Department for Transport

Economic Case for HS2: Updated appraisal of transport user benefits and wider economic benefits

A report to Government by HS2 Ltd

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hs2

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Department for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR
Telephone: 0300 330 3000
Website: www.dft.gov.uk
General email enquiries: FAX9643@dft.gsi.gov.uk

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List of acronyms

BCR	Benefit Cost Ratio
CO_2	Carbon Dioxide
DECC	Department of Energy and Climate Change
ECML	East Coast Main Line
EU ETS	European Union Emissions Trading System
GDP	Gross Domestic Product
LWM	London to West Midlands
MML	Midland Main Line
OBR	Office for Budget Responsibility
PDFH	Passenger Demand Forecasting Handbook
PV	Present Value
PVB	Present Value of Benefits
PVC	Present Value of Costs
QRA	Quantitative Risk Assessment
TfL	Transport for London
TPI	Tender Price Index
WCML	West Coast Main Line
WEI	Wider Economic Impact

Executive summary

1. This document provides an update to the *Economic Case for HS2: The Y Network and London – West Midlands*, published in February 2011 (referred to throughout this document as the "February 2011 Economic Case").[1] It forms part of HS2 Ltd's advice to Government, and presents changes to forecasts of demand and the updated economic appraisal of HS2.

2. The purpose of this document is to revise the February 2011 Economic Case modelling and appraisal to reflect changes to:

   - *economic forecasts* – we have updated our demand forecasts in light of revised economic forecasts;
   - *patterns of demand* – we have updated our modelling to incorporate recent changes in the demand for long distance travel;
   - *Y network development* – we have reviewed costs for the Y network, and separately costs for London to West Midlands, on the basis of further development of Y network station and route options; and
   - *forecast rail services without HS2* – we have updated assumptions on the rail services expected in the absence of HS2, as a result of increased information and the commitment by Government to additional rail enhancement schemes.

3. This update details the resulting implications for the appraisal of the costs and benefits of HS2. It follows the structure of the February 2011 report in presenting the overall economic case for HS2. As with the February 2011 report, we continue to assume that all costs are borne by the public sector and that there are no premium fares or sophisticated yield management on high speed rail.

4. While much of the appraisal of costs and benefits is unchanged from our previous work, we have made some modest adjustments to the presentation of results. In particular, we now use a 2011 price base and discount year. This brings the basis of the appraisal up-to-date, and reflects the fact that our cost estimates utilise the latest evidence from the construction industry.

5. Appraisal results are discussed both in the context of what would be the first phase of HS2, London to West Midlands, and of the wider Y Network, which is the Government's preferred strategy for the development of high speed rail. It should be noted that evidence presented on the Y network reflects the current state of analysis, which is due to be completed with a report to Government in March 2012.

6. There will always be uncertainty when forecasting so far into the future. Hence, in line with good practice, we have undertaken a set of sensitivity tests to explore the impact on the business case

1 See HS2 Ltd, 2011, *Economic Case for HS2 – The Y Network and London – West Midlands*, a report for the Department for Transport, http://highspeedrail.dft.gov.uk/library/documents/economic-case

of different input assumptions. We have, however, adopted a central case. Table 1 provides a summary on that central case, of the change in costs and benefits as a result of the update work, with figures from the February 2011 Economic Case converted to 2011 Present Value (PV) and prices to provide comparison.

7. Overall, we now expect the full Y network to deliver around £47.2 billion to £59.3 billion (2011 PV and prices) in benefits including Wider Economic Impacts. On this basis, the Benefit Cost Ratio (BCR) of HS2, including Wider Economic Impacts (WEIs), would be 1.8 to 2.5. In other words, for every £1 spent by Government, the scheme would deliver £1.80 to £2.50 in benefits. Similarly, the BCR excluding WEIs is 1.6 to 1.9.

8. We continue to develop our economic modelling. An enhanced model will be used for our ongoing work to develop a Y network, due to be reported to Government in March 2012, which will provide significantly greater detail around the accessibility of different station locations. It will also incorporate more information on shorter distance trips on the rail network north of the West Midlands. This will result in a further refinement of the BCR for the full Y network.

Table 1 – **Summary of the update to quantified benefits and costs of HS2 (£ billions 2011 PV/prices) and the resulting Benefit Cost Ratio (BCR)**

	London – West Midlands		Y Network	
	Economic Case February 2011	**Update January 2012**	**Economic Case February 2011**	**Update January 2012**
Capital cost	£20.2bn	£18.8bn	£34.6bn	£36.4bn
Operating costs	£7.0bn	£8.6bn	£15.8bn (£12.3bn – £19.3bn)	£21.7bn
Increase in rail revenue	£15.5bn	£13.9bn	£31.0bn	£31.8bn – £34.0bn
Economic benefits (excluding WEIs)	£18.9bn	£19.0bn	£42.7bn (£41.2bn – £44.2bn)	£41.4bn – £46.9bn
Wider Economic Impacts (WEIs)	£4.7bn	£4.1bn	£7.4bn (£4.7bn – £10.2bn)	£5.7bn – £12.3bn
BCR (including WEIs)	**2**	**1.7**	**2.6 (2.0–3.4)**	**1.8–2.5**

Source: HS2 Ltd
N.B. The numbers in brackets represent a range around the central numbers presented above them.

9. Our latest analysis demonstrates that there is a positive transport case for a high speed rail network, based on a Y configuration connecting London, Birmingham, Manchester and Leeds. A high speed line between London and the West Midlands would form the first stage of that network. As a stand-alone proposition, this still offers a positive transport case on its own terms, with a BCR of 1.7 including WEIs or 1.4 without.

1. Introduction

1.1 Scope and purpose of the document

1.1.1 This is HS2 Ltd's advice to Government and provides an update of the *Economic Case for HS2: The Y Network and London – West Midlands*[2] published in February 2011 for the public consultation on high speed rail. In light of the Transport Business Case[3] model adopted by the Department for Transport (DfT), and as announced in the review of decision making on 27 April 2011, the term 'Economic Case' refers to the assessment of all economic, environmental and social impacts. The February 2011 Economic Case for HS2 is also reflected within the Appraisal of Sustainability documents.[4]

1.1.2 This document addresses changes to forecasts of transport demand and the appraisal of these updated outputs. It covers the assessment of impacts:

- to transport users, including those that use HS2, those affected by changes to classic rail services, and those affected by the knock-on impacts of changes to rail crowding or road congestion levels;
- on the wider economy, including the impacts associated with improved competition and efficiency of firms as a result of better connectivity (so-called WEIs); and
- on costs, including costs to build, maintain and run HS2, and also changes in costs to the classic rail network.

1.1.3 This document includes limited assessment of environmental impacts. The assessment covers local air quality impacts, as a result of road decongestion, and also changes to carbon emissions. The purpose of this document is not, however, to provide a detailed assessment of environmental impacts; this is provided within other advice documents.[5] We present the BCR in line with Transport Analysis Guidance (WebTAG).[6] This is largely consistent with that published in the February 2011 Economic Case, with some minor modifications to the treatment of carbon (see section 3.6).

2 See HS2 Ltd, 2011, *Economic Case for HS2 – The Y Network and London – West Midlands*, a report for the Department for Transport, http://highspeedrail.dft.gov.uk/library/documents/economic-case

3 See Department for Transport, 2011, *Transport Business Case*, http://www.dft.gov.uk/publications/transport-business-case/

4 See Booz & Co (UK) Ltd and Temple Group Ltd, 2011, *HS2 London to the West Midlands Appraisal of Sustainability*, a report for HS2 Ltd and the Department for Transport, http://highspeedrail.dft.gov.uk/library/appraisalsustainability, and HS2 Ltd, 2011, *Review of HS2 London to West Midlands Appraisal of Sustainability*, a report for the Department for Transport

5 HS2 Ltd, 2011, *Review of HS2 London to West Midlands Appraisal of Sustainability*, a report for the Department for Transport

6 Department for Transport, 2011, *Transport Analysis Guidance – WebTAG*, http://www.dft.gov.uk/webtag/

We quote BCRs both with and without WEIs.

1.1.4 This document forms part of the evidence base used to consider consultation responses and to inform the decision-making process. In particular, it contains the results of sensitivity tests that were used to investigate the implications of several issues raised during consultation.

1.1.5 The basis of transport appraisal is to capture the full costs and benefits of an investment. This update covers financial costs, impacts for transport users, and some of the benefits that the scheme would have on the wider economy. We assess the direct impacts that HS2 would have on transport users through, for example, journey time savings and reductions in crowding on trains. We also measure the impacts, both positive and negative, that HS2 would have on the classic rail network. Finally, we look at some of the wider economic impacts on the economy, using DfT guidance to quantify and value these impacts.

1.1.6 Transport investments are very long-lived. Whilst they have significant upfront costs, they deliver benefits over a very long period of time. Some of today's rail network was originally built over 150 years ago, for example, the West Coast Main Line between London and Birmingham opened in 1838, yet still delivers benefits to passengers today. In order to compare costs and benefits occurring at different points in time, our appraisal brings all future year monetary values to a Present Value (PV) in 2011. This is done by adjusting future year values, reflecting the fact that benefits and costs occurring today are valued more highly than those in the future.

1.1.7 The assessment of costs and benefits should cover the full expected period of use of the asset. Transport infrastructure assets, such as tunnels and bridges, often have design lives in excess of 100 years. However, the impacts of uncertainty and discounting increase over time. In line with DfT practice for major capital investments, our appraisal has been carried out over the construction period plus 60 years of operation. This period strikes a balance between design life of the major civil engineering assets and the certainty and significance of the present value of future benefits. Details of the recommended approach to transport appraisal periods are set out in DfT WebTAG.[7]

1.2 What has changed?

1.2.1 We have taken this opportunity to update the modelling and forecasts for transport demand to reflect the:

- significant changes in demand for long distance travel that have occurred between 2007/8 and 2010/11, including the impacts of faster journey times and increased capacity on the West Coast Main Line (WCML);

7 See Section 3.7 Appraisal Period and Discounting in Department for Transport, 2007, *Guidance documents – Expert – TAG unit 3.13: Guidance on Rail Appraisal*, http://www.dft.gov.uk/webtag/documents/expert/unit3.13.php#037

- revision of our forecasts in light of updated economic forecasts and updated evidence on the demand for domestic air travel; and

- enhanced understanding of the Y network to Leeds and Manchester as a result of the ongoing work on station and route development, due to be presented in March 2012, and reviews of costs for both the Y network and London to West Midlands

1.2.2 This document details and describes the implications for the appraisal of costs and benefits of HS2. It follows the structure of the February 2011 Economic Case, setting out our assessment of demand without HS2, the effect on demand of the introduction of HS2, the benefits, costs and economic impacts of HS2, and the overall economic case.

1.2.3 These issues are discussed both in the context of what would be the first phase of HS2 from London to the West Midlands, which is the subject of the current decision, and of the Y network which is the Government's preferred strategy for the development of high speed rail. It should be noted that the latter reflects the current state of development of work, which is due to be completed with a report to Government in March 2012.

2. Updating our assessment of demand without HS2

2.1 Introduction

2.1.1 We have taken the opportunity to update both our assessment of the current demand across all modes and our forecasts of how this will change in the future. Our previous modelling was based on data on travel patterns in 2007/8. Since then there have been significant changes in the pattern of travel demand across the country and across modes. Despite the recent recession, there has been very significant growth in rail demand, while domestic air travel has declined. We have therefore updated this starting point to the latest available data for 2010/11.

