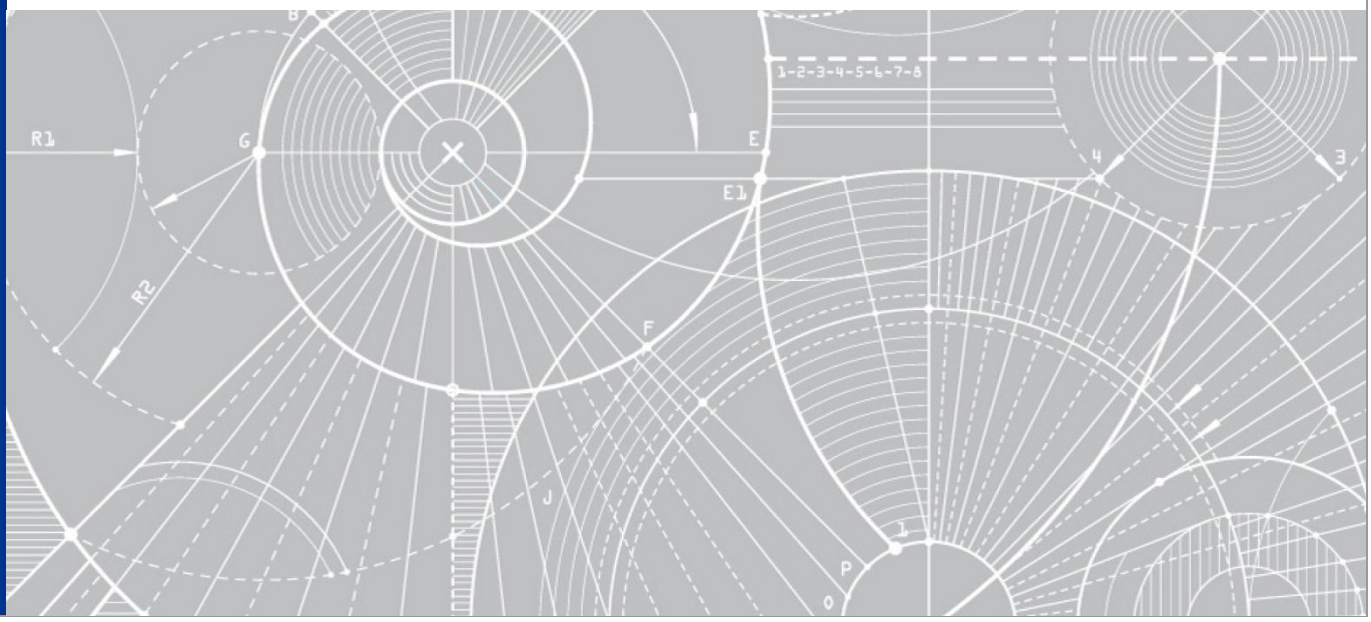
Appraisal Framework Module 4.

Surface Access: Heathrow Airport North West Runway

FINAL FOR CONSULTATION

AIRPORTS COMMISSION

5th November 2014



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Contents

Executive Summary

Background

The Airports Commission (AC) was established in 2012 by the UK Government to examine the need for additional UK airport capacity and to recommend how any additional capacity requirements can be met in the short, medium and long term. The Commission is due to submit a Final Report to the UK Government by summer 2015 assessing the environmental, economic and social costs and benefits of various solutions to increase airport capacity, considering operational, commercial and technical viability.

The AC published an Interim Report in December 2013 that short-listed three options to address the UK's long-term aviation connectivity and capacity needs, two focussed on expanding Heathrow Airport and one on expanding Gatwick through the provision of a second runway – the work leading up to the publication of the Interim Report is described as Phase 1. The short-listed options were to be further developed and appraised during Phase 2, with further phases of work programmed in the run-up to the submission of the Final Report in the summer of 2015.

The Phase 2 assessment with respect to surface transport was focussed specifically on three key elements as follows – the identified assessment time period was a busy day peak hour in 2030:

- Estimating airport passenger and employee surface transport demand associated with the expansion option in question;
- Identifying surface transport measures to meet net airport-related demand (associated with the expansion option in question), accounting for capacity implications related to background growth and non-airport travel demand; and
- Assessing the engineering feasibility and high-level cost of the surface transport measures identified to meet forecast travel demand.

The ultimate aim was to provide guidance to the AC on the feasibility of, and likely surface transport issues associated with each short-listed expansion option, with reference to three objectives set out in the AC's Appraisal Framework as follows:

- **Objective 1** – to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport;
- **Objective 2** – to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight; and
- **Objective 3** – to enable access to the airport from a wide catchment area.

The impact of freight-related surface access movements was judged likely to be relatively low when compared with air passenger and employee movements during the identified peak hours for all short-listed airport expansion options, and was consequently not assessed. A surface access freight impact assessment is therefore required as part of a future phase of work in order to address the element of **Objective 2** related to freight.

This Appraisal Report constitutes part of the Phase 2 surface access assessment of a new North West Runway at Heathrow Airport. It is the third report in a suite of documents for this assessment and should be read alongside two further documents for a full understanding of the approach employed by Jacobs to assess the surface transport implications of the new North West Runway. The full Phase 2 reporting structure published for consultation in October 2014 is as follows:

- The **Methodology Statement** summarises the approach employed by Jacobs to develop surface transport demand forecasts for a new North West Runway - this summary is supported by a Technical Appendix, which includes detailed information about the calibration of models used to generate forecasts and assess capacity/level of service implications;

- The **Assumptions Log** lists the assumptions used to develop the forecasts and compares them with those contained in the submission received by the AC from Heathrow Airport Ltd (HAL);
- The **Appraisal Report** details the results of the assessment undertaken and draws key conclusions on the impacts of a new North West Runway at Heathrow.

The assessment was undertaken with reference to a Core Transport Baseline and an Extended Transport Baseline, which together listed transport infrastructure and services expected or likely to be in place by 2030 regardless of any airport expansion that may be delivered in the UK. Full details of the schemes included in these baselines are provided in **Appendix A** – the Core Baseline only included those schemes that were fully committed and funded when the Phase 2 assessment commenced.

The primary focus of all the analysis was on the Extended Baseline, as by 2030, it was judged highly likely that further enhancements to the UK transport network would have been delivered above and beyond works that were fully committed at the beginning of Phase 2 when the baselines were defined. The Core Baseline was also assessed to highlight the importance of delivering planned but currently uncommitted infrastructure by 2030 to support expected growth in background demand and demand related to a new North West Runway at Heathrow. In addition to those schemes identified within the Extended Baseline was Southern Rail Access (SRA), which was shown to provide additional benefits required to alleviate capacity constraints on the rail network. Given the scheme's current status (with planning at a very early stage), the cost of this scheme was included as a potential airport expansion-related cost in the assessment.

The Heathrow Airport Ltd (HAL) submission

This surface access package is a combination of highway and public transport schemes. The rail access schemes included in the assessment as part of the Core Baseline scenario are:

- **Heathrow Express**: assumed to continue to provide service at the current frequency of 4tph;
- **LU Piccadilly line**: will continue to provide direct services to Heathrow with a frequency of 18tph by 2030;
- **Crossrail**: will provide connectivity for travel from Heathrow and Central London with a frequency of 4tph;
- **Western Rail Access (WRA) to Heathrow**: a proposed rail link between Reading and Heathrow with a planned operating frequency of 4tph service;
- **HS2**: HS2 passengers to access Heathrow via a connection at Old Oak Common - Heathrow Express and Crossrail services are expected to connect Heathrow to Old Oak Common, which will allow easy interchange for airport passengers between high speed and airport rail services.

Extended Baseline rail schemes are summarised in Appendix A.2 although none were judged likely to significantly impact on rail access to Heathrow. Two additional schemes not included in the Extended Baseline were however assessed as part of an 'Extended Baseline with SRA' scenario, with the costs of new rail infrastructure included within the assessment:

- **SRA**: planned service linking Heathrow to Staines, which is an important source of employees for the airport, with a service of 4tph;
- **Crossrail**: increased frequency of 6tph to/from Heathrow.

The key highway access schemes included in the assessment as part of the Extended Baseline are:

- Construction of a new Southern Road Tunnel access to the Heathrow East node;
- Collector-distributor roads to segregate airport traffic from other M25 traffic between J14 and J15;
- Implementation of a new one-way access arrangement for the Heathrow West campus;
- Committed hard shoulder running of M23 J8 to J10;

- Committed hard shoulder running of M4 J5 to J12;
- Committed hard shoulder running of M25 J5 to J7;
- Committed hard shoulder running of M25 J23 to J27;
- Committed hard shoulder running of M3 J2 to J4a; and
- Committed hard shoulder running of M4 J3 to J4.

Methodology overview

HAL's headline assumptions regarding passengers per annum and on-airport staff in 2030 were fed into a linked trip distribution/logistic regression (logit) mode share model to forecast peak-hour surface access demand to Heathrow from different parts of the UK using different modes of transport. The HAL numbers indicate that the net surface access impact of a new North West Runway would effectively amount to an additional 13.7mppa in 2030 (a total of 103.6mppa in the three-runway scenario less 82.5mppa in the two-runway scenario, assuming that 35% of all passengers in both scenarios are interliners). This compares with two key AC forecasts for the same year as follows:

- A net surface access impact of 10.4mppa in the 'Carbon-Capped Assessment of Need' (CC AON) scenario (109.3mppa with 32% interlining with three runways, less mppa 84.9mppa with 24.7% interlining with two runways); and
- A net impact of 16.3mppa in the 'Carbon-Traded Global Growth' (CT GG) scenario (125.2mppa with 32.9% interlining with three runways, less 87.5mppa with 22.6% interlining with two runways).

As with all the short-listed airport expansion options, the initial basis of the analysis for a new North West Runway at Heathrow was the scheme promoter's own forecasts. Two sensitivity tests were carried out using the passenger numbers from the AC scenarios summarised above, and an additional sensitivity test assessed the impact of the removal of the premium fare for the Heathrow Express (HEX) rail service – the current premium was assumed to remain as at present in the central Jacobs scenario in 2030. Summary results for these three sensitivity tests are provided in **Appendix B**. A range of other tests were also carried out to validate the model and to assess impacts related to specific changes in travel behaviour, and these are referenced wherever relevant in this report.

The model, which was calibrated using 2012 CAA passenger survey data, accounted for forecast growth in population and jobs in the UK, and Generalised Cost (GC) estimates (accounting for the impact of journey times, wait times, interchange times, assumed PT fares and car operating costs) were developed for the future transport network. For rail, journey time parameters associated with the rail schemes listed in the 'Extended Baseline with SRA' scenario defined above were tested.

The mode share forecasts were then assigned to road and rail corridors serving the airport and compared with background demand estimates sourced from the Department for Transport (DfT) and Network Rail (NR). Total rail demand was compared with seated and total capacity estimates and additional services related to planned but currently uncommitted infrastructure. Total road demand was compared with estimates of capacity on strategic road network links, accounting for the impact of committed and planned HA schemes included in the Core and Extended Baseline with SRA packages.

Forecasts from the strategic road network model were then fed into an independent assessment of road enhancements in the immediate vicinity of the airport.

Objective 1 - maximising the use of sustainable modes of transport

Our analysis predicted that public transport mode share of passenger surface access trips to/from Heathrow would increase from 41% in 2012 to 55% in 2031. The main change is predicted to be in the rail mode share, which is predicted to increase from 28% in 2012 to 43% in 2031. This represents a net impact of up to 2,400 additional rail trips to the airport in the AM peak hour in 2030 as a result of the new North West Runway, with up to 1,400 additional rail trips leaving the airport.

Objective 2 – accommodating the needs of other users (rail)

The rail demand forecasts from the mode share model were added to background demand forecasts provided by NR and TfL on the HEX and sections of the Piccadilly Line, Crossrail, WRA and SRA and then compared with seated and total capacity estimates.

The analysis indicated that on the majority of sections, the network is likely to have sufficient capacity to accommodate forecast demand including airport passengers associated with the new North West Runway, and that airport passengers travelling to and from London should not have any issues boarding trains during the AM peak-hour. The exception to this is the Piccadilly Line which will experience over-capacity conditions in 2030 due to background patronage. Without modelling the PM peak as part of this study, there may also be issues boarding Crossrail trains in Central London towards Heathrow.

Analysis of the Piccadilly line shows that with the introduction of Crossrail services the dependence on the Piccadilly Line lessens, with its share of total Heathrow rail demand forecast predicted to drop from 81% currently to 29% in 2030. This share decreases further with the inclusion of the Extended Baseline package (which assumes the SRA and 2 extra trains per hour in the Heathrow Crossrail service). However, due to background patronage the seated capacity on most sections of the Piccadilly Line is exceeded and passengers are unlikely to get a seat during the peak hour. The most congested link is from Kings Cross to Green Park where the VCR is at 114% capacity and 398% seated capacity. This means that passengers will experience heavily overcrowded conditions on this service primarily as a result of background demand with airport passengers accounting for between 1% and 15% between the Kings Cross to Acton Town sections rising to up to 20% without the Extended Baseline with SRA package. As a result investment is likely to be required above that included in the Extended Baseline to enhance rail services to the airport to accommodate the forecast increase in background non-airport-related demand due to background demand.

Crossrail replaces Heathrow Connect with a far superior service by reducing wait times and increasing train capacity, increasing the frequency from four to six trains' in the Core Baseline to the Extended Baseline with SRA also further increase the benefits to passengers. Crossrail serves many important destinations directly including the West End, The City and Canary Wharf reducing the need for passengers to use the underground network to access the Airport. Crossrail will improve the connectivity for passengers from outside London by serving important intercity and commuter stations such as Farringdon (Thameslink), Liverpool Street (Greater Anglia), Abbey Wood (North Kent Line) and Stratford (HS1). This decreases journey times and interchanges for passengers from Sussex, Kent, Essex, Hertfordshire and Cambridgeshire. Thus Crossrail is predicted to carry 31% of Heathrow rail demand in 2030. However, due to background demand the seated capacity is exceeded on most sections with airport passengers unlikely to get a seat on the train. An average VCR related to seated capacity of 188% to Heathrow and 308% from Heathrow is forecast on the Farringdon to Hayes and Harlington sections. Total VCR on Crossrail reaches a maximum of 92% of total capacity, meaning that airport passengers should be able to board trains but some will experience very crowded conditions during peak times due to the uneven loading of carriages and demand fluctuations across the peak hour.

WRA adds connectivity and reduced journey times to large areas to the west of Heathrow. Currently passengers from the west accessing by rail have the choice of a bus interchange at Reading or connecting to either the Heathrow Express or Heathrow Connect at Paddington. WRA reduces journey time and cost significantly for passengers from the South West and Wales as the interchange reduces

the need to 'double back' at Paddington. This also helps to relieve congestion at Paddington Station. Thus WRA is predicted to carry 10% of Heathrow rail demand in 2030. At the time of writing, no background patronage was available to assess the VCR for WRA. However, Heathrow-related demand accounts for between 13% and 26% of seated capacity between Maidenhead and Reading. This increases to between 17% and 31% on the Slough to Heathrow sections. Without the Extended Baseline with SRA packages there would be a marginal change of up to 19% and 34% on the Slough to Heathrow sections.

Heathrow Express is assumed to remain as it currently exists with the addition of an extra interchange at Old Oak Common, where it will connect with HS2 and services on the Great Western Mainline. Due to the premium pricing and the introduction of Crossrail the HEX rail share is expected to reduce to 12% of Heathrow demand by rail, similar to current levels. As a direct Heathrow service the lack of commuters and other passenger's results in the forecast demand on Heathrow Express being well within the available seated capacity, with at a maximum of 33% VCR. We would expect based on the crowding shown on Crossrail and the Piccadilly Line that in peak times, trips to Heathrow on Heathrow Express would increase with the guarantee of a seat.

The inclusion of SRA provides direct accessibility to new catchment areas through Waterloo, Clapham Junction and Staines. Our analysis shows that some additional shift from road to public transport occurs with passengers originating from the south-east due to better connections. Furthermore, the reliance on both the Piccadilly Line and Crossrail is reduced with the proportions using these services dropping from 38% and 35% to 29% and 31% respectively. However, on the sections between Waterloo and Staines the service is predicted to operate at or over seated capacity (between 91% and 191%) meaning passengers will likely have to stand for parts of their journey in peak times.

Overall the inclusion of heavy rail access to Heathrow from both the west and the south opens up journey opportunities for Airport passengers and employees that were hitherto not possible. The direct Crossrail service from Canary Wharf and Central London provides a complementary service to Heathrow Express and the Piccadilly Line. While the Crossrail service will share Great Western Main Line infrastructure with Heathrow Express from Paddington to Heathrow Airport, SRA will provide a new completely segregated route to a second London terminal.

In addition to redistributing patronage across the new services, these two new routes will offer improved resilience to London passengers over the present situation. If one route is closed by an incident, the other routes should be unaffected. At the present time, a closure of the Piccadilly Line or the existing heavy rail route to Paddington sees the majority of passengers being diverted onto the other service, leading to on-train capacity issues. The additional infrastructure should ensure that two of the three main rail routes to London are available more often, improving the overall resilience of rail transport to the Airport and through that, the passenger experience of public transport**.**

Objective 2 – accommodating the needs of other users (roads)

Strategic roads

In terms of road traffic, the Jacobs model forecasted a net impact of up to 1,200 additional car/taxi trips to the airport in the AM peak hour in 2030 as a result of the new North West Runway, with up to 600 additional car/taxi trips leaving the airport. This demand was added to background traffic forecasts sourced from the DfT on sections of the strategic highway network serving the airport and then compared with estimates of capacity on network links, accounting for the impact of committed and planned Highways Agency schemes included in the core and Extended Baseline with SRA packages.

The strategic highway analysis indicated that only two road sections of the network; the M4 between junction 3 and junction 4 and the M4 Airport Spur road, would need widening specifically as a result of traffic associated with the new North West Runway in 2030. This accounts for a stretch of motorway some 7km in length. Other key sections of the strategic network serving Heathrow, the M4 between junctions 2 and 3 and 4 and 4b, were highlighted as potential capacity issues where widening or other measures may be required.

Roads in the vicinity of the airport

Forecasts from the strategic model were then fed into an independent assessment of road enhancements in the immediate vicinity of the airport. The basis for this was the HAL proposal consisting of the schemes as follows:

- Divert the A4 to the north of the airport, leaving its current alignment at Colnbrook Bypass and re-joining its existing route to the east of the airport access at Emirates Roundabout at a new junction – this new route will be re-provided as a dual carriageway with existing bus priority measures;
- Replace the section of the A3044 which will be under parts of the new airfield, and provide a connection from A4 to Poyle;
- Remove the existing Western Perimeter Road and part of the Northern Perimeter Road;
- Grade-separate the roundabout junction where Airport Way meets the Southern Perimeter Road to allow dedicated access to Heathrow West and segregate through-movements on the Southern Perimeter Road;
- Provide a new and improved junction on the Southern Perimeter Road to allow access to the Southern Road Tunnel; and
- Implement a new one-way access arrangement for the Heathrow West campus, making use of an enhanced J14 for access – traffic would exit via J14a, making use of the existing structure and slip roads.

The analysis undertaken by Jacobs indicated that forecast flows were within assumed link capacities on the road network proposed by HAL in the vicinity of the airport. However, it should be noted that a full assessment of highway capacity was not possible due to lack of information on internal road layouts within the proposed North West Runway masterplan.

Objective 3 – enabling access to the airport from a wide catchment area

Rail journey cost and time

Turning to an assessment of overall level of service, our analysis shows that the overall demand-weighted average journey time of a rail trip to Heathrow (taking into account journey duration, wait times and interchanges required) is forecast to increase from 66 minutes in 2012 to 69 minutes in 2030. This is due to the greater proportion of passengers forecast using rail for longer distance trips as a result of additional services made feasible by the Extended Baseline schemes (including new Crossrail interchanges) and the SRA. As a result, the proportion of rail trips from outside London increases from 7% to 35%. The biggest increase comes from the South East where demand for rail increases from 2% to 18%.

The forecast change in demand-weighted rail journey times coupled with consideration of the new direct connections to Heathrow suggest that the overall rail catchment of the airport will be significantly larger in 2030 than it is today.

Public Transport isochrones analysis

Both the current and the Extended Baseline with SRA public transport (PT) service routes were coded in accessibility software to ascertain the changes in travel times by PT to Heathrow as a result. This isochrone analysis indicated that significant areas of the UK are expected to become accessible by PT to Heathrow as a result of committed and planned service enhancements. In particular, benefits for air passengers from the north-west of England were immediately evident, in addition to a number of other areas across the Midlands, East Anglia and the South West that also benefit from improved connections.

According to this analysis, the improvements to services associated with the Extended Baseline account for a 36% increase in the UK population within 3 hours PT travel time of Heathrow, suggesting that the proposal for a new North West Runway performs well against Objective 3 in the AC's Appraisal Framework.

Scheme costs

The schemes included in the Core Baseline and the Extended Baseline are not costed in this analysis as they are assumed to be delivered by 2030 regardless of the airport expansion.

A summary of the additional costs calculated is shown in the table below, and a summary of the methodology used to develop these costs is provided in the rail and road assessment chapters of this report.

The total capex costs have been estimated at between **£1.43bn** and **£2.72bn**. The range relates to the criteria that were applied to define the requirement for strategic road widening and rail infrastructure, as explained in the road and rail assessment chapters.

If optimism bias is included at 44% for road schemes and 66% for rail schemes as defined by the AC, this cost range rises to between **£2.16bn** and **£4.03bn**.

Asset replacement and operational expenditure (OPEX) were not considered during this study, but analysis of these costs has been undertaken in a different workstream and is detailed in a separate report, entitled '*Deliverable 13.2: Cost calculations*'.

Table 1: Summary scheme costs for package (£million)

Location	Requirement	Length (km - both dir)	Lower range		Upper range	
			Unit cost (£ per km for links)	Estimated Cost (£)	Unit cost (£ per km for links)	Estimated Cost (£)
M4 J3 to J4	Road Widening	3.8	£35m	£133m	£50m	£190m
M4 Airport Spur	Road Widening	2.8	£35m	£98m	£50m	£140m
M4 J2 to J3	Road Widening	17.6	£0	£0	£50m	£880m
M4 J4 and J4B	Road Widening	4.7	£0	£0	£50m	£235m
M4	Large M4 jnc 4b replacement	~	£150m	£150m	£150m	£150m
M4	Higher Capacity @ M4 J4a	~	£40m	£40m	£40m	£40m
M4	Capacity improvements to existing main airport tunnel	~	£40m	£40m	£40m	£40m
M25	M25 tunnelling costs (south of junction 15)	4	£80m	£320m	£100m	£400m
A4	Diversion of A4 Road alignment, dual carriageway	3.5	£25m	£87.5m	£25m	£87.5m
A3044	Diversion of A3044 Road alignment, dual carriageway	1	£25m	£25m	£25m	£25m
Airport Roads	Airport Way/Southern Perimeter Road Interchange, grade separated junction and flyover/bridge structures	1	£35m	£35m	£35m	£35m
Heathrow Road Tunnel	Southern Road Tunnel/Southern Perimeter Road Interchange		£10m	£10m	£10m	£10m
Airport One Way	One way system for western campus		£2m	£2m	£2m	£2m
SRA to Staines	Rail improvement			£487.5m		£487.5m
	TOTAL			**£1,428m**		**£2,722m**
	Risk			*0%*		*0%*
	Optimism bias (road)			*44%*		*44%*
	Optimism bias (rail)			*66%*		*66%*
	TOTAL (including risk and optimism bias)			**£2,164m**		**£4,027m**

Note: excludes land costs

1. Introduction

1.1 Background

1.1.1 The Airports Commission (AC) was established in 2012 by the UK Government to examine the need for additional UK airport capacity and to recommend how any additional capacity requirements can be met in the short, medium and long term. The Commission is due to submit a Final Report to the UK Government by summer 2015 assessing the environmental, economic and social costs and benefits of various solutions to increase airport capacity, considering operational, commercial and technical viability.

1.1.2 A key milestone in the AC's operational life was the delivery in December 2013 of an Interim Report. Following a general call for evidence, the Interim Report detailed the results of analysis of the capacity implications of forecast growth in UK aviation demand and a preliminary appraisal on a long-list of proposals put forward by scheme promoters to address the UK's long-term aviation connectivity and capacity needs – this work is described as Phase 1. The associated appraisal process identified three short-listed options, two focussed on expanding Heathrow Airport and one on expanding Gatwick through the provision of a second runway. These short-listed options were to be further developed and appraised during Phase 2, with further phases of work programmed in the run-up to the submission of the Final Report in the summer of 2015.

1.1.3 Shortly after its inception, the AC issued tenders for support contracts to engage independent technical advice on a range of aspects of the Commission's work. Jacobs together with sub-consultants Leigh Fisher and Bickerdike Allen Partners were appointed as the sole supplier on the Airport Operations, Logistics and Engineering Support Contract (ref: RM1082), which runs throughout the AC's lifespan up until the Summer of 2015.

1.2 Study scope

1.2.1 Under the terms of the RM1082 support contract, Jacobs were commissioned to develop the aforementioned Phase 2 assessment with respect to surface transport for a potential new North West Runway at Heathrow. This assessment focussed specifically on three key elements as follows:

- Estimating the net airport passenger and employee surface transport demand associated with a new North West Runway, accounting for expected growth in demand to and from the airport in its current form;
- Identifying surface transport measures to meet net airport-related demand associated with a new North West Runway, accounting for capacity implications related to background growth and non-airport travel demand; and
- Assessing the engineering feasibility and high-level cost of the surface transport measures identified to meet forecast travel demand.

1.2.2 The ultimate aim of the study was to provide guidance to the AC on the feasibility and likely surface transport issues associated with delivering a new North West Runway at Heathrow, with specific reference to three objectives set out in the AC's Appraisal Framework:

- **Objective 1** – to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport;
- **Objective 2** – to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight; and
- **Objective 3** – to enable access to the airport from a wide catchment area.

1.2.3 The terms of reference covered an assessment of forecast demand during a peak hour in 2030. In the case of Heathrow, this peak hour was identified as 0700-0800, when the highest proportion of daily surface access trips made by air passengers typically occurs at present. The impact of freight-related

surface access movements during this peak hour was judged likely to be relatively low when compared with air passenger and employee movements and was consequently not assessed as part of this study – this was also the case with the parallel assessments of the other short-listed airport expansion options. A surface access freight impact assessment is therefore required for all the short-listed options as part of a future phase of work in order to address the element of **Objective 2** related to freight.

1.2.4 Reporting for the Phase 2 surface transport assessment published for consultation in October 2014 was defined as follows:

- The Methodology Statement summarises the approach employed by Jacobs to develop surface transport demand forecasts for the new North West Runway - this summary is supported by a Technical Appendix, which includes detailed information about the calibration of models used to generate forecasts and assess capacity/level of service implications;
- The Assumptions Log lists the assumptions used to develop the forecasts and compares them with those contained in the submission received by the AC from Heathrow Airport Ltd (HAL);
- The Appraisal Report details the results of the assessment undertaken and draws key conclusions on the impacts of a new North West Runway at Heathrow.

1.2.5 This document is the Appraisal Report in the structure defined above and should be read alongside the other two documents for a full understanding of the approach employed by Jacobs to assess the surface transport implications of a new North West Runway. The environmental impact of the surface access proposals are contained in a separate report.

1.3 Methodology overview

1.3.1 The methodology employed by Jacobs to forecast passenger and staff travel demand associated with a new North West Runway at Heathrow is summarised in more detail in the Methodology Statement and its supporting Technical Appendix. The process is summarised here in **Figure 1**.

1.3.2 The analysis undertaken to generate forecasts discussed in this report was based on two models: a nested logit model forecasting both headline mode share and sub-rail mode share, and a trip distribution model based on changes in the Generalised Cost (GC) of travel between the airport and UK districts associated with proposed surface access enhancements (adjusted to reflect observed travel patterns). The approach used to forecast rail demand is consistent with the principles set out in the latest version of the Passenger Demand Forecasting Handbook (PDFH), released in 2013.

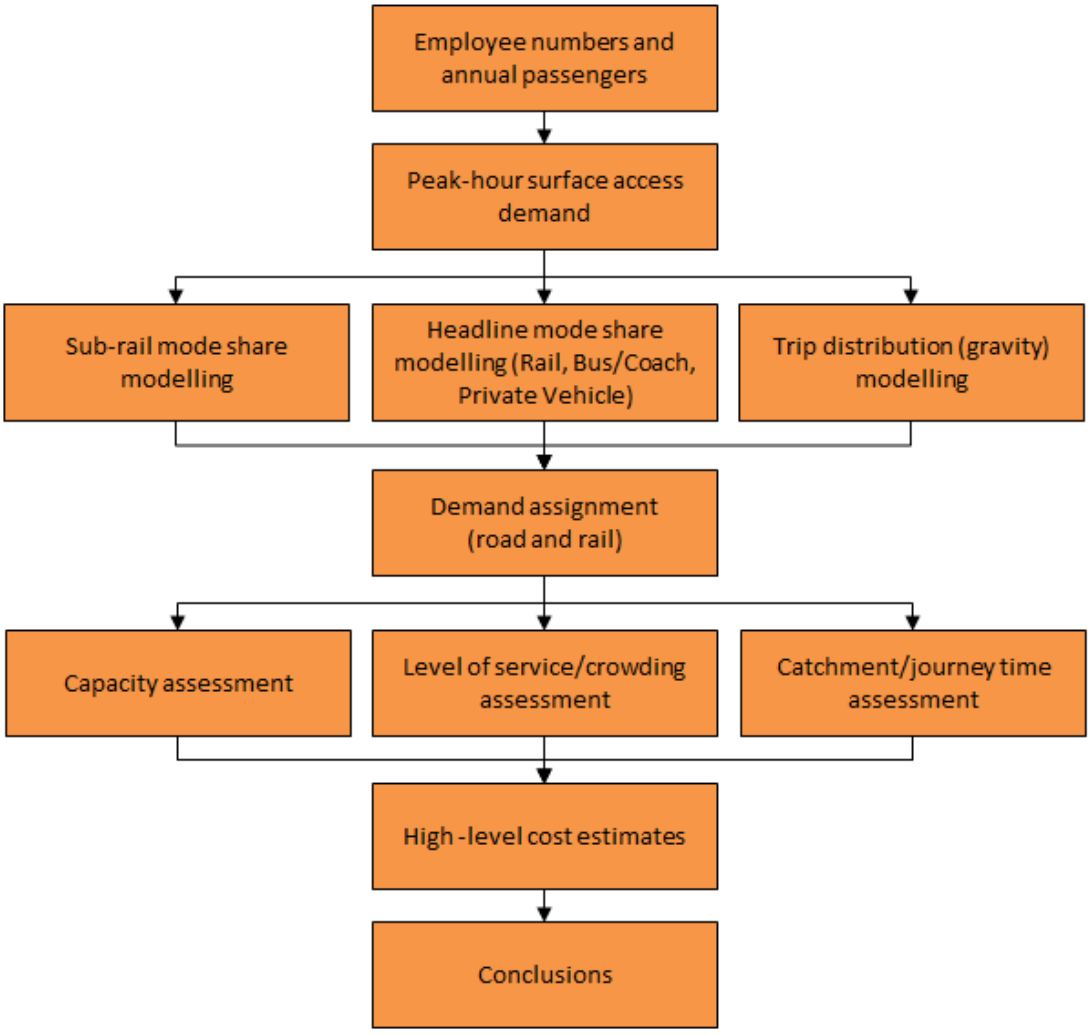
1.3.3 The assessment was undertaken with reference to a Core and an Extended Transport Baseline, which together listed transport infrastructure and services expected or likely to be in place by 2030 regardless of any airport expansion that may be delivered in the UK. Full details of the schemes included in these baselines are provided in Appendix A – the Core Baseline only included those schemes that were fully committed and funded when the Phase 2 assessment commenced.

1.3.4 The primary focus of all the analysis was on the Extended Baseline as by 2030 it was judged very likely that further enhancements to the UK transport network would have been delivered above and beyond the works that were fully committed at the beginning of Phase 2. The Core Baseline was also assessed to highlight the importance of delivering planned but currently uncommitted infrastructure by 2030 to support expected growth in background demand and demand related to a new North West Runway at Heathrow.

1.3.5 Constructing an appropriate Extended Baseline for a 2030 assessment involved making significant assumptions about the likely state of the transport network by that time, and this was a central factor in the decision not to extend the scope of the surface access assessment to include later years. There is currently a high degree of uncertainty surrounding some of the included schemes, not just in terms of their delivery but also their final form and characteristics, which in some cases are continually evolving as development work is progressed. The assessment detailed in this report was based on the best assumptions on the state of the 2030 transport network at the time of writing, but it is recommended

that the baselines continue to be refined and developed in liaison with the AC's stakeholders as part of any further assessment of surface access impacts.

Figure 1: Phase 2 – methodology overview



1.4 Heathrow submission

1.4.1 The HAL submission for a new North West Runway at Heathrow was received by the AC in May 2014 and includes a detailed assessment of surface transport demand and the capacity implications.

1.4.2 The assumptions used in the submission are summarised in more detail and compared with the Jacobs assumptions used during this study in the Assumptions Log. The key headlines are as follows:

- Heathrow would handle 82.5 million passengers per annum (mppa) and employ 72,100 staff in 2030 if a new North West Runway is not delivered (referred to as the two runway scenario);
- If a new North West Runway is delivered, the airport would handle 103.6mppa and employ 90,000 staff (referred to as Extended Baseline);
- 35% of passengers at the airport in both the two runway scenario and the Extended Baseline would be interliners (transit passengers) and would not use surface access. It is assumed that the scheme will not have an impact on their numbers, and it will remain the same for both the options;

- A headline mode share of 36% rail, 17% bus/coach and 48% private vehicles for non-transit air passengers was used, compared to 28% rail, 13% bus/coach and 59% private vehicles observed in 2012; and
- Headline employee commuting mode share was assumed to be 43% public transport and 47% private vehicles in both options, compared to 43% public transport and 47% private transport observed in 2013.

1.4.3 The HAL submission indicates that planned rail service options/connections in 2019 would include Heathrow Express, Piccadilly Line and Crossrail. By 2021 the submission assumed that Heathrow would have a connection through the Western Rail Access (WRA) improving connections to the West and to Wales, and would also have a connection through Southern Rail Access (SRA) to Waterloo and provide improved connections to South London and the South Coast. Heathrow further state by 2026, the addition of the HS2 rail line would provide fast access to Heathrow from the Midlands and the North, via an interchange at Old Oak Common. The Heathrow submission indicates that the planned rail services will be sufficient to accommodate the growth in rail numbers associated with the new North West Runway.

