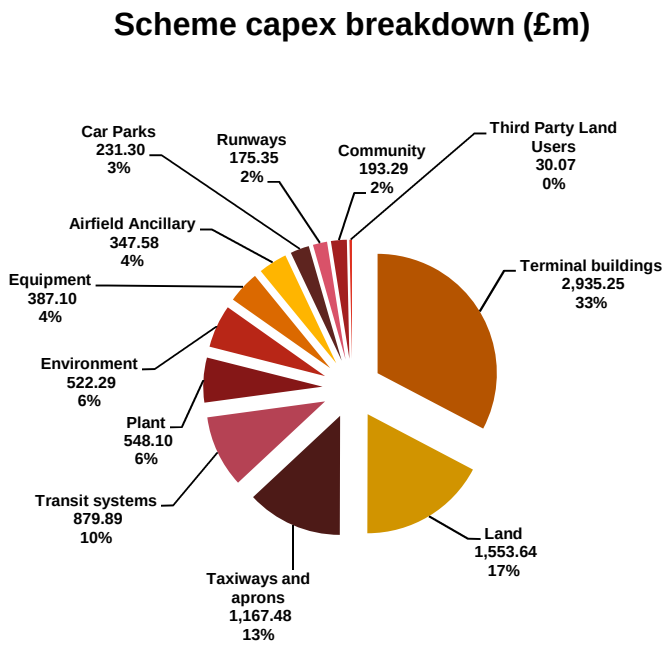
Table 47: Total scheme capex based on the GAL passenger forecast

Source	Cost scenarios	LGW 2R scheme capex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (R20)	7,801	11,633	5,377
	Case 2 (R20, MOB15)	**8,971**	**13,378**	**6,184**
	Case 3 (R20, FOB45)	11,312	16,867	7,797

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 2031 and open in 2036. The AC's view of the development shows construction concluding in 2035 – 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.

Figure 48 presents a breakdown of the AC's view of scheme capex by cost category (total of £8,971m).

Figure 48: Scheme capex breakdown based on the GAL passenger profile



Source: LeighFisher

Together, the cost of terminal buildings and land make up 50% of the total scheme capex (33% and 17% respectively). Taxiways and aprons are the next largest cost at 13% 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 24% of

scheme capex under the AoN-CC passenger profile as compared to 33% 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