2.1.2 In addition, forecasts of the future growth of the economy have been updated since our analysis was published for the consultation. In March 2011, revisions to medium-term Gross Domestic Product (GDP) forecasts were published by the Office for Budget Responsibility (OBR).[8] More significant revisions were subsequently made to long term economic forecasts by the OBR in July 2011[9]. We have therefore taken this opportunity to revise our forecasts of growth in light of this.

2.1.3 Economic forecasts were further revised in November 2011. This was too late to incorporate in our main analysis, however a sensitivity test of the implications of this revision is outlined in section 10. Revisions to economic forecasts of this kind will continue to affect our analysis of the economic case over time, should a decision be taken to proceed with HS2. The sensitivity of the economic case to changes to GDP forecasts is discussed later in this report.

2.2 Updating the base year

2.2.1 There have been significant changes to the pattern of long distance travel across the country and across different modes of travel. On the railways, there has been unprecedented growth in long distance trips despite the recent recession. This growth has been driven by a number of factors including:

- improved yield management techniques by operators and passengers switching to cheaper tickets (e.g. advance purchase tickets); and
- substantial improvements in service levels, particularly as a result of increased capacity from the completion of the WCML upgrades in 2008.

8 Office for Budget Responsibility, 2011, *Economic and Fiscal Outlook March 2011,* http://budgetresponsibility.independent.gov.uk/economic-and-fiscal-outlook-march-2011/

9 Office for Budget Responsibility, 2011, *Fiscal sustainability report – July 2011*, http://budgetresponsibility.independent.gov.uk/fiscal-sustainability-report-july-2011/

2.2.2 The result has been significant growth in long distance rail demand, particularly on the WCML. Indeed one third of the growth previously forecast by HS2 Ltd to occur on the WCML between 2008 and 2043 has been achieved in the last three years. Such rapid growth brings into sharp focus the increasing constraints on capacity on long distance lines. With continuing growth these lines will increasingly become crowded and congested. This also suggests greater benefits from HS2, with more passengers benefiting from the additional capacity and faster journeys delivered by the scheme.

2.2.3 This growth has in part been driven by lower fare yields (lower average fare paid per kilometre travelled), with more passengers switching to lower cost tickets. We would expect that this would tend to reduce revenues in our appraisal of HS2. However, in practice the yield in the update of the model does not fall as much as other measures would suggest.

2.2.4 Following further investigation, we believe that our previous modelling understated the yields on long distance services. As a result, we believe that the February 2011 Economic Case understated the potential revenue (and also therefore underestimated the BCR) that could be generated by the scheme.

2.3 Principles of forecasting

2.3.1 Our overall approach to forecasting remains as set out in the February 2011 Economic Case. While there has been significant recent growth in rail demand, we believe it is prudent to assume that this has been driven by a range of changes to ticket pricing and also by improvements to services, which have all served to encourage more people to travel by rail. We have made the conservative assumption that recent trends do not represent a long term change in the behaviour of passengers; we expect growth rates will return to the linkage with economic activity observed in the past.

2.3.2 For rail forecasts, we have continued to use the same relationships between changes in rail demand and factors such as economic growth. These relationships are set out in WebTAG[10], and are based on the rail industry's Passenger Demand Forecasting Handbook (PDFH). Several consultation responses highlighted that the DfT WebTAG guidance uses older versions of the PDFH, suggesting that this makes a material difference to forecasts. This issue is discussed in more detail in *The Economic Case for HS2: Value for Money Statement*.

2.3.3 The DfT has not incorporated the newer versions of PDFH into its guidance, because some elements are currently being consulted on prior to being validated for use in WebTAG. DfT requires modelling to use the most up to date validated data and we have therefore continued to apply current guidance in our central case. However, sensitivity tests have been conducted

10 See Department for Transport WebTAG Unit 3.15.4, *Rail Passenger Demand Forecasting Methodology,* taking numbers from the *Passenger Demand Forecasting Handbook* section 4.1, http://www.dft.gov.uk/webtag/documents/expert/unit3.15.4.php

to demonstrate the implications of these alternative assumptions on the benefits of HS2.

2.3.4 Rail forecasts have been adjusted to reflect the updated economic forecasts produced by the OBR in July 2011 as have values of time. The impact of the most recent November 2011 OBR forecasts is covered by sensitivity tests as reported in section 10.2.

2.3.5 In the case of demand for air travel, revised forecasts have been published by the DfT, taking account of the latest evidence from aviation markets. We have incorporated these forecasts into our modelling. Our forecasts of car demand remain in line with DfT's latest guidance, although these forecasts are now applied to levels of car demand in 2010/11 that are 2% below those in 2007/08.

2.3.6 For all modes these forecasts provide the overall market for long distance travel unconstrained by changes in service levels or crowding and congestion.

2.4 Future levels of demand and cap years

2.4.1 Over the past 20 years we have seen significant growth in demand for longer distance trips, particularly on rail. National Rail Trends data indicates that rail passenger trips have increased by around 70% over the last 20 years.[11] Currently, there is little evidence to suggest any slow down in rail growth.

2.4.2 Some consultation responses suggested that we should not attempt to forecast demand so far into the future (indeed beyond 10 years) using a so-called elasticity-based approach (where there is a fixed relationship between growth and certain key drivers). We recognise that these approaches can have limitations. However, our current forecasting approach is based on the best available evidence, using PDFH, which provides the most appropriate approach to forecasting demand based on the long-term relationship observed between economic growth and rail demand growth. We have always recognised the risks and uncertainties caused by these forecasts, which is why we conduct sensitivity tests to demonstrate the implications of different rates and levels of future growth.

2.4.3 We recognise that in practice there must come a point where growth in demand will slow or saturate. DfT guidance suggests the use of a cap at 2026.[12] This is not intended to reflect saturation, but is appropriate for relatively small rail investments and ensuring consistent assumptions so that these schemes can be compared. It is less appropriate for long-term planning of major infrastructure investment, such as HS2, which could only begin operation around this time.

2.4.4 We have not, therefore, applied the DfT's recommended cap year of 2026. We have nonetheless implemented a

11 See Office of Rail Regulation, *National Rail Trends*, http://www.rail-reg.gov.uk/server/show/nav.1863

12 See Department for Transport, 2007, *Transport Analysis Guidance (TAG) Unit 3.13.1 Guidance on Rail Appraisal*, http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.13.1.pdf

cap on the level of demand as a proxy for the concept of saturation. In the February 2011 Economic Case the cap demand level, which represented roughly a doubling of 2008 flows on the WCML or an increase of around 0.5 single rail trips over 100 miles (160 km) per person per year, was met in 2043.

2.4.5 We have continued to apply the principle of capping demand at a specific level, rather than at a particular point in time. We have, however, slightly revised the methodology in the light of changes in patterns of demand resulting from the updated base year. Our previous approach, which focused on flows on the WCML, was a useful proxy measure for capping overall demand across the country. However, with much higher growth on the WCML over the past few years, this approach risked producing a biased and misleading assessment; in effect, boosting the case for rail investment along the WCML simply because it was recently upgraded.

2.4.6 We have therefore instead applied the cap at the same overall level of rail demand across the country as a whole. This means that the total number of rail trips over 100 miles in the UK is forecast to increase by 92% to 305,000 single trips per day between 2010/11 and our new cap year of 2037. Some of this growth is due to people making more trips with the number of single rail trips over 100 miles per person per year increasing from 0.8 in 2011 to 1.3 in 2037. The remaining growth is due to the forecast 19% increase in the population of Britain.

2.4.7 While the cap level of rail demand remains the same as before, the recent rapid growth in demand means that we now expect to reach this cap earlier, in 2037. This reflects the fact that, while lower economic growth slows our forecasts of demand growth, we start from a much higher initial level of demand. Should future projections of economic growth increase compared to current projections, the cap would be reached earlier than 2037.

2.4.8 By contrast, air and road travel demand has not grown so quickly in recent times, and as a result our forecasts for air and road demand are lower at the new rail demand cap year. This is additionally compounded by revised forecasts for domestic air travel that are lower than previous estimates. As a result, the total number of trips across all modes is forecast to grow by 21% by 2037; equivalent to 268,500 additional single trips of over 100 miles per day. This compares to our previous demand forecast, which estimated 52% growth in the total number of trips by 2043.

2.5 Rail capacity without HS2

2.5.1 We have updated the assumptions on the services that are likely to run on the classic rail network in the future without HS2 on the basis of improved information, as plans have developed, and also as a result of the commitment to additional rail enhancement schemes by Government. In many

cases, this has increased capacity and improved journey times as investment takes place across the network. Some examples of these changes include:

- incorporation of Evergreen III on the Chiltern lines;
- enhanced capacity and frequency between London and some locations in the North West; and
- faster journey times on routes between London and Milton Keynes.

2.5.2 Many of these changes are due to timetable amendments which have recently been introduced or are planned over the coming years.

3. The proposed high speed rail network: the Y

3.1 Introduction

3.1.1 Work is progressing to develop a detailed proposal for the Y network. In October 2010, the Government announced that its preferred option for high speed rail north of Birmingham was for two separate corridors – one corridor direct to Manchester connecting onto the WCML, and the other to Leeds, via the East Midlands and South Yorkshire, connecting onto the East Coast Main Line (ECML). HS2 Ltd is due to report to Government in March 2012 on these proposals. We have used our latest understanding, from intensive work since the publication of the February 2011 Economic Case, to update our analysis of the costs and benefits of this wider network.

3.1.2 There have been several developments to the work published in February 2011:

- we have incorporated updated information on the likely patterns of demand to refine service patterns on HS2. This has increased capacity to Scotland and expanded services to include Edinburgh in particular. It has also reduced journey times to some locations in line with our latest view on the design of the Y network;
- an indicative specification for changes to classic services and using the capacity freed up – particularly on the East Coast Main Line (ECML), Midland Main Line (MML) and Cross-Country services – has now been incorporated into our modelling, to allow for the analysis of the impacts of released capacity beyond those for the WCML;
- we have updated our assumptions on the location of stations as our detailed work on developing the Y network has progressed. We are finalising our analysis of city centre and parkway stations, ahead of reporting to Government in March 2012;
- initial assumptions have also been made on potential services to Heathrow; and
- cost estimates now reflect our latest views of the likely cost to build, maintain and operate the proposed Y network, as well as changes in costs on the classic network.

3.1.3 We have previously quoted ranges for some impacts, particularly the cost savings and benefits associated with released capacity. These ranges have been removed as an indicative service specification is now included in our modelling. That is not to say there is no uncertainty; further optimisation of services may be possible and we continue to use the model developed for the February 2011 Economic Case. This model has some limitations when assessing released capacity as it does

not consider the potential impacts on shorter distance passengers, for example, commuters on rail lines north of the West Midlands.

3.1.4 This version of the model also has some limitation in its approach to modelling the accessibility of proposed parkway or city centre stations on the Y network outside London and the West Midlands. We have therefore incorporated a range to reflect varying assumptions on the modelling of HS2 stations. At the upper end of the range we have used the same accessibility assumption as used in the February 2011 Economic Case; this models all HS2 stations as having the same accessibility as the nearest city centre location regardless of their actual location, which may overstate the benefits of certain parkway locations. At the lower end of the range some stations are modelled with very restrictive accessibility so passengers can effectively only access by car. This does not reflect a design assumption – we expect all of the stations to have good public transport access – but it does represents a more conservative view of the potential benefits of HS2.