1.4.4 The submission states that the proposals *"provide an opportunity to improve one of the most congested sections of the M25. Our proposals will require a new, tunnelled section. The tunnel will be constructed alongside the existing route and minimise disruption to existing users of the motorway. Once built, new collector/distributor roads will run parallel to the motorway which will segregate airport and local traffic from the main carriageway, adding capacity to the M25. Separating traffic will reduce the weaving of cars from lane to lane and smooth the traffic flow for non-airport M25 traffic. Having listened to public feedback, we have also revised our proposals to avoid changes to the M25/M4 interchange."*

1.4.5 The analysis undertaken in this appraisal has challenged HAL's assumptions, undertaken an independent demand/capacity analysis of the proposed rail and road schemes, and defined an Extended Baseline with SRA surface transport package.

1.5 Report structure

1.5.1 The remainder of this report is structured as follows:

- Chapter 2 summarises the transport infrastructure and schemes included in the AC's Core and Extended Baselines, which underpinned the Jacobs surface access assessment of a new North West Runway at Heathrow;
- Chapter 3 summarises the headline and sub-rail mode share forecasts from the logit modelling;
- Chapter 4 summarises the rail capacity and level-of-service assessments based on forecast rail passenger trips to and from the airport;
- Chapter 5 summarises the road capacity assessment based on forecast car trips to and from the airport;
- Chapter 6 summarises the airport's public transport accessibility with the Extended Baseline and the SRA in place; and
- Chapter 7 contains our summary and conclusions.

2. Definition of Core and Extended Baselines

2.1 Core Baseline (rail)

2.1.1 A number of rail access routes to Heathrow are assumed to remain in place by 2030. These include: Heathrow Express to/from London Paddington, and the London Underground Piccadilly line. The Heathrow Connect service which runs to/from Paddington is planned to be discontinued from 2018 when Crossrail services are introduced. While the current agreement to run Heathrow Express expires in 2023, it has been assumed that this will be extended if the new North West Runway is delivered to accommodate increased demand to/from Heathrow.

2.1.2 In addition to existing rail access, the Core Baseline rail network includes all committed and almost certain rail schemes expected to provide access to Heathrow by 2030 and includes; Crossrail, London Underground Piccadilly Line improvements, HS2 (not including the proposed spur to Heathrow airport), and WRA to Reading. The full list of schemes included within the Core Baseline and Extended Baseline is included within **Appendix A**.

Heathrow Express

2.1.3 While it is acknowledged that there is uncertainty over the retention of Heathrow Express paths due to the franchise agreement being renegotiated in 2023, it has been assumed that Heathrow Express will continue to provide a non-stop airport service between London Paddington and Heathrow terminals. Heathrow Express currently offers a fast (15mins) and direct premium service for airport passengers. The current frequency of 4tph is assumed to remain unchanged. By 2030 Heathrow Express is assumed to stop at Old Oak Common and as such the journey time between London Paddington and Heathrow will increase.

LU Piccadilly line

2.1.4 The Piccadilly Line will continue to provide direct services to Heathrow terminals from various stations in London including Cockfosters, Finsbury Park, St. Pancras, Earl's court and Acton town. On this line, Passengers from the Uxbridge arm will continue to access Heathrow terminals via Acton town. Current plans to increase the capacity of the line involve updating with new trains as well as new signalling systems. Signalling works are currently planned to begin in 2019 and new trains should be in service by 2022.

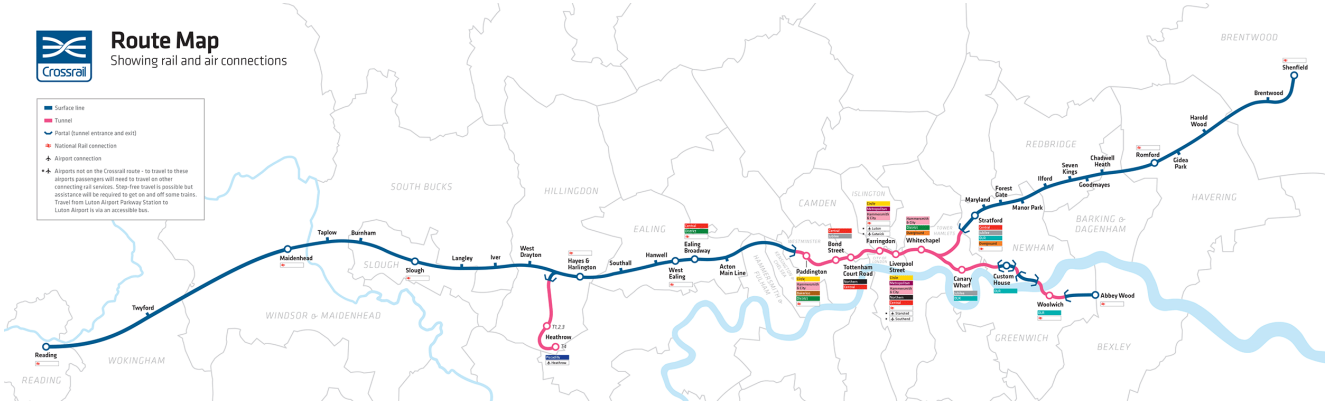
2.1.5 To date, 15tph (representing over half of Piccadilly line trains) call at Heathrow. However, by 2030, it is estimated that the new upgrade to the line would increase this to 18tph.

Crossrail

2.1.6 Crossrail will provide connectivity for travel from Heathrow via Paddington. It will also provide direct services to the West End, the City, Docklands and the Eastern suburbs to Shenfield and Abbey Wood. Through "single interchange" connections, it will also connect London Underground lines, and the National Rail network (via Farringdon and Liverpool Street) to cities and towns in the East of England such as Cambridge, Peterborough, Bedford, Colchester, Ipswich and Norwich. Through an interchange at Old Oak Common, Crossrail will provide connections to HS2 for Birmingham and beyond. These is also the opportunity to provide additional connectivity to parts of London via the West London Line and North London Line, and regional connectivity via a new link to the West Coast Main Line, which are currently are currently under development.

2.1.7 Network Rail, who are responsible for delivering the western section of the Crossrail route are providing the necessary infrastructure. The service operators are expected to serve Heathrow with a frequency of 4tph.

Figure 2: Crossrail Route



Source: httop://www.crossrail.co.uk/route/maps

WRA to Heathrow

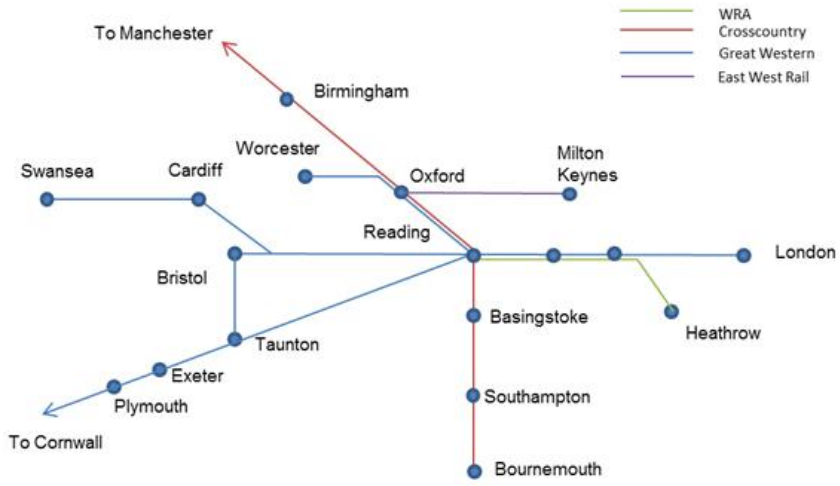
2.1.8 WRA to Heathrow is a proposed rail link between Reading and Heathrow, via Maidenhead/Twyford and Slough (**Figure 3**). Currently, all rail passengers from the west access Heathrow via an interchange at London Paddington or a "Railair" bus connection from Reading. WRA will enable a direct access to Heathrow from Reading and is expected to reduce train times by up to 53mins. Journey times would be approximately 7 minutes from Slough via a direct route, and 28 minutes from Reading.

2.1.9 The planned operating frequency will be 4tph service to Reading, Slough and Maidenhead. HAL have an aspiration to extend this service to Reading, but we have not included this within our analysis as discussions with NR have indicated that there are line capacity issues between Reading and Oxford that would need to be resolved first.

2.1.10 WRA to Heathrow has been selected as a Core Baseline rail scheme brought forward from the Extended Baseline for the assessment of new North West Runway at Heathrow. Discussions with Network Rail identified the scheme had progressed further than the rail options in the Extended Baseline and the GRIP 3 (single option selection) study for WRA is included in Network Rail's Enhancement Delivery Plan for CP5 as a regulated output[1]. It is anticipated to be operational in CP6 subject to funding, a value for money assessment and agreement of acceptable terms with the aviation industry.

[1] source *http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/cp5-delivery-plan/*

Figure 3: Proposed WRA



HS2

2.1.11 HS2 is planned for construction in two phases. HS2 Phase 1 is currently planned for completion in 2026 and will run from London (Euston station), through the Chilterns, Warwickshire to Birmingham International, South Northamptonshire and Central Birmingham (Curzon Street station). HS2 will run up to 14tph in each direction for Phase 1 and is expected to reduce journey time to/from Birmingham from 85mins to 50mins.

2.1.12 In 2030, HS2 passengers will access Heathrow via a new interchange station at Old Oak Common. Heathrow Express and Crossrail services are expected to connect Heathrow to Old Oak Common, which will allow easy interchange for airport passengers between high speed and airport rail services.

2.2 Extended Baseline with SRA (rail)

2.2.1 At the time of writing, schemes in the Extended Baseline were not committed or funded but were judged highly likely to be required and in place by 2030 to accommodate forecast demand on the UK transport network regardless of any airport expansion – these schemes are identified in **Appendix A.2**.

2.2.2 In addition to the schemes in the Extended Baseline, the rail package defined for further assessment also included the following two proposals:

- SRA is assumed to be in place, connecting Heathrow to Staines and thence Waterloo, improving connections to key catchments in South London, Surrey, Hampshire and on the South Coast – this was assumed to be a 4tph service to Waterloo, Clapham Junction, Richmond, Twickenham, Feltham and Staines via the Windsor Lines – although this option is at present significantly less progressed than WRA, NR have advised that at the end of CP5 the theoretical capacity of the Windsor Lines will be 20tph due to committed infrastructure enhancements, with a service level of 18tph in the peak and 16tph in the off-peak – this suggests that 4tph would be possible in the off-peak with only 2tph achievable in the peak unless trade-offs with other rail services are made – it should be noted that running a service at full network capacity all day carries a performance risk that will need to be further assessed;
- The frequency of Heathrow-bound Crossrail services is assumed to increase from 4tph to 6tph to reduce overcrowding and maximise rail mode share.

2.3 Core and Extended Baselines (roads)

2.3.1 The Extended Baseline highway network constitutes the existing strategic road network serving Heathrow, all relevant committed changes to the network and interventions proposed by Heathrow as necessary to accommodate the new airport layout. These interventions relate to the motorway network, roads in the vicinity of the airport, and the on-airport road network.

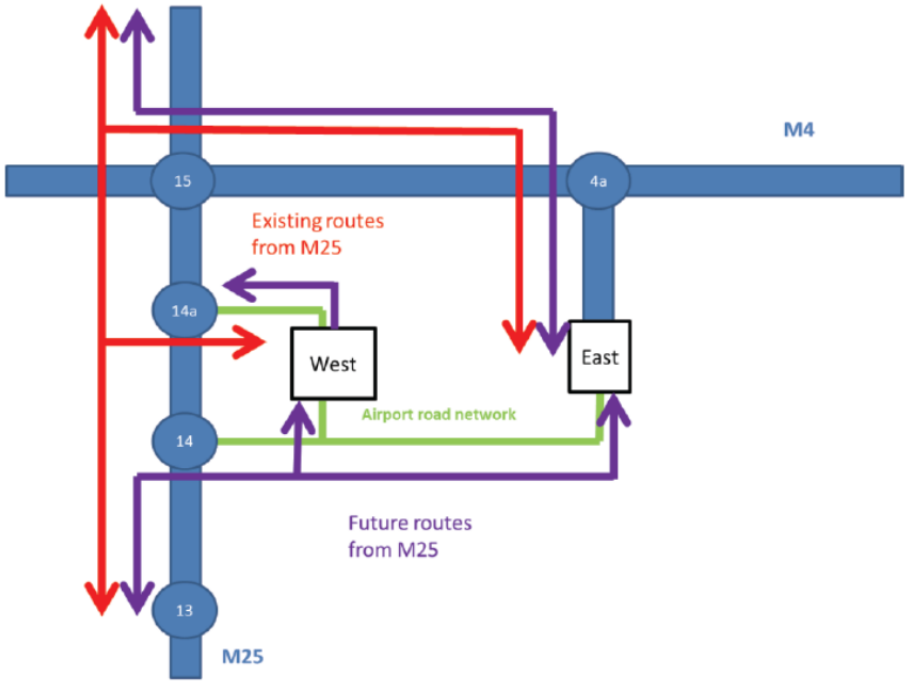
2.3.2 Changes to the motorway network to accommodate the new airport layout include:

- M25 to be placed in sections of tunnel under the new runway. This could be constructed off the current alignment of the M25 allowing the new sections to be completed prior to closing the existing carriageway;
- Construction of a new Southern Road Tunnel access to the Heathrow East terminal, to enable traffic travelling from the south on the M25 to access the airport from J14;
- A system of collector-distributor roads would be constructed to segregate through traffic from traffic joining or leaving the M25 between J14 and J15; and
- Implementation of a new one-way access arrangement for the Heathrow West campus. **Figure 4** shows the proposed road access arrangement.

2.3.3 In addition, HAL proposes to make changes to the road network in the vicinity of the airport, and the on-airport road network to accommodate the new layout. These interventions include:

- Divert the A4 to the north of the airport, leaving its current alignment at Colnbrook Bypass and re-joining its existing route to the east of the airport access at Emirates Roundabout at a new junction. This new route will be re-provided as a dual carriageway with existing bus priority measures:
- Replace the section of the A3044 which will be under parts of the new airfield, and provide a connection from A4 to Poyle;
- Remove the existing Western Perimeter Road and part of the Northern Perimeter Road;
- Construct a new Southern Road Tunnel to Heathrow East;
- Grade separate the roundabout junction where Airport Way meets the Southern Perimeter Road to allow dedicated access to Heathrow West and segregate through movements on the Southern Perimeter Road; and
- Provide a new and improved junction on the Southern Perimeter Road to allow access to the Southern Road Tunnel.

Figure 4: Heathrow Road Access Proposal



Source: HAL's "Taking Britain Further – Volume 1"

2.3.4 Access to the Heathrow would be provided, based on HAL's submission as follows;

2.3.5 "A system of collector-distributor roads would be constructed to segregate through traffic from traffic joining or leaving the M25 between J14 and J15. This will reduce the number of locations where traffic joins and leaves the M25. It will also improve traffic flow on the mainline M25 for all – reducing the weaving that currently takes place by removing the need for large volumes of traffic to cross lanes, which slows traffic speeds.

2.3.6 Access to Heathrow is currently signed from J4 of the M4 (Terminal 1, 2 and 3), and from J4b (via M25 for Terminal 4 and Terminal 5), J14 (Terminal 4) and J14a (Terminal 5) of the M25. We will construct a new Southern Road Tunnel access to the Heathrow east node, which will enable traffic travelling from the south on the M25 to access the airport from J14. This will reduce driving distances and improve resilience. We estimate that around one third of traffic accessing the Central Terminal Area will re-route via the southern road tunnel, helping to reduce traffic using the M4/M25 junction, M4 and spur.

2.3.7 A new one-way access arrangement will be introduced for the Heathrow West campus, making use of an enhanced J14 for access. Traffic would exit via J14a, making use of the existing structure and slip roads."

Bus/Coach network

2.3.8 Currently, there are a number of bus/coach options for accessing Heathrow. These can be categorised into three groups:

- Rail-air bus services which provide direct buses/coaches to Heathrow from the national rail network. This service is available from Woking, Watford Junction, Reading and Feltham stations;
- Coach services which connect Heathrow with more than 500 local and national destinations; and
- Bus services which connect Heathrow and towns in West London. These buses are part of the TfL network. Currently, 31 bus routes serve Heathrow at a frequency of around 80 buses per

hour. This includes 13 routes that provide early morning or 24-hour services, allowing shift workers to access the airport by public transport for an early shift.

2.4 Other modes

2.4.1 HAL states that cycle and walk mode play an important role in airport access with 10% of employees travelling by this mode. This is supported by providing high-quality facilities for cyclists and providing cycle parking at key locations and workplaces around the airport.

2.4.2 Heathrow's existing cycle hub has over 2,300 members and offers discounted cycle and equipment, free labour on maintenance and training to all airport employees.

Supporting sustainability

2.4.3 Currently HAL implement a range of policy related measures to encourage employees to use more sustainable modes of transport. These include offering a range of discounted travel products to all employees working at the airport and implementing an employee car sharing scheme. The baseline assumes that these policies remain in place.

3. Headline forecasts

3.1 Methodology

3.1.1 As mentioned in **Chapter 1**, two key models were developed by Jacobs to assess the impact of a new North West Runway at Heathrow Airport – a nested logit model forecasting sub-rail and headline mode share, and a trip distribution model forecasting surface access trip origins and destinations. The models were linked as the shortest calculated Generalised Cost (GC) between each district in the UK and the airport was used as a key parameter in the distribution model. As a result, districts with relatively improved transport connections to the airport in 2030 were allocated an increased proportion of total airport demand, reflecting the assumption that improved transport connections would induce demand between these areas and Heathrow. This change in distribution was then fed back into the logit model to forecast the modes of transport that would be used by these trips.

3.1.2 The remainder of this chapter describes the headline and sub-rail mode share forecasts arising from the 2030 nested logit model developed for Heathrow. These forecasts provided the basis for the assessment of the new North West Runway proposal against **Objective 1** in the AC's Appraisal Framework, which is 'to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport'.

3.1.3 The sub-car mode share (i.e. the split between taxi, kiss-and-fly, short-term parking and long-term parking demand) from the 2012 CAA Heathrow passenger survey data was used to estimate a composite GC for car between each district and the airport in the base model. The complexities involved with forecasting sub-car mode share in 2030 (which would involve assumptions related to car ownership levels, background traffic congestion, availability of short- and long-term parking at the airport, average parking tariffs and dwell times, kiss-and-fly arrangements etc.) would be significant, and the decision was taken to apply the 2012 sub-car mode share by district in the 2030 model to calculate future composite car GCs.

3.1.4 It should be noted that the GCs developed for the logit modelling are fixed costs and do not account for the variable impact of congestion or crowding on journey time/experience. This approach is consistent with the subsequent road and rail assessments undertaken, which are described in the following chapters in this report – both these assessments were based on a static analysis of forecast demand compared with, but not constrained by, network capacity.

3.1.5 The distribution model also does not account for associated changes in passenger characteristics at other airports in the UK and Europe, in particular with regard to interlining, which may have a significant impact on the surface access catchment of Heathrow in future. Further assessment is therefore required to determine the most appropriate passenger catchment as the basis for analysing surface access impacts in the event of a new North West Runway being delivered.

3.2 Sensitivity tests

3.2.1 As with all the short-listed airport expansion options, the initial basis of the analysis for a new North West Runway at Heathrow was the scheme promoter's own forecasts. The headline mppa and employee numbers from the HAL submission are summarised in Table 2 alongside the AC's 'Carbon-Capped Assessment of Need' (CC AoN) and 'Carbon-Traded Global Growth' (CT GG) scenarios.

3.2.2 Sensitivity tests were undertaken using the headline numbers from both the AC scenarios identified in the table, and these tests resulted in significantly increased numbers of passengers arriving and departing at Heathrow during the peak hour in 2030 when compared with the HAL submission forecasts. The resulting impact on the capacity of the road and rail surface transport access links is reported in Appendix B alongside the results of an additional sensitivity test modelling HEX without a premium fare.

Table 2: Heathrow Airport 2030 growth forecasts

Scenario	Core Scheme (current runway capacity)				Capacity Expansion (extra/extended runway)				
	Total annual pax	Annual interlining pax	Inter-lining %	Annual surface access pax	Total annual pax	Annual interlining pax	Inter-lining %	Annual surface access pax	Net annual surface pax growth
Jacobs Model (HAL Submission)	82,500,000	~	35.0%	53,625,000	103,600,000	~	35.0%	67,340,000	13,715,000
Carbon-Capped Assessment of Need	84,919,152	21,012,136	24.7%	63,907,016	109,264,920	34,912,782	32.0%	74,352,138	10,445,122
Carbon-Traded Global Growth	87,452,728	19,796,496	22.6%	67,656,232	125,153,056	41,171,271	32.9%	83,981,785	16,325,553

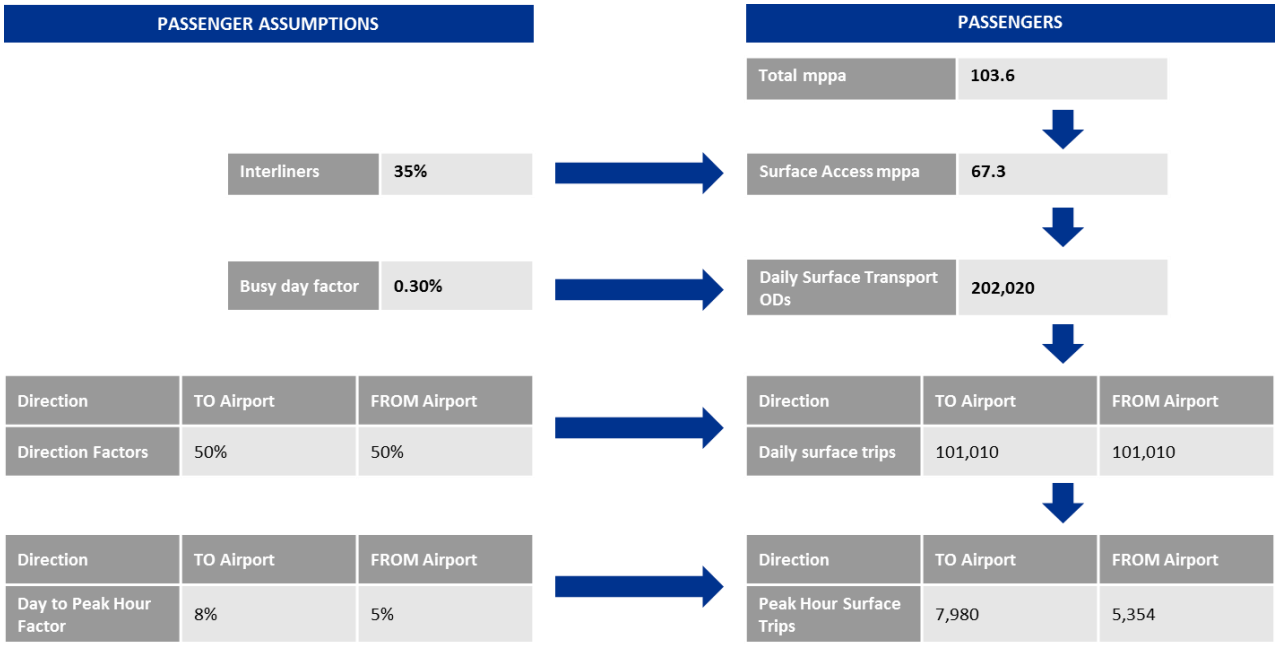
Source: HAL submissions taken from "Taking Britain Further – Volume 1", Sensitivity Tests provided by the Airports Commission

3.3 Forecast demand

3.3.1 The following analysis in the main body of the report concentrates on the central scenario of the mppa and employee forecasts adopted by HAL.

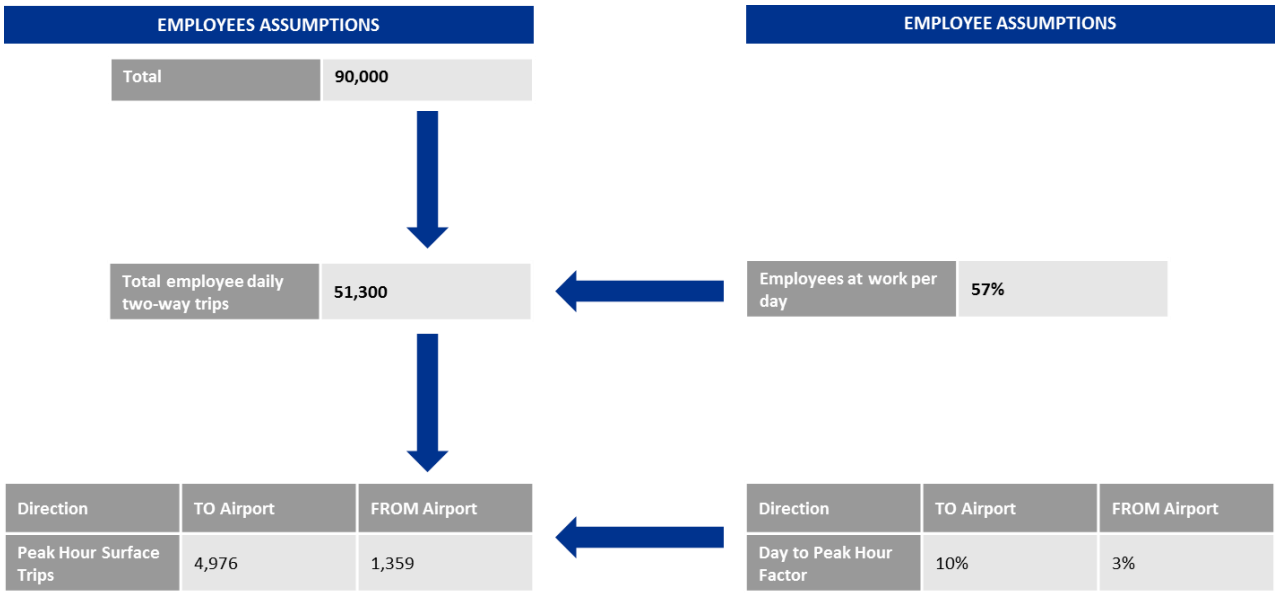
3.3.2 **Figure 5** presents the flow process whereby the total annual passengers are converted to a daily trip and then peak hour demand both to and from the airport.

Figure 5: Passenger Headline Forecasts



3.3.3 The approach is replicated for employees as presented within Figure 6 with the conversion of total employees to the number of employees working at Heathrow on any given day.

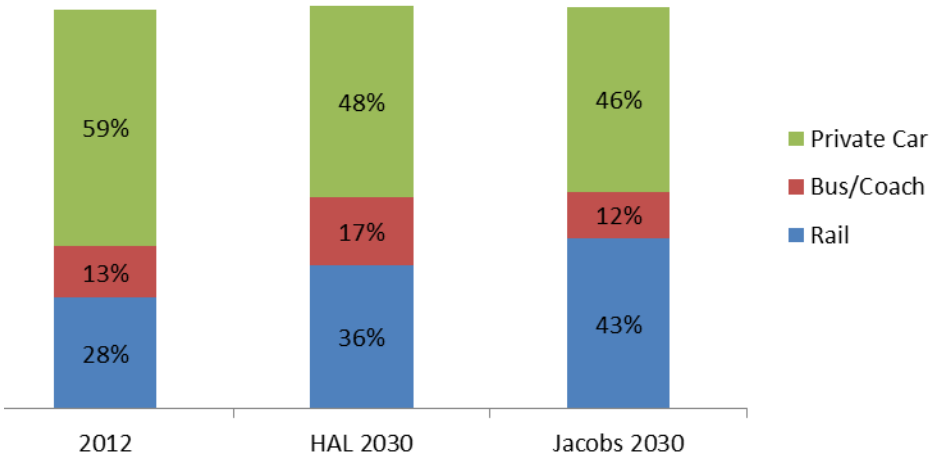
Figure 6: Employee Headline Forecasts



3.4 Mode share (Core Baseline)

3.4.1 Following the method outlined in **Section 2.3** above, the forecasted mode share of passengers in the Core Baseline network is presented in **Figure 7** alongside the mode share observed in 2012.

Figure 7: Passenger demand by transport mode in core baseline.



Source: 2012 Observed taken from Civil Aviation Authority Heathrow Survey, HAL submissions taken from "Taking Britain Further – Volume 1", Sensitivity Tests provided by the Airports Commission

3.4.2 Our analysis shows that with the baseline network in place by 2030, 43% of passengers are predicted to travel to and from Heathrow by rail, a value which is significantly higher than the 28% rail share observed in 2012. The proportion of passengers arriving at Heathrow by car is expected to reduce from 59% in 2012 to 46% in 2030. This would mean that there will be over 56 million passengers using public transport compared to around 29 million today, and 6 million more passengers travelling to and from the airport by car.

3.4.3 The increase in public transport patronage and decrease in car proportion is linked to an increase in rail accessibility from a number of regions, where passengers are predicted to shift from car to rail journeys. For various regions, the new rail routes provide a direct access to Heathrow which was not in place in 2012. This introduces more interchanges that serve as gateways to the airport from the wider rail network including Reading which provides access from the West of Heathrow (including the

South West and South of Wales) and Old Oak Common which provides access from Birmingham on the HS2.

3.4.4 Furthermore, Crossrail provides faster and alternative direct public transport to Heathrow from places in the southeast which in 2012 were connected, via a number of interchanges. Our analysis shows that the greatest shift from road to public transport occurs with passengers originating from catchment areas which have improved rail accessibility. In particular the most significant shift is observed with passengers originating from the surrounding areas to the west of Heathrow (Slough, Southampton, Windsor, and Maidenhead), the east of London, the City of London, Reading, and Manchester.

3.4.5 The geographic distributions of employees are assumed to be in line with current travel patterns and so employee mode share has been assumed to remain stable. The analysis of airport-related traffic assumed a headline car mode share of 47% for employees, based on 2013 Heathrow employee survey.

3.4.6 **Table 3** summarises the predicted rail sub-mode split in 2030, and compares it to the observed rail sub-mode split in 2012.

Table 3: Forecast AM peak hourly demand by rail service in the baseline

Rail Service	2013		2030 Baseline			
	Busiest		From		To	
Heathrow Express	649	17%	428	16%	671	15%
Crossrail/Heathrow Connect	84	2%	949	36%	1,598	35%
Piccadilly Line	3,173	81%	953	36%	1,750	38%
Western Rail Access	-	0%	300	11%	534	12%
TOTAL	3,906	100%	2,629	100%	4,553	100%

Source: 2013 values taken from HAL Submission (Taking Britain Further – Volume 1) – Figure 4.26

3.4.7 In 2030, approximately 38% of rail passengers are predicted to use the Piccadilly Line to reach the airport. This is a significant reduction in proportion from 81% which used this service in 2012. The vast majority of passengers are predicted to shift from the Piccadilly line to Crossrail and WRA. Thus our assessment shows that there will be a reduction in airport related passengers using the Piccadilly line in 2030.

3.4.8 In addition to the increase in capacity generated from the upgrade of the Piccadilly Line, the reduction in passengers will generate free capacity for other rail users. This is likely to improve comfort and convenience for travellers on the Piccadilly line. Furthermore, a reduction in proportion means that less people may be affected as a consequence of linkage failure on this service, and the baseline presents a more resilient network than is found currently.

3.4.9 Unlike the Heathrow Connect service which had an insignificant mode share of 2% in 2012, Crossrail is expected to attract significantly more patronage with up to 35% of rail passengers predicted to use it to access Heathrow. This demand for Crossrail reduces the demand on more congested sections of the Piccadilly line, particularly sections through central London.

3.4.10 The model predicts a clear demand for WRA with approximately 12% of rail users predicted to access Heathrow via this service.

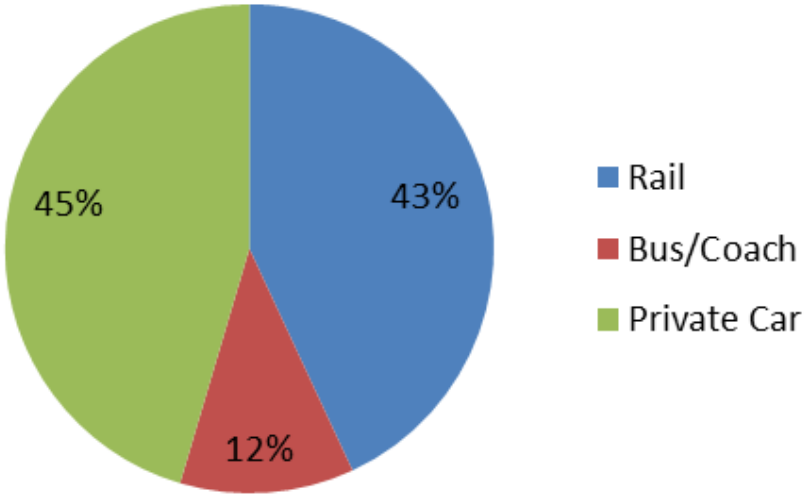
3.4.11 The proportion of demand for Heathrow Express is predicted to remain relatively constant, with around a 15% rail share.

3.5 Mode share (Extended Baseline with SRA)

3.5.1 As defined in **Section 2.2** above, the 'Extended Baseline with SRA' scenario increased the number of services on the Heathrow section of Crossrail from 4tph to 6tph, and assumed the construction of SRA.

3.5.2 **Figure 8** summarises the mode share predicted by the model with the rail Extended Baseline with SRA. Our analysis shows that these proposed updates have minimal impact on main mode share of public transport, with the proportion of passengers arriving at Heathrow by rail increasing by less than 1%.

Figure 8: Passenger demand by transport mode in Extended Baseline with SRA.



3.5.3 **Table 4** summarises the predicted airport related demand on rail services in the Extended Baseline with SRA scenario compared to the demand in the Baseline. The model predicts a clear demand for SRA with this service obtaining a mode share of 17%.

Table 4: Forecast hourly demand by rail services in the Test scenario

Rail Service	2030 Core Baseline				2030 Extended Baseline with SRA			
	From		To		From		To	
Heathrow Express	428	16%	671	15%	338	13%	524	11%
Crossrail	949	36%	1,598	35%	859	32%	1,420	31%
Piccadilly Line	953	36%	1,750	38%	742	28%	1,370	30%
Western Rail Access	300	11%	534	12%	273	10%	487	11%
Southern Rail Access	0	0%	0	0%	444	17%	793	17%
TOTAL	**2,629**	**100%**	**4,553**	**100%**	**2,656**	**100%**	**4,593**	**100%**

3.5.4 The inclusion of SRA provides direct accessibility to new catchment areas through Waterloo, Clapham Junction and Staines. Our analysis shows that additional shift from road to public transport occurs with passengers originating from the south-east; particularly from areas surrounding Croydon and Dartford.