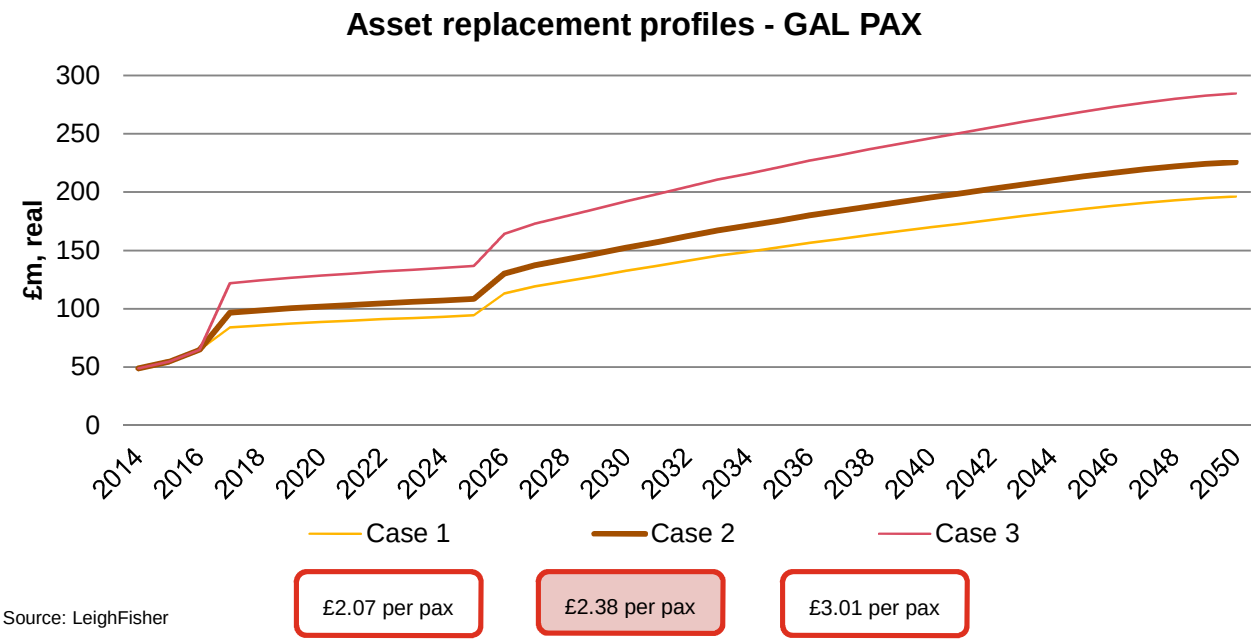
Core capex

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 49 and Table 48.

Figure 49: Asset replacement costs based on the GAL passenger (PAX) forecast



Source: LeighFisher

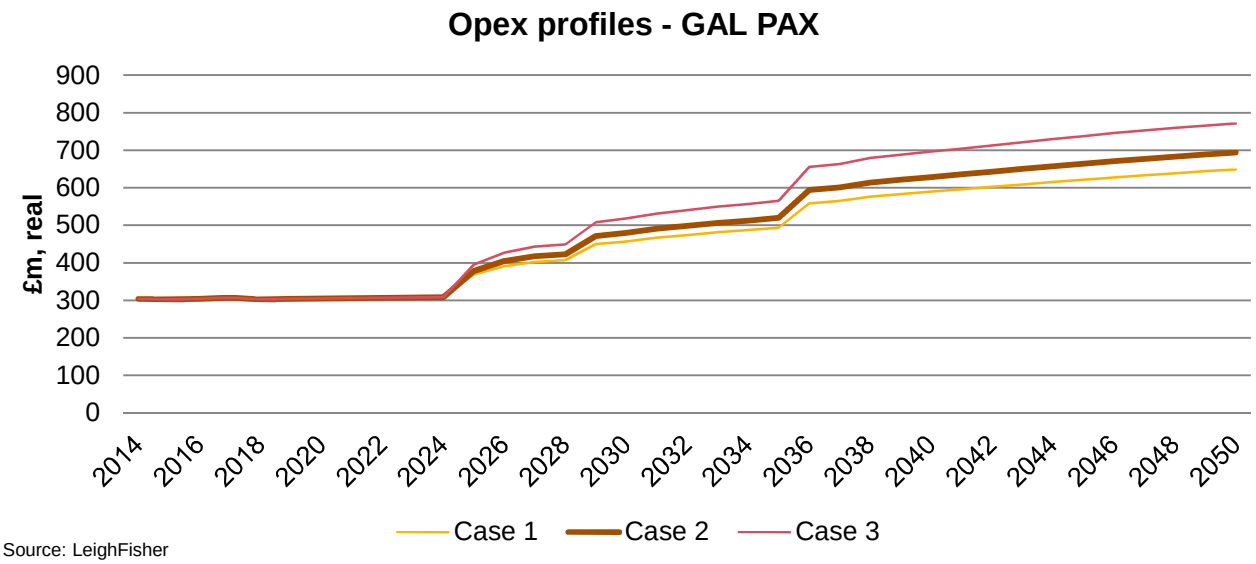
Table 48: Total asset replacement costs based on the GAL passenger forecast

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, MOB15)	**5,716**	**12,650**	**2,904**
	Case 3 (R20, FOB45)	7,163	15,905	3,619

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 50 and Table 49. GAL's view of opex costs is also presented.