3.1.5 For our ongoing work on the Y network, which we are reporting to Government on in March, we will use an enhanced modelling framework that improves the representation of both released capacity and station accessibility for areas outside London and the West Midlands.

3.1.6 The following sections focus mainly on the upper end of this range as this is more directly comparable with our past work, and therefore allows a clearer explanation of the changes that have occurred since February 2011. Section 5 brings this together to explain the implications of the range for the economic case.

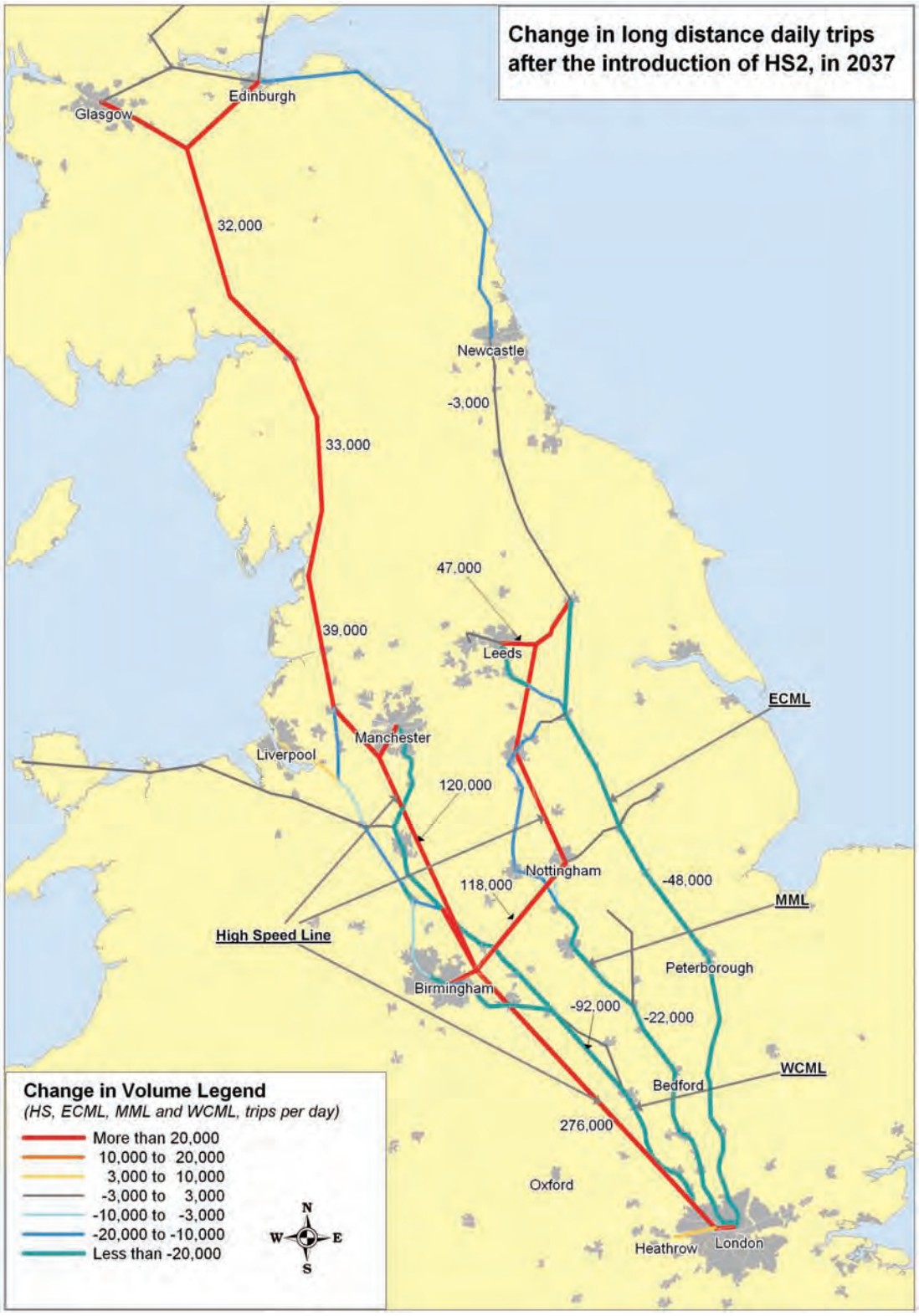
3.2 Demand for long distance travel with the Y network

3.2.1 In the February 2011 Economic Case it was forecast that around 240,000 passengers per day (i.e. total single journeys) would be expected to use the main HS2 line in and out of London in 2043; this is now expected to be some 270,000 passengers per day in 2037. In addition, almost 110,000 passengers are expected to use HS2 for inter-regional (non-London) trips, reflecting the improved connectivity that the Y network offers the regions of the UK.

3.2.2 Overall, demand is higher on HS2 compared to our previous forecasts. This is primarily driven by the expansion of services to Edinburgh and the overall increase in capacity and frequency to Scotland. Overall demand from Scotland to London is over 70% higher than our previous forecasts. This improved set of services increases the benefits and also the operational costs of HS2.

3.2.3 In the February 2011 Economic Case we estimated that around six million trips per year, previously taken by air travel, would be transferred to HS2, as high speed rail became a more viable alternative travel choice from

Figure 1 – **Change in long distance daily trips after introduction of the Y network, in 2037**



Disclaimer: This is a schematic reference for HS2. It does not represent the geographical location of potential HS2 lines.

places like Scotland. The forecast shift in demand from air has now fallen to 4.5 million trips per year, as lower forecast air growth leads to a smaller potential market. This still represents a significant shift, with the market share of rail increasing from 54% to 81% between the whole of Scotland and London, for example.

3.2.4 The proportion of people shifting from car or taking new or more frequent trips is largely unchanged – again reflecting the fact that although these markets are forecast to be marginally smaller, improved rail services encourage a greater degree of modal shift.

Table 2 – **Source of trips of passengers using HS2 services on the Y Network by mode**

Passengers using HS2, 2037 (forecast)	
Switch from classic rail	65%
New trips	24%
Shift from air	3%
Shift from car	8%
Total	**100%**

Source: HS2 Ltd model

3.2.5 A proposal to serve Heathrow will also form part of HS2 Ltd's report to Government in March 2012. In our updated appraisal we have incorporated two trains per hour serving Heathrow – one for each leg of the Y. These services would be used by around 6,500 passengers per day, with 14% accessing Heathrow, and 86% accessing areas of West London and nearby locations such as Reading. We are continuing to investigate ways to optimise these services to maximise the market, and so the benefits for Heathrow services.

3.2.6 In London, we estimate that the number of passengers using Euston station would increase by around 78,300 per day. Many of these passengers would otherwise have used London Kings Cross and St Pancras – the net increase in passengers boarding trains in central London termini is 20,900 or 12%. Just over 60% of these passengers currently use London Underground for accessing these stations, and we would expect this to continue.

3.2.7 It is in the three hour morning peak at which the impacts on London Underground are at their most intense. Across all directions and lines, the number of passengers on London Underground trains at Euston would increase by 3% as a result of HS2, and average loading would increase from 185% to 191%. This is a relatively small increase but would add pressure to an already crowded network. This provides an illustration of the potential scale of impacts on the London Underground, however, our modelling of this network is not as detailed as those designed to look specifically at the London Underground network. We will be working with Transport for London (TfL) to understand fully the implications of this additional demand on the London Underground.

3.3 Transport user impacts

3.3.1 In the February 2011 Economic Case document we set out how we assessed the impacts of HS2 on transport users across the country. The impacts are driven by:

- quicker journeys;
- improved reliability associated with high speed rail;
- reductions in crowding;
- reductions in congestion on the road network; and
- other impacts such as changes in the costs of accessing the rail network, time spent waiting for a train, or the number of times a passenger has to change train on their journey.

3.3.2 The model we use is designed to capture all of these impacts, whether they are positive or negative and whether they are directly related to HS2 or represent other knock-on impacts. The model looks at the change in overall journey not simply the experience on HS2. Therefore, if someone chooses a longer journey to access a HS2 station in order to gain a faster journey time once onboard

Table 3 – **Summary of February 2011 Economic Case results in £ billions 2009 and 2011 PV/prices**

	London – West Midlands		Y Network	
	2009 PV and prices	**2011 PV and prices**	**2009 PV and Prices**	**2011 PV and prices**
Capital cost	£17.8bn	£20.2bn	£30.4bn	£34.6bn
Operating costs	£6.2bn	£7.0bn	£13.9bn *(£10.8–£17.0bn)*	£15.8bn *(£12.3bn–£19.3bn)*
Increase in rail revenue	£13.7bn	£15.5bn	£27.3bn	£31.0bn
Economic benefits (excluding WEIs)	£16.6bn	£18.9bn	£37.6bn *(£36.3–£38.9bn)*	£42.7bn *(£41.2bn–£44.2bn)*
Wider Economic Impacts (WEIs)	£4.1bn	£4.7bn	£6.6bn *(£4.1–£9.0bn)*	£7.4bn *(£4.7bn–£10.2bn)*
BCR (including WEIs)	**2.0**	**2.0**	**2.6 (2.0–3.4)**	**2.6 (2.0–3.4)**

Source: HS2 Ltd
N.B. The numbers in brackets represent a range around the central numbers presented above them.

the HS2 train, we would count the negative cost of the increase in access time together with the benefit of the reduction in journey time. Similarly, if there are any trips disadvantaged, for example, due to changes on the classic network, this would be captured in the model.

3.3.3 A number of consultation responses suggested that we were over-stating the benefits of faster journey times because of the values of time used. They pointed out that, particularly with modern technology, people could work on trains and more generally make use of their travel time. The DfT has reviewed the evidence presented in consultation responses, as well as wider research on the value of travel time savings. Their conclusions are discussed in *The Economic Case for HS2: Value for Money Statement*. We have continued to apply the DfT recommended values of time for the appraisal of HS2. However, a sensitivity test on the value of time is described later in this report.

3.3.4 While much of the appraisal of benefits is unchanged from our previous work, we have made some modest adjustments to the presentation of results. In particular, we now use a 2011 price base and discount year. This brings the basis of the appraisal up-to-date, and reflects the fact that our cost estimates utilise the latest evidence from the construction industry. For reference purposes, we re-report the results from the February 2011 Economic Case on this new basis. Table 3 shows that adjusting the price base year does not change the overall BCR.

3.4 Summary of impacts on transport users

3.4.1 We estimate the total benefits of the Y network to be around £41.4 billion to £46.9 billion (2011 PV and prices) and net revenues of £31.8 billion to £34.0 billion (2011 PV and prices). Overall this represents an increase in benefits compared to the February 2011 Economic Case, which applied the same assumptions on accessibility as the upper bound. This is almost entirely driven by changes in service patterns. Without these the benefits and revenues would be lower, reflecting the slower forecast growth in GDP and enhanced capacity of the rail network without HS2. Both of these reduce the benefits offered by HS2, and the attractiveness of the scheme to new passengers who drive revenue growth.

3.4.2 On a like for like basis, the reduction in benefits as a result of these factors is more than offset by slightly faster journey times and the enhanced services to Scotland.