3.5.5 Our analysis also shows a decrease in the predicted proportion of demand for Heathrow Express with demand decreasing from around 17% in 2013 to 12% in 2030. The model predicts a further significant decrease in the proportion of airport-related passengers on the Piccadilly line, with new demand level of over 8% less than those in the Core Baseline assessment and over 50% reduction in the proportion

of airport passenger demand than those observed currently. There is less significant reduction in the airport-related demand on Crossrail and WRA to Heathrow.

3.5.6 The Extended Baseline with SRA provides additional capacity to Heathrow and provides direct access from the south of London. This additional network capacity produces a more resilient network by redistributing patronage (freeing up capacity for other rail users) and so reducing the likelihood of unforeseen capacity pinch points, especially on the Piccadilly line.

3.5.7 **Table 5** presents a breakdown of mode share by main regions in the UK. The analysis shows that the proposed rail improvements will generally increase public transport share across the UK. The greatest benefits are observed for trip originating from areas in the South East, East of England, and North West where the public transport share increases by over 50% from the share in 2012. From South East (Not London), 31% of passengers are expected to access Heathrow via rail, a figure much higher than the 5% observed in 2012. The North West has a significant decrease in access by private car, with only 10% accessing Heathrow by car compared to 53% in 2012 and the proportion of passengers arriving at Heathrow by rail increasing from 35% in 2012 to 85% in 2030. The rail improvements are also expected to reduce the number of passengers accessing the airport by car from the Inner London area, where the car mode share is predicted to reduce from 40% to 32%.

Table 5: Passenger mode share by region

FINAL Region	2012			2030 Extended Baseline with SRA		
	Car Taxi Minicab	Bus Coach	Rail	Car Taxi Minicab	Bus Coach	Rail
Inner London	40%	4%	57%	32%	4%	64%
Outer London	68%	9%	23%	64%	6%	30%
South East (not London)	75%	20%	5%	48%	22%	31%
East Midlands	69%	16%	15%	52%	24%	24%
East of England	75%	12%	13%	49%	13%	39%
North East	41%	23%	36%	24%	10%	66%
North West	53%	12%	35%	10%	5%	85%
Scotland	45%	13%	42%	48%	9%	43%
South West	60%	30%	10%	58%	25%	17%
Wales	51%	38%	12%	49%	36%	15%
West Midlands	63%	26%	12%	50%	25%	26%
Yorkshire + the Humber	41%	22%	37%	13%	19%	68%

Source: 2012 data taken from Civil Aviation Authority Heathrow Survey

3.6 Supporting sustainability

3.6.1 More sustainable outcomes can be achieved by implementing a range of initiatives to support more efficient use of cars and taxis that travel to Heathrow, and so reduce the number of cars on the road network and emission.

3.6.2 Continuing to reduce employee travel by car through encouraging car share will help to offset the expected increase in airport-related car movements. Currently, over 92% of employees that access Heathrow by car drive in single occupancy cars. Analysis shows that reducing this figure to just over 80% could reduce the car trips further by up to 2.5%.

3.6.3 Providing stricter parking management policies for employees and providing incentives for car sharing is likely to support the shift to public transport and encourage car share where possible.

3.6.4 Heathrow's own analysis shows that many taxis and private vehicles dropping off at the airport have an empty return journey. This results in approximately 40,000 additional vehicle movements a day to and from Heathrow. This represents over 25% of current car trips to and from Heathrow, so plans to reduce these trips could have an impact on the volume of airport-related trips. A setup which matches passenger to drivers that have dropped off at the airport and encourages taxi sharing is likely to reduce traffic movement. Currently, Heathrow suggest that 78% of taxi trips return empty. Analysis shows that reducing this by 10% along with an increase in car share could reduce car trip further by up to 4%

3.6.5 Providing support to passengers by advising on the most appropriate surface access mode should increase awareness and further support the shift to more sustainable modes of transport.

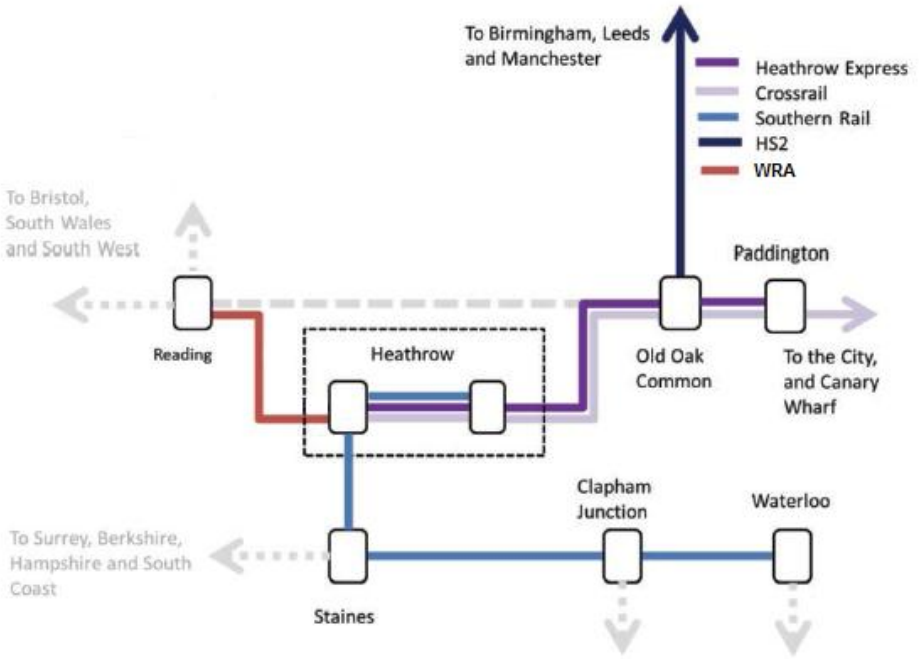
4. Rail assessment

4.1 Overview

4.1.1 The starting point of this assessment was to identify the 2030 rail access baseline. At the time of assessment, this consists of existing rail access and any committed rail developments that are expected to provide access to Heathrow by 2030 as detailed within **Sections 2.1** and **2.2**. The Core Baseline rail network includes Heathrow Express, HS2 (not including the proposed spur to Heathrow Airport), Crossrail, Piccadilly Line and WRA to Reading, while the Extended Baseline rail includes all other schemes listed within Appendix A including an assumed increased frequency on the Heathrow section of Crossrail from 4tph to 6tph, and the delivery of SRA.

4.1.2 **Figure 9** shows a map of the rail network proposed by Heathrow and termed the 'Extended Baseline with SRA' scenario.

Figure 9: 'Extended baseline with SRA' rail network



Source: HALs "Taking Britain Further – Volume 1" Modified to remove WRA to Oxford and Heathrow Express not continuing to Reading

4.1.3 Both the Core Baseline and Extended Baseline with SRA rail network package are assessed in this analysis.

4.1.4 As discussed in **Section 2**, this assessment constitutes a static analysis of forecast rail demand compared with but unconstrained by expected available network capacity in 2030. Further assessment is therefore required using a strategic dynamic modelling approach to better understand the impacts of forecast demand on rail network performance and passenger journey time/experience, including:

- The extent to which rail passengers (including those not related to the airport) change their route to avoid over-crowded services, and the associated knock-on impacts on other services;
- The extent to which new rail services related to uncommitted infrastructure may induce an increase in background demand; and

- The wider impacts of crowding on the rail network providing secondary connections to GWML services, notably the London Underground.

4.2 Committed improvements to the GWML

4.2.1 The Western Route is undergoing a significant modernisation programme to meet the demands of growing patronage. Two of the key outputs are to increase route capacity and improve train service reliability. The projects included in the programme are outlined below.

Reading Station Area Redevelopment

4.2.2 Reading station is recognised as one of the busiest railway junctions on the UK network. The complicated track layout coupled with limited platform space forms a bottleneck, limiting capacity and delays trains stopping at or passing through the station. The location of Reading station means delays can have a knock-on effect along the entire length of the Great Western Main Line (GWML) and can cause particular problems closer to London as line occupancy increases.

4.2.3 Reading Station Area Redevelopment (RSAR) will be completed in the summer of 2015. The refurbishment of the station building has been delivered in 2014, a year earlier than originally planned. It now has the additional capacity of five new platforms and a new modern train depot to its west side. Changes to the existing track layout and signalling arrangements will further facilitate increased capacity and reliability. This includes a new 2 km viaduct to the west of the station running alongside the old depot, providing fast main lines over the relief and freight lines. Along with other separation changes to the east and west of the station heavy freight trains heading north from Southampton along the GWML will be grade separated. The completion of the project is anticipated to achieve a minimum of four additional train paths per hour in each direction and a 38% improvement in train performance.

Electrification

4.2.4 The GWML is currently electrified with the 25Kv overhead line system from Paddington platforms 3 to 12 to Airport Junction. The system was installed for the introduction of Heathrow Express services. It is planned to extend electrification of the remaining Paddington platforms and a further 235 miles of the route to Newbury and Oxford by 2016, with Bristol and Cardiff by 2017. Gauge clearing for electrification includes structural clearance of around 160 bridges and four long tunnels. It has been estimated that the introduction of electric services will provide 20% more seats overall than the current diesel trains.

Intercity Express Programme

4.2.5 The Intercity Express Programme (IEP) is integrated with the electrification of the GWML. Network Rail is responsible for the infrastructure changes. Agility Trains will provide and maintain the Hitachi built trains, replacing the current class 43/Mark 3 High Speed Trains (HST). The trains will be a combination of full electric and a bi-mode version. The latter will be powered by means of diesel and electricity thus enabling access to non-electrified routes. The trains will be capable of 125 mph in various formations between five and ten cars.

4.2.6 Trains will be introduced on the GWML between December 2017 and 2018. Service introduction will bring additional capacity and faster services to the major cities along the GWML between London, Reading, Bristol, Cardiff and Swansea. The current proposal also includes trains being deployed on commuter routes such as London to Oxford. It is understood the trains will have a higher capacity ratio than the current HST fleet by having 16% more seats per carriage.

Deployment of the European Traffic Management System

4.2.7 The European Traffic Management System level 2 without (ERTMS) is being progressively introduced in the UK. The deployment is planned on the GWML, between Paddington and Heathrow in December 2017, to allow Crossrail services to operate. ERTMS, with lineside signals remaining will be completed between Paddington to Bristol in 2019, implemented as an overlay to the traditional colour-light signals with removal of signals anticipated by 2026. Once the lineside signals have been removed in 2026, ERTMS removes signal-sighting as a constraint to both line speed and capacity of the network. This means that block sections can be tailored more precisely to average train speeds, yielding greater capacity from existing infrastructure.

4.2.8 There are infrastructure constraints however in exploiting ERTMS capacity benefits which include the ability to terminate and despatch trains from terminal locations, general terminal capabilities, capacity constraints at junctions and differing train speeds. It is difficult at the present time to quantify the capacity benefits ERTMS may be able to offer. A better understanding of the benefits of ERTMS in association with any infrastructure and operational constraints is required

Swindon to Kemble Redoubling

4.2.9 The redoubling of 12.5 miles of track between Kemble and Swindon was completed in August 2014. The route forms part of the Gloucester/Cheltenham Spa line to Paddington. The enhancement will provide infrastructure to support four train paths per hour each way to meet future growth forecasts. In addition it is estimated the single line section causes approximately 900 minutes delay per annum therefore removing the single line constraint should result in a performance benefit.

4.3 Core Baseline

Heathrow Express (4 trains per hour)

4.3.1 Heathrow Express is assumed to remain as it currently exists with the addition of an extra interchange at Old Oak Common, where it will interchange with HS2 and services on the Great Western Main Line (GWML).

4.3.2 Heathrow Express is assumed to remain a premium service offering the fastest and most comfortable rail service to Central London and Old Oak Common with rolling stock designed to meet the needs of airport-related passengers (large luggage racks, extra wide doors and flight information available on board). This high level of service comes at higher fares than other public transport options such as Crossrail, which serves the same rail corridor as Heathrow Express. Thus Heathrow Express is likely to continue to serve business and premium leisure passengers.

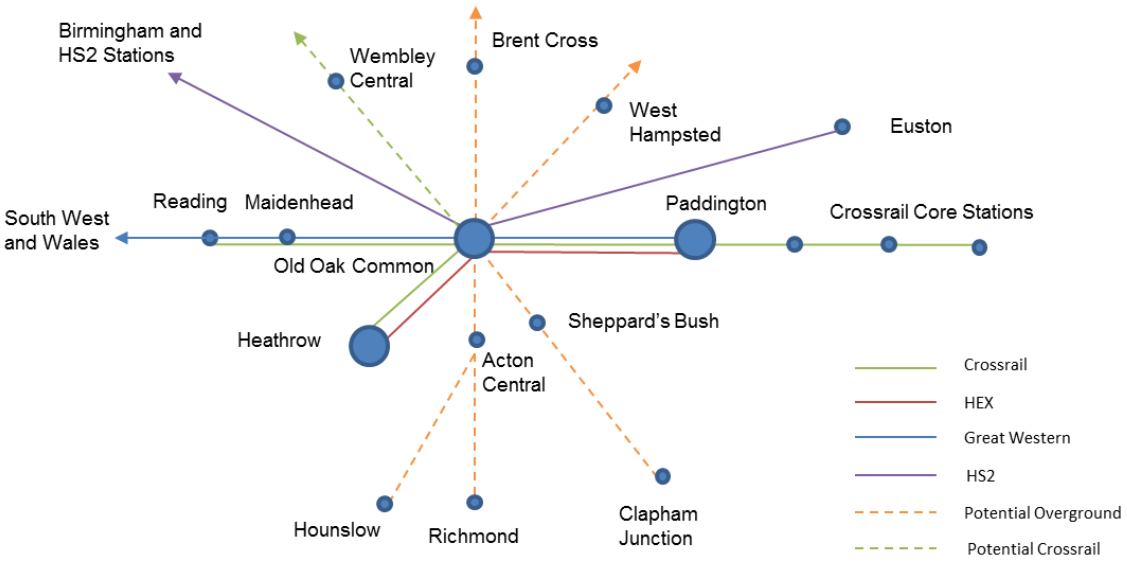
4.3.3 As stated previously the retention of Heathrow Express, as the planning assumption, comes at the expense of London bound travel on the GWML which is expected to exceed capacity by 2023. A trade-off is therefore required between direct non-stop services to Heathrow and accommodating the Main Line demand to Paddington.

HS2 and Old Oak Common

4.3.4 TfL is consulting on the inclusion of additional West London Line and North London Line connectivity at Old Oak Common and there are also proposals for a link to enable Crossrail services to operate from Old Oak Common to suburban stations on the West Coast Main Line. These schemes would increase the potential demand for passengers travelling via Old Oak Common.

4.3.5 There are also plans to develop Old Oak Common into a business district with connectivity at its core which could further increase demand for Heathrow Express services to the Airport. The new connection at Old Oak Common is presented in **Figure 10**.

Figure 10: New connections from Old Oak Common



London underground (18tph)

4.3.6 London Underground currently serves Heathrow with the Piccadilly line providing the cheapest access to Central London from Heathrow; however Crossrail will provide a faster service from Central London and is assumed to run at the same cost in 2018. The Piccadilly line will still provide an important link to Kings Cross (for trains to the north) and important tourist destinations such as Piccadilly Circus and Kensington. The underground is also an important access point for staff from Hounslow and Ealing. TfL plans to increase the frequency of trains during the peak by 2030 to 18 trains per hour and will have introduced new higher density rolling stock.

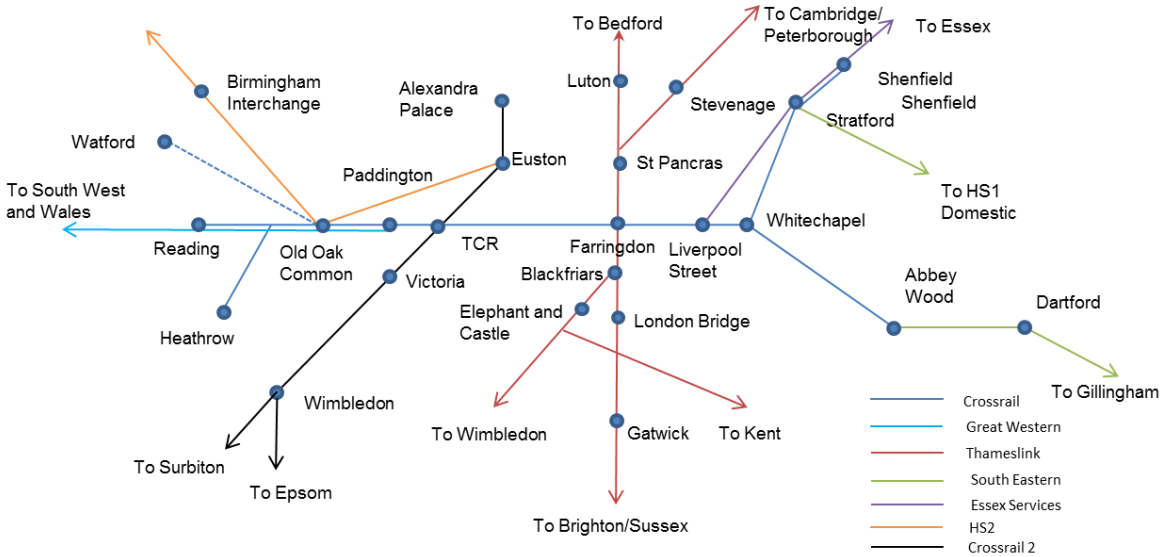
Crossrail (4tph)

4.3.7 Crossrail is due to be introduced from 2018 and will operate to Heathrow at four trains per hour. Crossrail trains from Heathrow will operate via Old Oak Common (connecting to HS2 when implemented in 2026) through the 'core' section onto the two branches to Shenfield and Abbey Wood. Crossrail serves many important destinations directly including the West End, The City and Canary Wharf reducing the need for passengers to use the underground network to access the Airport. Crossrail will improve the connectivity for passengers from outside London by serving important intercity and commuter stations such as Farringdon (Thameslink), Liverpool Street (Greater Anglia), Abbey Wood (North Kent Line) and Stratford (HS1). This decreases journey times for passengers from Sussex, Kent, Essex, Hertfordshire and Cambridgeshire and avoids the need for passengers to interchange via the Underground.

4.3.8 Heathrow's proposal increases the number of trains destined to Heathrow to 6 trains per hour assuming 4 of the 6 trains branching to Abbey Wood and 2 to Shenfield. Crossrail replaces Heathrow Connect with a far superior service by reducing wait times increasing train capacity. With the proposed increase in frequency from 4 to 6 trains as part of the Extended Baseline with SRA option, this would further increase the benefits to passengers.

4.3.9 Crossrail rolling stock is primarily designed to cater for commuter passengers with high occupancy carriage layouts, so will therefore not have the same provision for luggage and comfort as Heathrow Express. It will however be included as part of the Oyster fare structure and so will offer cheaper fares than Heathrow Express. A schematic map presenting the improved connectivity through Crossrail is presented in **Figure 11**.

Figure 11: Schematic map of improved Connectivity due to Crossrail



WRA to Heathrow (4tph)

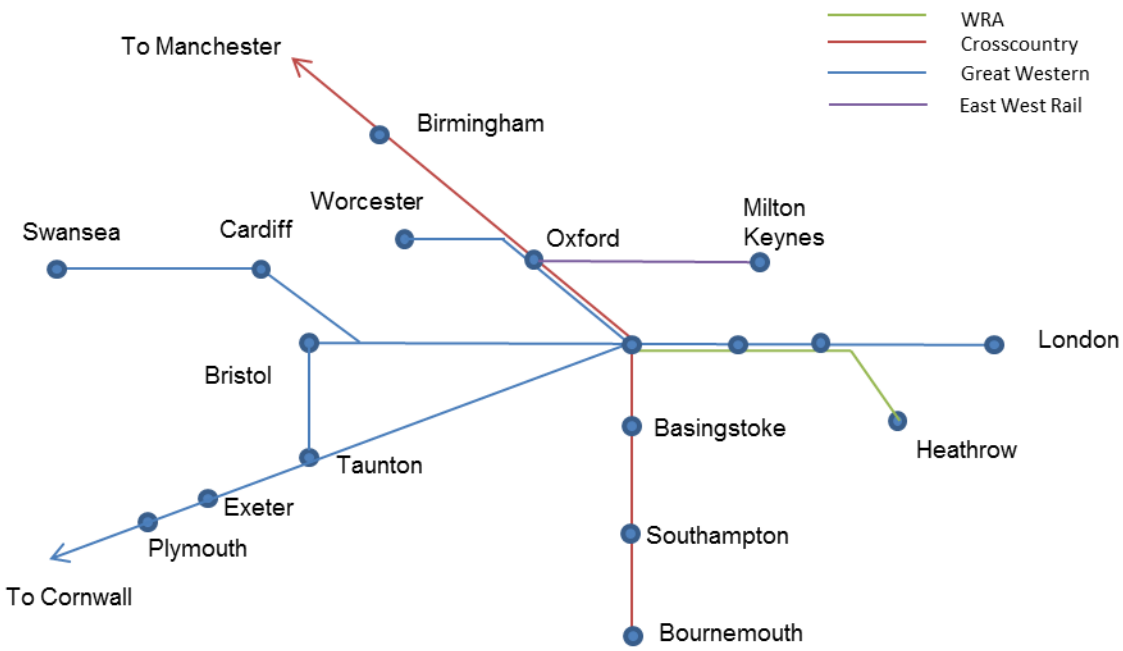
4.3.10 WRA to Heathrow adds capacity, connectivity and provides reduced journey times from large areas in the west to Heathrow. Currently passengers from the west accessing by rail have the choice of a bus interchange at Reading or connecting to the London Underground, Heathrow Express or Heathrow Connect at Paddington. WRA to Heathrow is proposed to reduce journey times for passengers from the South West and Wales as the interchange reduces the need to 'double back' at Paddington. Proposed journey times on WRA to Heathrow are 6 minutes from Slough and 28 minutes from Reading. Fares to Reading are also proposed to be cheaper than services through to Paddington.

4.3.11 Key locations for employees such as Slough and Maidenhead would benefit from direct rail access and connecting to Reading, and potentially Oxford, serving two important growth cities in the U.K. Reading Station, which also serves cross-country services to Southampton and Manchester, provides an alternative to connecting via London. If provided, there are well developed plans for an East West Rail link which would connect Oxford to Milton Keynes and potentially Bedford in the future, further boosting Heathrow's connectivity.

4.3.12 HAL's proposals highlight the potential for extending WRA to Oxford, but this has not been included in our analysis as we understand from discussions with Network Rail that line capacity issues between Reading and Oxford would have to be resolved first.

4.3.13 As shown in **Figure 14**, the GWML between Heathrow and Reading is predicted to be over capacity by 2023, with the section to Oxford as far as Didcot Parkway also over capacity. Network Rail has recently published the industry's Western Route Study Draft for Consultation which assesses future capacity and connectivity on the GWML in CP6 and beyond. The Route Study assesses the potential options for linking services at Reading. **Figure 12** presents the connectivity through Western Rail for Heathrow passengers.

Figure 12: Schematic map of improved Connectivity due to WRA



4.4 Extended Baseline with SRA

SRA

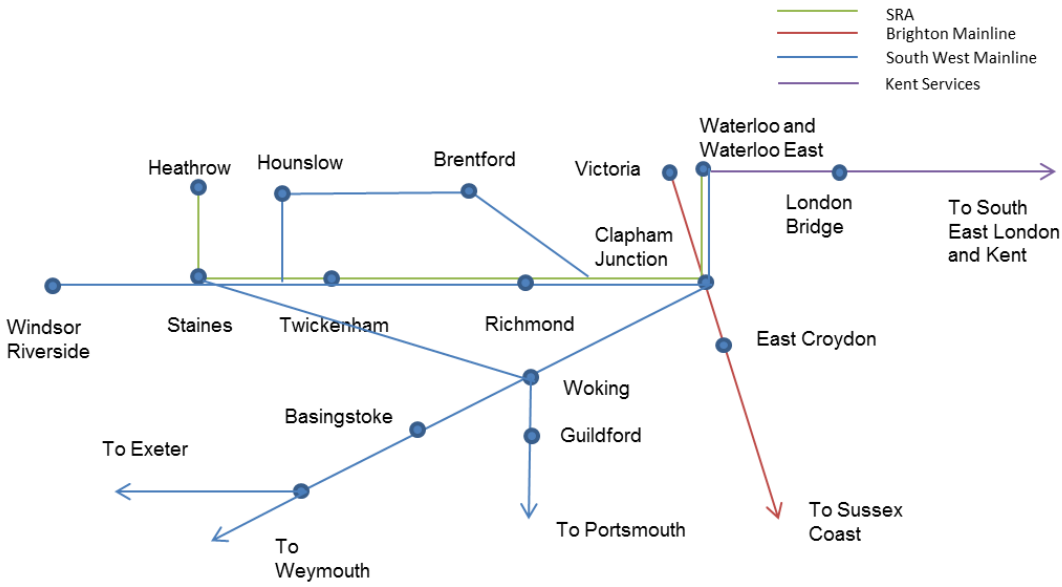
4.4.1 Heathrow has over the last twenty years developed plans to connect to the rail lines to the south near Staines to provide a further link to London and direct rail access to towns in Surrey. The planned service would link the Airport to Staines (which is an important source of employees for the airport) and then to London Waterloo. Network Rail has also undertaken some preliminary analysis which indicates that SRA could be a plausible option, but further, more detailed assessment is required. It is to be noted that while there are other proposed connections to Surrey, such as connection to Woking, they have not been considered in the current assessment as they still require more detailed analysis before they can be considered as options. However, once finalised, they would certainly further improve the regional connectivity to Heathrow.

4.4.2 The SRA would offer increased connectivity in south west London with direct connections to Richmond, Clapham Junction and Waterloo. Clapham Junction provides an interchange to the South West and Brighton mainlines and Waterloo provides connections with lines towards South London and Kent at Waterloo East. Any service would need to function as a commuter railway in addition to serving the airport as the lines on which it runs to London are very congested with commuter traffic and as such would most likely operate high density commuter rolling stock.

4.4.3 The development of this line is still in the very early stages of planning with the proposed route still under some discussion, and previous plans for a southern rail link have faced difficulty in both projected demand and issues involving level crossings. However with greater demand created by the new North West Runway from increased passenger numbers and employees, SRA becomes a more viable proposition.

4.4.4 Figure 13 presents the connectivity to Heathrow via SRA.

Figure 13: Schematic map of improved Connectivity due to SRA



Crossrail (6tph)

4.4.5 Heathrow's proposal increases the number of trains destined to Heathrow to 6 trains per hour assuming 4 of the 6 trains branching to Abbey Wood and 2 to Shenfield. Crossrail replaces Heathrow Connect with a far superior service by reducing wait times increasing train capacity. With the proposed increase in frequency from 4 to 6 trains as part of the Extended Baseline with SRA option, this would further increase the benefits to passengers.

4.5 GWML capacity

4.5.1 Although the projects previously described will have a positive impact on GWML capacity and reliability, NR has identified parts of the Western Route approaching or exceeding capacity by 2024 (Control Period 6 (CP6)). **Figure 14** overleaf shows the 2023 high peak load on seated capacity on the GWML.

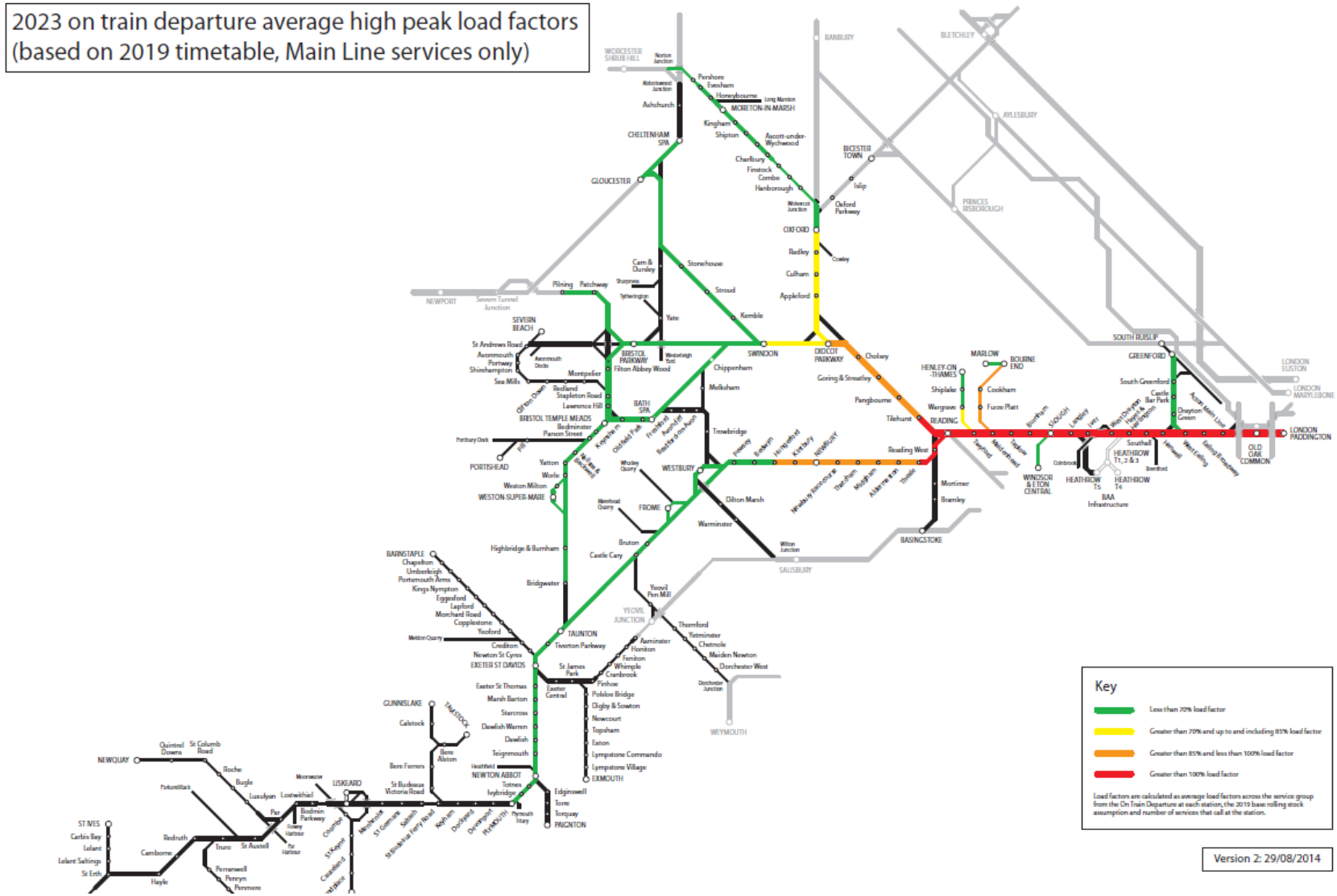
4.5.2 **Figure 14** shows that the GWML peak rail passenger demand is predicted to be higher than planned seated capacity between Reading and London Paddington by 2023. This overcapacity is predicted as far as Swindon, Didcot and Newbury with the average load factor exceeding 85%, indicating some services will incur crowding[2]. By 2033 crowding is anticipated to get worse with more passengers standing for longer time as demand continues to increase on the GWML. The Western Route Study, Draft for Consultation, predicts passenger demand to London Paddington will increase by 29% to 2023, and 99% to 2043.

4.5.3 This suggests further rail investment in CP6 and beyond will be required to provide capacity to accommodate growth in rail passenger demand.

4.5.4 The nature of the GWML means that any infrastructure capacity constraints will affect the entire route, including routes which feed into it. For example, delayed long distance services can create significant levels of secondary delay further west. The details of anticipated capacity constraints in 2023 and 2043 across the Western Route and potential choices to overcome them are detailed in the rail industry's Western Route Study, published on Network Rail's website.

[2] Network Rail's London and South East Route Utilisation Strategy 2011 showed that when the average load factor in the high peak hour exceeds 85%, many of the individual passenger services are incurring crowding, with the number of passengers exceeding capacity.

Figure 14: 2023 High Peak Load Factors GWML



Source: Network Rail's "Western Route Study Draft for Consultation 2014"

4.6 2030 rail demand

4.6.1 To inform the Airports Commission, Jacobs developed a surface access model which predicts rail mode shares for trips to and from the airport, and forecasts demand on the available rail network. The approach to forecasting rail transport demand for Heathrow was undertaken in 3 key stages as follows:

- Estimate total peak-hour demand to and from the airport by main mode of surface transport. This stage considers the change in generalised costs that arise from the inclusion of the SRA and any increase in frequency. **Table 6** and **Table 7** summarises the forecast mode share in each scenario. The rail and underground mode share of 43% represents an increase from the current observed rail and underground mode share of 28% as a result of modifications to the rail network;
- Allocate total peak-hour trips to and from the airport to geographic regions in the UK; and
- Assign rail trips from different geographic regions to different rail corridors and services.

4.6.2 **Table 6** summarises the predicted demand on the Baseline network scheme and Heathrow's proposed scheme. Adding extra services on Crossrail and including the SRA has not altered the overall rail mode share.

Table 6: Predicted passenger mode shares (2030 AM Peak)

Rail mode	2030 Base case		2030 Extended Baseline with SRA	
	From	To	From	To
Private Vehicle	46%	46%	45%	45%
Bus/Coach	12%	12%	12%	12%
Rail	43%	43%	43%	43%
TOTAL	**100%**	**100%**	**100%**	**100%**

Note: Numbers rounded to nearest percentage

4.6.3 The rail demand forecasts were allocated to rail services depending on associated trip origins and information on the rail journey including cost, journey time and number of interchanges. **Table 7** shows that by providing alternative access to Heathrow from the SRA there is a more even distribution of rail passengers across the lines, with the SRA taking 17% of the rail sub-mode share. Our analysis shows that Crossrail and the Piccadilly line are likely to be the most popular choices for passengers to access the Airport.

Table 7: Predicted Rail Demand by Service (AM peak 2030)

Rail Service	2030 Base case				2030 Extended Baseline with SRA			
	From		To		From		To	
Heathrow Express	428	16%	671	15%	338	13%	524	11%
Crossrail	949	36%	1,598	35%	859	32%	1,420	31%
Piccadilly Line	953	36%	1,750	38%	742	28%	1,370	30%
Western Rail Access	300	11%	534	12%	273	10%	487	11%
Southern Rail Access	0	0%	0	0%	444	17%	793	17%
TOTAL	**2,629**	**100%**	**4,553**	**100%**	**2,656**	**100%**	**4,593**	**100%**

4.6.4 Rail demand by service was then compared with estimates of rail capacity and forecasted background demand in 2030.

4.7 2030 rail capacity analysis

4.7.1 As identified within **Section 4.2** overall demand on the GWML is predicted to exceed capacity by 2024 towards London. Direct train services to Heathrow on the Western Route come at a trade-off to accommodating other train users and hence a balance must accord with **Objectives 1** and **2** of the AC's Appraisal Framework.