Figure 50: Opex profiles based on the GAL passenger (PAX) forecast



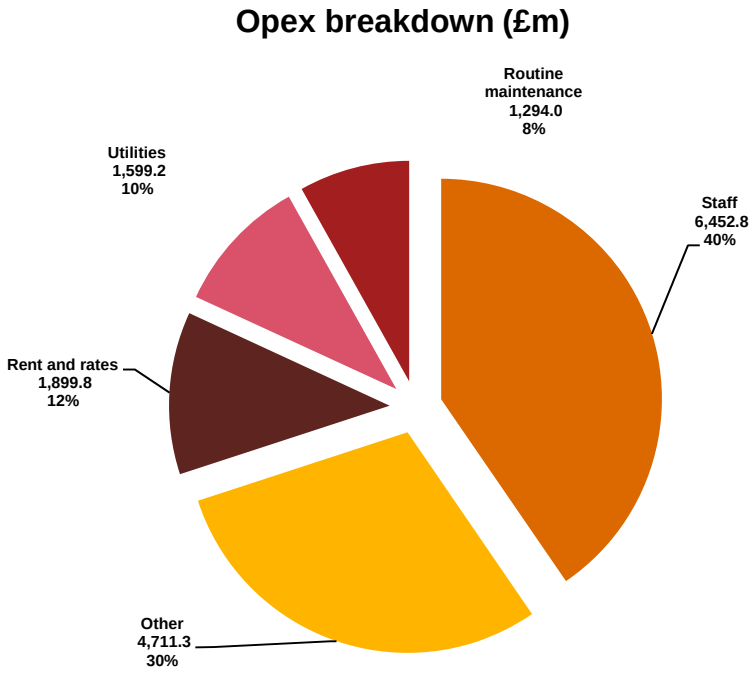
Source: LeighFisher

Table 49: Total opex based on the GAL passenger forecast

Source	Cost scenarios	Total Opex		
		Real (£m)	Nominal (£m)	NPC (£m)
AC	Case 1 (Ro.5 per annum)	17,352	33,618	9,043
	Case 2 (Ro.5 per annum, MOB15)	**18,186**	**35,452**	**9,394**
	Case 3 (Ro.5 per annum, FOB41)	19,631	38,630	10,004

Figure 51 presents a breakdown of the AC's view of opex by cost category (total of £15,957m). This excludes risk and OB of £2,229m.

Figure 51: Opex breakdown based on the GAL passenger profile



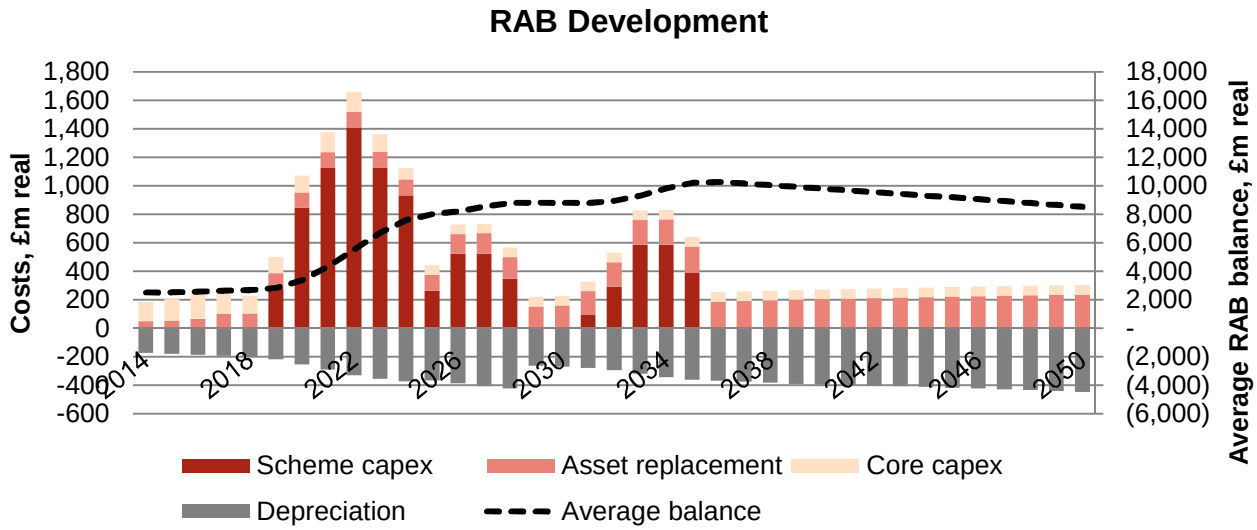
Source: LeighFisher

Regulated Asset Base

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

Figure 52 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 52: Cost additions and changes to the RAB under the GAL passenger forecast



Source: LeighFisher

Table 50: 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	20,147
Additions	17,791	31,597
Depreciation	(12,110)	(26,012)
Closing RAB as of 2050	8,183	28,234
Average RAB balance peak	9,914	28,467
Year average RAB balance peaks	2036	2050

The average RAB balance peaks at £9.9bn 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; and
- Capital costs are incurred in closer succession, reducing the time for depreciation of capital assets;