3.4.3 Table 4 breaks down the lower bound estimate of benefits according to who benefits and why. This table excludes noise, air quality, accidents and the HS1 link and loss of indirect tax. The main driver of benefits is journey time savings, worth £24.5 billion, followed by reliability and reduced crowding which deliver £5.2 billion and £6.7 billion respectively. As before, it is business passengers who benefit most

Table 4 – **Breakdown of benefits for lower bound estimate of the Y Network (£ millions 2011 PV/Prices)**

Benefit	Business	Other	Total
Journey Time Saving	18,700	5,800	24,500
Improved Reliability	4,100	1,100	5,200
Reduced Crowding	1,800	4,900	6,700
Other Rail User Impacts	2,900	2,600	5,500
Other Impacts	1,200	900	2,100
Total Benefits	28,800	15,300	44,100

Source: HS2 Ltd

from HS2, enjoying savings equivalent to £28.8 billion to £32.3 billion, which is around 70% of the total user benefits of HS2.

3.5 Regional impacts and Wider Economic Impacts

3.5.1 A high speed rail network would generate benefits across much of the UK. These benefits extend beyond areas directly served by HS2, as people use the road and classic rail network to access high speed stations. Additional benefits would come from the extra capacity HS2 provides and the opportunity to reuse the capacity freed up on the WCML, ECML and MML.

3.5.2 It is difficult to analyse exactly where, geographically, the benefits of HS2 would accrue. Our modelling tells us where trips start and finish, but does not tell us exactly where the benefits would fall. For example, we can identify business people travelling from Manchester for meetings in London, but whether it is the Manchester business person who benefits or the London based firm or client they are meeting, is harder to identify.

3.5.3 Table 5 shows the proportion of monetised benefits to those taking long distance trips according to where they start their journey. Looking at the benefits according to where a trip finishes would give a similar pattern of benefits. Whilst trips from London deliver the biggest proportion of benefits, there are also large benefits for trips starting in the East Midlands, West Midlands, North West, North East and Scotland. £8.3 billion to £10.3 billion of benefits accrue to trips outside London and the South East demonstrating the significant level of potential benefits resulting from improved connectivity between the wider UK regions and their cities.

3.5.4 The impacts on transport users are not, however, the sole source of benefits to HS2. Improvements to the transport network can lead to greater efficiency in the economy through improved linkages between firms, and

Table 5 – **Monetised benefits to long distance passengers by origin of trip on the Y network (£ million, 2011 PV/prices)**

Regional User Benefits	Business	Other	Total
London	22%	11%	33%
South East	4%	2%	5%
West Midlands	9%	6%	14%
North West	10%	6%	16%
East Midlands	5%	3%	7%
Yorkshire and Humber	6%	4%	10%
North East	2%	1%	3%
Scotland	4%	2%	6%
Other	3%	1%	4%
Total	**65%**	**35%**	**100%**

Source: HS2 Ltd

between firms and their workers. There may also be significant local effects; for instance, a new station can act as a magnet for economic activity and drive regeneration in deprived areas.

3.5.5 These impacts are harder to quantify and value, and so we have tended to present them separately. The DfT has released guidance,[13] which remains in draft, to help value some of these benefits. The impacts covered are:

- *agglomeration impacts – a* transport scheme, such as HS2, can improve links between firms. When links between these firms are improved, this would lead to a greater clustering of firms, i.e. more related businesses would be closer together. This phenomenon of clustering of similar firms could support enhanced knowledge-sharing, a greater specialisation of staff resources, and enhanced competition between suppliers. Such productivity benefits to business are supportive of the wider economy of a particular area;
- *labour market impacts* – these are mainly benefits whereby shorter or cheaper journeys encourage more people into the labour force (due to a similar effect to an increase in wages), or encourage those who already have jobs to work longer hours because their commute or journey to a meeting takes less time. A second benefit in this category is where people move to more productive jobs because they are able to travel to them more

13 Department for Transport, 2009, *Guidance documents – Expert TAG Unit 3.5: The Economy Objective*, unit 3.5.14C The Wider Impacts Sub-Objective – for consultation, http://www.dft.gov.uk/webtag/documents/expert/unit3.5.14c.php

easily. Both of these effects would boost the level of productivity in the economy; we have, however, only been able to quantify the first type of labour market impact; and

- *imperfect competition* – the standard transport appraisal approach calculates the benefits arising from a reduction in transport costs to a firm. In many cases, however, the cost of production does not exactly match the value to the consumer of the product or service produced so the value of cost reductions is likely to be greater than the simple reduction in transport cost. This category of benefits is referred to by DfT as "imperfect competition" and measures this additional value, over and above the cost savings to business.

3.5.6 In the February 2011 Economic Case we estimated these WEIs for the Y network, by extrapolating from the development of phase one London to West Midlands and taking a cautious view of the potential additional benefits. This suggested WEIs would be between £4.7 billion and £10.2 billion (2011 PV and prices). We have now applied DfT's draft guidance on calculating WEIs to the modelling of the Y network. This suggests that WEIs could add some £12 billion (2011 PV and prices) to the benefits of HS2 (around 20% of the total benefits). Almost 75% percent of this is due to agglomeration benefits, with the remainder mainly the result of increased output of imperfectly competitive markets.

3.5.7 In theory, this should represent a conservative estimate of WEIs, since the model does not yet fully reflect the impact of changes in released capacity for local passengers. However, we believe that further investigation of this result is needed to ensure the benefits are justified and not driven by particular assumptions in the draft guidance. In the meantime we have taken a more conservative approach and have not adjusted our estimates of WEIs from those published at the consultation stage. We have therefore used a range, with the lower end of the range assuming no additional agglomeration benefits over and above those offered by the first phase between London and the West Midlands. The £12 billion figure provides an upper bound in our range.

3.5.8 The WEIs guidance is carefully designed to measure national impacts. However, at a regional and local level the effects of HS2 on the distribution of activity could also be very significant.

3.5.9 As we reported during consultation, we have given consideration to the impacts of changes in geographic patterns of economic activity at local and regional levels that might result from HS2, but at a qualitative level only. This work shows that there are many reasons for the success or failure of individual high speed rail stations – often specific to the local circumstances. However, there are some consistent messages in this literature:

- *integration is key* – simply building a station or link to a high speed

network is not enough. For success to be achieved, the station has to be integrated into the wider strategic plans of local agencies, especially integration with the local transport network. There are many factors which are important in regeneration beyond transport alone. It is not surprising therefore that wider strategies on land use planning, and even education and skills, are needed to integrate a station successfully into the local and regional economy;

- *role as a hub* – there are examples of success where a high speed rail station also has hub-like connectivity, with good links to the local or regional rail network as well as the high speed network. Thus the station becomes a focus for the regional economy as well as a wider market supported by high speed;

- *regional impact* – although there are many examples where growth and regeneration has been delivered around a high speed rail station, there may be balancing effects across the wider area. However, the circumstances in which, and extent to which, this happens is not clear; and

- for high speed rail to deliver these benefits there needs to be clear and strongly-led spatial and economic planning.

3.5.10 These local impacts are considered more fully in *the Review of HS2 London to West Midlands Appraisal of Sustainability* report.

3.6 Other impacts of HS2

3.6.1 The February 2011 Economic Case did not discuss wider environmental and social impacts, although some were included in the BCR. This reflected the fact that these issues were included in more detail in our other advice.[14] However, WebTAG suggests that some of these impacts should be included within the monetised impacts and also reported in the BCR. We therefore cover these issues below.

Carbon impacts

3.6.2 There remains a significant degree of uncertainty on the impact of HS2 on the actual carbon emissions of transport in the UK. This is described and assessed in the February 2011 Appraisal of Sustainability. However, there is greater clarity on the way to monetise the impacts, of potential changes to carbon emissions as a result of HS2, and include them within the BCR:

- the cost of carbon emissions from electricity consumed by HS2 trains (and changes in the classic rail network) is included in our operating costs. The electricity generation sector is in the EU Emissions Trading System (EU ETS), and therefore has to pay for any carbon emitted (which is then reflected in

14 See Booz & Co (UK) Ltd and Temple Group Ltd, 2011, *HS2 London to the West Midlands Appraisal of Sustainability*, a report for HS2 Ltd and the Department for Transport, http://highspeedrail.dft.gov.uk/library/appraisalsustainability, and HS2 Ltd, 2011, *Review of HS2 London to West Midlands Appraisal of Sustainability*, a report for the Department for Transport

energy prices). We have applied guidance consistent with both WebTAG and the cross-Government Inter-departmental Analyst Group[15] to ensure this cost is reflected in our electricity costs;

- the cost of carbon in air transport is also reflected in the fares paid by passengers (since the aviation sector will also be in the EU ETS from 2012). As a result, a cost or benefit associated with changes to aviation emissions is captured through the transport user benefits of passengers who choose to switch from air to HS2; and

- the costs and benefits of changes in car emissions are not, however, reflected in the prices paid since this sector is not within the EU ETS. We estimate that HS2 would lead to a reduction of 850 million to 950 million vehicle km per year and a reduction in emissions of 3.9 to 4.9 $MtCO_2$. This gives a benefit of around £190 million to £240 million (2011 PV and prices).

3.6.3 All of these impacts are now captured in the BCR reported in section 5.

Road externalities

3.6.4 The reduction in road travel, as a result of HS2, would also have small knock-on environmental and social impacts. Fewer car trips would help to improve local air quality in some areas, and would also reduce road noise and road accidents. We use WebTAG guidance[16] to value these impacts, leading to benefits of £490 million to £550 million (2011 PV and prices). These have been incorporated in the "other quantifiable benefits" in past documentation and in section 5.

15 Department of Energy and Climate Change, *IAG guidance for policy appraisal*, http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

16 See Department for Transport, 2011, *Guidance documents – Expert TAG Unit 3.3.3C: The Local Air Quality Sub-Objective – for consultation*, http://www.dft.gov.uk/webtag/documents/expert/unit3.3.3c.php and Department for Transport, 2011, *The Accidents Sub-Objective TAG Unit 3.4.1,* http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.4.1.pdf

4. Costs for the 'Y' network

4.1 Introduction

4.1.1 We have described the demand for high speed rail and the benefits that it would bring. The economic case also depends on the costs of both the construction and operation of the railway. Costs for the Y network are presented in this section at Q2 2011 prices; they have been developed based on prices at that point in time. The costs are then converted into 2011 PV for comparison to benefits (which are also at 2011 PV) in the appraisal.

4.1.2 As with any major infrastructure project, HS2 would come with a high capital cost, although this would be offset, to some extent, by revenues from passengers over time. If the scheme progresses, a key aim would be to reduce the planned costs of the project in order to increase its value for money.

4.1.3 The components of the estimated cost of HS2 are:

- capital construction cost – the cost of land purchases, design, materials, construction (including labour and power), allowance for risk and an allowance for "optimism bias"[17] in line with HM Treasury guidance[18];
- rolling stock capital costs – the purchase costs of rolling stock (trains) plus an allowance for optimism bias; and
- operating costs – the operation and maintenance of the railway including train crew and station staff, the maintenance of the rolling stock including depots and two years of testing the railway before it opens, again with optimism bias.

4.1.4 We have updated our cost estimates to reflect the latest scheme design, review of costs and our enhanced knowledge on the design of the Y network. Through our work on the full Y network, we have continued to develop the HS2 approach to cost estimation. During September and October 2011, the Department for Transport undertook a cost challenge process on our London to West Midlands cost estimates. Finally, as a result of the consultation exercise held during 2011, the scope of the HS2

17 Optimism bias is the the tendency of project planners to be optimistic about the costs. HM Treasury guidance states that when planning Government funded projects, an allowance to compensate for this tendency must be included. This is referred to as an "allowance for optimism bias".