4.7.2 To assess Heathrow bound train capacity, capacities and background demand were identified in discussions with TfL and NR. Following on from the discussions, a capacity threshold of 85% total capacity was identified[3]. The airport-related and background demand were compared to this capacity threshold. Where demand is shared among a number of lines (Crossrail core sections for example) the line demand is shared equally among the services; however in reality the origin of a service would affect the level of background demand.

4.7.3 **Table 8** summarises the results from the comparison of demand against capacity. The table outlines the airport-related and demand on key rail sections along with the assumed capacity and background demand provided by Network Rail. The table also presents the volume to capacity ratio (VCR)[4] predicted in the Baseline and the Extended Baseline with SRA scenarios, and compares this to the 85% capacity threshold.

[3] Network Rail's London and South East Route Utilisation Strategy published in 2011 showed that when the average load factor in the peak exceeds 85%, many of the individual passenger's services are incurring crowding, with the number of passengers exceeding capacity.

[4] The volume to capacity ratio (VCR) is the performance measure used to assess the impact of demand on the network.

Table 8: Volume capacity analysis of rail access network

Line	Section	Direction	Committed Capacity			Proposed Capacity			2030 Background Passengers	2030 Airport Rail Forecast		Background only forecast V/C		Airport + Background rail forecast V/C			
												Hourly total capacity		Hourly Seated capacity		Hourly Total capacity	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity	Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Core baseline Rail network	Extended Baseline Rail Network	Core Baseline Rail Network	Extended Baseline Rail Network	Core Baseline Rail Network	Extended Baseline Rail Network	Core Baseline Rail Network	Extended Baseline Rail Network
Heathrow Express	Paddington - Old Oak Common	To	4	1568	4608	4	1568	4608	0	586	455	0%	0%	37%	29%	13%	10%
	Old Oak Common - Heathrow	To	4	1568	4608	4	1568	4608	0	671	524	0%	0%	43%	33%	15%	11%
	Heathrow - Old Oak Common	From	4	1568	4608	4	1568	4608	0	428	338	0%	0%	27%	22%	9%	7%
	Old Oak - Paddington	From	4	1568	4608	4	1568	4608	0	381	299	0%	0%	24%	19%	8%	6%
LU Piccadilly Line	Kings Cross - Green Park	To	18	4176	14616	18	4176	14616	16380	295	238	112%	112%	399%	398%	114%	114%
	Green Park - Earls Court	To	18	4176	14616	18	4176	14616	13090	1032	768	90%	90%	338%	332%	97%	95%
	Earls Court - Acton Town	To	18	4176	14616	18	4176	14616	6160	1227	904	42%	42%	177%	169%	51%	48%
	Acton Town - Heathrow	To	18	4176	14616	18	4176	14616	4500	1750	1370	31%	31%	150%	141%	43%	40%
	Heathrow - Acton Town	From	18	4176	14616	18	4176	14616	11700	953	742	80%	80%	303%	298%	87%	85%
	Acton Town - Earls Court	From	18	4176	14616	18	4176	14616	13510	765	579	92%	92%	342%	337%	98%	96%
	Earls Court - Green Park	From	18	4176	14616	18	4176	14616	15470	661	504	106%	106%	386%	383%	110%	109%
	Green Park - Kings Cross	From	18	4176	14616	18	4176	14616	11900	198	160	81%	81%	290%	289%	83%	83%
Crossrail	Romford – Stratford [1]	To	1	450	1500	2	900	3000	0	2	2	0%	0%	0%	0%	0%	0%
	Stratford – Whitechapel	To	1	450	1500	2	900	3000	412	27	38	27%	14%	98%	50%	29%	15%
	Abbey Wood - Canary Wharf [1]	To	3	1350	4500	4	1800	6000	0	33	43	0%	0%	2%	2%	1%	1%
	Canary Wharf - Whitechapel	To	3	1350	4500	4	1800	6000	1275	95	83	28%	21%	101%	75%	30%	23%
	Whitechapel - Liverpool Street	To	4	1800	6000	6	2700	9000	1650	168	164	28%	18%	101%	67%	30%	20%
	Liverpool Street - Farringdon	To	4	1800	6000	6	2700	9000	1900	280	270	32%	21%	121%	80%	36%	24%
	Farringdon - Tottenham Court Road	To	4	1800	6000	6	2700	9000	2187	562	522	36%	24%	153%	100%	46%	30%
	Tottenham Court Road - Bond Street	To	4	1800	6000	6	2700	9000	2512	674	615	42%	28%	177%	116%	53%	35%
	Bond Street - Paddington	To	4	1800	6000	6	2700	9000	2787	1009	926	46%	31%	211%	138%	63%	41%
	Paddington - Old Oak Common	To	4	1800	6000	6	2700	9000	1712	1131	1034	29%	19%	158%	102%	47%	31%
	Old Oak Common - Ealing Broadway	To	4	1800	6000	6	2700	9000	3425	1360	1174	57%	38%	266%	170%	80%	51%
	Ealing Broadway - Hayes and Harlington	To	4	1800	6000	6	2700	9000	3750	1503	1316	63%	42%	292%	188%	88%	56%
	Hayes and Harlington - Heathrow	To	4	1800	6000	6	2700	9000	700	1598	1420	12%	8%	128%	79%	38%	24%
	Heathrow - Hayes and Harlington	From	4	1800	6000	6	2700	9000	1400	949	859	23%	16%	131%	84%	39%	25%
	Hayes and Harlington - Ealing Broadway	From	4	1800	6000	6	2700	9000	7500	906	812	125%	83%	467%	308%	140%	92%
	Ealing Broadway - Old Oak Common	From	4	1800	6000	6	2700	9000	6850	850	757	114%	76%	428%	282%	128%	85%
	Old Oak Common - Paddington	From	4	1800	6000	6	2700	9000	3425	739	679	57%	38%	231%	152%	69%	46%
	Paddington - Bond Street	From	4	1800	6000	6	2700	9000	5575	664	613	93%	62%	347%	229%	104%	69%

Line	Section	Direction	Committed Capacity			Proposed Capacity			2030 Background Passengers	2030 Airport Rail Forecast		Background only forecast V/C		Airport + Background rail forecast V/C			
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity	Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Core baseline Rail network	Extended Baseline Rail Network	Hourly total capacity		Hourly Seated capacity		Hourly Total capacity	
												Core Baseline Rail Network	Extended Baseline Rail Network	Core Baseline Rail Network	Extended Baseline Rail Network	Core Baseline Rail Network	Extended Baseline Rail Network
	Bond Street - Tottenham Court Road	From	4	1800	6000	6	2700	9000	5025	439	404	84%	56%	304%	201%	91%	60%
	Tottenham Court Road - Farringdon	From	4	1800	6000	6	2700	9000	4375	366	343	73%	49%	263%	175%	79%	52%
	Farringdon - Liverpool Street	From	4	1800	6000	6	2700	9000	3800	188	181	63%	42%	222%	147%	66%	44%
	Liverpool Street - Whitechapel	From	4	1800	6000	6	2700	9000	3300	113	110	55%	37%	190%	126%	57%	38%
	Whitechapel - Canary Wharf	From	3	1350	4500	4	1800	6000	2550	64	56	57%	43%	194%	145%	58%	43%
	Whitechapel - Stratford	From	1	450	1500	2	900	3000	825	18	26	55%	28%	187%	95%	56%	28%
	Canary Wharf - Abbey Wood [1]	From	3	1350	4500	4	1800	6000	0	4	3	0%	0%	0%	0%	0%	0%
	Stratford – Romford [1]	From	1	450	1500	2	900	3000	0	1	2	0%	0%	0%	0%	0%	0%
WRA	Oxford - Reading	To	0	0	0	2	0	0	0	0	0	0%	0%	0%	0%	0%	0%
	Reading - Maidenhead	To	4	1568	4608	4	1568	4608	0	369	328	0%	0%	24%	21%	8%	7%
	Maidenhead - Slough	To	4	1568	4608	4	1568	4608	0	450	406	0%	0%	29%	26%	10%	9%
	Slough - Heathrow	To	4	1568	4608	4	1568	4608	0	534	487	0%	0%	34%	31%	12%	11%
	Heathrow - Slough	From	4	1568	4608	4	1568	4608	0	300	273	0%	0%	19%	17%	7%	6%
	Slough - Maidenhead	From	4	1568	4608	4	1568	4608	0	269	243	0%	0%	17%	15%	6%	5%
	Maidenhead - Reading	From	4	1568	4608	4	1568	4608	0	231	207	0%	0%	15%	13%	5%	4%
	Reading - Oxford	From	0	784	2304	2	0	0	0	0	0	0%	0%	0%	0%	0%	0%
SRA	Waterloo - Clapham Junction	To	4	2000	4000	4	2000	4000	1459	0	357	36%	36%	73%	91%	36%	45%
	Clapham junction - Richmond	To	4	2000	4000	4	2000	4000	1753	0	510	44%	44%	88%	113%	44%	57%
	Richmond - Staines	To	4	2000	4000	4	2000	4000	1329	0	636	33%	33%	66%	98%	33%	49%
	Staines - Heathrow	To	4	2000	4000	4	2000	4000	0	0	793	0%	0%	0%	40%	0%	20%
	Heathrow - Staines	From	4	2000	4000	4	2000	4000	0	0	444	0%	0%	0%	22%	0%	11%
	Staines - Richmond	From	4	2000	4000	4	2000	4000	2658	0	382	66%	66%	133%	152%	66%	76%
	Richmond - Clapham junction	From	4	2000	4000	4	2000	4000	3506	0	318	88%	88%	175%	191%	88%	96%
	Clapham junction - Waterloo	From	4	2000	4000	4	2000	4000	2918	0	232	73%	73%	146%	158%	73%	79%

Source: Background Passengers for 2030 provided by Transport for London and Network Rail where appropriate.

Heathrow Express

4.7.4 Heathrow Express continues to operate well within seated capacity as it does currently with only a maximum volume to capacity ratio of 33%; however as a premium service passengers would expect to have a seat for their entire journey. Heathrow Express is predicted to have a slight reduction in mode share from the Baseline to Extended Baseline with SRA as there is greater competition from SRA and the increase of frequency on Crossrail. The route would have spare on-train capacity for an increase in demand from passengers from potential Old Oak Common developments. Were airport passengers to have significant increase in there value of time by 2030, this would make Heathrow Express more popular than the slower but cheaper other options as passengers are more willing to pay for the faster service. Furthermore, the spare on-train capacity on Heathrow Express services may be utilised by passengers avoiding crowding during peak periods on other rail services such as Crossrail and the Piccadilly line. A sensitivity test on the fare premium of Heathrow Express services was undertaken which shows that bringing the fare in line with the Piccadilly Line would see utilisation on Heathrow Express increase to 85% of seated capacity. Further analysis on this sensitivity test is presented within Appendix B.

Piccadilly line

4.7.5 Heathrow Airport passengers contribute only around 8% of Piccadilly Line passengers in the central sections, rising to around 40% in the sections approaching Heathrow. Thus the very high volume to capacity ratios in the central sections (of almost 400% of seated capacity and up to 114% of crush capacity) are mainly due to background demand.

4.7.6 Passengers travelling from inner London are unlikely to be able to guarantee a seat during the peak period with over capacity conditions expected due to background patronage; however loading factors do fall close to seat capacity between Acton and the Airport. Where significant crowding does occur passengers may switch to less crowded rail options which serve similar routes, such as SRA, Crossrail or Heathrow Express.

Crossrail

4.7.7 Crossrail trains are designed for very high passenger occupancy; however with only the committed four trains per hour these trains do become heavily congested between Hayes and Old Oak Common. However with the extra two trains per hour the load factor falls below 100%. Passengers would, however, not be guaranteed a seat whilst travelling to the airport during the morning peak and this is likely to be repeated in the evening peak where passengers to the airport would be travelling in the same direction as the vast majority of commuter passengers. However passengers originating at Heathrow would be able to access a seat as the service originates at the Airport. Heathrow bound passengers account for around 10% of passengers using Crossrail in the central section, increasing to above 90% in the sections approaching Heathrow. Overall Crossrail attracts a similar mode share as the Piccadilly line with 31% of passengers predicted to access the airport using the service.

WRA to Heathrow

4.7.8 WRA to Heathrow was modelled without background flows as currently services in the area operate primarily to London as this is where the majority of the demand for the line is generated. A four train per hour service would have spare capacity with the busiest sections reaching 31% of seat capacity. The services popularity with employees may be increased by offering reduced season tickets for airport employees. Currently Reading serves Heathrow with frequent coach services, if WRA where to fully capture the public transport market then loading factors may increase, however this would still not cause the service to approach capacity. Some non-airport passengers may use the service to interchange onto the Piccadilly line or connect to services on SRA, as an alternative to travelling through London.

SRA

4.7.9 During peak periods the sections between Staines and London are predicted to be exceptionally busy due to high demand from commuter passengers experiencing up to 96% of crush capacity. During these periods, passengers originating at Heathrow would be able to get a seat, however those travelling from London during peak hours would be conflicting with commuter passengers. SRA is popular with employees from nearby areas who could access the airport directly or by a single interchange at Staines. SRA reduces congestion on Crossrail as passengers from Central and South London have a second option for accessing the airport via interchange at Waterloo or Clapham Junction.

4.8 Accommodating other rail users

4.8.1 The surface access options proposed provides adequate crush capacity for use by other rail users (thus achieving **Objective 2** that the Airports Commission set), apart from the central sections of the Piccadilly Line between Kings Cross and Earls Court. However, the contribution of the surface access demand of this section of the Piccadilly line is only 8% of demand. The new rail services (Crossrail, WRA and SRA), reduce the demand for the Piccadilly line and so provides a more reliable and resilient network, reducing the number of airport related passengers on the over capacity service.

4.8.2 The Great Western Main Line is undergoing a significant route modernisation programme to meet the demands of growing patronage over time. Two of the key outputs are to increase route capacity and improve train service reliability. These include redevelopment of Reading station, Electrification of the remainder of the route and the introduction of new signalling and trains.

4.8.3 Although these improvements will have a positive impact on GWML capacity and reliability, Network Rail has identified parts of the Great Western region approaching or exceeding capacity by 2024 (Control Period 6 (CP6)). This suggests further investment in CP6 and beyond will be required. The nature of the GWML means that any single or multiple capacity constraints will affect the entire route, including routes which feed into it. For example, delayed long distance services can create significant levels of secondary delay the further west they come as line occupancy increases towards London.

4.8.4 Our analysis of the impact of demand on the rail access proposition shows that on the Heathrow express, Crossrail, WRA and SRA there is adequate capacity. On the other hand, the sections between Kings cross to/from Acton on the Piccadilly line service remain critical; however, this could be offset by an increase in the capacity of trains on the Piccadilly line.

4.8.5 Including non-airport related traffic, Heathrow express, Crossrail, WRA and SRA have spare capacities of about 90%, 10%, 90% and 5% respectively. The threshold is based on crush capacity and additional passengers may still be required to stand for parts of their journey. The Piccadilly line is predicted to be over capacity due to background demand based 4 passengers per square meter.

4.9 Level of Service Analysis

4.9.1 In addition to rail capacity, our model was also used to assess the impact of proposed enhancements to rail services to and from Heathrow on passenger journey time and cost. Overall demand-weighted averages were calculated from model outputs and then compared with averages derived from the calibrated base model. The results of this process are summarised in this section and are based on the assessment of the new North West Runway proposal against **Objective 3** in the AC's Appraisal Framework, which is 'to enable access to the airport from a wide catchment area'.

Generalised Costs (GCs)

4.9.2 GC provides a measure that takes into account not only the total journey duration but also the impacts related to journey comfort, wait times and interchanges required (in the case of public transport), and the monetary cost of the journey (covering public transport fares and car operating costs) – as

explained in the Methodology Statement, estimates of GC for car, bus/coach and rail trips between Heathrow and districts in the UK were the primary input to the main mode share model, which was developed to forecast demand to and from the airport. We assumed a Value of Time of 27p per minute for leisure passengers and 69p per minute for business passengers.

4.9.3 As a result of the uncertainties surrounding future changes in rail fares, the central scenario in the 2030 model assumed no changes in real values between now and 2030 – however new services have been given fare structures similar to services operating today and where more details are known such as Crossrail operating on Oyster they have been given the appropriate fare as of 2014. **Table 9** shows example fares used within the forecast model.

Table 9: Example Fares in the Model

Station	TFL (Crossrail/Tube)	Heathrow Express	Heathrow Connect	WRA
Paddington	£5.00	£21.00	£9.90	NA
	£5	£23.80	£12.70	NA
Reading	£27.20	£43.20	£32.20	£13
	£87	£105.20	£94.10	£64.50

Source: Transport for London and Network Rail 2014 Pricing Websites

Journey times

4.9.4 In order to provide more clarity on these service improvements the components of GC related to fares and penalties applied for wait and interchange times were removed – the remaining components effectively comprises a "clock time" estimate for rail trips to Heathrow from each district. This clock time consisted of total in-vehicle time (including connecting taxi trip time where this was a secondary mode for Heathrow Express services), wait time (based on service frequency) and interchange time. It should be noted that the clock times reported in this section do not include first and last leg walk times for any journey. Where appropriate all values were taken from the Passenger Demand Forecasting Handbook (PDFH).

4.9.5 Clock time estimates were weighted by forecast demand based on the mode shares to calculate an overall average time to reach Heathrow by rail in 2012 and in 2030 – these averages were based on the same methodology used to calculate the overall average GC. **Table 10** shows compares average weighted clock times for passengers to Heathrow in 2012 and 2030. If employees are included in the demand-weighted average calculation this reduces the average clock time, reflecting the fact that employees tend to be clustered close to the airport.

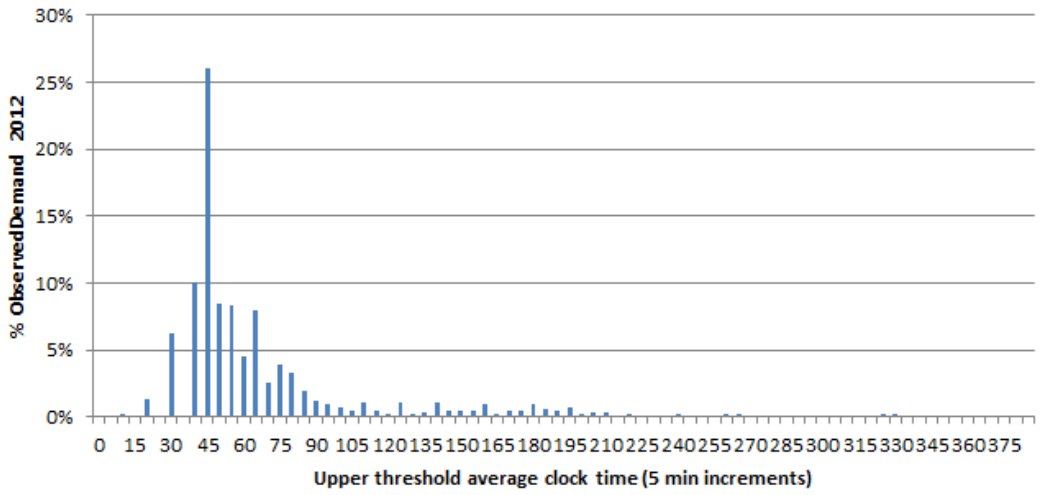
Table 10: Demand-weighted average rail journey times for passengers (minutes)

Year	SRA	WRA	Tube	Crossrail/ Connect	HEX PT	HEX Taxi	HEX(All)	All rail
2012			71	88	66	33	55	66
2030	80	86	65	64	71	42	59	69

4.9.6 The overall clock time for rail increases in 2030 as the greater array of passengers using rail for longer distance trips as a result of improving journey times to the west, north and via Crossrail interchange has increased the number of passengers using long distance services. In particular WRA to Heathrow passengers have an average journey time of 86 minutes, much longer that the actual journey length of the service based on further connections prior to WRA. The average Journey times for existing services largely consistent with the base model.

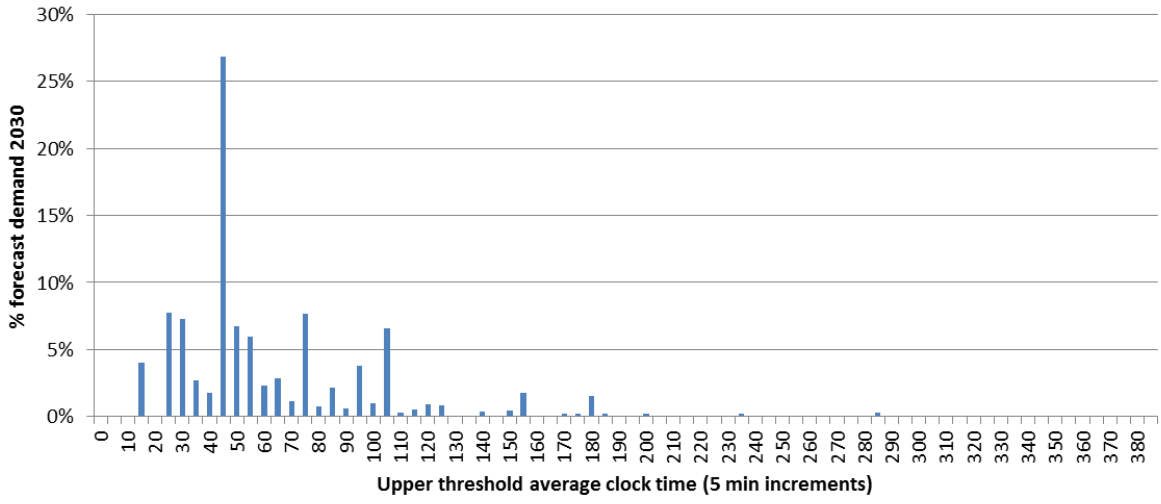
4.9.7 **Figure 15** and **Figure 16** show the 2012 and 2030 forecast distributions of rail clock time weighted by regional average demand. Journey times are shown with 5-minute increments with the upper limit indicated – the first graph shows for example that the peak for journeys is 45 – 50 minutes, the same pattern as for 2030. The 2030 model forecasts 57% of all trips are within one hour, compared to 60% in 2012, again this is due to the increase in rail trips coming primarily from the South East and East of England.

Figure 15: Heathrow 2012 rail clock times by passenger demand



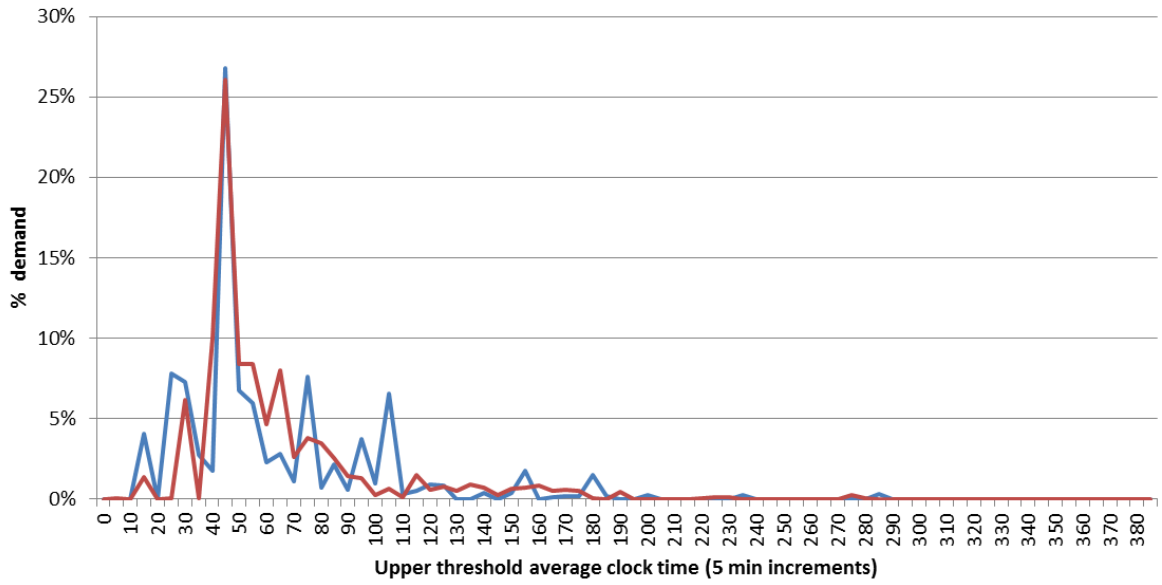
Source: 2012 Civil Aviation Authority Heathrow Survey

Figure 16: Heathrow 2030 rail clock times by passenger demand



4.9.8 **Figure 17** compares the average clock time weighted by regional demand as described above. The profile remains largely similar with the peak around the 45 – 50 minutes as this represents the clock time for important areas of demand such as Westminster and the City.

Figure 17: Comparison of rail clock times by passenger demand



4.9.9 **Table 11** shows the rail clock times for identified representative trips to/from Heathrow assumed in the Jacobs 2012 and 2030 models by standard rail or HEX (with either a public transport or taxi secondary mode) from districts that currently produce a high proportion of public transport demand at Heathrow. **Table 11** shows all 33 London Boroughs and the top ten districts outside London ranked according to the number of annual public transport trips generated to Heathrow according to the CAA Survey Data.

4.9.10 The table highlights a reduction in rail journey times from many areas, especially those served by a direct new service such as Crossrail, WRA and SRA (categorised under standard rail) such as Reading. Big decreases in clock time occur for Manchester and Birmingham due to the HS2 service speeds and from and the connection at Old Oak Common being closer to the airport than terminating at Euston. Passengers from the South West and Wales also benefit with reduced journey times from Plymouth, Bristol and Cardiff by around 20 minutes.

Table 11: Comparison of minimum rail clock times from key districts to Heathrow in 2012 and 2030

District	Representative station	Heathrow 2012			Heathrow 2030			Difference			
		Standard Rail	Tube	HEX	Standard Rail	Tube	HEX	Standard Rail	Tube	HEX	Overall
All 33 London boroughs (ranked by PT passenger trips to Heathrow in 2012)											
Westminster	Oxford Circus	59	57	35	41	57	38	-18	0	3	3
Kensington and Chelsea	South Kensington	64	44	36	46	44	39	-18	0	3	3
Camden	Kings Cross St. Pancras Underground	65	58	39	49	58	42	-16	0	3	3
Southwark	London Bridge	76	63	46	54	66	46	-22	3	0	0
Lewisham	New Cross	99	81	61	65	81	64	-34	0	3	3
City of London	Moorgate	69	71	43	40	71	46	-29	0	3	-3
Tower Hamlets	Canary Wharf	79	69	54	49	69	50	-30	0	-4	-5
Kingston upon Thames	Surbiton	139	77	113	79	82	78	-60	5	-35	1
Barnet	Finchley Central	103	87	51	66	87	54	-37	0	3	3
Hammersmith and Fulham	Hammersmith	64	35	40	47	35	43	-17	0	3	0
Redbridge	Redbridge	101	88	80	71	88	79	-30	0	-1	-9
Enfield	Cockfosters	111	89	89	81	89	88	-30	0	-1	-8
Lambeth	Clapham High Street	84	73	44	57	73	44	-27	0	0	0
Newham	Stratford	89	76	57	64	76	60	-25	0	3	3
Hackney	Hackney Central	101	82	50	76	82	53	-25	0	3	3
Merton	Wimbledon	82	64	57	69	64	60	-13	0	3	3
Hillingdon	Hatton Cross	95	7	58	56	7	61	-39	0	3	0
Richmond upon Thames	Richmond	85	54	50	41	54	49	-44	0	-1	-9
Greenwich	Greenwich	105	88	54	69	88	57	-36	0	3	3
Harrow	South Harrow	106	50	84	53	50	88	-53	0	4	0
Islington	Highbury & Islington	79	65	44	65	65	47	-14	0	3	3
Brent	Wembley Park	80	78	49	60	78	52	-20	0	3	3
Bromley	Bromley South BR	132	85	106	78	88	111	-54	3	5	-7
Hounslow	Hounslow Central	79	14	54	55	14	57	-24	0	3	0
Bexley	Bexley BR	151	102	105	85	105	93	-66	3	-12	-17
Waltham Forest	Walthamstow Central	92	80	63	66	80	66	-26	0	3	3
Haringey	Wood Green	97	74	53	72	74	56	-25	0	3	3
Wandsworth	Clapham Junction	74	56	47	62	56	47	-12	0	0	0
Sutton	Sutton Common	104	105	88	94	106	91	-10	1	3	3
Ealing	Acton Town	58	27	57	34	27	60	-24	0	3	0
Barking and Dagenham	Barking	97	95	75	71	95	78	-26	0	3	-4

District	Representative station	Heathrow 2012			Heathrow 2030			Difference			
		Standard Rail	Tube	HEX	Standard Rail	Tube	HEX	Standard Rail	Tube	HEX	Overall
Croydon	East Croydon	122	85	98	77	88	80	-45	3	-18	-8
Havering	Upminster	121	115	81	74	115	84	-47	0	3	-7
Top 10 DISTRICTS BY Pt Passengers 2012											
Oxford	Oxford	135	129	113	65	129	113	-70	0	0	-48
Crawley	Crawley	134	105	110	117	105	110	-17	0	0	0
Southampton	Southampton Central	161	139	139	104	138	136	-57	-1	-3	-35
Reading	Reading	82	86	61	41	86	54	-41	0	-7	-20
Bristol, City of	Bristol Temple Meads	164	153	143	120	153	140	-44	0	-3	-23
Reading	Reading	82	86	61	41	86	54	-41	0	-7	-20
Cambridge	Cambridge	151	129	129	127	129	132	-24	0	3	-2
Brighton and Hove	Brighton	157	125	134	121	125	110	-36	0	-24	-15
Cardiff	Cardiff Central	189	173	168	151	173	165	-38	0	-3	-17
Birmingham	Birmingham New Street	169	140	144	80	112	73	-89	-28	-71	-67
Other key stations											
Plymouth	Plymouth	277	243	256	221	243	253	-56	0	-3	-22
Leeds	Leeds	206	173	184	189	173	187	-17	0	3	0
Manchester	Manchester Piccadilly	217	178	192	131	153	124	-86	-25	-68	-54

Source: 2012 Civil Aviation Authority Heathrow Survey

Interchanges

4.9.11 **Table 12** compares the current and future number of interchanges that would need to be made by rail passengers making the same identified representative trips between Heathrow and the same key trip generating districts in the Jacobs 2012 and 2030 models. It indicates that the number of interchanges from many districts would reduce as Crossrail serves many London Boroughs and regions directly and reduces the number of connections needed from many areas of the South East. Many new locations are served directly such as Reading. The Southern Link reduces connection to the South Coast and south western boroughs of London.

4.9.12 The representative rail trip identified by Jacobs between Heathrow and each district for the purpose of developing a logit model was based on a qualitative assessment of the shortest GC route choice for each sub-rail mode. It should be noted that this identified shortest GC trip did not necessarily involve the shortest possible in-train time or the minimum number of interchanges feasible between Heathrow and each district as other factors, including service frequency and fare, had to be taken into account when identifying an appropriate route choice for each sub-rail mode

Table 12: Comparison of minimum connection times from key districts to Heathrow in 2012 and 2030

District	Representative station	Heathrow 2012			Heathrow 2030			Difference			
		Standard Rail	Tube	HEX (PT)	Standard Rail	Tube	HEX	Standard Rail	Tube	HEX	Overall
All 33 London boroughs (ranked by PT passenger trips to Heathrow in 2012)											
Westminster	Oxford Circus	1	1	1	1	1	1	0	0	0	0
Kensington and Chelsea	South Kensington	1	0	1	1	0	1	0	0	0	0
Camden	Kings Cross St. Pancras Underground	1	0	1	1	0	1	0	0	0	0
Southwark	London Bridge	2	1	2	1	1	1	-1	0	-1	0
Lewisham	New Cross	3	2	3	1	2	3	0	0	0	-1
City of London	Moorgate	1	1	1	0	1	1	0	0	0	-1
Tower Hamlets	Canary Wharf	2	1	2	0	1	1	-1	0	-1	-1
Kingston upon Thames	Surbiton	3	2	3	1	2	2	-1	0	-1	-1
Barnet	Finchley Central	3	1	3	1	1	3	0	0	0	0
Hammersmith and Fulham	Hammersmith	1	0	1	1	0	1	0	0	0	0
Redbridge	Redbridge	2	1	2	1	1	2	0	0	0	0
Enfield	Cockfosters	3	0	3	2	0	3	0	0	0	0
Lambeth	Clapham High Street	3	2	3	1	2	3	0	0	0	-1
Newham	Stratford	2	1	2	1	1	2	0	0	0	0
Hackney	Hackney Central	3	2	3	1	2	3	0	0	0	-1
Merton	Wimbledon	1	1	1	1	1	1	0	0	0	0
Hillingdon	Hatton Cross	3	0	3	2	0	2	-1	0	-1	0
Richmond upon Thames	Richmond	2	1	2	0	1	1	-1	0	-1	-1
Greenwich	Greenwich	3	2	3	1	2	3	0	0	0	-1
Harrow	South Harrow	3	1	3	2	1	3	0	0	0	0
Islington	Highbury & Islington	2	1	2	1	1	2	0	0	0	0
Brent	Wembley Park	2	1	2	2	1	2	0	0	0	0
Bromley	Bromley South BR	3	2	3	1	2	3	0	0	0	-1
Hounslow	Hounslow Central	2	0	2	2	0	2	0	0	0	0
Bexley	Bexley BR	3	2	3	1	2	2	-1	0	-1	-1
Waltham Forest	Walthamstow Central	2	1	2	1	1	2	0	0	0	0
Haringey	Wood Green	3	0	3	2	0	3	0	0	0	0
Wandsworth	Clapham Junction	1	1	1	0	1	1	0	0	0	-1
Sutton	Sutton Common	2	3	2	1	3	2	0	0	0	-1
Ealing	Acton Town	1	0	2	1	0	1	0	0	-1	0

District	Representative station	Heathrow 2012			Heathrow 2030			Difference			
		Standard Rail	Tube	HEX (PT)	Standard Rail	Tube	HEX	Standard Rail	Tube	HEX	Overall
Barking and Dagenham	Barking	1	1	1	1	1	1	0	0	0	0
Croydon	East Croydon	3	2	3	1	2	2	-1	0	-1	-1
Havering	Upminster	3	1	3	1	1	3	0	0	0	0
Top 10 DISTRICTS BY Pt Passengers 2012											
Oxford	Oxford	1	2	1	1	2	1	0	0	0	0
Crawley	Crawley	3	2	3	2	2	2	-1	0	-1	0
Southampton	Southampton Central	2	2	2	1	2	2	0	0	0	-1
Reading	Reading	1	2	1	0	2	1	0	0	0	-1
Bristol, City of	Bristol Temple Meads	1	2	1	1	2	1	0	0	0	0
Reading	Reading	1	2	1	0	2	1	0	0	0	-1
Cambridge	Cambridge	2	1	2	0	1	2	0	0	0	-1
Brighton and Hove	Brighton	3	2	3	1	2	2	-1	0	-1	-1
Cardiff	Cardiff Central	1	2	1	1	2	1	0	0	0	0
Birmingham	Birmingham New Street	3	2	3	1	2	1	-2	0	-2	-1
Other key stations											
Plymouth	Plymouth	1	2	1	1	2	1	0	0	0	0
Leeds	Leeds	2	1	2	2	1	2	0	0	0	0
Manchester	Manchester Piccadilly	3	2	3	1	2	1	-2	0	-2	-1

4.10 Rail Scheme costs

4.10.1 The schemes included in the Core Baseline and the Extended Baseline are not costed in this analysis as they are assumed to be delivered by 2030 regardless of the airport expansion.