18 HM Treasury, *Optimism Bias*, http://www.hm-treasury.gov.uk/green_book_guidance_optimism_bias.htm

London to West Midlands route has been further amended.

4.2 Capital construction costs

4.2.1 HS2's cost and risk consultant, Davis Langdon, has updated and extended the HS2 set of base rates drawing on the extensive Davis Langdon cost database, which is used annually to produce the industry standard *Spon's Civil Engineering and Highway Works Price Book*. Where appropriate these rates have been adjusted to remove any inherent out-turn cost effects within the as-built rates which are accounted for elsewhere within the HS2 cost model. In some specific cases, adjustments of between 7.5% and 12% have also been made to compensate for the fact that a significant amount of urban benchmarking information was used to establish the original rates. In the case of HS2, large parts of the route would be "green field" construction. Prices have been updated to Q2 2011 levels using the current Tender Price Index (TPI). The updated rates (with updated TPI) increase estimated base construction costs by around 2%.

4.2.2 A further review has been undertaken of contractor overheads, design and client-related costs. We considered the application of contractor and design costs at the asset type level, recognising that different assets require different levels of effort and that some of the proposed station locations have a higher level of complexity and staging than others.

4.2.3 An early assessment has also been made to consider a bottom-up approach to costing design and client costs by considering the level of resource required to design and deliver the project as a whole. This approach should provide a more appropriate cost for the HS2 project recognising the scale of work required but also some of the efficiencies that are achievable in terms of overheads etc. In overall terms, the efficiencies arising from this work reduce the overall costs of the project by just under 5%.

4.2.4 As a result of the recent DfT cost challenge process, a number of adjustments have been made to our London to West Midlands estimate. Additional provisions have been made for Euston London Underground works (+£100 million), London to West Midlands depot facilities (+£100 million) and additional risk for train operating company compensation charges (+£130 million). We have further calibrated our allowances for Statutory Charges and reduced the London to West Midlands provision to £70 million (from £200 million) through calibration with Crossrail experiences. Provisions have also been made for relocation of Heathrow Express and Intercity Express Programme depots in the Old Oak Common area.

4.2.5 Through the work we have been undertaking on the full Y concept of operations, we have identified some emerging operational requirements within the West Midlands area. At this stage we have made a provision of £225 million within our London to West Midlands estimate to cater for this.

4.2.6 Cost summaries are shown below for the full Y network post implementation of phase two West Midlands to Manchester and Leeds. These include the cost of phase one, which are based on the London – West Midlands route as amended post-consultation. Further details of these costs can be found in section 7. In order to derive costs for phase two (the construction of the full Y network including extensions to Manchester and Leeds) we have used data available from an interim milestone in our work for routes to Manchester and Leeds. The phase two work will conclude with our report to Government due at the end of March 2012. At this point, cost estimates will be updated as needed, to align with the proposals put forward to Government.

4.2.7 Our current estimate for the cost of the full Y network is around £32.7 billion (at Q2 2011 prices), including full optimism bias. We will be developing a cost range in the next few months. The approximate allocation between the components that make up the total for the full Y network, including the costs of phase one, are shown below.

Table 6 – **Capital cost estimates for the full Y Network; £ millions Q2 2011 prices (rounded to nearest £5m)**

Item	£ millions	Includes
Rail systems	1,485	Track, ballast, fencing, drainage, junctions
Control systems	440	Signalling control and telecommunications
Traction power systems	515	Overhead line equipment and power supply
Stations	2,490	LWM stations, plus two terminal stations and three interchange stations
Civil works	2,115	Earthworks, retaining walls and roads
Structures	2,360	Bridges and viaducts
Tunnels	2,275	Twin and single bore tunnels
Utilities	300	Relocation of utilities e.g. water, power
Additional items	470	People mover and rail reconstruction work
Contractor administration costs	1,690	Preparatory work, site supervision, testing, training, spare equipment.
Total Construction Cost	**14,140**	**Excluding risk**
Environmental mitigation	465	Additional environmental mitigation
Land costs/compensation	1,490	LWM estimate plus extrapolation beyond LWM
Depot facilities	900	As LWM, plus two light maintenance rolling stock depots and two infrastructure maintenance depots

Item	£ millions	Includes
Provisional sum	320	Allowance for emerging requirements from concept of operations work
Project overheads	830	Client and project management costs
Design	1,215	All design costs and topographical/ground investigation surveys
Existing rail interface costs	205	Possession management, Compensation for operational disruption
Statutory charges	210	Consultation and planning consent related costs
Construction risk	2,215	Route section and route-wide construction risks from the Quantified Risk Analysis (LWM only)
Additional scheme risk provision	10,680	Provision for external risks in line with HM Treasury Supplementary Green Book Guidance
Estimated Total Cost for the full Y network	**32,670**	**At Q2 2011 prices**

Source: HS2 Ltd

4.3 Risk and our approach to calculating this

4.3.1 The costs for phase one, London – West Midlands, are currently developed to a higher level of detail than the cost of the rest of the Y network. Phase one costs include a full Quantitative Risk Assessment (QRA), which has meant we have refined the application of optimism bias to this stage of the scheme. Total allowance for risk and optimism bias for phase one is equivalent to an additional 64% of infrastructure costs. A quantitative risk analysis has not been undertaken yet for our work on routes to Manchester and Leeds, so the full 66% optimism bias has been applied to phase two costs in line with HM Treasury guidance.

4.4 Rolling stock capital costs

4.4.1 The enhanced level of services, which have been included in the Y network, mean that we require more rolling stock to operate the network than we had previously estimated. We have also included provision for 260m trains, reflecting further consideration of the possible composition of the fleet in the longer term. As a result, we estimate the costs of rolling stock for the full Y network would be just over £8 billion including risk and optimism bias.

Table 7 – **Rolling stock capital cost estimates for the full Y network (includes stock required for phase one operation); £ millions Q2 2011 prices**

Item	£ millions
Captive fleet (105 x 200m sets) base cost	2,785
Classic-compatible fleet (68 x 200m sets) base cost	2,705
Classic-compatible fleet (15 x 260m sets) base cost	775
Total base cost at Q2 2011 prices	**6,260**
Captive fleet (105 x 200m sets) risk at 18%	500
Classic-compatible fleet (68 x 200m sets) risk at 40%	1,080
Classic-compatible fleet (15 x 260m sets) risk at 40%	310
Total risk provision at Q2 2011 prices	**1,890**

Source: HS2 Ltd

4.4.2 Should the project proceed, we would undertake further work regarding assumptions on rolling stock costs during 2012. Consideration of the scale of the total fleet for the Y, and the associated procurement and phasing strategies, should enable more cost-effective solutions than the values estimated currently.

4.5 Operating costs

4.5.1 We have reviewed and challenged our operating cost estimates, particularly in the light of a review that looked across the operating costs of both HS2 and the Strategic Alternatives considered by DfT. As a result we have updated and added new costs to our calculations:

- staff salaries and efficiency have been adjusted in line with the latest evidence of classic line costs from the Strategic Alternatives;
- we now include a variable cost element for HS2 services operating on the classic network to reflect the principle that more intensively used railways require more maintenance. We had previously assumed that the costs of maintaining classic lines were fixed costs which would be paid regardless of changes as a result of HS2; and
- we have also included additional HS2 train crew costs. We had previously allowed for the costs of HS2 drivers and conductors. We assumed that catering and any other service staff would be a commercial decision for an operator – therefore additional revenues would offset such staff costs. However, it is possible that some of the revenue generated is actually implicit in fare yields used in modelling. We have therefore included an additional allowance to reflect the possible costs of increased staffing.

4.5.2 Using the latest service specification – which has additional trains running on the Y network – the above changes have added around £2.9 billion (PV, 2011 PV and prices) to the costs of operating and maintaining the rail network. Most of this is associated with increased costs for train crew.

Table 8 – **Operating costs for the full HS2 Y network by category (2011 PV/prices)**

Operating cost type	£ millions (PV)
HS2 infrastructure operations and maintenance	1,900
Rolling stock maintenance	6,600
Rolling stock traction power	6,100
Train crew	3,900
Station costs	500
Other HS2 operating costs	1,200
Classic line cost saving from released capacity	-5,100
Additional provision for optimism bias	6,500
Total	**21,700**

Source: HS2 Ltd

4.5.3 The enhanced service pattern also imposes further costs of around £1.3 billion (PV, 2011 PV and prices) for rolling stock maintenance. Enhanced services and minor changes to the unit costs (such as energy prices) lead to small changes in other categories – and a cost reduction of almost £400 million (PV, 2011 PV and prices) overall. Taking all of these changes into account, and adding 41% optimism bias means that our cost estimates for the Y network have increased by just under £6 billion.

5. Benefits, costs and economic impacts for the Y network

5.1.1 We have updated our assessment of the costs and benefits of the Y network, drawing on the latest evidence on demand for long distance travel and the latest economic and other forecasts. Critical to this is lower economic growth reducing values of time and the associated benefits. Whilst there has been a substantial increase in the overall demand for long distance rail travel, the forecasts for air and car demand are substantially lower, leading to lower mode shift and lower revenues to offset the cost of the scheme. The faster services to Milton Keynes, and the increased capacity between London and the North West, that are now planned without HS2, all act as a downward pressure on benefits and incremental revenues.

5.1.2 Against this, the work we have done on the Y network since February 2011 has allowed us to take a better, although still indicative, view of what services might be improved. We have enhanced the service levels on HS2, improving benefits and revenues, and we have modelled, for the first time, an

Table 9 – **HS2 Y Network quantified costs and benefits (£ billions) of HS2 (2011 PV/prices) and resulting BCR**

1	Transport User Benefits	Business	£28.8bn – £32.3bn
		Other	£15.3bn – £17.4bn
2	Other quantifiable benefits		£1.0bn – £1.1bn
3	Loss to Government of Indirect Taxes		-£3.6bn – -£3.9bn
4	**Net Transport Benefits (PVB) = (1) + (2) + (3)**		**£41.4bn – £46.9bn**
5	Wider Economic Impacts (WEIs)		£5.7bn – £12.3bn
6	**Net Benefits including WEIs = (4) + (5)**		**£47.2bn – £59.3bn**
7	Capital Costs		£36.4bn
8	Operating Costs		£21.7bn
9	**Total Costs = (7) + (8)**		**£58.1bn**
10	Revenues		£31.8bn – £34.0bn
11	**Net Costs to Government (PVC) = (9) – (10)**		**£26.3bn – £24.1bn**
12	BCR without WEIs (ratio) = (4)/(11)		1.6 – 1.9
13	**BCR with WEIs (ratio) = (6)/(11)**		**1.8 – 2.5**

Source: HS2 Ltd

initial view of the potential impacts on the classic network and opportunities to re-use released capacity, where previously we used extrapolated results from our London to West Midlands analysis.

5.1.3 The delivery of this enhanced service pattern increases costs. However, the enhanced service also provides opportunities as it has the potential to deliver more released capacity on the classic network as well as further cost savings. These changes, together with improvements to our cost estimates, have meant the estimated cost of constructing, maintaining and operating the network has increased by around £7.8 billion (2011 PV and prices).

5.1.4 Overall, we now expect the full Y network to deliver £41.4 billion to £46.9 billion (2011 PV and prices) in benefits (excluding WEIs), an increase of £0.3 billion to £2.8 billion. Business and other transport users would see the bulk of this (£28.8 billion to £32.3 billion and £15.3 billion to £17.4 billion respectively).

5.1.5 DfT considers the value for money of a scheme in terms of the value of benefits per pound of Government spending. The cost of the scheme is not the same value as total Government spending on the project; since HS2 would increase revenues on the rail network, by £31.8 billion to £34.0 billion (item 10), which would partially offset the overall cost of the scheme. The net cost to Government would therefore be £24.1 billion to £26.3 billion (item 11) which is outweighted by the benefits of £47.2 billion to £59.3 billion.

5.1.6 The BCR is the net benefit divided by the net cost to Government. On this basis the BCR of HS2, including WEIs, would be 1.8 to 2.5. In other words, for every £1 spent by Government, the scheme would deliver up to £2.50 in benefits. Similarly, the BCR excluding WEIs is 1.6 to 1.9.

5.1.7 We continue to develop our modelling to address these issues. An enhanced model will be used for our analysis, to be submitted to Government in March 2012, which will provide significantly greater detail around the accessibility of different station locations, as well as incorporating more information on shorter distance trips on the rail network north of the West Midlands, important for the assessment of released capacity.

6. The case for HS2 London to West Midlands

6.1 Passenger demand for HS2 (London – West Midlands)

6.1.1 Our updated modelling forecasts a similar number of passengers using HS2 to those we had forecast in the analysis published in February 2011. Around 148,000 passengers would use HS2 each day on the section between Birmingham Interchange and Old Oak Common. However, the composition of these passengers has changed slightly, with reduction in mode shift as a result of the lower potential market from air and road which has largely been offset by a higher number of new trips. There is also higher diversion of existing rail passengers, reflecting higher demand on the WCML without HS2.

6.1.2 The maps in Figure 2 and Figure 3 show the implications of these changes in demand, and the choices of passengers on the rail network. Figure 2 shows the change in long distance passenger flows on HS2 trains and the WCML. Figure 3 shows the percentage of seats occupied on average across the whole day (load factor) on these long distance trains. North of Birmingham, the demand for WCML and HS2 is combined – as both would use the same tracks. Here we see significant increases in passenger flows along the WCML.

6.1.3 As we forecast previously, there would also be a significant net increase in long distance passengers using the WCML and HS2 south of Birmingham. Overall, the number of passengers on this section of the route would increase by more than 24,300 per day by 2037. HS2 services south of Birmingham, including "classic compatible" services, would be well used with an average percentage loading factor of 64% of seats filled (average of trains travelling in both directions). As this is an average figure across the day, this means that during peak periods almost all of the seats would be filled.

6.1.4 The pattern of where people travel to and from is also similar, and station usage is comparable to our previous forecasts. In Birmingham, 59,000 passengers would use HS2 stations; around 60% would use Birmingham Curzon Street Station with the remainder using Birmingham Interchange Station. In London, around 69,200 passengers would use Old Oak Common Station each day and 152,500 passengers would use Euston Station.

6.1.5 We have not attempted to update the modelling of the potential international demand via the HS1 link. Our modelling is based on well-established relationships between the relative market shares of rail and air compared to rail journey times. We estimated in the February 2011 Economic Case

Figure 2 – **Change in long distance daily trips after the introduction of HS2 (London – West Midlands), in 2037**

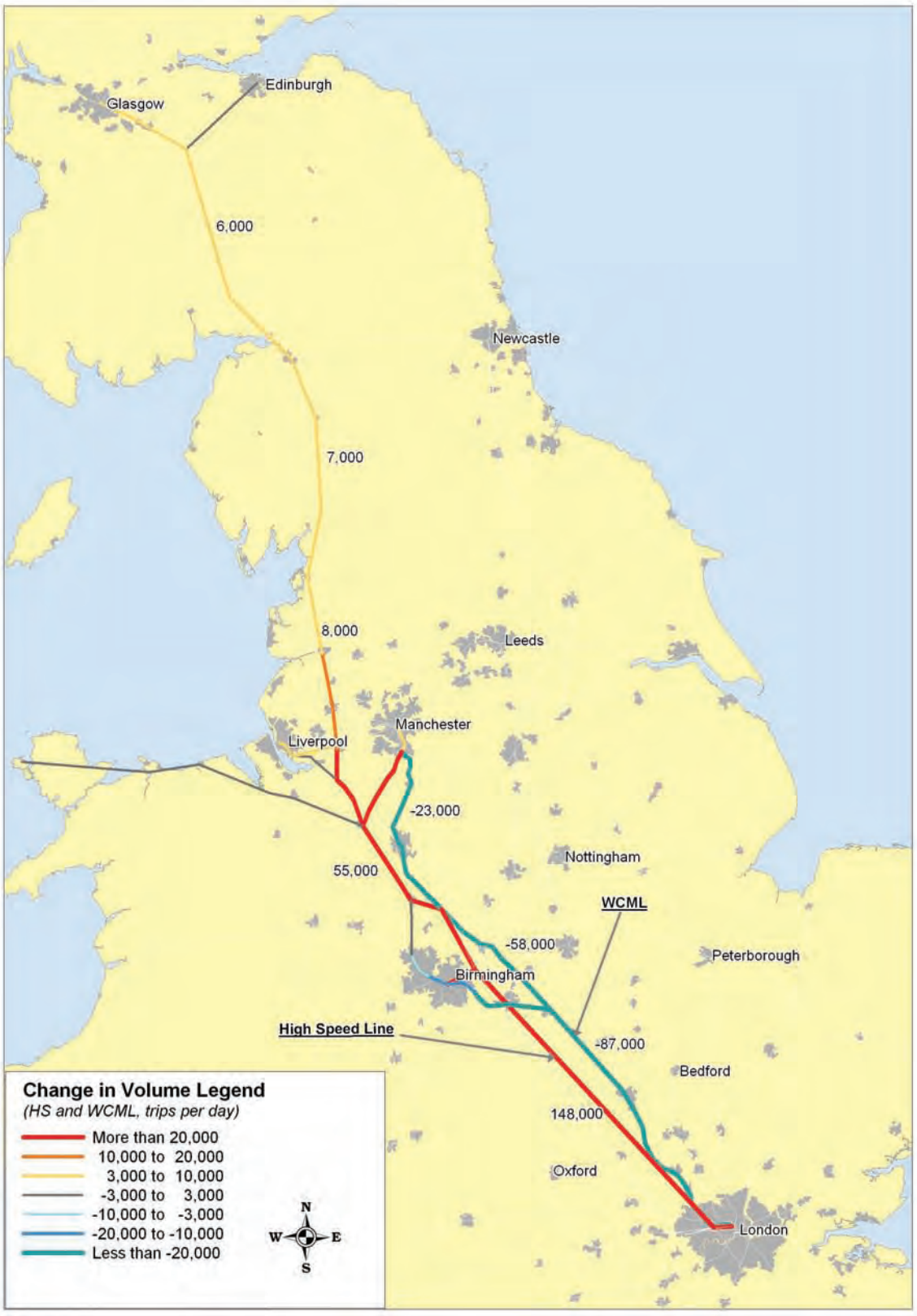


Figure 3 – **Forecast daily load factors on long distance services after the introduction of HS2 (London – West Midlands), in 2037**

that the link could deliver benefits of around £350 million (2009 PV and prices), assuming international services started from Old Oak Common. Updating this to reflect 2011 PV and prices, as well as the lower values of time (from lower economic growth), would reduce the benefits, but would remain approximately £350 million at 2011 PV and prices.

6.1.6 This does not currently reflect a range of potential further benefits from this link. In particular, it does not measure the benefits to markets in the west of London and the Heathrow area. It also assumes there is no scope for running international and domestic passengers on the same train, and takes no account of the potential benefits of cross-London connectivity for domestic passengers (e.g. Kent to Heathrow). HS2 Ltd's previous analysis, *International Connections*[19], remains the best available evidence on the potential impacts of a HS1 link.

6.2 Transport user impacts

6.2.1 The total benefits to transport users over the course of the 60 year appraisal period, separated by type of benefit and the type of passenger, are set out in Table 10 below.

6.2.2 Overall, transport user benefits have increased slightly to £20.1 billion. This reflects the substantial increase in demand that has been seen on the WCML in the past few years. As a result, flows in 2037 are somewhat higher than we previously forecast, despite the adjusted approach to capping demand. This means that for HS2 London to West Midlands there are more rail passengers who gain the benefits of HS2, which more than off-sets the impacts of lower economic growth and values of time.

6.2.3 Net rail revenues are now forecast to increase by £13.9 billion, slightly lower than our previous forecasts. The reduction is driven by a smaller air

Table 10 – **Benefits to transport users, by business passengers and other passengers for London – West Midlands (£ million, 2011 PV/prices)**

Benefit	Business	Other	Total
Journey Time Saving	7,400	2,600	**10,000**
Improved Reliability	2,200	1,000	**3,200**
Reduced Crowding	700	2,100	**2,900**
Other Rail User Impacts	1,500	1,700	**3,200**
Other Impacts	400	400	**800**
Total Benefits	**12,300**	**7,800**	**20,100**

Source: HS2 Ltd

19 Atkins Ltd, 2011, *International Connections – A report for HS2 Ltd*, http://www.hs2.org.uk/assets/x/77823

market leading to around 57% fewer people shifting from air than in our previous forecasts.

6.2.4 While the majority of users of HS2 would be leisure passengers, around two thirds of the quantified benefits would be to business users. This largely reflects the high value that business users and their employers attach to faster journeys.

6.2.5 The impacts in Table 10 are not limited to passengers on HS2. Our indicative service pattern includes changes to the use of capacity on the classic network. Passengers switching to HS2 would reduce crowding levels for other passengers on the WCML, and capacity freed up by HS2 could be used to increase local, fast commuter and regional services.

6.2.6 While the majority of transport users would benefit from the introduction of HS2, a small number of passengers would experience longer journey times or less frequent services.

6.3 Regional benefits and Wider Economic Impacts

6.3.1 Table 11 shows the distribution of benefits according to where a trip starts. As with the results published in February 2011, it shows that London generates the largest proportion of benefits according to trip origin. This is not surprising given the majority of demand on HS2 London to West Midlands is between London and the major regional centres. These results are broadly in line with the previous analysis in the February 2011 Economic Case.

Table 11 – **Monetised benefits to long distance passengers by origin of trip, London – West Midlands**

Regional User Benefits	Business	Other	Total
London	24%	14%	38%
South East	3%	2%	5%
West Midlands	14%	9%	23%
North West	16%	10%	25%
East Midlands	1%	1%	1%
Yorkshire and Humber	0%	0%	0%
North East	0%	0%	0%
Scotland	1%	1%	3%
Other	2%	2%	4%
Total	**62%**	**38%**	**100%**

Source: HS2 Ltd

6.3.2 We have applied DfT's draft guidance on WEIs. We now estimate WEIs will be around £4.1 billion (2011 PV and prices), which is slightly lower than previous estimates. This reduction reflects both the reductions in economic growth forecasts and also the fact that the improved commuter services on the WCML reduce the potential benefits of HS2 to shorter distance passengers. It is these shorter distance trips which drive the agglomeration benefits of HS2 London-West Midlands. These estimates are mainly driven by benefits in London and the concerns identified in our estimates for the Y network do not apply to this estimate.

6.4 Other impacts of HS2

6.4.1 As with our work on the Y network, we have incorporated further impacts of carbon benefits from road travel, impacts on air quality and reduced risk of accidents as a result of fewer car trips, into the BCR.