4.10.2 The out-turn cost for the SRA rail package was assumed to be at £75m per km for the section from Heathrow to Staines in line with the Phase 1 analysis giving an estimated to cost **£487.5m**. Including an optimism bias of 66% this cost increases to **£809m**.

5. Roads assessment

5.1 Methodology

5.1.1 The methodology for assessing the impact of the new North West Runway at Heathrow on road capacity is described in the Methodology Statement. As indicated in that report, a key aim was to establish the capacity enhancements that would likely be required in 2030 as a result of DfT forecast increases in background traffic volumes (including the airport in its current form), as distinct from the enhancements that would be required specifically as a result of the net impact of airport-related traffic associated with a new North West Runway. This provided the basis for the assessment (from a roads perspective) of the new North West Runway proposal against **Objective 2** in the AC's Appraisal Framework, which is 'to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight'.

5.1.2 The analysis of airport-related traffic assumed a headline mode share for private vehicles of 45% for passengers and 47% for employees with the new North West Runway in place, with the passenger mode share forecast based on outputs from the headline mode share logit model. For the purposes of this analysis, all private vehicles were assumed to be cars with an average vehicle occupancy of 1.53 for passengers and 1.1 for employees.

5.1.3 The assessment was split into two stages, with an initial focus on the strategic road network in the south-east of England. The outputs from this first stage were then fed into a more detailed analysis of the road network in the vicinity of the airport. Two scenarios were tested to draw conclusions with regard to the net impact of airport-related traffic associated with the second runway on road capacity, as follows:

- Background traffic (Core Baseline enhancements);
- Background + airport traffic (Core Baseline enhancements):

5.1.4 As with the rail assessment described in the previous chapter, the roads analysis constitutes a static assessment of forecast demand compared with, but unconstrained by, expected available capacity in 2030. Further assessment is therefore required using a dynamic modelling approach to better understand the impacts of forecast demand on road network performance and road user journey time/experience, including:

- the extent to which road users (including those making trips unrelated to the airport) change their route to avoid congested sections of the road network, and the associated knock-on impacts;
- The effect of forecast demand on junction performance and the resulting congestion impacts, both on strategic roads and the network in the vicinity of the airport (both stages of the assessment described above focussed on a comparison of forecast demand against theoretical link capacity).

5.1.5 A more detailed analysis of airport-related traffic by geographic region is presented in **Table 13** below.

Table 13: Mode Share by Region

FINAL Region	2012			2030 Extended Baseline with SRA		
	Car Taxi Minicab	Bus Coach	Rail	Car Taxi Minicab	Bus Coach	Rail
Inner London	40%	4%	57%	32%	4%	64%
Outer London	68%	9%	23%	64%	6%	30%
South East (not London)	75%	20%	5%	48%	22%	31%
East Midlands	69%	16%	15%	52%	24%	24%
East of England	75%	12%	13%	49%	13%	39%
North East	41%	23%	36%	24%	10%	66%
North West	53%	12%	35%	10%	5%	85%
Scotland	45%	13%	42%	48%	9%	43%
South West	60%	30%	10%	58%	25%	17%
Wales	51%	38%	12%	49%	36%	15%
West Midlands	63%	26%	12%	50%	25%	26%
Yorkshire + the Humber	41%	22%	37%	13%	19%	68%

5.1.6 Large reductions in car mode share are predicted between 2012 and 2030, particularly in the south east (27%) and East of England (26%), as better connection for rail from WRA and Crossrail attract passengers to switch from car to rail. Car trips from the London Inner and Outer London are also predicted to reduce, however the fall is smaller public transport use was already reasonably high.

5.1.7 There are large changes for some of the regions outside of these areas but with the exception of the South West, these areas make up a relatively small proportion of demand for the Airport (90% of passengers are from London, the South East, East of England and the South West (CAA 2012 Survey Data)).

5.2 Airport impacts

5.2.1 In total, 5,961 passengers/employees are predicted to travel to the airport in the peak hour by road and 3,069 passengers/employees are predicted to travel from the airport in the same hour. Exact patterns of arriving and departing passengers will depend on the flight patterns operating at the airport in 2030 and any changes to night flying hours (especially regarding early morning arrivals) would affect the level of peak hour demand and at what time this occurs. Any changes to the employment pattern may also redistribute some staff trip arrivals to other parts of the day.

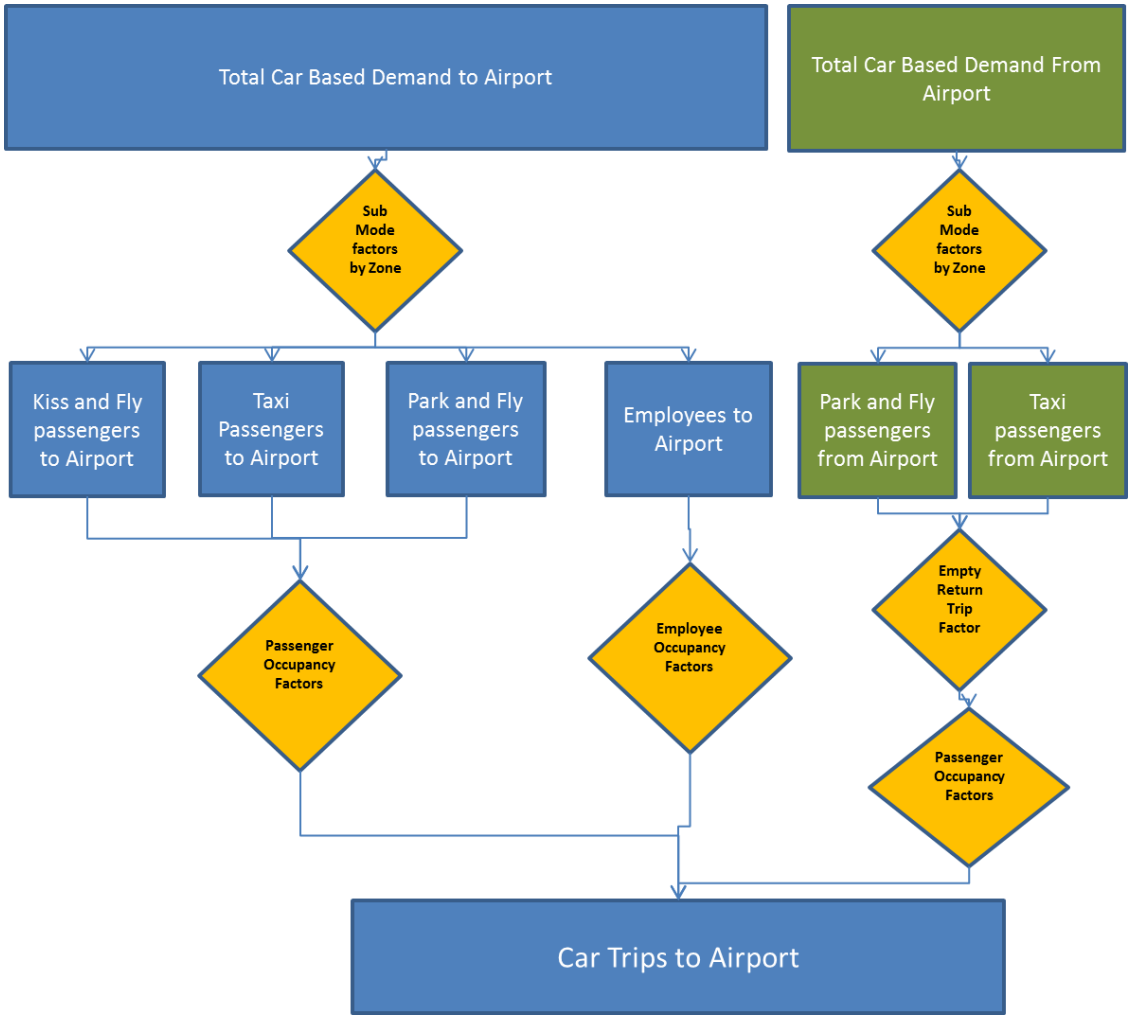
5.2.2 Peak hour demand forecast by car mode are converted to vehicle trips within the model using the following assumptions:

- All private vehicles are cars with average vehicle occupancy of 1.1 for employees (a slight decrease on the 1.2 predicted by Heathrow) and 1.5 for passengers. This is based on Heathrow's predictions and on analysis of 2012 CAA survey data; and
- Additional vehicle movements are allowed for empty trips generated from Kiss and fly passengers and 78% of all taxis are assumed to generate an empty return.

5.2.3 The car trips were derived at zonal level and assigned to links in the road network based on the shortest route between origin-destination pair using major roads. In total, 5,437 vehicles are predicted to travel to the airport in the peak hour and 3,617 vehicles predicted to travel from the airport in the same hour. **Figure 18** below shows the example of the 'to Airport' car trips methodology, this highlights the addition of the 'from Airport' empty return trips from taxis and kiss and fly passengers which account for the increase in car trips from car passengers. **Figure 20** and **Figure 21** illustrate in

schematics map form car trips to and from the 2 runway airport, while **Figure 22** and **Figure 23** illustrate car trips to and from the 3 runway airport.

Figure 18: Car Trip Methodology (Demand to Airport Example)



5.2.4 In general terms, the analysis suggests that a new North West Runway at Heathrow does not markedly increase traffic on the strategic road network. This is primarily due to a large forecast mode share shift to public transport and the assumed increase in car occupancy among employees who drive to/from the airport. For example, the forecast reduction in car mode share from areas in Surrey due to improvements in public transport results in a reduction in the total volume of car trips to/from these areas between 2012 and 2030, despite an overall increase in airport passengers.

5.2.5 However, a noticeable increase in traffic flow as a result of the new North West Runway occurs on some specific links in the immediate vicinity of the airport, particularly on routes where 'kiss & fly' and taxi remain popular car sub-mode choices due to short distances between the Airport and trip origins/destinations. This is illustrated in Figure 24, which compares 2012 and forecast 2030 airport-related flows and indicates that the highest difference in the AM peak hour occurs on the M4 between the airport and London – in total, over 1,500 cars are forecast inbound to the airport along this route with the new North West Runway in place. The plan indicates that the largest differences between 2012 and forecast 2030 flows generally occur on the M4 both to the east and to the west of the airport, with only minor increases evident on the M25.

JACOBS

Figure 19: Road Network

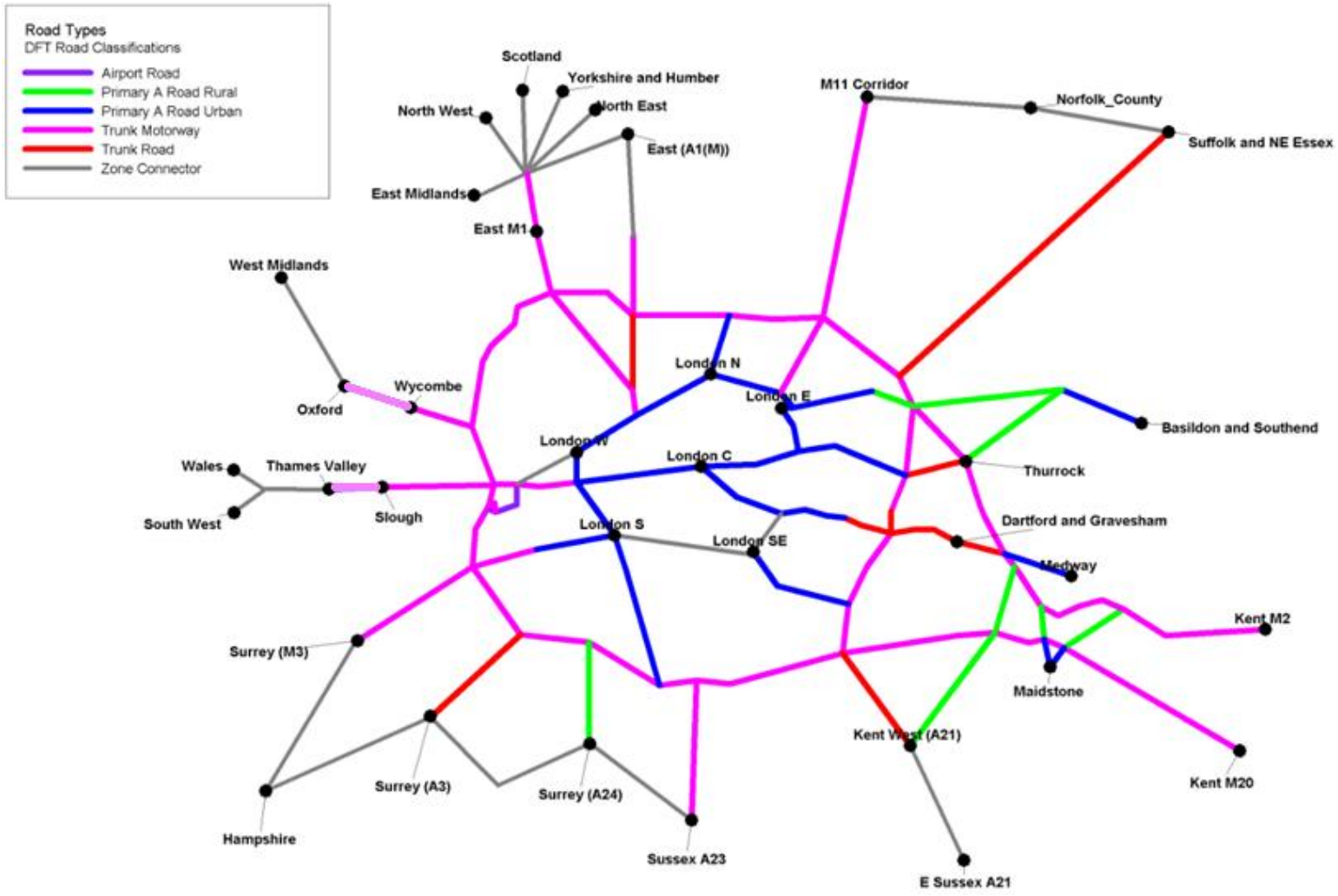


Figure 20: 2030 Forecast peak-hour demand to 2-runway Heathrow

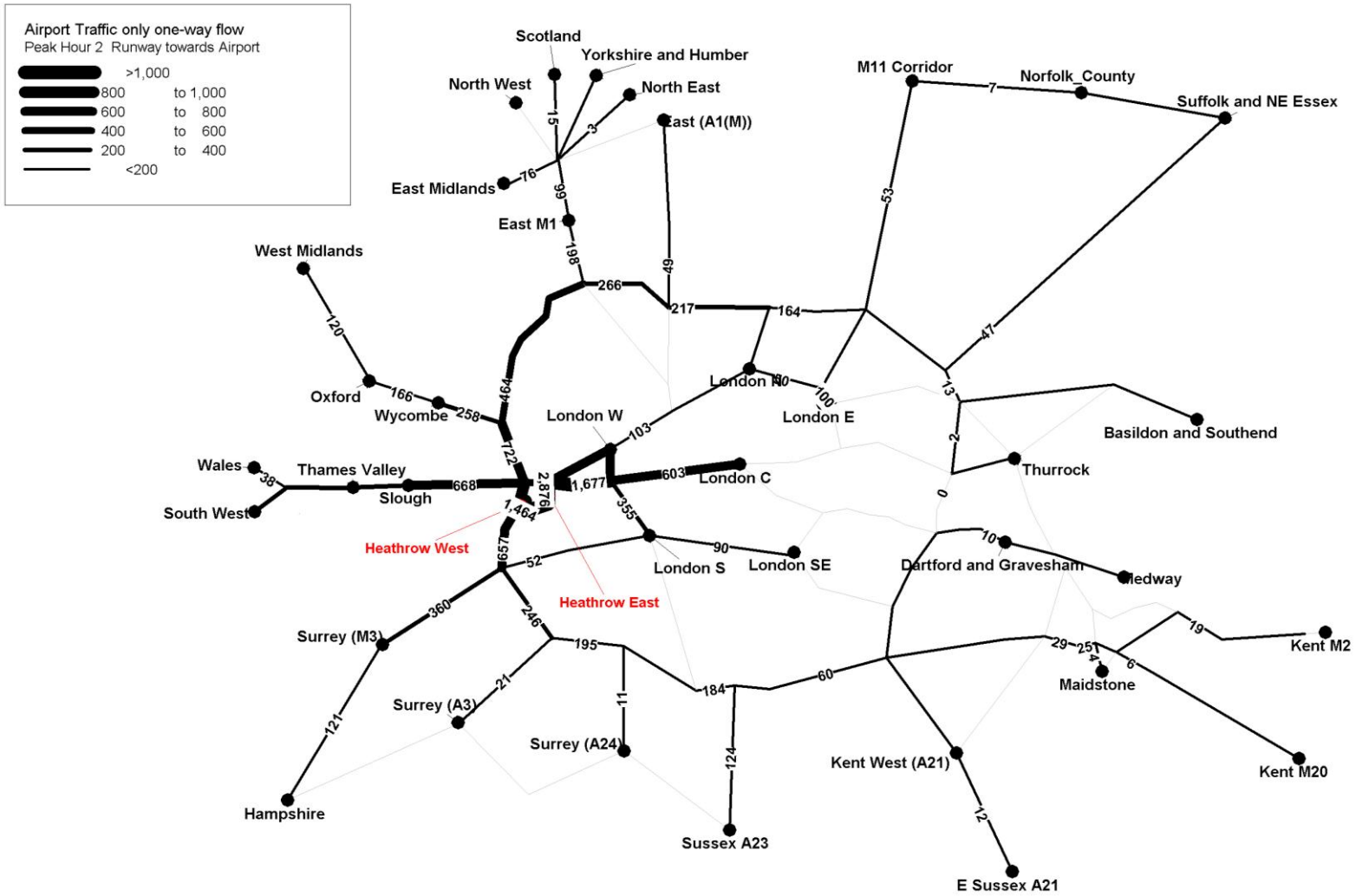


Figure 21: 2030 Forecast peak-hour demand from 2-runway Heathrow

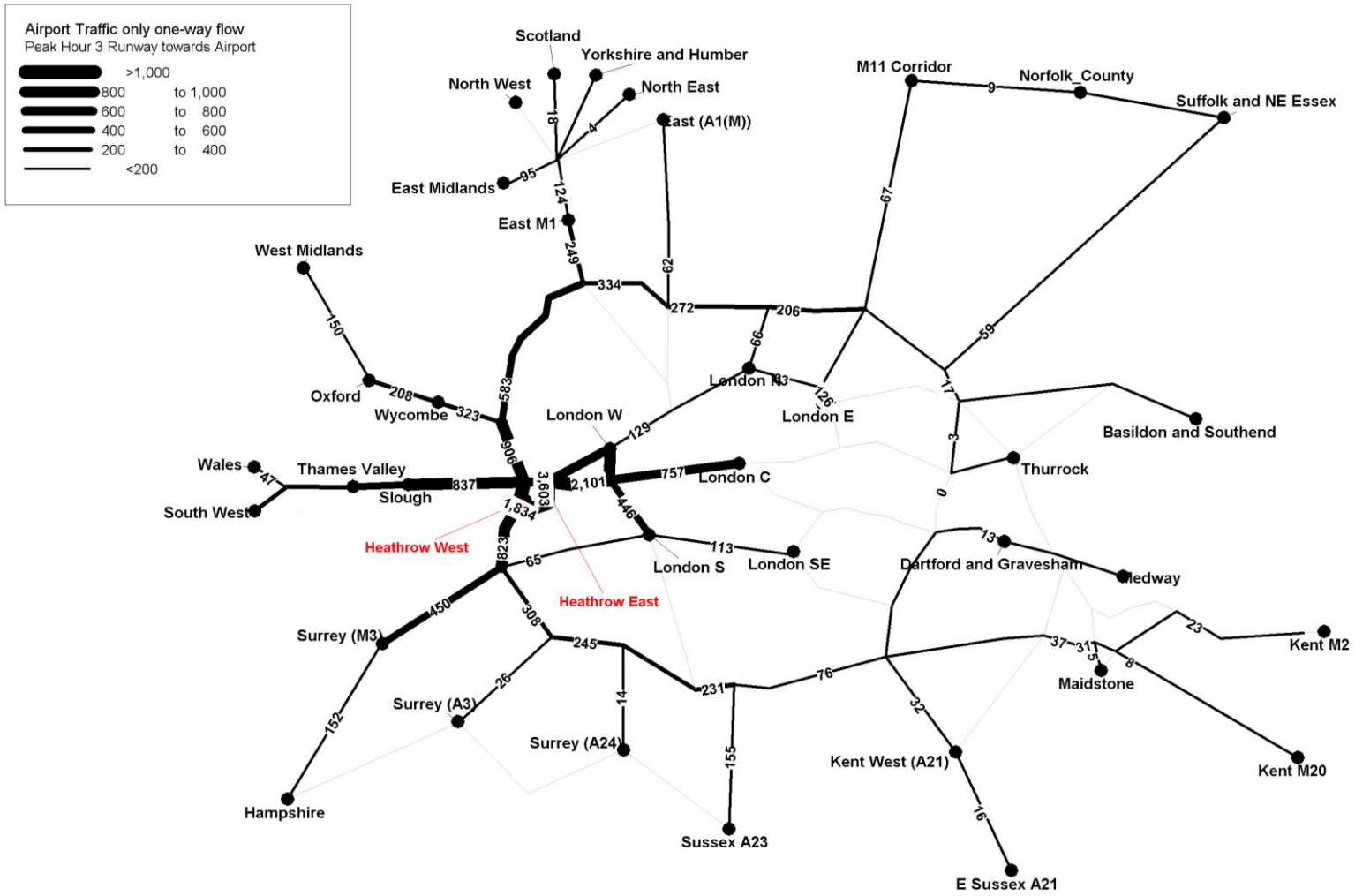


Figure 22: 2030 Forecast peak-hour demand to 3-runway Heathrow

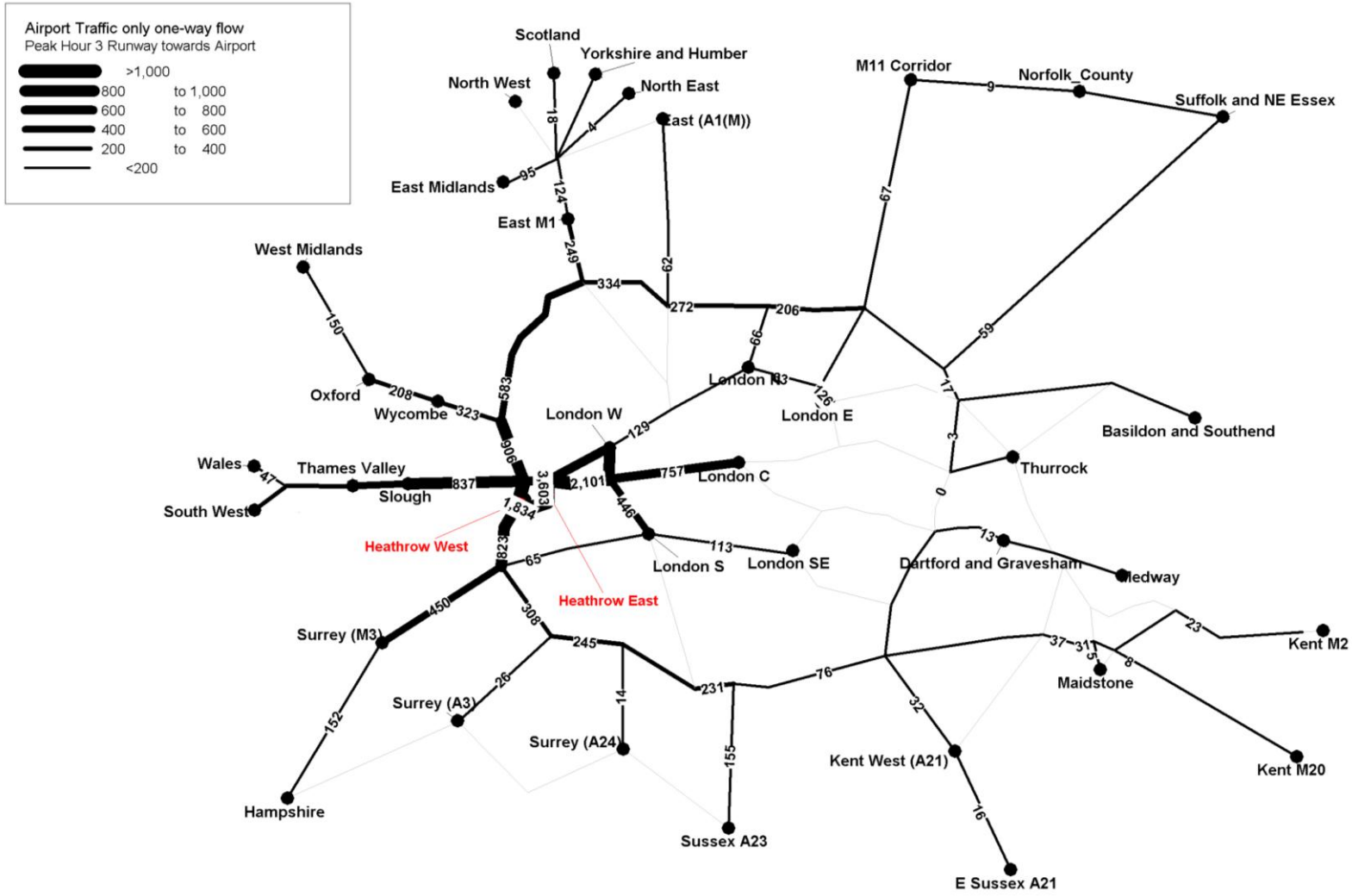


Figure 23: 2030 Forecast peak-hour demand from 3-runway Heathrow

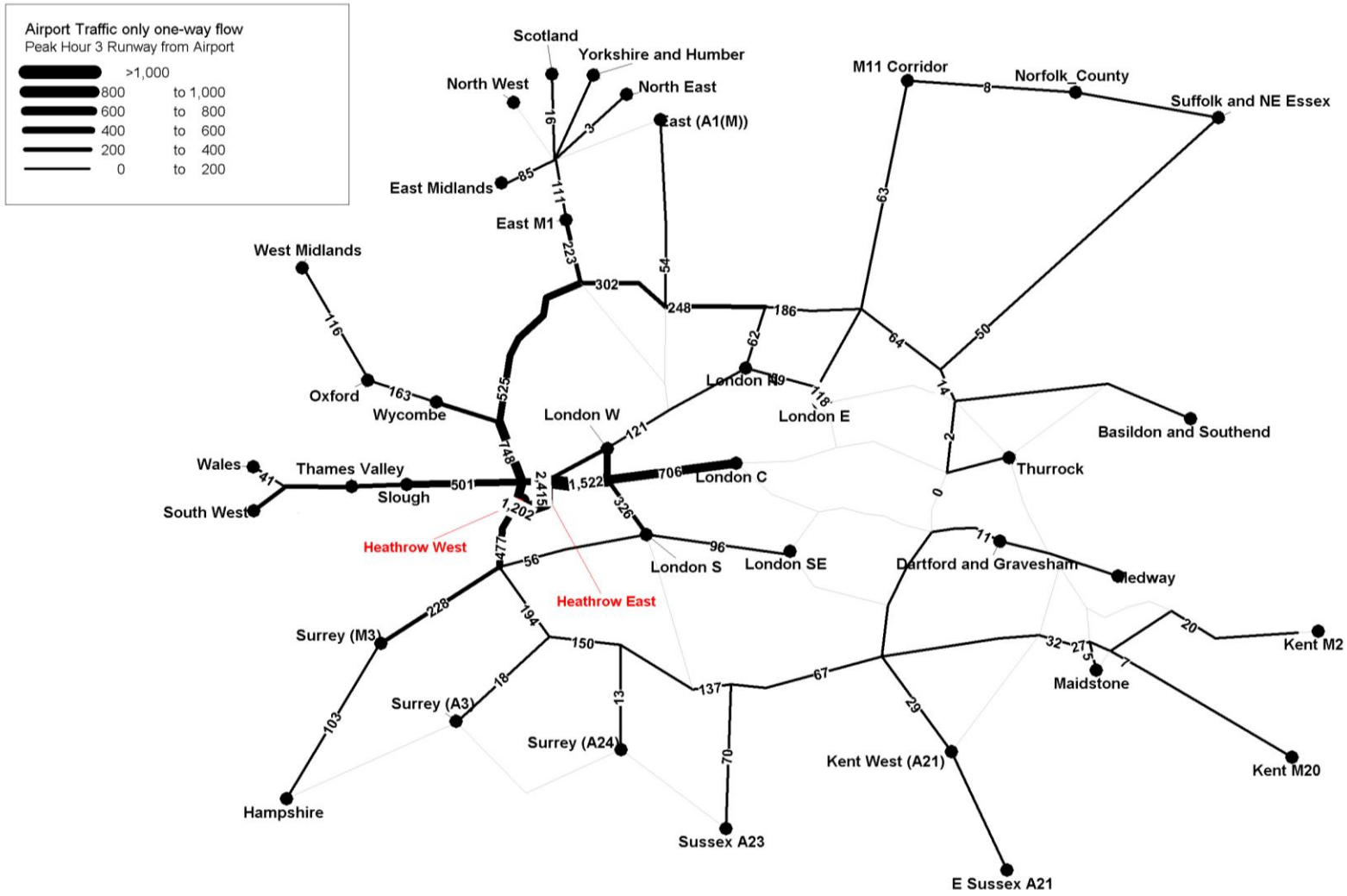
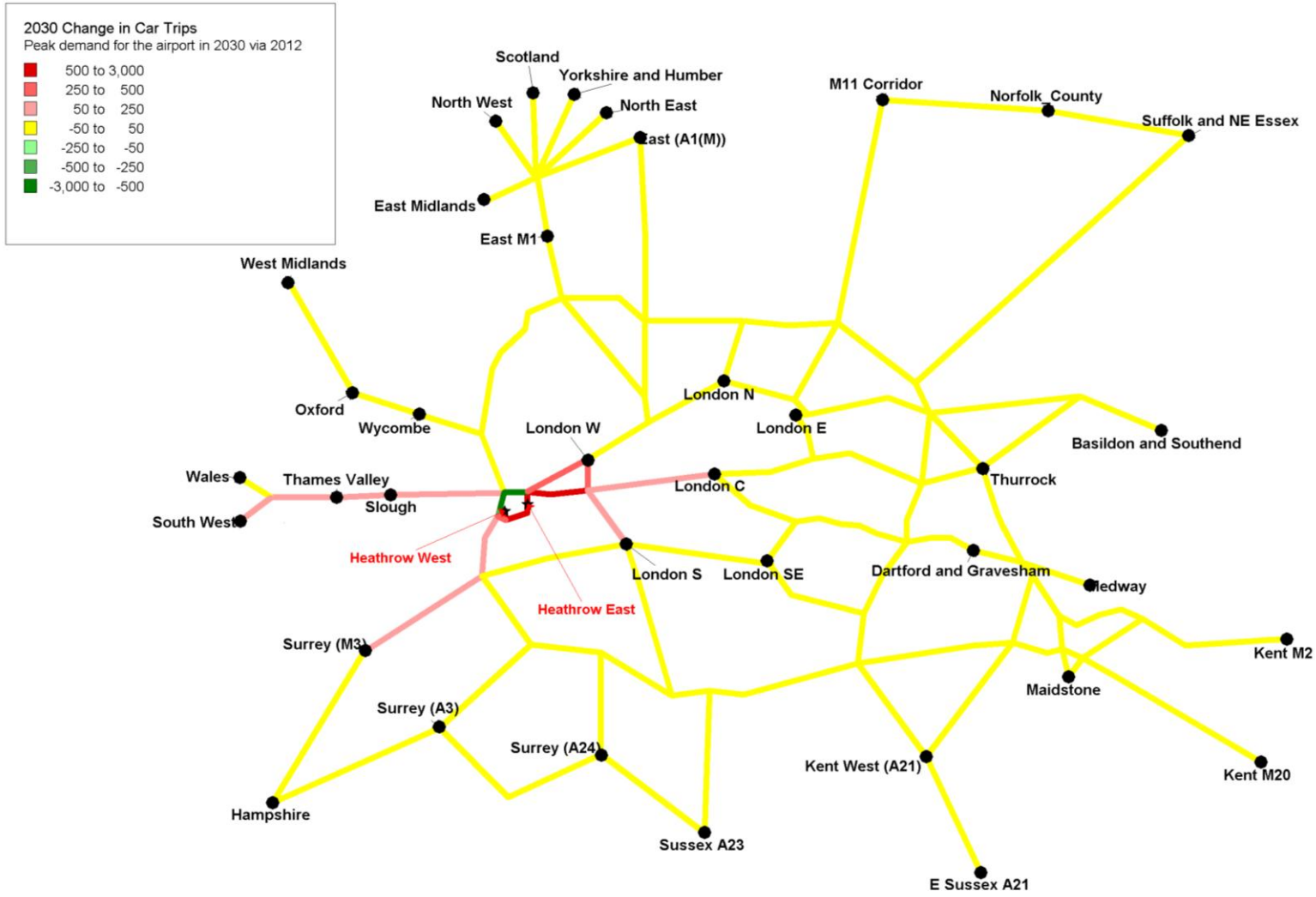


Figure 24: Traffic flow comparison 2030 – 2012 Base



5.3 Highway network

5.3.1 The highway network assessed constitutes the existing strategic road network serving Heathrow, relevant committed changes to the network and a number of interventions proposed by Heathrow. These interventions include:

- Construction of a new Southern Road Tunnel access to the Heathrow East node;
- Collector-distributor roads to segregate airport traffic from other M25 traffic between J14 and J15;
- Implementation of a new one-way access arrangement for the Heathrow West campus;
- Committed hard shoulder running of M23 J8 to J10;
- Committed hard shoulder running of M4 J5 to J12;
- Committed hard shoulder running of M25 J5 to J7;
- Committed hard shoulder running of M25 J23 to J27;
- Committed hard shoulder running of M3 J2 to J4a; and
- Committed hard shoulder running of M4 J3 to J4.

5.4 2030 Demand and Capacity Analysis

5.4.1 Current background traffic was added to the network alongside the Airport Traffic generated in 2030. **Figure 25** and **Figure 26** show the impact of Heathrow remaining as a two runway airport, compared to **Figure 27** and **Figure 28** showing the impact of a new North West Runway at Heathrow Airport. **Table 14** highlights the impact on a selected number of links and the relative increases in volume capacity ratios associated by adding the new North West Runway.

5.4.2 In the development of the strategic links for improvements the following assumptions within the table are listed below:

- The V/C discussed do not account for sections with high and low weaving impacting traffic due to the strategic nature of the model used in the analysis; and
- For M4 J2-3, where the number of lanes in the base year goes from 3 lanes each direction to 2 lanes in each direction, the lower capacity has been considered to identify any bottleneck issues.

Table 14: Volume capacity analysis of selected highway network links

Road name	Section	To airport			From airport		
		Background only	+ airport with 2 runways	+ airport with 3 runways	Background only	+ airport with 2 runways	+ airport with 3 runways
M25	J3 and J4	94%	94%	94%	94%	94%	94%
	J5 and LA boundary	72%	72%	72%	72%	72%	72%
	J6 and J7	87%	88%	88%	87%	88%	88%
	J7 and J8	89%	91%	92%	89%	90%	91%
	J8 and J9	88%	90%	91%	88%	90%	90%
	J9 and J10	93%	95%	96%	93%	94%	94%
	J10 and J11	108%	111%	112%	108%	110%	111%
	J11 and J12	112%	115%	115%	112%	114%	114%
	J12 and LA boundary	100%	108%	110%	100%	105%	106%
	J13 and J14	117%	125%	128%	117%	122%	123%
	J14 and 14A	98%	108%	111%	98%	106%	107%
	J14A and 15	112%	121%	123%	112%	118%	120%
	J15 and J16	89%	97%	99%	89%	96%	97%
	J17 and J18	84%	89%	91%	84%	89%	90%
	J18 and J19	85%	90%	91%	85%	90%	91%
	J23 and J24	91%	94%	95%	91%	94%	94%
	J25 and LA boundary	90%	92%	93%	90%	92%	93%
M4	J2 and J3	54%	82%	89%	54%	75%	80%
	J3 and J4	84%	105%	111%	84%	100%	103%
	J4 and J4B	77%	84%	86%	77%	82%	83%
	J4B and J8	64%	70%	72%	64%	68%	69%
M1	J6A and 7	102%	105%	105%	102%	104%	105%
	J13 and J14	91%	92%	93%	91%	92%	93%
M11	M25 and J7	90%	91%	91%	90%	91%	91%
M20	J3 and J4	93%	93%	93%	93%	93%	93%
	J4 and J5	104%	104%	104%	104%	104%	104%
	J5 and J6	110%	111%	111%	110%	111%	111%
M40	J1A and J2	91%	95%	96%	91%	94%	95%
M4 Spur	M4 and Airport	17%	89%	107%	17%	65%	77%
A2	A102 and A2213	112%	112%	112%	112%	112%	112%
	A2260 spur roads and Slip for A227	88%	88%	88%	88%	88%	88%
A296	M25 1B and A296	120%	120%	120%	120%	120%	120%
A406	A406 and LA boundary	90%	90%	90%	90%	90%	90%

Figure 25: Impact of 2030 background + 2-runway demand (to airport)

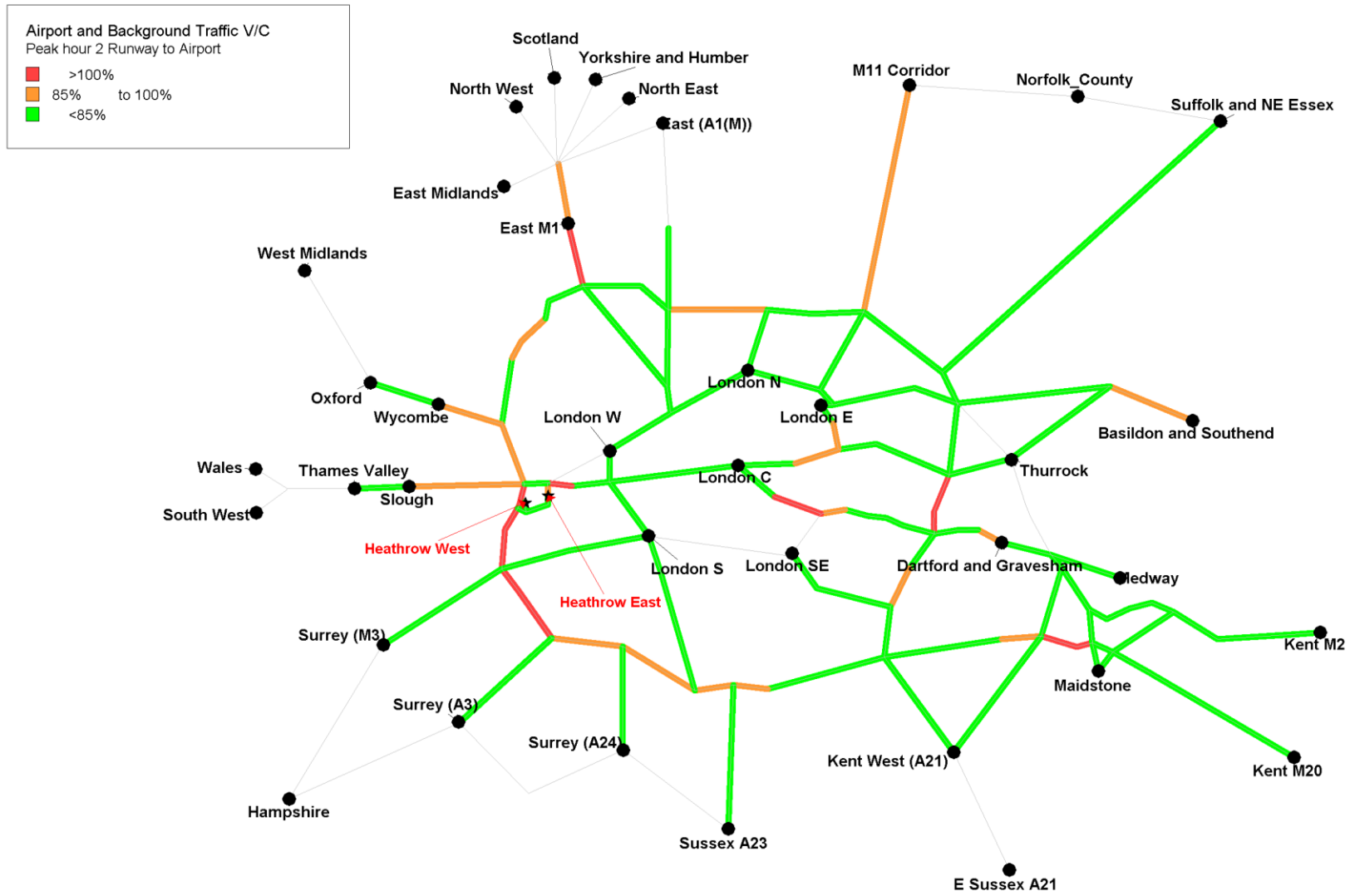


Figure 26: Impact of 2030 background + 2-runway demand (from airport)

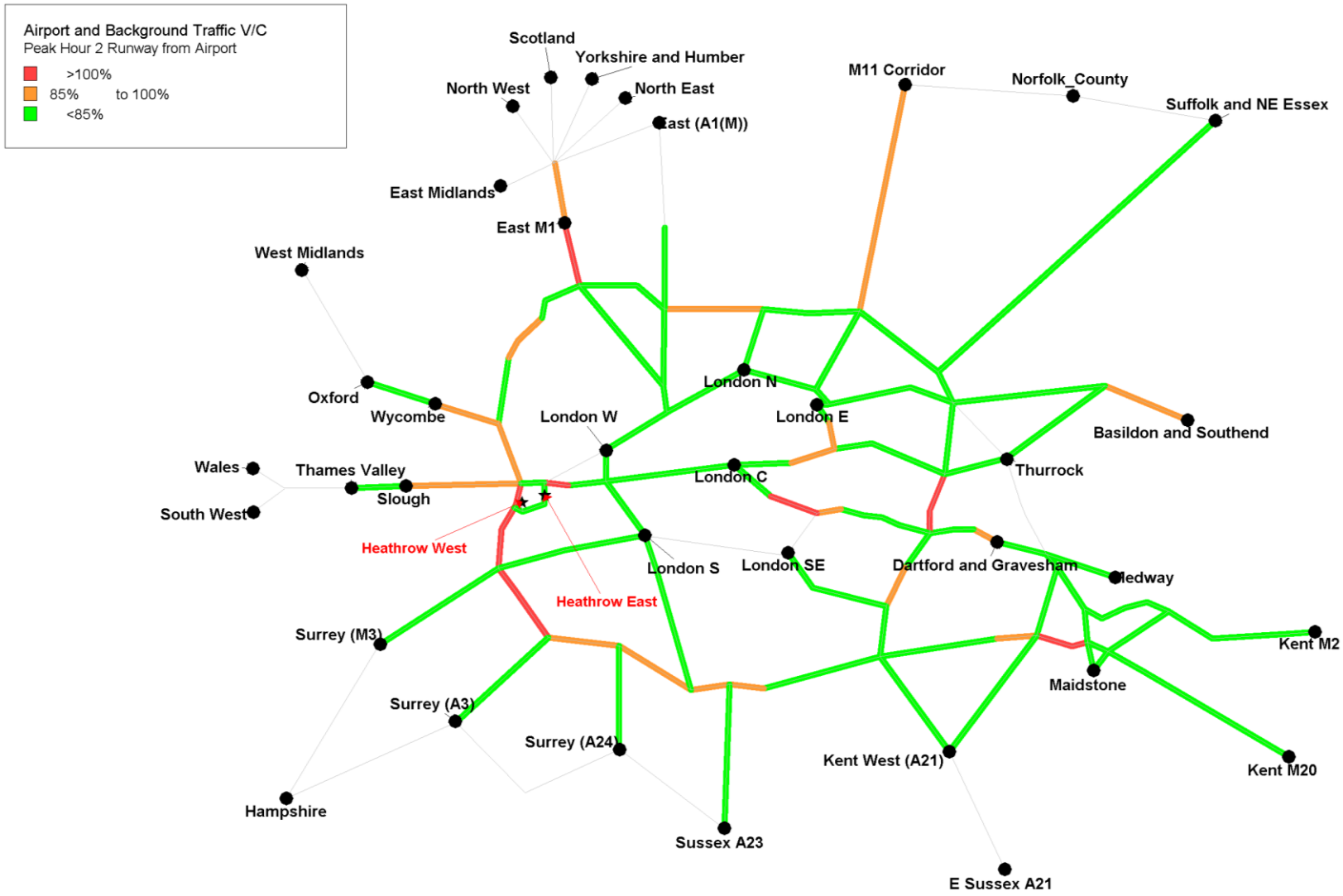


Figure 27: Impact of 2030 background + 3-runway demand (to airport)

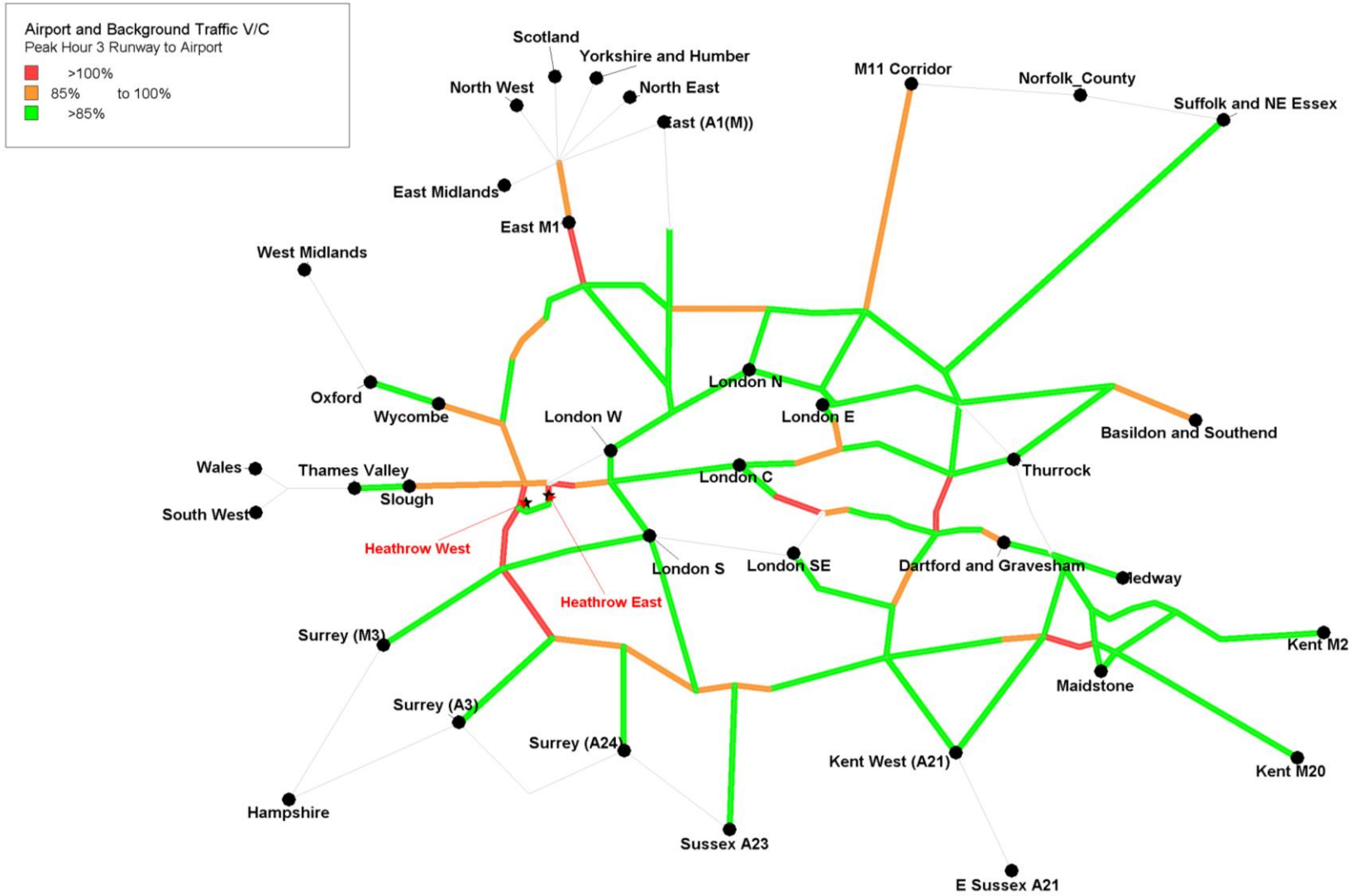
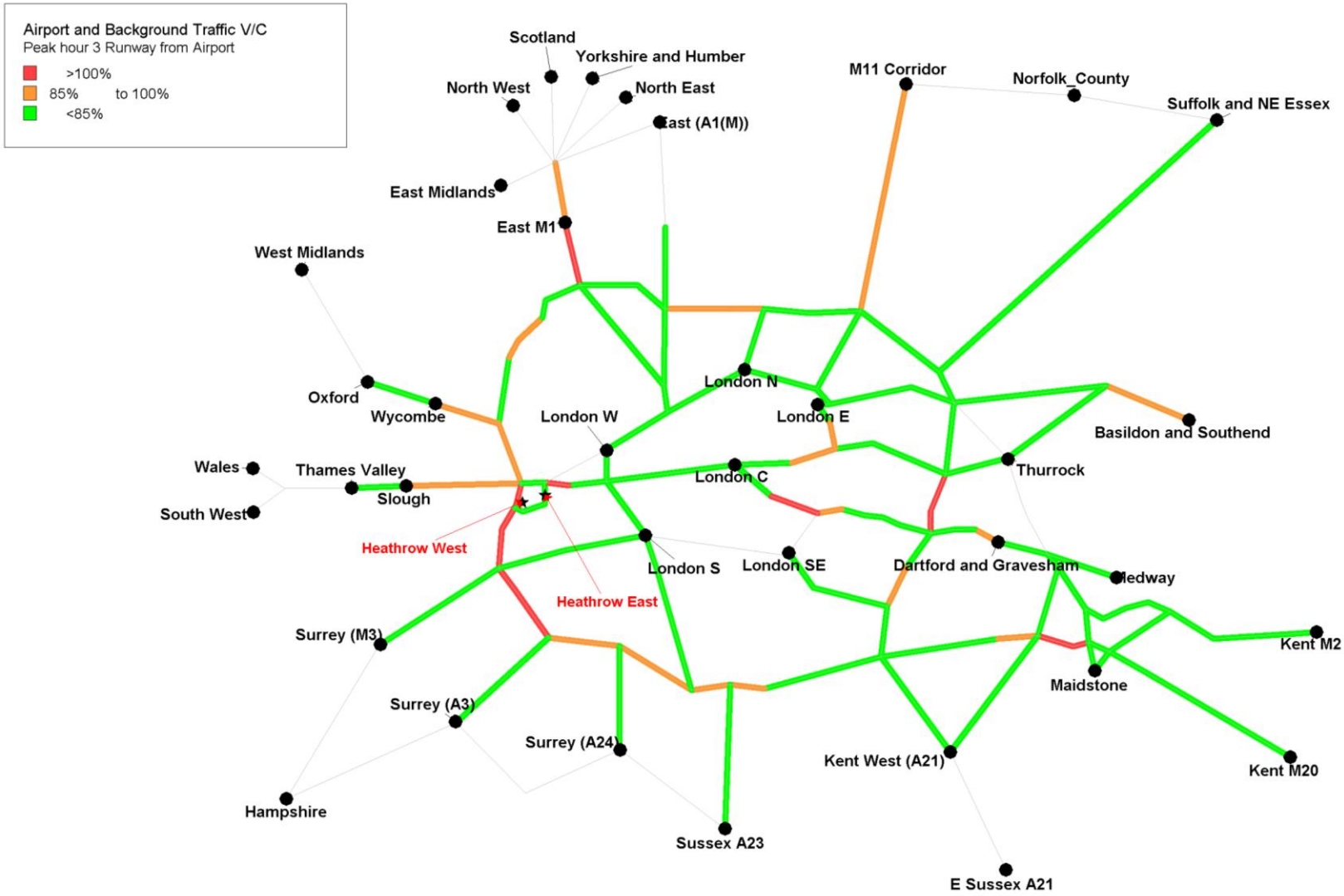


Figure 28: Impact of 2030 background + 3-runway demand (from airport)



5.5 Strategic road widening recommendations

5.5.1 Background demand consists of the majority of demand on the modelled network with the exception of roads directly serving the airport such as the M4 Spur. On sections of the M4 nearest the airport up 32% of traffic on the road are Heathrow passengers and employees.

5.5.2 Many sections of the modelled network are over or approaching capacity in 2030, including key sections of the M25 between Junctions 7 and 16. Whilst the airport does contribute some traffic, the impact of increasing from 2 to 3 runways is only a minor cause, and in many cases the actual flows are similar to those from the airport in 2012; for this reason there is not a compelling case for the airport to be responsible for improvements to the network in these areas.

5.5.3 The analysis indicates that in addition to the inventions identified in **Section 5.3**, we have defined that the following road links need capacity enhancement as a result of the additional runway at Heathrow:

- M4 between junction 3 and junction 4; and
- M4 Airport Spur.

5.5.4 In addition, works may be required on the following links which exceed the 85% v/c ratio due to airport-related demand from the new North West Runway:

- M4 between junction 2 and junction 3; and
- M4 between junction 4 and junction 4B.

5.5.5 These recommendations are based on background demand increasing in line with DfT projections and that the new public transport infrastructure delivers the public transport mode share that the model predicts. If traffic does not increase by 2030 then there may be fewer requirements to improve road infrastructure. Any large developments in the local area around Heathrow may also affect the traffic patterns.

5.5.6 For the purposes of this analysis, we have costed road widening at the sections above which are shown to be over-capacity due to the provision of an extra runway. However, we recommend that more detailed analysis is undertaken to determine whether other methods of increasing capacity are more suitable at the individual sections defined above (e.g. collector-distributor roads, closures of junctions/slip roads).

5.6 Assessment of roads in the vicinity of the airport

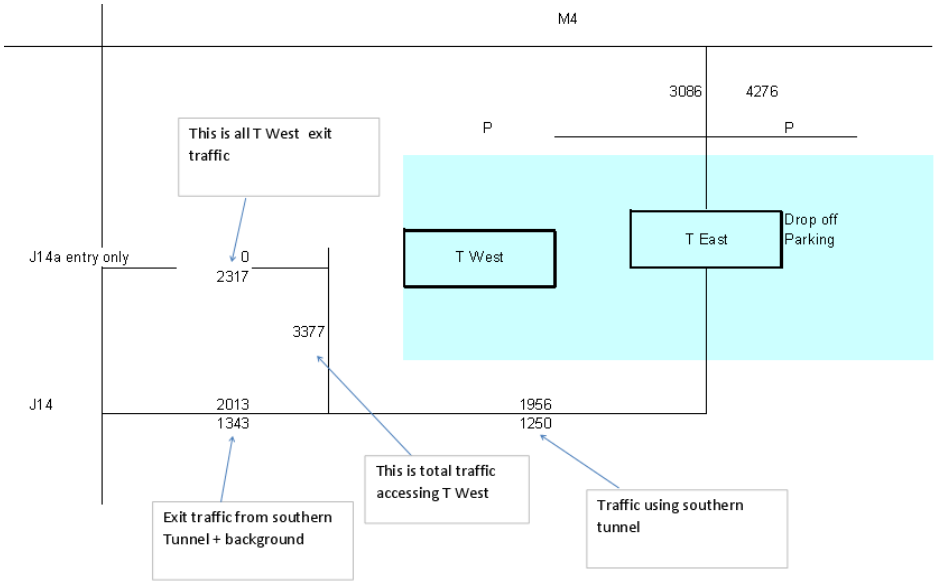
5.6.1 Impacts on the road network in the vicinity of Heathrow were calculated as per the approach detailed in the Methodology Statement and supporting Technical Appendix. This approach resulted in a forecast of 5,437 vehicle arrivals in the peak hour with the new North West Runway in place, and 3,617 vehicle departures. These forecasts do not provide sufficient detail to identify exactly where in the airport these trips are going to or coming from and the route taken, although previous work by Jacobs has used a working assumption that 42% of trips would be to the eastern terminals, and 58% to the western terminals. Using assumptions from the 2012 CAA passenger survey it would be possible to further group these trips into kiss & fly, short stay car park, long stay car park, car rental etc., however it is not clear from the current proposals where the long stay car parks and car rental locations will be located and this will affect trip distribution and therefore the volume of traffic on main carriageway links. It is therefore not currently possible to estimate the traffic flows on roads in the vicinity of the airport.

5.6.2 Based on the percentages described above, if it was assumed that all the identified trips went directly to the terminals, there would be 2,284 arrivals at the eastern terminal, and 3,153 at the western. For departures, there would be 1,519 trips leaving the eastern terminal and 2,098 leaving the western. The preliminary plans for the access roads indicate at least two lanes on the immediate approaches and exits from the terminals. Assuming a capacity of 2,000 vehicles per lane which was based on an

average capacity of this road type, there would be ample capacity on these roads to cope with the anticipated airport-related demand.

5.6.3 The Jacobs strategic assessment forecast the traffic volumes for the HAL option as presented in **Figure 29**.

Figure 29: Jacobs Strategic Assessment – Forecast Total Traffic Volumes



5.6.4 What is not clear however is the amount of usage there would be of the surface roads around the airport, which would serve trips to long stay car parks, maintenance depots, hotels and businesses around the airport. A number of roads currently serving the airport are shared with non-airport traffic, particularly the A3113 which as well as facilitating access from the M25 Junction 14 to Terminal 4 and the cargo terminal also provides access to Stanwell and other destinations for general traffic. It is not currently known from the future proposals which access roads will be airport-only and which will be available to general traffic.

5.6.5 As an example of the uncertainty concerning access roads, it is understood that the southern access road and the proposed southern tunnel can be used for trips to the eastern terminal from the M25 and also to the western terminal for trips from the M4, i.e. as a through route. This southern tunnel will link up with the existing tunnel currently providing access to Terminals 1-3, however it is not clear if any controls will be in place to prevent rat-running through the tunnels by non-airport traffic. This route through the airport offers a more direct route for north-south trips so there is the potential for it to be used be significant volumes of non-airport traffic.

5.6.6 Were measures in place to prevent rat runs, and not withstanding further analysis of the road network in the vicinity of Heathrow, airport-related traffic would be within capacity with the following proposed infrastructure package proposed by HAL:

- Divert the A4 to the north of the airport, leaving its current alignment at Colnbrook Bypass and re-joining its existing route to the east of the airport access at Emirates Roundabout at a new junction. This new route will be re-provided as a dual carriageway with existing bus priority measures;
- Replace the section of the A3044 which will be under parts of the new airfield, and provide a connection from A4 to Poyle;
- Remove the existing Western Perimeter Road and part of the Northern Perimeter Road;

- Grade separate the roundabout junction where Airport Way meets the Southern Perimeter Road to allow dedicated access to Heathrow West and segregate through movements on the Southern Perimeter Road;
- Provide a new and improved junction on the Southern Perimeter Road to allow access to the Southern Road Tunnel; and
- Implement a new one-way access arrangement for the Heathrow West campus, making use of an enhanced J14 for access. Traffic would exit via J14a, making use of the existing structure and slip roads.

5.7 Supporting sustainability

5.7.1 The surface access option proposed provides the ability and incentive for passengers and workforce to use sustainable forms of transport by improving accessibility to Heathrow by rail.

5.7.2 Our analysis shows that the proposed Heathrow surface access increases the use of sustainable transport. Particularly, the proportion of passengers arriving at Heathrow by car is expected to reduce from 59% in 2013 to 45% in 2030. Given the growth in passengers and employees this would still mean that there will be over 6 million more passengers travelling to and from the airport by car.

5.7.3 Heathrow proposes to further influence passenger travel pattern through improved information technology by:

- Encouraging integrated public transport ticketing services with airline ticket purchasing;
- Developing Onward Travel Zones to provide support to passengers planning and making journeys and ensuring they can choose the best surface access mode for their needs; and
- Providing better information for passengers, including real-time information with accurate arrival times and multi-lingual services. This will give an improved waiting environment.

5.7.4 Heathrow's proposes to reduce airport-related car trips by implementing initiatives to encourage more efficient use of private cars and taxis. These initiatives which should facilitate a reduction in the no of empty car trip and improve vehicle occupancy levels include:

- Provide sufficient car parking to meet demand with the aim to reduce discourage 'kiss and fly' or taxi use. Heathrow's proposal involves expanding the terminal 5 short stay car park to 6,000 spaces for west terminal and expanding the new terminal car park to 4,000 spaces for the east terminal; and
- Develop a taxi backfilling scheme to match passengers to drivers that have dropped off at the airport and encourage taxi sharing by matching passenger journeys to similar destinations.

5.7.5 Heathrow proposes to further support sustainability by implementing policy related measure that encourage employee's mode shift. These measures include managing travel patterns by introducing personalised travel plans for employees, offering discounted public transport travel costs and implementing strict parking management policies for employees.

5.7.6 The surface access option will alleviate traffic congestion, by delivering a significant shift from car to rail. However, a further bus improvement intervention may be necessary to complement the investment as this is likely to induce some shift from car to bus, albeit a less significant shift.

5.7.7 Heathrow commits to work with bus/coach operators and local authorities, to improve local bus network for employees, enhance the coach network and support local connectivity. They propose a number of such improvements including:

- Increasing 24hr services, and frequency of existing routes to improve bus routes that serve key employee catchment areas including; North-south connectivity through Hillingdon, South of Airport (particularly bus 555) and the west (Slough, Maidenhead, Windsor);
- Developing a new/ extended route to Ruislip and Wembley via Ealing;

- Developing new east-west route to serve catchments along the N9 route during the day;
- Developing new coach routes to serve Southampton, Basingstoke, Swindon, Bromley, Croydon, Sutton, High Wycombe and Wokingham; and
- Introducing enhanced services to Surrey to connect to Guildford and enhance frequency to Woking.

5.7.8 In addition, these improvements will require Heathrow to provide facilities that are capable of handling the operation of the expanded services.

5.8 Accommodating other road users

5.8.1 The surface access proposal will present adequate capacity for use by other road users. The additional road widening will reduce congestion on some key routes in the Highway strategic network.

5.8.2 During construction, significant delays are expected on routes with interventions that require lane closures. These include upgrade to exiting junctions, construction of new tunnels linking existing roads and construction of new junctions. **Table 15** lists the intervention and the expected severity of impact on reliability of the network during construction.

Table 15: list of interventions and likely impact level

Intervention	Impact
Tunnelling the M25	Moderate
M4 J2 to J3 widening	Severe
M4 J4 to J4a widening	Severe
Constructing a system of collector-distributor roads	Moderate
Construct a new Southern Road Tunnel access	Moderate
Implementation of a new one-way access arrangement	Minimal
Realigning the A4 to the north of airport	Severe
Replace sections of the A3044	Severe
Remove the existing Western Perimeter Road	Minimal
Grade separate the roundabout	Severe
Construct new junction on the Southern Perimeter Road	Severe

5.8.3 To minimise impact where possible, all new highway structures/alignment should be constructed before the removal of existing roads. It is essential that detailed traffic management plans are in place to support this.

5.9 Road Scheme costs

5.9.1 Out-turn costs of recent road widening schemes on the M25 were used as a basis for estimating the total cost associated with providing the capacity enhancements summarised above. These total estimates include pure engineering costs, land costs, environmental mitigation costs and the consequential costs of the schemes themselves.

5.9.2 It has been reported that the recently-constructed M25 junctions 16-23 (M40-A1 (M)) widening programme cost £3.4bn for the 35km stretch. The Government's Public Accounts Committee have been critical of these costs and have suggested that improved management could have resulted in a total spend of £2.4bn. Furthermore, the total costs included construction and 30 years-worth of maintenance. Assuming that the maintenance costs accounted for 20% of the total suggests a new-build efficient cost of £1.92bn, equivalent to £55m/km.

5.9.3 It has also been reported that the recently-constructed M25 junctions 27-30 (M11-A13) widening programme through rural Essex cost £360m for the 27km stretch. This equates to a total spend per km of £13m.

5.9.4 Taking a weighted average of these costs per km (most of the widening due to the new North West Runway at Heathrow will be more similar to the junctions 16-23 programme than the junctions 27-30 programme), we have assumed that the Heathrow road widening costs will vary between £35m-£50m/km. A similar approach and a value of £50m per km was adopted during the Phase 1 analysis.

5.9.5 **Table 16** overleaf summarises the estimated costs for the Extended Baseline with SRA surface access proposal for Heathrow.

5.9.6 Taking the unit road widening costs described above, we estimate that the strategic highway cost of the new North West Runway at Heathrow in the optimal surface access proposal will vary between **£0.94bn** and **£2.23bn**. This variation is due to two reasons as follows:

- The variation of the length of road to be widened depending on whether the criteria to widen is 100% capacity or 85% capacity; and
- The variation in unit widening costs.

5.9.7 These costs exclude risk and optimism bias. With an optimism bias of 44%, the Extended Baseline road surface package costs range from **£1.35bn** to **£3.22bn.**

5.9.8 Asset replacement and operational expenditure (OPEX) were not considered during this study, but analysis of these costs was undertaken in a different worksteam and are detailed in a separate report, entitled ‘Deliverable 13.2: Cost calculations’.

Table 16: Costings for extended baseline surface access package

Location	Requirement	Length (km - both dir)	Lower range		Upper range	
			Unit cost (£ per km for links)	Estimated Cost (£)	Unit cost (£ per km for links)	Estimated Cost (£)
M4 J3 to J4	Road Widening	3.8	£35m	£133m	£50m	£190m
M4 Airport Spur	Road Widening	2.8	£35m	£98m	£50m	£140m
M4 J2 to J3	Road Widening	17.6	£0	£0	£50m	£880m
M4 J4 and J4B	Road Widening	4.7	£0	£0	£50m	£235m
M4	Large M4 jnc 4b replacement	~	£150m	£150m	£150m	£150m
M4	Higher Capacity @ M4 J4a	~	£40m	£40m	£40m	£40m
M4	Capacity improvements to existing main airport tunnel	~	£40m	£40m	£40m	£40m
M25	M25 tunnelling costs (south of junction 15)	4	£80m	£320m	£100m	£400m
A4	Diversion of A4 Road alignment, dual carriageway	3.5	£25m	£87.5m	£25m	£87.5m
A3044	Diversion of A3044 Road alignment, dual carriageway	1	£25m	£25m	£25m	£25m
Airport Roads	Airport Way/Southern Perimeter Road Interchange, grade separated junction and flyover/bridge structures	1	£35m	£35m	£35m	£35m
Heathrow Road Tunnel	Southern Road Tunnel/Southern Perimeter Road Interchange		£10m	£10m	£10m	£10m
Airport One Way	One way system for western campus		£2m	£2m	£2m	£2m
		TOTAL		**£940.5m**		**£2,235m**
		Risk		*0%*		*0%*
		Optimism bias		*44%*		*44%*
		TOTAL (including risk and optimism bias)		**£1,354m**		**£3,218m**

6. Airport catchment analysis

6.1 Introduction

6.1.1 This section sets out a summary of the appraisal of the optimised surface access package against the Airport Commission's **Objective 3**:

- To enable access to the airport from a wide catchment area.

6.2 Public Transport accessibility

6.2.1 The Public Transport (PT) surface access catchment area to Heathrow was assessed utilising the Visography TRACC software which is a multi-modal transport accessibility analysis tool designed to generate travel times using a multitude of PT and road modes to give accurate journey times from a given set origins and destinations.

6.2.2 In line with **Sections 4.3** and **4.4**, both the current PT service routes and Extended Baseline with SRA service routes were coded within the software in industry standard (ATCO.CIF) format to ascertain the changes in travel times by PT to Heathrow. PT surface access modes included within the assessment were as follows:

- Heavy rail services;
- Light rail and underground services;
- Local bus services; and
- National coach services.

6.2.3 **Figure 30** and **Figure 31** present the accessibility by travel band isochrones from Heathrow Airport for the base year and the Extended Baseline with SRA in 2030 respectively. The figures show large improvements in accessibility to the North and West due to the WRA (and HS2) in accessing Heathrow.

6.2.4 **Table 17** summarises the population within journey time bands to Heathrow by PT. These exclude connections through car to stations and interliners to Heathrow from other airports. Improvements to PT services accounts for a 36% increase in UK population now accessible to Heathrow within 3 hours.