6.4.2 We estimate that HS2 London to West Midlands would reduce road travel by around 303 million vehicle km per year. This would lead to a reduction in carbon emissions worth just under £100 million (2011 PV and prices) and improved air quality, reduced accidents, and a reduction in roadside noise of around £210m (2011 PV and prices). The valuation of noise impacts from HS2 trains is a reduction of £50 million (2011 PV and prices).

7. Costs for London – West Midlands

7.1 Introduction

7.1.1 As outlined in Section 4, we have reviewed our cost estimates for the London to West Midlands scheme in the light of updated and extended base rates and the latest evidence on prices and changes in route decisions. The implications for our cost estimates are summarised in this section.

7.2 Capital construction costs

7.2.1 The estimated cost of construction has fallen overall by around £500 million. This is driven by scope reductions due to changes post-consultation and efficiencies in project on-costs (project management, design and contract costs). The capital cost of construction is now estimated at between £15.4 billion and £17.3 billion.

7.2.2 This includes an allowance of £2.2 billion for construction risk and £4.2 billion to cover additional risks in line with HM Treasury guidance on

Table 12 – **Capital cost estimate for London to West Midlands at 2011 prices; £ millions Q2 2011 prices (rounded to nearest £5m)**

Item	£ millions	Includes
Rail systems	510	Track, ballast, fencing, drainage, junctions
Control systems	145	Signalling Control and telecommunications
Traction Power systems	185	Overhead line equipment and power supply
Stations	1,675	Euston, Old Oak Common, Birmingham Interchange, Curzon St
Civil Works	585	Earthworks, retaining walls and roads
Structures	790	Bridges and Viaducts
Tunnels	1,410	Twin and single bore tunnels
Utilities	120	Relocation of utilities e.g. water, power
Additional items	470	People mover and rail reconstruction work
Contractor administration costs	775	Preparatory work, site supervision, testing, training, spare equipment.
Total Construction Cost	**6,665**	**Excluding risk**

Item	£ millions	Includes
Environmental mitigation	250	Additional environmental mitigation
Land costs/compensation	965	Land acquisition/compensation plus scheme administration (as assessed at Sept 2011)
Depot facilities	500	Main rolling stock depot, London stabling and infrastructure maintenance depot
Provisional sum	225	Allowance for emerging requirements from concept of operations work
Project overheads	435	Client and project management costs
Design	600	All design costs and topographical/ground investigation surveys
Existing rail interface costs	190	Possession management, compensation for operational disruption
Statutory charges	70	Consultation and planning consent related costs
Construction risk	2,215	Route section and route-wide construction risks from the Quantified Risk Analysis
Additional scheme risk provision	4,165	Provision for external risks in line with HM Treasury Supplementary Green Book Guidance
Estimated Total Cost (Mean) for London to West Midlands	**16,280**	**At Q2 2011 prices**

Source: HS2 Ltd

adjustments for optimism bias. This means that overall a risk and optimism bias allowance of 64% has been applied to the costs for this phase.

7.3 Rolling stock capital costs

7.3.1 Our estimate of rolling stock is unchanged for operation of the day one service. Within the service specification assumptions modelled, there is a slight addition to HS2 services to Preston, which was required to make the "with HS2" scenario consistent with the revised view of future services without HS2. These now anticipate more services to the North West. We have also made minor changes to the modelling of services to Scotland to improve consistency with the scheme design.

7.3.2 Our classic compatible services on London to West Midlands continue to use 200m trains. On the Y network we are currently considering the use of 260m trains. We will be considering whether to incorporate such rolling stock into our strategy for London to West Midlands.

Table 13 – **Rolling stock capital cost estimates – phase one London to West Midlands; £ millions Q2 2011 prices**

Item	£ millions
Captive fleet (16 x 200m sets) base cost	425
Classic-compatible fleet (45 x 200m sets) base cost	1,790
Total base cost at 2011	**2,215**
Captive fleet (16 x 200m sets) risk at 18%	75
Classic-compatible fleet (45 x 200m sets) risk at 40%	715
Total risk provision at 2011	**790**

Source: HS2 Ltd

7.4 Operating costs

7.4.1 As with the Y network, we have reviewed the costs of operating the London to West Midlands scheme. The changes that have been made are outlined in Section 4.5, and add around £1.2 billion (2011 PV and prices) to the operating costs of HS2 (London to West Midlands) services.

7.4.2 In addition the changes to services on the classic rail network without HS2 mean that we have made some slight changes to our assumptions on re-use of capacity freed up on the classic rail network. In particular we have increased services to some locations on the WCML between London and Birmingham. This means more and longer trains running on the classic network, and so a smaller saving in classic rail operating costs.

7.4.3 Minor changes to the services run on HS2, and other cost assumptions partially offset this cost increase, but overall the net operating costs of HS2 London – West Midlands have increased by around £1.6 billion (2011 PV and prices).

Table 14 – **Operating costs for HS2 (London to West Midlands) by category (£ million 2011 PV/prices)**

Operating Cost Type	£ millions (PV)
HS2 Infrastructure operations and maintenance	800
Rolling stock maintenance	2,600
Rolling stock traction power	2,200
Train crew	1600
Station costs	300
Other HS2 operating costs	600
Classic line cost saving from released capacity	-1,900
Additional provision for optimism bias	2,600
Total	**8,600**

Source: HS2 Ltd

8. Benefits, costs and economic impacts for London – West Midlands

8.1.1 We have updated the analysis of costs and benefits of HS2 London to West Midlands. Lower GDP growth has reduced the benefits of the scheme. However, the rapid growth in demand on the WCML in recent years has produced higher forecast rail demand on this route in the future which more than offsets the impact of slower economic growth.

8.1.2 However, the cost to Government (item 11 in Table 15) has increased because of lower revenues from lower mode shift, and higher operating costs; partly driven by more conservative assumptions on train crew. This results in a slightly lower BCR overall.

8.1.3 Table 15 sets out each element of the appraisal. The net transport benefits (item 4) would be worth almost £19.0 billion. Benefits to business and other transport users make up the bulk of this (£12.3 billion and £7.8 billion respectively), with small further benefits (£600 million) from reductions

Table 15 – **Quantified costs and benefits (£ billions) of HS2 London to West Midlands (2011 PV/prices) and resulting BCR**

1	Transport User Benefits	Business	£12.3bn
		Other	£7.8bn
2	Other quantifiable benefits		£0.6bn
3	Loss to Government of Indirect Taxes		-£1.6bn
4	**Net Transport Benefits (PVB) = (1) + (2) + (3)**		**£19.0bn**
5	Wider Economic Impacts (WEIs)		£4.1bn
6	**Net Benefits including WEIs = (4) + (5)**		**£23.1bn**
7	Capital Costs		£18.8bn
8	Operating Costs		£8.6bn
9	**Total Costs = (7) + (8)**		**£27.4bn**
10	Revenues		£13.9bn
11	**Net Costs to Government (PVC) = (9) – (10)**		**£13.5bn**
12	BCR without WEIs (ratio) = (4)/(11)		1.4
13	**BCR with WEIs (ratio) = (6)/(11)**		**1.7**

Source: HS2 Ltd

in accidents, air quality and carbon emissions from lower road traffic, as well as the benefits of the HS1 link. From this we have subtracted £1.6 billion (item 3) – the loss to the Government of indirect tax revenue as a result of fewer people travelling by car and therefore paying less fuel duty, for example. A further £4.1 billion could be added through WEIs (item 5). The total benefits of the scheme, net of the loss of indirect taxes are therefore estimated to be £23.1 billion (item 6).

8.1.4 Against these benefits, the costs of HS2 (London to West Midlands) would be substantial. Over the 60 years of an appraisal, costs would be £27.4 billion (item 9). The bulk of these are capital costs (almost £18.8 billion). The remainder (30% of costs) is the net impact on operating costs, covering both HS2 trains and the classic network. After taking account of increases in revenue, the net cost to Government would be £13.5 billion (item 11).

8.1.5 The BCR of HS2 (London to West Midlands), including WEIs would be 1.7 (item 13). In other words for every £1 spent by Government, the scheme would deliver £1.70 in benefits. The BCR excluding WEIs is 1.4. Since the benefits per £1 spent are higher than £1, this BCR represents a positive economic case.

9. Further considerations for the economic case

9.1 The role of the private sector

9.1.1 We have assumed that the construction of HS2 is funded and financed by central government. However, it may well be the case that other organisations may contribute to the costs of HS2, including local authorities and private sector organisations who may benefit from the opportunities opened up by the scheme.

9.1.2 Contributions from local authorities do not alter the BCR of the scheme as all public expenditure is treated in the same way, although private sector contributions would reduce the cost of the scheme. This type of contribution is not "free money", as any contributions would reduce the benefits (as they are a cost to the private sector). Even so, these contributions would tend to improve the BCR of the scheme as the benefits per £1 of Government spending will increase with lower costs to the public sector.

9.1.3 This opportunity exists particularly around stations and on certain sections of the network that would have benefits for particular organisations. A contribution to these costs of £1.6 billion for the London to West Midlands scheme would only marginally increase the BCR from 1.4 to 1.5 excluding WEIs. On the Y network a contribution of £3 billion would marginally increase the BCR from 1.6 to 1.9 to 1.6 to 2.0 excluding WEIs.

9.2 Further benefits from HS2

9.2.1 We have attempted to capture all the impacts of HS2. However, there are some which require more detail than is available at the current stage of development. For example, we expect that the redevelopment of Euston Station would offer the potential to enhance the passenger experience. A better station layout would minimise walk times between key areas of the station, whilst better design of information, seating, retail and other factors would provide benefits to passengers.

9.2.2 We do not attempt to value these potential benefits in our central case as they would be dependent on the detailed design of the final station. However, Atkins have undertaken a brief review of the potential scale of the benefits, based on the number of passengers using Euston Station and evidence from similar station enhancements. Their indicative analysis suggested potential benefits of between £1 billion and £1.7 billion (2011 PV and prices), which would increase the BCR to around 1.5, excluding WEIs. Further work will set out more clearly the quality of the

station facilities and area, which will allow us to quantify the impacts with greater confidence.

9.2.3 Other potential benefits include performance improvements on the WCML as a result of running a more homogenised train service on the line (with the fastest trains transferred onto HS2, the trains running along the line have more similar service characteristics which typically aids performance) and the possible use of released capacity to enhance provision for transporting freight. All of these may improve the economic case but none are included at this stage in the BCR.

9.2.4 Finally, we continue to use the modelling tools that have been used for developing the economic case for HS2 London – West Midlands. We believe this provides a conservative estimate of some of the benefits; particularly in terms of understating the station access some of the benefits for the Y network. The updated modelling approach that we are currently finalising for our March 2012 report on the Y network will address these issues.

9.3 Other factors: fares, competition and regulation

9.3.1 We have set out our latest view of the costs and benefits of HS2, both for the initial phase between London and the West Midlands and the full Y network. All forecasts are necessarily subject to uncertainty. In section 10 we examine the key uncertainties by means of sensitivity tests. While some of the drivers are beyond the direct control of Government, others can be influenced by decisions the government would take and subsequent work should the project be taken forward.

9.3.2 Key examples include the fares policy that might be adopted for HS2 and the competition and regulatory environment in which HS2 might operate. In the absence of that analysis, we have been conservative in our assessment. We have not assumed any premium fares, sophisticated yield management or pricing policy and we have assumed that Government can specify services, as they have done to date in the franchise processes.

9.3.3 There are also potential benefits from a more refined fares policy or yield management. We have previously undertaken some limited analysis of premium fares (i.e. fixed percentage increases to all fares). From this work we concluded that a crude premium fare, which increases the costs of all ticket types, could lead to higher revenues.