Table 17: Population catchment for Heathrow by travel time band

PT journey time to airport	Heathrow Base	Heathrow Extended Baseline with SRA
Up to 30 minutes	230,000	700,000
Up to 60 minutes	2,400,000	3,800,000
Up to 90 minutes	9,900,000	11,500,000
Up to 120 minutes	16,000,000	20,000,000
Up to 150 minutes	22,000,000	29,000,000
Up to 180 minutes	28,000,000	38,000,000

Figure 30: Heathrow base year PT accessibility

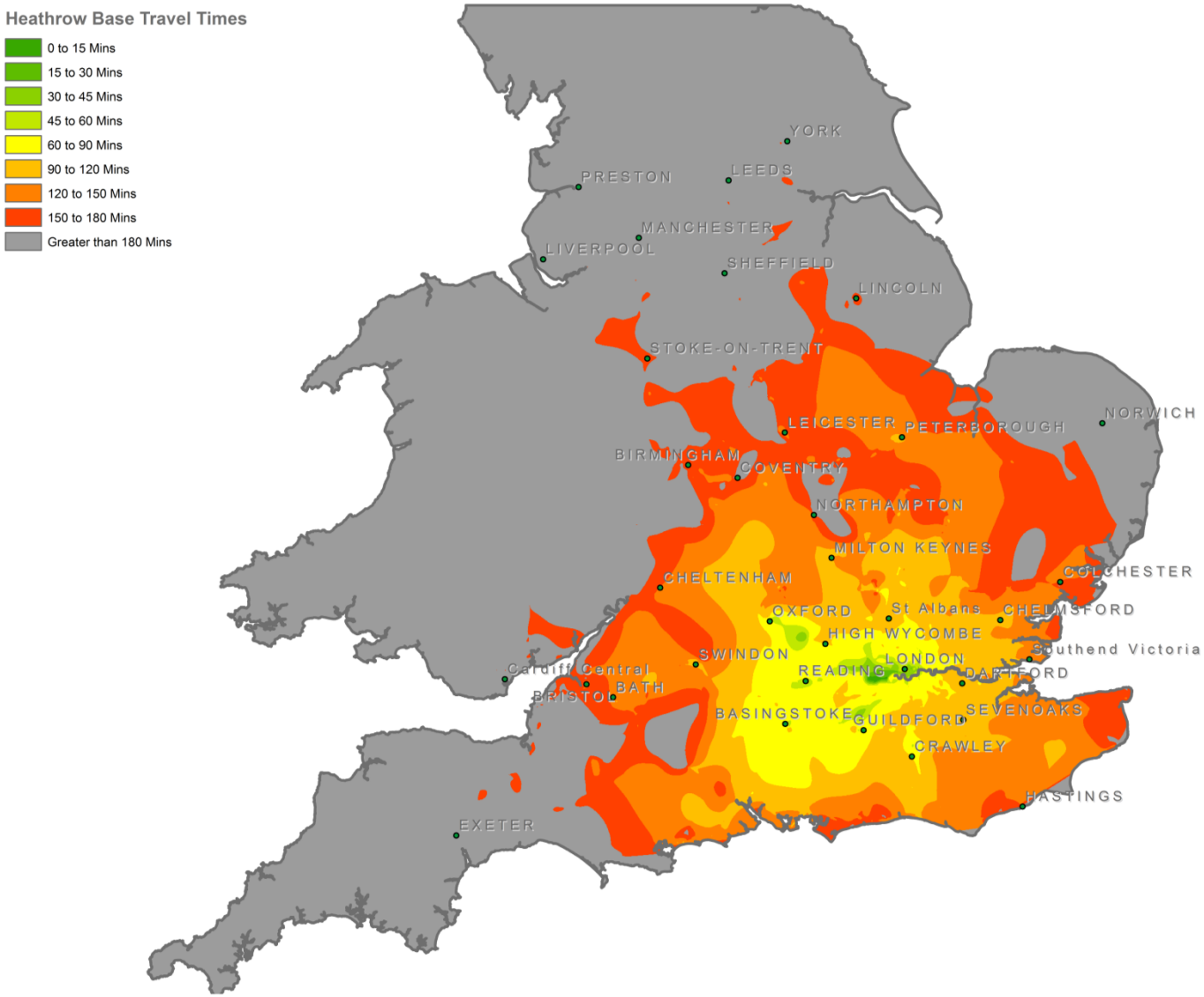
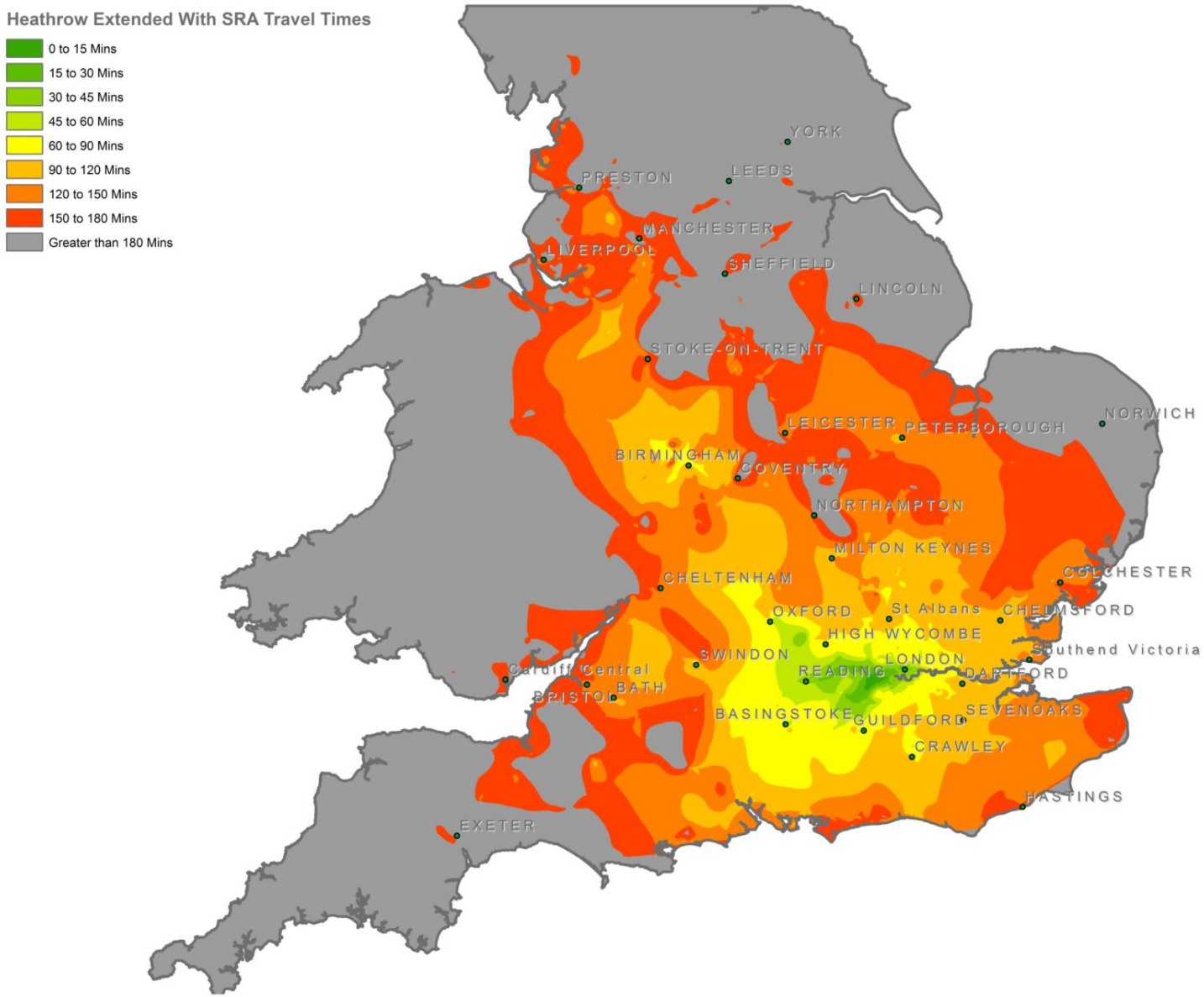


Figure 31: Heathrow 'Extended Baseline with SRA' PT accessibility



7. Summary and conclusions

7.1 Approach

7.1.1 This Heathrow surface transport study involved estimating airport passenger and employee surface transport demand associated with a new North West Runway at the airport in 2030; identifying surface transport measures to meet airport-related demand; and assessing the feasibility and high-level cost of the surface transport measures identified. The ultimate aim of the study was to provide guidance to the AC on the feasibility and likely surface transport issues associated with delivering a new North West Runway at Heathrow, with specific reference to three objectives set out in the AC's Appraisal Framework:

- **Objective 1** - to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport;
- **Objective 2** - to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight; and
- **Objective 3** - to enable access to the airport from a wide catchment area.

7.1.2 A Core Baseline and an Extended Baseline of infrastructure schemes that would be developed irrespective of the delivery of a new North West Runway were defined, and infrastructure required to accommodate airport-related demand was identified and assessed. The primary focus of all the analysis was on the Extended Baseline as by 2030 it was judged very likely that further enhancements to the UK transport network would have been delivered above and beyond the works that were fully committed at the beginning of Phase 2. In addition to those schemes identified within the Extended Baseline was SRA, which was shown to provide additional benefits required to alleviate capacity constraints on the rail network. Given the scheme's current status (with planning at a very early stage), the cost of this scheme was included as a potential airport expansion-related cost in the assessment.

7.1.3 Demand/capacity assessments need to be undertaken at peak hour level rather than an annual or daily level. Thus, from assumptions on million passengers per annum (mppa) at Heathrow both with and without a new North West Runway in 2030, and current observed behaviour at the airport, we were able to derive peak hour airport-related passenger and employee demand levels.

7.1.4 The next key task was to determine the private/public transport mode share and the rail sub-mode share, and a mode share logit model was developed by Jacobs for this purpose. Currently, 59% of passengers at Heathrow travel to the airport by car or taxi, and of the 41% who travel by public transport, 28% use rail and 13% bus/coach. Similarly, around 43% of employees at Heathrow currently commute to the airport by car/taxi, with the 47% public transport mode share split between 35% using bus and 12% using rail.

7.1.5 The HAL submission indicated that an air passenger public transport mode share target of 52% (36% rail, 17% bus/coach) was used to test the impact of the new North West Runway on the rail network and road network. Employee mode share was assumed to be 43% public transport and 47% private vehicle.

7.1.6 We then had to define the surface access trip distribution of passengers and employees at Heathrow. To do this, we developed and calibrated a trip distribution model for Heathrow (based on CAA 2012 passenger survey data), assumed the calibrated parameters remained constant, and used the model to predict passenger trip distribution at the Heathrow airport. At this stage the predicted future trip distribution was compared with the observed trip distribution patterns in 2012 with improved surface access accounting for relatively minor adjustments to overall trip distribution. Based upon the minor difference it was decided to use the observed travel patterns for both passengers from the 2012 CAA survey data and for employees the 2009 Heathrow Airport survey.

7.1.7 The next task was to assign the airport surface transport trips to the respective rail and highway networks. Rail trips were assigned using the sub-rail component of the headline mode share logit

model (also calibrated using 2012 CAA passenger survey data) to predict demand on different rail services. We held discussions with Network Rail and TfL to derive the non-airport related background demand that was predicted to use each rail service in 2030, to determine whether additional capacity was required to cater for airport-related demand and to assess the impact of background demand on passenger level of service. The net impact of demand associated with the new North West Runway was added to the background forecast to determine whether additional capacity was required and to assess the impact on passenger level of service.

7.1.8 The HAL submission indicated that their proposed rail infrastructure package and predicted rail passengers can be accommodated on the rail network without unduly impacting on commuters and other users. As a result, the aforementioned rail assessment undertaken as part of this study was focussed on assessing the validity of this claim.

7.1.9 To assign car/taxi trips, we defined a strategic road network of motorways and major A-roads used to access the airport. We extracted daily observed flows on each of the links from the TRADS database, and current Heathrow-related traffic was predicted and removed from the base year demand to account for background traffic levels. DfT National Traffic Model (NTM) outputs were used to forecast the increase in background non-airport-related demand in 2030. This enabled us to identify capacity issues not related to Heathrow. We then manually assigned airport-related forecast demand with the new North West Runway in place to the strategic road network and identified capacity issues on individual links caused by traffic related to airport expansion. This analysis then fed into an independent assessment of the proposed road network in the vicinity of the airport included in the HAL submission, with the proportion of traffic using each terminal assumed to be consistent with HAL's assumptions.

7.2 Conclusions

Objective 1 - maximising the use of sustainable modes of transport

7.2.1 Our analysis predicted that public transport mode share of passenger surface access trips to/from Heathrow would increase from 41% in 2012 to 55% in 2031. The main change is predicted to be in the rail mode share, which is predicted to increase from 28% in 2012 to 43% in 2031. This represents a net impact of up to 2,400 additional rail trips to the airport in the AM peak hour in 2030 as a result of the new North West Runway, with up to 1,400 additional rail trips leaving the airport.

Objective 2 – accommodating the needs of other users (rail)

7.2.2 The rail demand forecasts from the mode share model were added to background demand forecasts provided by NR and TfL on the HEX and sections of the Piccadilly Line, Crossrail, WRA and SRA and then compared with seated and total capacity estimates.

7.2.3 The analysis indicated that on the majority of sections, the network is likely to have sufficient capacity to accommodate forecast demand including airport passengers associated with the new North West Runway, and that airport passengers travelling to and from London should not have any issues boarding trains during the AM peak-hour. The exception to this is the Piccadilly Line which will experience over-capacity conditions in 2030 due to background patronage. Without modelling the PM peak as part of this study, there may also be issues boarding Crossrail trains in Central London towards Heathrow.

7.2.4 Analysis of the Piccadilly line shows that with the introduction of Crossrail services the dependence on the Piccadilly Line lessens, with its share of total Heathrow rail demand forecast predicted to drop from 81% currently to 29% in 2030. This share decreases further with the inclusion of the Extended Baseline package (which assumes the SRA and 2 extra trains per hour in the Heathrow Crossrail service). However, due to background patronage the seated capacity on most sections of the Piccadilly Line is exceeded and passengers are unlikely to get a seat during the peak hour. The most congested link is from Kings Cross to Green Park where the VCR is at 114% capacity and 398%

seated capacity. This means that passengers will experience heavily overcrowded conditions on this service primarily as a result of background demand with airport passengers accounting for between 1% and 15% between the Kings Cross to Acton Town sections rising to up to 20% without the Extended Baseline with SRA package. As a result investment is likely to be required above that included in the Extended Baseline to enhance rail services to the airport to accommodate the forecast increase in background non-airport-related demand due to background demand.

7.2.5 Crossrail replaces Heathrow Connect with a far superior service by reducing wait times and increasing train capacity, increasing the frequency from four to six trains' in the Core Baseline to the Extended Baseline with SRA also further increase the benefits to passengers. Crossrail serves many important destinations directly including the West End, The City and Canary Wharf reducing the need for passengers to use the underground network to access the Airport. Crossrail will improve the connectivity for passengers from outside London by serving important intercity and commuter stations such as Farringdon (Thameslink), Liverpool Street (Greater Anglia), Abbey Wood (North Kent Line) and Stratford (HS1). This decreases journey times and interchanges for passengers from Sussex, Kent, Essex, Hertfordshire and Cambridgeshire. Thus Crossrail is predicted to carry 31% of Heathrow rail demand in 2030. However, due to background demand the seated capacity is exceeded on most sections with airport passengers unlikely to get a seat on the train. An average VCR related to seated capacity of 188% to Heathrow and 308% from Heathrow is forecast on the Farringdon to Hayes and Harlington sections. Total VCR on Crossrail reaches a maximum of 92% of total capacity, meaning that airport passengers should be able to board trains but some will experience very crowded conditions during peak times due to the uneven loading of carriages and demand fluctuations across the peak hour.

7.2.6 WRA adds connectivity and reduced journey times to large areas to the west of Heathrow. Currently passengers from the west accessing by rail have the choice of a bus interchange at Reading or connecting to either the Heathrow Express or Heathrow Connect at Paddington. WRA reduces journey time and cost significantly for passengers from the South West and Wales as the interchange reduces the need to 'double back' at Paddington. This also helps to relieve congestion at Paddington Station. Thus WRA is predicted to carry 10% of Heathrow rail demand in 2030. At the time of writing, no background patronage was available to assess the VCR for WRA. However, Heathrow-related demand accounts for between 13% and 26% of seated capacity between Maidenhead and Reading. This increases to between 17% and 31% on the Slough to Heathrow sections. Without the Extended Baseline with SRA packages there would be a marginal change of up to 19% and 34% on the Slough to Heathrow sections.

7.2.7 Heathrow Express is assumed to remain as it currently exists with the addition of an extra interchange at Old Oak Common, where it will connect with HS2 and services on the Great Western Mainline. Due to the premium pricing and the introduction of Crossrail the HEX rail share is expected to reduce to 12% of Heathrow demand by rail, similar to current levels. As a direct Heathrow service the lack of commuters and other passenger's results in the forecast demand on Heathrow Express being well within the available seated capacity, with at a maximum of 33% VCR. We would expect based on the crowding shown on Crossrail and the Piccadilly Line that in peak times, trips to Heathrow on Heathrow Express would increase with the guarantee of a seat. Sensitivity testing on Heathrow Express pricing resulted in the spreading the demand of rail passengers to Heathrow with pricing in line with the Oyster car system. However, given the sections where current rail users experience most congestion, on the Piccadilly Line and Crossrail within Central London, are where the proportion of airport demand is at its lowest, the benefits of this would be limited. Further analysis is presented within **Appendix B.3**

7.2.8 The inclusion of SRA provides direct accessibility to new catchment areas through Waterloo, Clapham Junction and Staines. Our analysis shows that some additional shift from road to public transport occurs with passengers originating from the south-east due to better connections. Furthermore, the reliance on both the Piccadilly Line and Crossrail is reduced with the proportions using these services dropping from 38% and 35% to 29% and 31% respectively. However, on the sections between Waterloo and Staines the service is predicted to operate at or over seated capacity (between 91% and 191%) meaning passengers will likely have to stand for parts of their journey in peak times.

7.2.9 Overall the inclusion of heavy rail access to Heathrow from both the west and the south opens up journey opportunities for Airport passengers and employees that were hitherto not possible. The direct Crossrail service from Canary Wharf and Central London provides a complementary service to Heathrow Express and the Piccadilly Line. While the Crossrail service will share Great Western Main Line infrastructure with Heathrow Express from Paddington to Heathrow Airport, SRA will provide a new completely segregated route to a second London terminal.

7.2.10 In addition to redistributing patronage across the new services, these two new routes will offer improved resilience to London passengers over the present situation. If one route is closed by an incident, the other routes should be unaffected. At the present time, a closure of the Piccadilly Line or the existing heavy rail route to Paddington sees the majority of passengers being diverted onto the other service, leading to on-train capacity issues. The additional infrastructure should ensure that two of the three main rail routes to London are available more often, improving the overall resilience of rail transport to the Airport and through that, the passenger experience of public transport.

Objective 2 – accommodating the needs of other users (roads)

7.2.11 In terms of road traffic, the Jacobs model forecasted a net impact of up to 1,200 additional car/taxi trips to the airport in the AM peak hour in 2030 as a result of the new North West Runway, with up to 600 additional car/taxi trips leaving the airport. This demand was added to background traffic forecasts sourced from the DfT on sections of the strategic highway network serving the airport and then compared with estimates of capacity on network links, accounting for the impact of committed and planned Highways Agency schemes included in the core and Extended Baseline with SRA packages.

7.2.12 The strategic highway analysis indicated that only two road sections of the network; the M4 between junction 3 and junction 4 and the M4 Airport Spur road, would need widening specifically as a result of traffic associated with the new North West Runway in 2030. This accounts for a stretch of motorway some 7km in length. Other key sections of the strategic network serving Heathrow, the M4 between junctions 2 and 3 and 4 and 4b, were highlighted as potential capacity issues where widening or other measures may be required.

7.2.13 Forecasts from the strategic model were then fed into an independent assessment of road enhancements in the immediate vicinity of the airport. The basis for this was the HAL proposal consisting of the schemes as follows:

- Divert the A4 to the north of the airport, leaving its current alignment at Colnbrook Bypass and re-joining its existing route to the east of the airport access at Emirates Roundabout at a new junction – this new route will be re-provided as a dual carriageway with existing bus priority measures;
- Replace the section of the A3044 which will be under parts of the new airfield, and provide a connection from A4 to Poyle;
- Remove the existing Western Perimeter Road and part of the Northern Perimeter Road;
- Grade-separate the roundabout junction where Airport Way meets the Southern Perimeter Road to allow dedicated access to Heathrow West and segregate through-movements on the Southern Perimeter Road;
- Provide a new and improved junction on the Southern Perimeter Road to allow access to the Southern Road Tunnel; and
- Implement a new one-way access arrangement for the Heathrow West campus, making use of an enhanced J14 for access – traffic would exit via J14a, making use of the existing structure and slip roads.

7.2.14 The analysis undertaken by Jacobs indicated that forecast flows were within assumed link capacities associated with HAL's proposed road network in the vicinity of the airport. However, it should be noted that a full assessment of highway capacity was not possible due to lack of information on internal road layouts within the proposed North West Runway masterplan.

Objective 3 – enabling access to the airport from a wide catchment area

7.2.15 Turning to an assessment of overall level of service, our analysis shows that the overall demand-weighted average journey time of a rail trip to Heathrow (taking into account journey duration, wait times and interchanges required) is forecast to increase from 66 minutes in 2012 to 69 minutes in 2030. This is due to the greater proportion of passengers forecast using rail for longer distance trips as a result of additional services made feasible by the Extended Baseline schemes (including new Crossrail interchanges) and the SRA. As a result, the proportion of rail trips from outside London increases from 7% to 35%. The biggest increase comes from the South East where demand for rail increases from 2% to 18%.

7.2.16 The forecast change in demand-weighted rail journey times coupled with consideration of the new direct connections to Heathrow suggest that the overall rail catchment of the airport will be significantly larger in 2030 than it is today.

7.2.17 Both the current and the Extended Baseline with SRA public transport (PT) service routes were coded in accessibility software to ascertain the changes in travel times by PT to Heathrow as a result. This isochrone analysis indicated that significant areas of the UK are expected to become accessible by PT to Heathrow as a result of committed and planned service enhancements. In particular, benefits for air passengers from the north-west of England were immediately evident, in addition to a number of other areas across the Midlands, East Anglia and the South West that also benefit from improved connections.

7.2.18 According to this analysis, the improvements to services associated with the Extended Baseline with SRA account for a 36% increase in the UK population within 3 hours PT travel time of Heathrow, suggesting that the proposal for a new North West Runway performs well against **Objective 3** in the AC's Appraisal Framework.

7.3 Scheme costs

7.3.1 The schemes included in the Core Baseline and the Extended Baseline are not costed in this analysis as they are assumed to be delivered by 2030 regardless of the airport expansion.

7.3.2 A summary of the additional costs calculated is shown in the table below, and a summary of the methodology used to develop these costs is provided in the rail and road assessment chapters of this report.

7.3.3 The total capex costs have been estimated at between **£1.43bn** and **£2.72bn**. The range relates to the criteria that were applied to define the requirement for strategic road widening, as explained in the roads assessment chapter.

7.3.4 If optimism bias is included at 44% for road schemes and 66% for rail schemes as defined by the AC, this cost range rises to between **£2.16bn** and **£4.03bn**.

7.3.5 Asset replacement and operational expenditure (OPEX) were not considered during this study, but analysis of these costs was undertaken in a different worksteam and are detailed in a separate report, entitled 'Deliverable 13.2: Cost calculations'.

Table 18: Summary scheme costs for package (£million)

Location	Requirement	Length (km - both dir)	Lower range		Upper range	
			Unit cost (£ per km for links)	Estimated Cost (£)	Unit cost (£ per km for links)	Estimated Cost (£)
M4 J3 to J4	Road Widening	3.8	£35m	£133m	£50m	£190m
M4 Airport Spur	Road Widening	2.8	£35m	£98m	£50m	£140m
M4 J2 to J3	Road Widening	17.6	£0	£0	£50m	£880m
M4 J4 and J4B	Road Widening	4.7	£0	£0	£50m	£235m
M4	Large M4 jnc 4b replacement	~	£150m	£150m	£150m	£150m
M4	Higher Capacity @ M4 J4a	~	£40m	£40m	£40m	£40m
M4	Capacity improvements to existing main airport tunnel	~	£40m	£40m	£40m	£40m
M25	M25 tunnelling costs (south of junction 15)	4	£80m	£320m	£100m	£400m
A4	Diversion of A4 Road alignment, dual carriageway	3.5	£25m	£87.5m	£25m	£87.5m
A3044	Diversion of A3044 Road alignment, dual carriageway	1	£25m	£25m	£25m	£25m
Airport Roads	Airport Way/Southern Perimeter Road Interchange, grade separated junction and flyover/bridge structures	1	£35m	£35m	£35m	£35m
Heathrow Road Tunnel	Southern Road Tunnel/Southern Perimeter Road Interchange		£10m	£10m	£10m	£10m
Airport One Way	One way system for western campus		£2m	£2m	£2m	£2m
SRA to Staines	Rail improvement			£487.5m		£487.5m
	TOTAL			**£1,428m**		**£2,722m**
	Risk			*0%*		*0%*
	Optimism bias (road)			*44%*		*44%*
	Optimism bias (rail)			*66%*		*66%*
	TOTAL (including risk and optimism bias)			**£2,164m**		**£4,027m**

Note: excludes land costs

Appendix A. Core and Extended Baselines

A.1 Core Baseline

A.1.1 Rail infrastructure (excluding high speed)

In addition to the existing network and services, the rail Core Baseline will include all of the schemes identified in the Network Rail (NR) Control Period 5 (2014-19) Enhancement Delivery Plan, with the exception of Western Rail Access (WRA) to Heathrow, which does not yet have a fully secured funding package. This is available online at http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/cp5-delivery-plan/.

Elements of relevance to proposals may include (but not be limited to):

- Crossrail;
- Reading Area Station redevelopment;
- Thameslink programme;
- ERTMS in-cab signalling roll-out;
- East Coast Main Line capacity enhancements;
- West Anglia Main Line enhancements;
- Great Eastern Main Line capacity enhancement (Bow Junction);
- East Kent re-signalling;
- Redhill Station additional platform;
- London Victoria Station capacity improvements;
- London Waterloo Station capacity improvements;
- Great Western Main Line electrification;
- Intercity Express Programme roll-out;
- Thames Valley branch line enhancements;
- Oxford Corridor capacity improvements;
- Swindon to Kemble redoubling; and
- Birmingham Gateway development.

Scheme promoters are encouraged to consult the Enhancement Delivery Plan for the full details and delivery timescales for schemes.

A.1.2 Rail services (excluding high speed)

The Department for Transport (DfT) is responsible for the design and procurement of new and replacement rail franchises on the national rail network for which it is the franchising authority. The DfT is in the process of tendering a number of rail franchises, details of the rail franchise schedule can be found at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301976/rail-franchise-schedule.pdf. This includes information on the timing and scope of competitions for future franchises. Each individual franchise has its own specific requirements and addresses a particular set of challenges and so the requirements set out in each franchise competition are tailored to meet the needs of the areas they serve. The DfT has moved towards more output-based specifications to give greater flexibility to bidders while recognising the need for Government to protect essential service levels for all passengers. Details of the Department's activities during each of the stages of a

franchise competition can be found at https://www.gov.uk/government/publications/franchise-competition-process-guide.

In developing the baseline the Commission will assume that service levels will be broadly similar as they are today unless an infrastructure scheme or introduction of new rolling stock triggers a change. Details of the investment programme for 2014-19 can be found at http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/cp5-delivery-plan/.

The Commission will monitor the results of current franchise competitions and, when the outcomes of these competitions become known, will discuss the implications of the franchise with scheme promoters. The Commission recognises that dialogue on this issue will need to continue after the receipt of revised scheme proposals.

The outcome of the competition for the Thameslink, Southern and Great Northern franchise is clearly of particular relevance to scheme promoters and understanding and discussing the components of this will be a priority for the Commission.

A.1.3 Rail – High Speed

In respect of the High Speed 1 link and the Channel Tunnel, the Commission will assume for its baseline no fundamental changes to infrastructure or services, though it will use existing demand forecasts for both passenger and freight traffic to inform its baseline for capacity utilisation.

In respect of the High Speed 2 link, the Commission has noted that the "phase 1" route between London Euston and Birmingham and the "phase 2" route from Birmingham to Manchester and Leeds represents stated Government policy and has cross-party support. The Commission has, therefore, decided to include these elements of the scheme in its Core Baseline. The Commission has also noted, however, the Secretary of State for Transport's statement that he will delay a decision on whether to proceed with a spur from HS2 to Heathrow Airport until after the Airports Commission's Final Report. This spur will not, therefore, form part of the Core Baseline.

For an overview of the HS2 programme, scheme promoters are encouraged to consult the following documents:

- https://www.gov.uk/government/publications/hs2-strategic-case
- https://www.gov.uk/government/publications/high-speed-rail-investing-in-britains-future-phase-two-the-route-to-leeds-manchester-and-beyond

The Commission has also noted that the recent review by Sir David Higgins made a number of recommendations regarding the delivery of HS2. On the basis of this, the Government has already taken the decision not to proceed with a link between HS2 and HS1. This link will not, therefore, form part of either baseline. It is possible that the Government may suggest further changes to the timing and phasing of the HS2 delivery programme on the basis of Sir David's report; the Commission will monitor developments and incorporate any material changes into the baseline. Sir David's report is available at: http://assets.hs2.org.uk/sites/default/files/inserts/Higgins%20Report%20-%20HS2%20Plus.pdf.

A.1.4 London Underground, London Overground and Docklands Light Railway

The Commission has taken advice from TfL on the status of various forthcoming enhancements to the London Underground, Overground and DLR networks. On the basis of information provided, the Commission will include the following schemes in the Core Baseline:

- London Underground Subsurface upgrade – Signalling and rolling stock replacement, complete by 2018;
- Croxley link – Metropolitan line link to Watford Junction, planned to complete by 2021;
- Northern line upgrade – planned to complete by 2020;

- Victoria line upgrade – planned increase in service frequency to 36tph;
- Piccadilly line upgrade – planned for completion by 2026;
- Bakerloo line upgrade – planned for completion by 2031;
- Central line upgrade – planned for completion by 2031;
- London Underground station redevelopments – e.g. Bank and Victoria;
- Waterloo & City Line Upgrade – Planned for completion by 2031;
- London Overground extension of class 378s to 5 car – deployed by end 2015;
- Gospel Oak to Barking electrification – complete by 2019;
- DLR 3-car upgrade Poplar to Stratford – complete by 2026; and
- DLR Inter-peak service enhancements (base service plan A) – due September 2014.

A.1.5 Strategic roads network

Following discussions with the Highways Agency (HA), the Commission's view is that the following schemes should be included in the Core Baseline:

- M23 Junction 8 to 10 "smart motorway" (all lanes running) – subject to value for money and deliverability assessment;
- M25 Junction 23 to 27 "smart motorway" (all lanes running) – complete by 2015;
- M25 Junction 5 to 6/7 "smart motorway" (all lanes running) – complete by 2014; and
- M3 Junction 2 to 4a "smart motorway" (all lanes running) – complete by 2016.

A.2 Extended Baseline

A.2.1 Rail infrastructure (excluding high speed)

The Commission has held discussions with NR, the DfT and other parties with an interest in the process regarding rail schemes which are likely – but not certain – to be funded in the coming years to meet growth in background demand regardless of decisions on airport expansion. These include:

- WRA to Heathrow: which forms part of the Control Period 5 settlement (meaning it is highly likely to progress) but does not yet have a fully agreed funding package. Should the funding package be secured, this scheme would become part of the Core Baseline.
- Gatwick Airport Station redevelopment: recommended as part of the Commission's interim report. Discussions are ongoing between Government, NR and the airport regarding the nature and scale of the redevelopment.
- Proposed capacity enhancements to the Brighton Main Line: Currently under development and may potentially be identified for funding as part of the CP6 (2019-2024) programme. Components include:
- Windmill Bridge Junction area re-modelling
    - New flyover for Up London Bridge Fast line
    - New flyover carrying the Down London Bridge Fast over the Wallington and Victoria Slow lines
    - Reusing the current dive under for realigned Up London Bridge Slow services removes path conflicts of current flat junction
    - New 6th track between East Croydon and Windmill Bridge
    - East Croydon Station remodelling and additional platforms

  - Selhurst Spurs lengthened to provide 12-car signal standing – removes current conflicts
- Stoats Nest Junction grade separated junction for Up Redhill trains to join the Up Fast line
- London Victoria re-designation of platform 8 and new access from platform 9 approach
- Clapham Junction area alterations to allow for additional train paths (no feasibility work yet undertaken)
- Keymer Junction – third track to enable Up Lewes train to join main line whilst an Up train is passing and enables the Brighton Main Line to remain open when the junction is unusable.
- Potential outcomes of the Wessex, Sussex and East Sussex route studies: which will inform the future development of infrastructure and services on those routes.
- London Victoria: further redevelopment beyond 2019, subject to business case.
- Clapham Junction: further redevelopment beyond 2019, subject to business case.
- Crossrail 2 – subject to significant further specification and assessment.

A.2.2 Rail Services (excluding high speed)

As with the development of the Core Baseline, the Commission will monitor progress on the DfT's refranchising programme. Where the outcomes of franchise competitions are not known, but the Invitation to Tender gives clear indications regarding the probable contents of the franchise, these will be incorporated into the Extended Baseline.

A.2.3 High Speed Rail

The Government has deferred a decision regarding a spur from HS2 to Heathrow Airport until after the Airports Commission publishes its final report. This spur will, therefore, be placed within the Extended Baseline. The Commission notes, however, that the need to progress the HS2 hybrid bill through Parliament may result in changes in Government policy in this area and will keep any such developments under review, in respect of the relationship of the spur to the baselines.

A.2.4 London Underground, London Overground and Docklands Light Railway

The Commission has taken advice from TfL on the status of various forthcoming enhancements to the London Underground, Overground and DLR networks. On the basis of information provided, the Commission will include the following schemes in the Extended Baseline:

- Jubilee line upgrade: increase to 34tph, requires additional stock;
- Northern line extension to Battersea: subject to TWA approval, potentially open in 2020;
- Northern line full separation: potentially by 2026;
- Bakerloo line southern extension: aspirational only at present;
- London Overground additional 2 tph all day between Clapham Junction and Stratford via West / North London Lines – planned for 2019, but dependant on additional rolling stock;
- London Overground additional 2tph on East London Line – dependant on additional rolling stock;
- London Overground Gospel Oak to Barking extended to Barking Riverside – possible by 2021;
- London Overground 6- and 8-car operation on East, North and West London Lines – possible in 2020s / 2030s;
- DLR new franchise service plan – by 2016/17;
- North route double tracking phase 2 – requires additional rolling stock;
- DLR Royal Rocks initial capacity enhancements – requires additional rolling stock;
- DLR full 3-car operation – requires additional rolling stock;

- DLR extension to Catford – aspirational only at present; and
- DLR extension to Bromley – aspirational only at present.

A.2.5 Strategic Roads

Following discussions with the HA, the Commission's view is that the following schemes should be included in the Extended Baseline:

- M4 Junction 3 to 12 "smart motorway" (all lanes running) – subject to value for money and deliverability assessment;
- Lower Thames Crossing – work progressing, but no decision yet as to nature of any option that might proceed.

Appendix B. Sensitivity tests

B.1 Carbon-capped Assessment of Need (CC AON)

Headline passenger figures utilised as part of the Extended Baseline with Southern Rail Access (SRA) were taken from HAL's submission documentation a long with the number of interliners (or transferring passengers). However the Airports Commission has undertaken extensive scenario analysis on airport passenger forecasts. We have undertaken sensitivity tests on two of these scenarios: "carbon-capped Assessment of Need (AoN)" and "Carbon-traded Global Growth (GG)". The difference between this central scenario and these two sensitivity tests are summarised in **Table 19**.

Table 19: Heathrow Airport 2030 growth forecasts

Scenario	Core Scheme (current runway capacity)				Capacity Expansion (extra/extended runway)				
	Total annual pax	Annual interlining pax	Inter-lining %	Annual surface access pax	Total annual pax	Annual interlining pax	Inter-lining %	Annual surface access pax	Net annual surface pax growth
Jacobs Model (HAL Submission)	82,500,000	~	35.0%	53,625,000	103,600,000	~	35.0%	67,340,000	13,715,000
Carbon Capped Assessment of Need (AoN)	84,919,152	21,012,136	24.7%	63,907,016	109,264,920	34,912,782	32.0%	74,352,138	10,445,122
Carbon Traded Global Growth (GG)	87,452,728	19,796,496	22.6%	67,656,232	125,153,056	41,171,271	32.9%	83,981,785	16,325,553

Source: HAL submissions taken from "Taking Britain Further – Volume 1", Sensitivity Tests provided by the Airports Commission

The HAL numbers indicate that the net surface access impact of a new North West Runway would effectively amount to an additional 13.7mppa in 2030 (a total of 103.6mppa in the three-runway scenario less 82.5mppa in the two-runway scenario, assuming that 35% of all passengers in both scenarios are interliners). Comparing this against the CC AoN we have a net surface access impact of 10.4mppa in the 'Carbon-Capped Assessment of Need' (CC AON) scenario (109.3mppa with 32% interlining with three runways, less mppa 84.9mppa with 24.7% interlining with two runways).

This gives us an overall reduction in net impact on the road network of 300 car trips in a peak hour. However, given the rail assessment is based on total demand for rail passengers this equates to an increase in passengers of over 600 in a peak hour from the Extended Baseline with SRA scenario.

Table 20 and **Table 21** provide the summary information for the CC AoN sensitivity test and the rail capacity analysis.

Table 20: CC AoN Summary Table

Mode		Sections/Periods	Result	Percentage	
Main Mode Share	Car	All	6,683	45%	
	Bus	All	1,694	12%	
	Rail	All	6,337	43%	
				% Crush	% Seat
Rail Demand	SRA	Richmond - Heathrow	852	21%	43%
		Heathrow - Richmond	484	12%	24%
	WRA	Slough - Heathrow	523	11%	33%
		Heathrow - slough	297	6%	19%
	Tube	Acton - Heathrow	1467	41%	143%
		Heathrow - Acton	807	86%	299%
	Cross Rail	Hayes - Heathrow	1543	25%	83%
		Heathrow - Hayes	942	26%	87%
	HEX	OOC to Heathrow	575	12%	37%
		Heathrow - OOC	372	8%	24%
No of Highway links with V/C above 1		CBL	24	15%	
		EBL	19	12%	
No of Highway links with V/C above 0.85		CBL	47	29%	
		EBL	42	26%	

Table 21:CC AoN Rail VOC Summary

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
Heathrow Express	Paddington - Old Oak Common	To	4	1568	4608	501	32%	11%
	Old Oak Common - Heathrow	To	4	1568	4608	575	37%	12%
	Heathrow - Old Oak Common	From	4	1568	4608	372	24%	8%
	Old Oak - Paddington	From	4	1568	4608	330	21%	7%
LU Piccadilly Line	Kings Cross - Green Park	To	18	4860	18180	263	399%	114%
	Green Park - Earls Court	To	18	4860	18180	845	334%	95%
	Earls Court - Acton Town	To	18	6000	18180	991	171%	49%
	Acton Town - Heathrow	To	18	9000	18180	1467	143%	41%
	Heathrow - Acton Town	From	18	4860	18180	807	299%	86%
	Acton Town - Earls Court	From	18	4860	18180	637	339%	97%
	Earls Court - Green Park	From	18	4860	18180	556	384%	110%
	Green Park - Kings Cross	From	18	4860	18180	176	289%	83%
Crossrail	Romford – Stratford [1]	To	2	450	3000	3	0%	0%
	Stratford – Whitechapel	To	2	450	3000	42	50%	15%
	Abbey Wood - Canary Wharf [1]	To	4	1350	6000	47	3%	1%
	Canary Wharf - Whitechapel	To	4	1350	6000	92	76%	23%

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
	Whitechapel - Liverpool Street	To	6	1800	9000	181	68%	20%
	Liverpool Street - Farringdon	To	6	1800	9000	298	81%	24%
	Farringdon - Tottenham Court Road	To	6	1800	9000	575	102%	31%
	Tottenham Court Road - Bond Street	To	6	1800	9000	677	118%	35%
	Bond Street - Paddington	To	6	1800	9000	1020	141%	42%
	Paddington - Old Oak Common	To	6	1800	9000	1138	106%	32%
	Old Oak Common - Ealing Broadway	To	6	1800	9000	1288	175%	52%
	Ealing Broadway - Hayes and Harlington	To	6	1800	9000	1434	192%	58%
	Hayes and Harlington - Heathrow	To	6	1800	9000	1543	83%	25%
	Heathrow - Hayes and Harlington	From	6	1800	9000	942	87%	26%
	Hayes and Harlington - Ealing Broadway	From	6	1800	9000	891	311%	93%
	Ealing Broadway - Old Oak Common	From	6	1800	9000	834	285%	85%
	Old Oak Common - Paddington	From	6	1800	9000	749	155%	46%
	Paddington - Bond Street	From	6	1800	9000	676	232%	69%
	Bond Street - Tottenham Court Road	From	6	1800	9000	445	203%	61%
	Tottenham Court Road - Farringdon	From	6	1800	9000	378	176%	53%
	Farringdon - Liverpool Street	From	6	1800	9000	200	148%	44%
	Liverpool Street - Whitechapel	From	6	1800	9000	121	127%	38%
	Whitechapel - Canary Wharf	From	4	1350	6000	61	145%	44%
	Whitechapel - Stratford	From	2	450	3000	28	95%	28%

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
	Canary Wharf - Abbey Wood [1]	From	4	1350	6000	3	0%	0%
	Stratford – Romford [1]	From	2	450	3000	2	0%	0%
WRA	Reading - Maidenhead	To	4	1568	4608	358	23%	8%
	Maidenhead - Slough	To	4	1568	4608	440	28%	10%
	Slough - Heathrow	To	4	1568	4608	523	33%	11%
	Heathrow - Slough	From	4	1568	4608	297	19%	6%
	Slough - Maidenhead	From	4	1568	4608	266	17%	6%
	Maidenhead - Reading	From	4	1568	4608	227	14%	5%
SRA	Waterloo - Clapham Junction	To	4	2000	4000	392	93%	46%
	Clapham junction - Richmond	To	4	2000	4000	557	115%	58%
	Richmond - Staines	To	4	2000	4000	690	101%	50%
	Staines - Heathrow	To	4	2000	4000	852	43%	21%
	Heathrow - Staines	From	4	2000	4000	484	24%	12%
	Staines - Richmond	From	4	2000	4000	418	154%	77%
	Richmond - Clapham junction	From	4	2000	4000	349	193%	96%
	Clapham junction - Waterloo	From	4	2000	4000	256	159%	79%

Overall the main mode share is not affected by the increase in mppa due to the lack of crowding and congestion in both the rail and highway assignment model assignments.

Assessing rail volume to capacity ratios, the increase in mppa results in 2% increase in seated and 1% crush capacity volume to capacity ratios on Crossrail between Hayes and Harlington. Thus the conclusions presented within the Extended Baseline with SRA are still valid. Crowding levels are within crush capacities on all lines with the exception of the Piccadilly Line between Kings Cross and Green Park, however there is no change in this value of 114% compared to the Extended Baseline with SRA Scenario.

Table 22 shows the volume to capacity on selected links within the strategic highway network.

Overall the impact of the Carbon Captured Assessment of Need passenger levels show little change from the Extended Baseline with SRA assessment. No further rail or road packages would be required to support the new North West Runway under this scenario.

Table 22: CC AoN Highway VOC Selected Links

Road name	Section	To Airport			From Airport		
		Background only Scenario	2-runway Scenario	3-runway Scenario	Background only Scenario	2-runway Scenario	3-runway Scenario
M25	J10 and J11	108%	112%	112%	108%	110%	111%
M25	J11 and J12	111%	115%	116%	111%	114%	114%
M25	J12 and LA boundary	99%	108%	110%	99%	105%	106%
M25	J13 and J14	117%	126%	128%	117%	122%	123%
A296	M25 1B and A296	120%	120%	120%	120%	120%	120%
A2	A102 and A2213	112%	112%	112%	112%	112%	112%
M20	J4 and J5	104%	104%	104%	104%	104%	104%
M20	J5 and J6	110%	111%	111%	110%	111%	111%
M1	J6A and 7	102%	105%	105%	102%	105%	105%
M4 Spur	M4 and Airport	15%	95%	110%	15%	71%	80%
M25	J14 and 14A	97%	109%	111%	97%	106%	107%
M25	J14A and 15	111%	121%	123%	111%	119%	120%
M4	J3 and J4	84%	107%	112%	84%	101%	104%
A2	A2260 spur roads and Slip for A227	88%	88%	88%	88%	88%	88%
M25	J3 and J4	94%	94%	94%	94%	94%	94%
M25	J6 and J7	87%	88%	88%	87%	88%	88%
M25	J7 and J8	89%	91%	92%	89%	90%	91%
M25	J8 and J9	88%	91%	91%	88%	90%	90%
M25	J9 and J10	92%	95%	96%	92%	94%	94%
M25	J15 and J16	88%	98%	99%	88%	96%	98%
M25	J17 and J18	84%	90%	91%	84%	89%	90%
M25	J18 and J19	85%	91%	92%	85%	90%	91%
M25	J23 and J24	91%	94%	95%	91%	94%	94%
M25	J25 and LA boundary	89%	93%	93%	89%	92%	93%
M20	J3 and J4	93%	93%	93%	93%	93%	93%
M11	M25 and J7	90%	91%	91%	90%	91%	91%
M40	J1A and J2	91%	96%	97%	91%	94%	95%
M4	J2 and J3	53%	85%	91%	53%	77%	81%
A406	A406 and LA boundary	90%	90%	90%	90%	90%	90%
M4	J4 and J4B	75%	84%	85%	75%	82%	83%
M4	J4B and J8	63%	71%	72%	63%	68%	69%
M1	J13 and J14	91%	93%	93%	91%	92%	93%
M25	J5 and LA boundary	72%	72%	72%	72%	72%	72%

B.2 Sensitivity Test 2 Carbon-traded Global Growth (CT GG)

The HAL numbers indicate that the net surface access impact of a new North West Runway would effectively amount to an additional 13.7mppa in 2030 (a total of 103.6mppa in the three-runway scenario less 82.5mppa in the two-runway scenario, assuming that 35% of all passengers in both scenarios are interliners). Comparing this against the 'Carbon-Traded Global Growth' (CT GG) there is a net impact of 16.3mppa in the 'CT GG scenario (125.2mppa with 32.9% interlining with three runways, less 87.5mppa with 22.6% interlining with two runways).

This results in a net overall increase of 250 car trips in a peak hour. The total demand for rail passengers increases by 1,450 in a peak hour from the Extended Baseline with SRA scenario.

Table 23 and **Table 24** provide the summary information for the CT GG sensitivity test and the rail capacity analysis.

Table 23 CT GG Summary Table

Mode		Sections/Periods	Result	Percentage	
Main Mode Share	Car	All	7,549	45%	
	Bus	All	1,913	12%	
	Rail	All	7,158	43%	
				% Crush	% Seat
Rail Demand	SRA	Richmond - Heathrow	934	23%	47%
		Heathrow - Richmond	538	13%	27%
	WRA	Slough - Heathrow	573	12%	37%
		Heathrow - slough	331	7%	21%
	Tube	Acton - Heathrow	1599	42%	146%
		Heathrow - Acton	896	86%	302%
	Cross Rail	Hayes - Heathrow	1713	27%	89%
		Heathrow - Hayes	1056	27%	91%
	HEX	OOC to Heathrow	645	14%	41%
		Heathrow - OOC	419	9%	27%
No of Highway links with V/C above 1		CBL		24	
		EBL		20	
No of Highway links with V/C above 0.85		CBL		48	
		EBL		42	

Table 24 CT GG Rail VOC Summary

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
Heathrow Express	Paddington - Old Oak Common	To	4	1568	4608	564	36%	12%
	Old Oak Common - Heathrow	To	4	1568	4608	645	41%	14%
	Heathrow - Old Oak Common	From	4	1568	4608	419	27%	9%
	Old Oak - Paddington	From	4	1568	4608	372	24%	8%
LU Piccadilly Line	Kings Cross - Green Park	To	18	4860	18180	297	399%	114%
	Green Park - Earls Court	To	18	4860	18180	951	336%	96%
	Earls Court - Acton Town	To	18	6000	18180	1110	174%	50%
	Acton Town - Heathrow	To	18	9000	18180	1599	146%	42%
	Heathrow - Acton Town	From	18	4860	18180	896	302%	86%
	Acton Town - Earls Court	From	18	4860	18180	717	341%	97%
	Earls Court - Green Park	From	18	4860	18180	627	385%	110%
	Green Park - Kings Cross	From	18	4860	18180	199	290%	83%
Crossrail	Romford – Stratford [1]	To	2	450	3000	3	0%	0%
	Stratford – Whitechapel	To	2	450	3000	48	51%	15%
	Abbey Wood - Canary Wharf [1]	To	4	1350	6000	54	3%	1%
	Canary Wharf - Whitechapel	To	4	1350	6000	103	77%	23%

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
	Whitechapel - Liverpool Street	To	6	1800	9000	204	69%	21%
	Liverpool Street - Farringdon	To	6	1800	9000	337	83%	25%
	Farringdon - Tottenham Court Road	To	6	1800	9000	647	105%	31%
	Tottenham Court Road - Bond Street	To	6	1800	9000	761	121%	36%
	Bond Street - Paddington	To	6	1800	9000	1150	146%	44%
	Paddington - Old Oak Common	To	6	1800	9000	1281	111%	33%
	Old Oak Common - Ealing Broadway	To	6	1800	9000	1445	180%	54%
	Ealing Broadway - Hayes and Harlington	To	6	1800	9000	1597	198%	59%
	Hayes and Harlington - Heathrow	To	6	1800	9000	1713	89%	27%
	Heathrow - Hayes and Harlington	From	6	1800	9000	1056	91%	27%
	Hayes and Harlington - Ealing Broadway	From	6	1800	9000	1000	315%	94%
	Ealing Broadway - Old Oak Common	From	6	1800	9000	939	288%	87%
	Old Oak Common - Paddington	From	6	1800	9000	845	158%	47%
	Paddington - Bond Street	From	6	1800	9000	763	235%	70%
	Bond Street - Tottenham Court Road	From	6	1800	9000	502	205%	61%
	Tottenham Court Road - Farringdon	From	6	1800	9000	427	178%	53%
	Farringdon - Liverpool Street	From	6	1800	9000	226	149%	45%
	Liverpool Street - Whitechapel	From	6	1800	9000	137	127%	38%
	Whitechapel - Canary Wharf	From	4	1350	6000	69	146%	44%
	Whitechapel - Stratford	From	2	450	3000	32	95%	29%

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
	Canary Wharf - Abbey Wood [1]	From	4	1350	6000	4	0%	0%
	Stratford – Romford [1]	From	2	450	3000	2	0%	0%
WRA	Reading - Maidenhead	To	4	1568	4608	401	26%	9%
	Maidenhead - Slough	To	4	1568	4608	488	31%	11%
	Slough - Heathrow	To	4	1568	4608	573	37%	12%
	Heathrow - Slough	From	4	1568	4608	331	21%	7%
	Slough - Maidenhead	From	4	1568	4608	298	19%	6%
	Maidenhead - Reading	From	4	1568	4608	256	16%	6%
SRA	Waterloo - Clapham Junction	To	4	2000	4000	441	95%	47%
	Clapham junction - Richmond	To	4	2000	4000	621	119%	59%
	Richmond - Staines	To	4	2000	4000	765	105%	52%
	Staines - Heathrow	To	4	2000	4000	934	47%	23%
	Heathrow - Staines	From	4	2000	4000	538	27%	13%
	Staines - Richmond	From	4	2000	4000	468	156%	78%
	Richmond - Clapham junction	From	4	2000	4000	393	195%	97%
	Clapham junction - Waterloo	From	4	2000	4000	289	160%	80%

The increase in overall surface passengers results in airport-related rail flows increasing by 25%. However, as the airport-related flows constitute a small percentage of the overall demand, the impact on the v/s ratios is relatively small.

On the busiest sections of Crossrail, predicted volumes/capacity ratios peaks increase from 92% in the Extended baseline with SRA to 94% in this sensitivity test. On the Piccadilly Line there is a similar 2% increase in v/c ratios in this sensitivity test.

WRA, SRA and sections of Crossrail with low background patronage have the largest proportional change, with up to an 11% increase between Hays and Harlington to Heathrow section of Crossrail, however these are well within the capacity of these sections of rail line. Overall the rail demand would still operate similar the Extended Baseline with SRA, with all sections except the central sections of the Piccadilly Line predicted to operate within crush capacity in 2030.

Table 25 below presents the impact on the strategic road network.

The impact on the highway is to increase the level of traffic on roads which were already over-capacity in the HAL scenario, for example the v/c rations on junction 3 -4 of the M4 increases from 103% to 107%, and the airport spur increases from 107% to 119%. There would also be a predicted increase of 215 vehicles between the base scenario on the M25 between J15 and J16 on one of the busiest sections of the M25.

Overall although the busiest sections of the road and rail sections are predicted to get busier in this scenario, no further new infrastructure schemes are required.

Table 25 CT GG Highway VOC Summary

Road name	Section	To Airport			From Airport		
		Background only Scenario	2-runway Scenario	3-runway Scenario	Background only Scenario	2-runway Scenario	3-runway Scenario
M25	J10 and J11	108%	112%	113%	108%	111%	111%
M25	J11 and J12	112%	115%	116%	112%	114%	114%
M25	J12 and LA boundary	100%	109%	111%	100%	105%	107%
M25	J13 and J14	117%	126%	129%	117%	123%	124%
A296	M25 1B and A296	120%	120%	120%	120%	120%	120%
A2	A102 and A2213	112%	112%	112%	112%	112%	112%
M20	J4 and J5	104%	104%	104%	104%	104%	104%
M20	J5 and J6	110%	111%	111%	110%	111%	111%
M1	J6A and 7	102%	105%	106%	102%	105%	105%
M4 Spur	M4 and Airport	15%	99%	119%	15%	74%	88%
M25	J14 and 14A	97%	109%	112%	97%	106%	109%
M25	J14A and 15	111%	122%	125%	111%	119%	121%
M4	J3 and J4	84%	109%	115%	84%	103%	107%
A2	A2260 spur roads and Slip for A227	88%	88%	88%	88%	88%	88%
M25	J3 and J4	94%	94%	94%	94%	94%	94%
M25	J6 and J7	87%	88%	88%	87%	88%	88%
M25	J7 and J8	89%	91%	92%	89%	90%	91%
M25	J8 and J9	88%	91%	91%	88%	90%	90%
M25	J9 and J10	92%	95%	96%	92%	94%	95%
M25	J15 and J16	89%	98%	101%	89%	97%	99%
M25	J17 and J18	84%	90%	92%	84%	90%	91%
M25	J18 and J19	85%	91%	93%	85%	91%	92%
M25	J23 and J24	91%	94%	95%	91%	94%	95%
M25	J25 and LA boundary	90%	93%	94%	90%	93%	93%
M20	J3 and J4	93%	93%	94%	93%	93%	93%
M11	M25 and J7	90%	91%	91%	90%	91%	91%
M40	J1A and J2	91%	96%	97%	91%	95%	95%
M4	J2 and J3	54%	86%	94%	54%	78%	84%
A406	A406 and LA boundary	90%	90%	90%	90%	90%	90%
M4	J4 and J4B	76%	84%	87%	76%	82%	84%
M4	J4B and J8	64%	71%	73%	64%	68%	70%
M1	J13 and J14	91%	93%	93%	91%	92%	93%
M25	J5 and LA boundary	72%	72%	73%	72%	72%	72%

B.3 HEX standard fare

The assumption within the Extended Baseline with SRA assessment is that the Heathrow Express (HEX) pricing structure will not change with the introduction of a new North West Runway at Heathrow. However, given the levels of congestion experienced on the Piccadilly Lines and on Crossrail and the need for the Airports Commission to meet its **Objectives 1** and **2** it could be argued that premium pricing on HEX is sub optimum in terms of capacity on the Great Western Main Line.

Thus a range on sensitivity tests was undertaken on the pricing of HEX fare structure.

Figure 32 below shows the change in passengers and the Seated and Crush capacity on the HEX service. This shows a linear trend as the HEX premium price is relaxed.

Figure 32: Capacity Analysis by Various HEX Pricing Structures

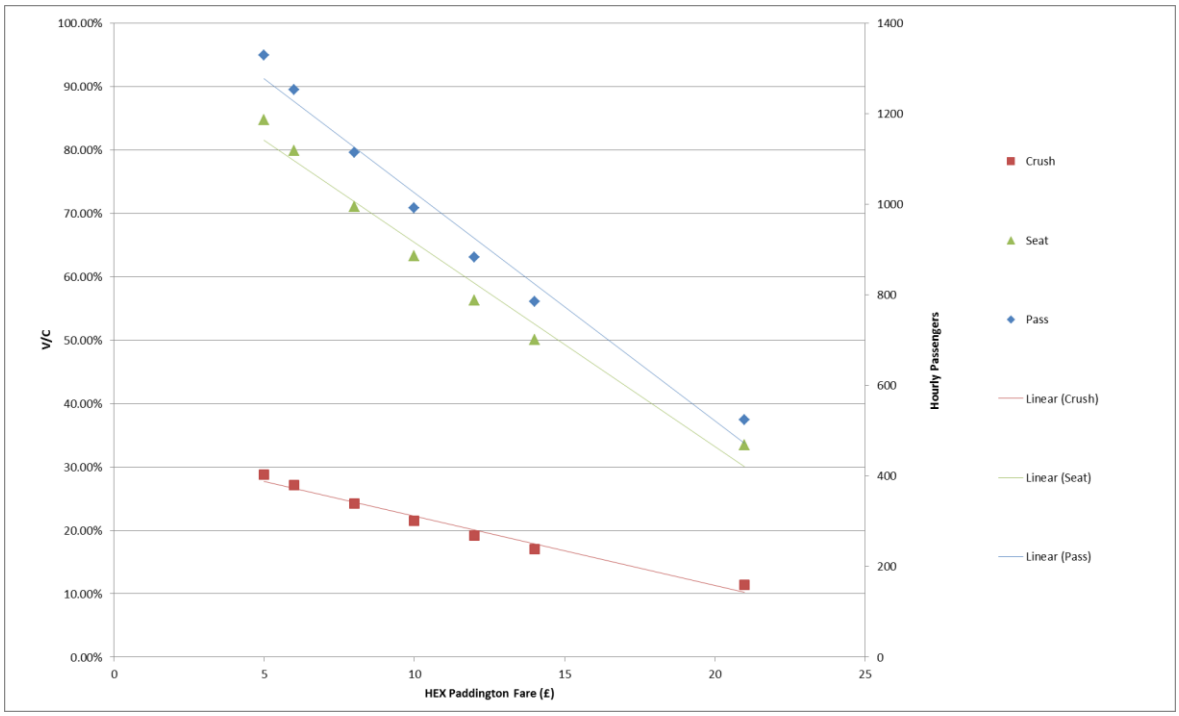


Table 26 below presents the HEX pricing summary table were the pricing structure of HEX to be at the Oyster Card level.

Table 26 HEX Summary Table

Mode		Sections/Periods	Result	Percentage	
Main Mode Share	Car	All	5,912	44%	
	Bus	All	1,531	11%	
	Rail	All	5,883	44%	
				% Crush	% Seat
Rail Demand	SRA	Richmond - Heathrow	656	16%	33%
		Heathrow - Richmond	360	9%	18%
	WRA	Slough - Heathrow	432	9%	28%
		Heathrow - slough	240	5%	15%
	Tube	Acton - Heathrow	1130	39%	135%
		Heathrow - Acton	594	84%	294%
	Cross Rail	Hayes - Heathrow	1135	20%	68%
		Heathrow - Hayes	678	23%	77%
	HEX	OOC to Heathrow	1329	29%	85%
		Heathrow - OOC	843	18%	54%
No of Highway links with V/C above 1		CBL		23	
		EBL		19	
No of Highway links with V/C above 0.85		CBL		47	
		EBL		41	

Table 27 HEX Rail Sub Mode Share

Rail Service	2030 Extended Baseline with SRA				2030 HEX Sensitivity			
	From		To		From		To	
Heathrow Express	338	13%	524	11%	843	31%	1,329	28%
Crossrail	859	32%	1,420	31%	678	25%	1,135	24%
Piccadilly Line	742	28%	1,370	30%	594	22%	1,130	24%
Western Rail Access	273	10%	487	11%	240	9%	432	9%
Southern Rail Access	444	17%	793	17%	360	13%	656	14%
TOTAL	2,656	100%	4,593	100%	2,715	100%	4,681	100%

Table 27 above shows that with no premium pricing on HEX, the rail mode share is predicted to almost treble increase from 12% around 30%. Passengers are attracted from both Crossrail and Piccadilly Line services. The lowering of pricings gives a much more balanced patronage of rail passengers to Heathrow lowering the demand for Crossrail and Piccadilly line by approximately 400 and 450 passengers in a peak hour respectively.

Table 28 overleaf shows the impact of reducing prices of HEX on the volume to capacity ration on rail services. The increase in passenger on HEX increases the seated volume to capacity ratio to 85% and the crush volume to capacity ratio to 29%. All other services experience a reduction in volume to capacity ratio up to a maximum of 11% on Crossrail services. Given the low levels of airport passengers to background passengers the effects are minimal on most services. The biggest improvement would be on SRA whereby there would be a reduction of up to 7% on these congested services.

Table 28 HEX Rail VOC Table

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
Heathrow Express	Paddington - Old Oak Common	To	4	1568	4608	1130	72%	25%
	Old Oak Common - Heathrow	To	4	1568	4608	1329	85%	29%
	Heathrow - Old Oak Common	From	4	1568	4608	843	54%	18%
	Old Oak - Paddington	From	4	1568	4608	733	47%	16%
LU Piccadilly Line	Kings Cross - Green Park	To	18	4860	18180	186	397%	113%
	Green Park - Earls Court	To	18	4860	18180	586	327%	94%
	Earls Court - Acton Town	To	18	6000	18180	698	164%	47%
	Acton Town - Heathrow	To	18	9000	18180	1130	135%	39%
	Heathrow - Acton Town	From	18	4860	18180	594	294%	84%
	Acton Town - Earls Court	From	18	4860	18180	445	334%	95%
	Earls Court - Green Park	From	18	4860	18180	384	380%	108%
	Green Park - Kings Cross	From	18	4860	18180	125	288%	82%
Crossrail	Romford – Stratford [1]	To	2	450	3000	2	0%	0%
	Stratford – Whitechapel	To	2	450	3000	30	49%	15%
	Abbey Wood - Canary Wharf [1]	To	4	1350	6000	34	2%	1%
	Canary Wharf - Whitechapel	To	4	1350	6000	65	74%	22%

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
	Whitechapel - Liverpool Street	To	6	1800	9000	127	66%	20%
	Liverpool Street - Farringdon	To	6	1800	9000	210	78%	23%
	Farringdon - Tottenham Court Road	To	6	1800	9000	410	96%	29%
	Tottenham Court Road - Bond Street	To	6	1800	9000	484	111%	33%
	Bond Street - Paddington	To	6	1800	9000	710	130%	39%
	Paddington - Old Oak Common	To	6	1800	9000	791	93%	28%
	Old Oak Common - Ealing Broadway	To	6	1800	9000	909	161%	48%
	Ealing Broadway - Hayes and Harlington	To	6	1800	9000	1038	177%	53%
	Hayes and Harlington - Heathrow	To	6	1800	9000	1135	68%	20%
	Heathrow - Hayes and Harlington	From	6	1800	9000	678	77%	23%
	Hayes and Harlington - Ealing Broadway	From	6	1800	9000	634	301%	90%
	Ealing Broadway - Old Oak Common	From	6	1800	9000	585	275%	83%
	Old Oak Common - Paddington	From	6	1800	9000	519	146%	44%
	Paddington - Bond Street	From	6	1800	9000	469	224%	67%
	Bond Street - Tottenham Court Road	From	6	1800	9000	318	198%	59%
	Tottenham Court Road - Farringdon	From	6	1800	9000	269	172%	52%
	Farringdon - Liverpool Street	From	6	1800	9000	141	146%	44%
	Liverpool Street - Whitechapel	From	6	1800	9000	85	125%	38%
	Whitechapel - Canary Wharf	From	4	1350	6000	44	144%	43%
	Whitechapel - Stratford	From	2	450	3000	20	94%	28%

Line	Section	Direction	Proposed Capacity			Extended baseline Airport Passengers	Volume Capacity Analysis	
			Train Frequency (per hr)	Hourly Seated Capacity	Hourly Total Capacity		Hourly Seated capacity	Hourly Total capacity
	Canary Wharf - Abbey Wood [1]	From	4	1350	6000	3	0%	0%
	Stratford – Romford [1]	From	2	450	3000	1	0%	0%
WRA	Reading - Maidenhead	To	4	1568	4608	283	18%	6%
	Maidenhead - Slough	To	4	1568	4608	354	23%	8%
	Slough - Heathrow	To	4	1568	4608	432	28%	9%
	Heathrow - Slough	From	4	1568	4608	240	15%	5%
	Slough - Maidenhead	From	4	1568	4608	212	13%	5%
	Maidenhead - Reading	From	4	1568	4608	179	11%	4%
SRA	Waterloo - Clapham Junction	To	4	2000	4000	273	87%	43%
	Clapham junction - Richmond	To	4	2000	4000	399	108%	54%
	Richmond - Staines	To	4	2000	4000	504	92%	46%
	Staines - Heathrow	To	4	2000	4000	656	33%	16%
	Heathrow - Staines	From	4	2000	4000	360	18%	9%
	Staines - Richmond	From	4	2000	4000	300	148%	74%
	Richmond - Clapham junction	From	4	2000	4000	249	188%	94%
	Clapham junction - Waterloo	From	4	2000	4000	178	155%	77%

Table 29 overleaf presents the volume to capacity ratio on the strategic road network.

Table 29 HEX Highway VOC Table

Road name	Section	To Airport			From Airport		
		Background only Scenario	2-runway Scenario	3-runway Scenario	Background only Scenario	2-runway Scenario	3-runway Scenario
M25	J10 and J11	108%	111%	112%	108%	110%	111%
M25	J11 and J12	112%	115%	115%	112%	114%	114%
M25	J12 and LA boundary	100%	108%	110%	100%	104%	106%
M25	J13 and J14	117%	125%	127%	117%	122%	123%
A296	M25 1B and A296	120%	120%	120%	120%	120%	120%
A2	A102 and A2213	112%	112%	112%	112%	112%	112%
M20	J4 and J5	104%	104%	104%	104%	104%	104%
M20	J5 and J6	110%	111%	111%	110%	111%	111%
M1	J6A and 7	102%	105%	105%	102%	104%	105%
M4 Spur	M4 and Airport	17%	87%	105%	17%	63%	75%
M25	J14 and 14A	98%	108%	111%	98%	105%	107%
M25	J14A and 15	112%	121%	123%	112%	118%	120%
M4	J3 and J4	84%	105%	110%	84%	99%	103%
A2	A2260 spur roads and Slip for A227	88%	88%	88%	88%	88%	88%
M25	J3 and J4	94%	94%	94%	94%	94%	94%
M25	J6 and J7	87%	88%	88%	87%	88%	88%
M25	J7 and J8	89%	91%	92%	89%	90%	91%
M25	J8 and J9	88%	90%	91%	88%	89%	90%
M25	J9 and J10	93%	95%	96%	93%	94%	94%
M25	J15 and J16	89%	97%	99%	89%	96%	97%
M25	J17 and J18	84%	89%	91%	84%	89%	90%
M25	J18 and J19	85%	90%	91%	85%	90%	91%
M25	J23 and J24	91%	94%	95%	91%	94%	94%
M25	J25 and LA boundary	90%	92%	93%	90%	92%	93%
M20	J3 and J4	93%	93%	93%	93%	93%	93%
M11	M25 and J7	90%	91%	91%	90%	91%	91%
M40	J1A and J2	91%	95%	96%	91%	94%	95%
M4	J2 and J3	54%	81%	88%	54%	74%	79%
A406	A406 and LA boundary	90%	90%	90%	90%	90%	90%
M4	J4 and J4B	77%	84%	86%	77%	82%	83%
M4	J4B and J8	64%	70%	72%	64%	68%	69%
M1	J13 and J14	91%	92%	93%	91%	92%	93%
M25	J5 and LA boundary	72%	72%	72%	72%	72%	72%

The impact when compared against the Extended Baseline with SRA shows almost no change on the strategic road network.

The Heathrow Express pricing shows little overall impact with respect to meeting **Objective 1** of the Airports Commission with very little increase in sustainable mode use. However, in spreading the demand for of the rail passengers to Heathrow this will have an improvement in meeting **Objective 2** in accommodating the needs of other users. Given the sections where current rail users experience most congestion, on the Piccadilly Line and Crossrail within Central London, are where the proportion of airport demand is at its lowest, the benefits of this would be limited.