9.3.4 However, the analysis also suggested that the scope for premium fares varies significantly across different markets (both journey purpose and geographically). Routes to Birmingham for business travel in particular show scope for relatively substantial increases in revenues.

9.3.5 This is important from an affordability perspective since even a 5% increase in revenue across HS2 would generate

around £1.6 billion on the Y network. It is not, however, without downsides. Passengers on HS2 would have to pay higher fares and for some it would no longer be worth travelling on HS2. For these people the benefits from faster and less crowded journeys would be less than the additional fare.

9.3.6 The above assumes only premium services are offered – reflecting the principle of paying for the time savings offered by HS2. However, HS2 would also offer substantial capacity enhancements, and, at least in the off-peak, it is possible there may be some spare capacity. At such times, it may be feasible for yield management techniques to increase revenues by introducing lower fares. With the right regulatory structure this could provide an opportunity to boost the business case for HS2; widening the market to people who would not have previously travelled, while both spreading the benefits offered by HS2 to wider groups and increasing revenues. The extent to which this is possible depends on the extent to which markets can be separated – we see this today in lower fares and discounts offered to more price sensitive groups during off peak times, for example, 16-25 Railcards.

9.3.7 If a decision is taken to go ahead, there would be significant further work on the regulatory and fares structures to understand the potential benefits that could be secured. In the meantime, we have been conservative and not included any of the potential benefit of changes to fares.

10. Sensitivity tests

10.1 Scope of sensitivity tests

10.1.1 This chapter explains the detail of the sensitivity tests undertaken and examines how the economic case would change under the alternative assumptions tested. It remains the case that there are too many variables to test individually. It would be impractical to cover all potential scenarios and we believe that attempting to choose scenarios would risk hiding the key drivers of the economic case for HS2.

10.1.2 The majority of variables that could be considered would ultimately have one of four impacts:

- vary the level and pattern of demand;
- change the valuation of benefits;
- change the design of the scheme;
- change the cost of the scheme.

10.1.3 We have updated the analysis in the February 2011 Economic Case which looks at each of these high level changes in turn.

10.1.4 We have additionally undertaken some further sensitivity tests to address specific issues raised during the consultation. The results from these tests are reported here, and form part of the evidence base considered by Government following the consultation. Whilst this document provides some interpretation and explanation, it is not designed to directly respond to the issues raised and does not in itself draw conclusions on them. The Government's views on these issues are contained in *The Economic Case for HS2: Value for Money Statement*.

10.1.5 The BCRs that are used in this section consistently exclude WEIs. The relevant BCRs for comparison are 1.4 for London to West Midlands and 1.6 for the Y network.

10.2 The level and pattern of demand without HS2

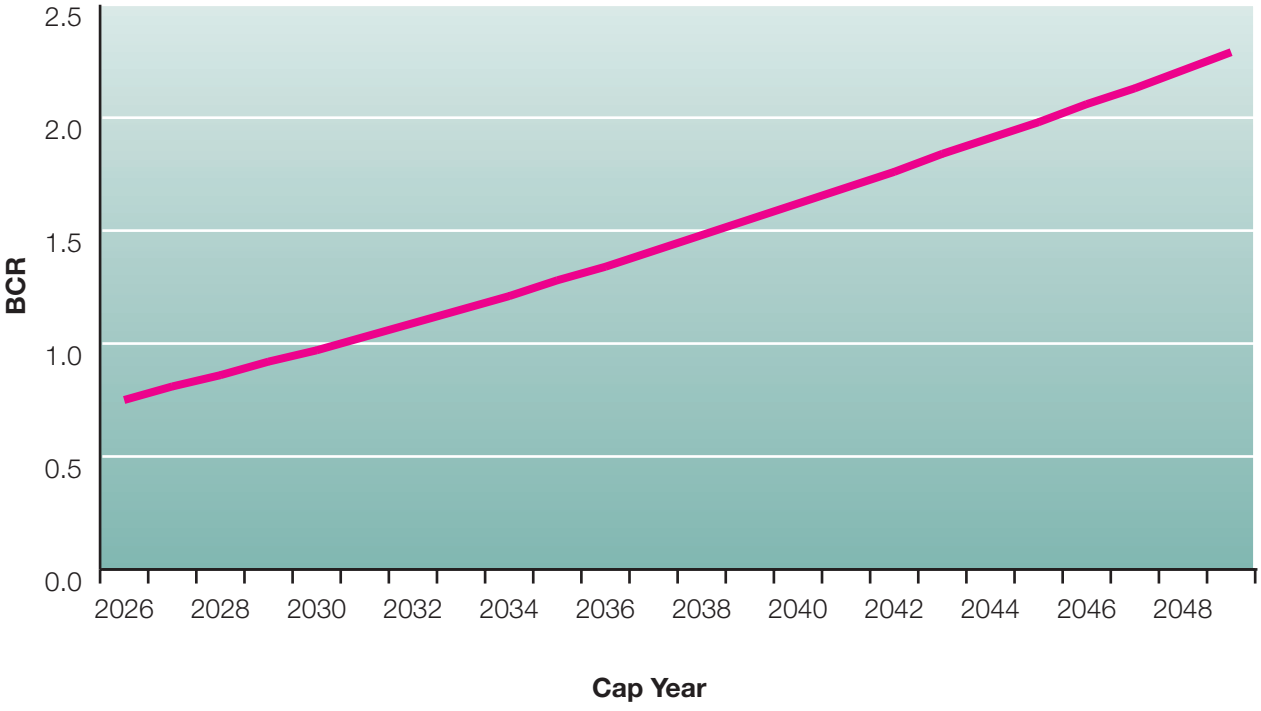
10.2.1 The level and rate of demand growth, in particular, are key drivers in the economic case for HS2. The level of demand is particularly important as it principally defines *whether* the scheme is justified (whereas the rate of growth affects *when* it is justified). Many consultation responses suggested our demand forecasts were too high, or were projected too far into the future. Government sets out its views on the evidence of alternative forecasting approaches in *The Economic Case for HS2: Value for Money Statement*. We present in the following section the implications of alternative assumptions for the rate of growth in demand, and the ultimate level of demand that may be achieved.

10.2.2 We have capped demand on the rail network at a level that we believe is reasonable. It represents an average increase of 0.5 single rail trips over 100 miles per person per year by 2037. The difference between trip rates for the highest and lowest income quintiles is four times this – and with incomes expected to grow substantially by 2037, it is reasonable to expect average trip rates to increase accordingly. In addition, we have seen little evidence of growth slowing on the long distance rail network – indeed long distance train operating companies have seen demand grow by 13% over the past three years, despite the recent recession.

10.2.3 However, the ultimate level of demand is inevitably uncertain and the business case is sensitive to this assumption. If demand stopped growing earlier, the business case would be weaker. If we capped demand in 2026, the BCR would fall to 0.8 excluding WEIs. Of course, if demand continues to grow beyond 2037, then the case for HS2 is improved. If the demand cap were five years later (in 2042) the BCR would increase to 1.8 (see figure 4).

10.2.4 The cap year and demand level are important factors in decision making. If demand does stop growing earlier than we expect, then the case for HS2 is weaker and there is a risk that HS2 would not realise the benefits and revenues needed to justify the costs. However, there is a similar risk, if demand continues to grow to 2037 or beyond, that failing to build HS2 would lead to more severe problems

Figure 4 – **Impact on BCR of Different Demand Cap Years**



Source: HS2 Ltd

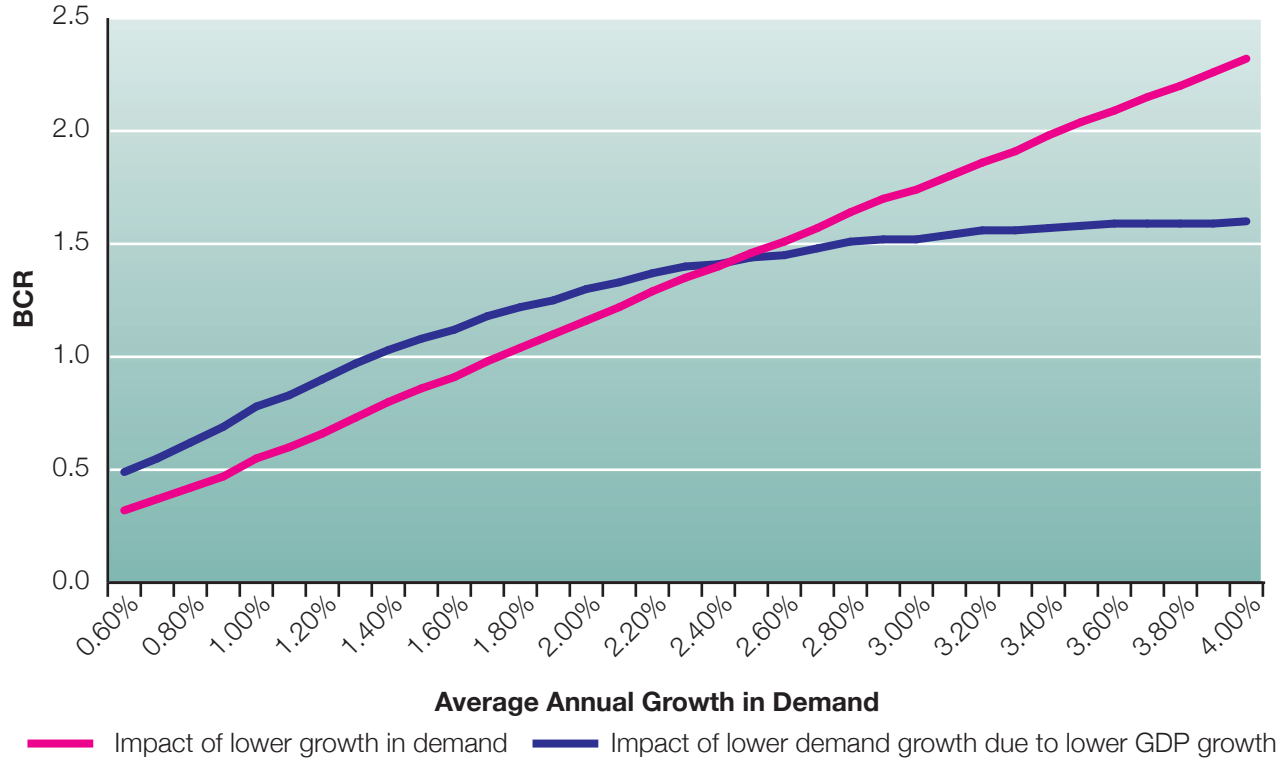
of crowding and capacity constraints on the existing classic lines.

10.2.5 The rate of growth is also important. A further impact on the BCR occurs when changes in demand growth are driven by different assumptions on economic growth, which changes the value of time in the appraisal. Figure 5 outlines the implications if different levels of growth in demand for rail The red line shows the implications of different growth in demand; the blue line shows the implication if this change were driven by differences in economic growth (which changes the value of benefits as well as the level of demand).

10.2.6 As demand grows faster, the increase in the BCR slows. This reflects the fact that at high rates of demand growth the demand cap is reached before the opening of the scheme. At this point, even faster growth has no further impact on demand or benefits in the opening year. However, if faster demand growth is driven by faster GDP growth, the BCR continues to increase as higher value of time adds to the overall value of benefits of HS2.

10.2.7 Our updated appraisal has used the latest forecasts of economic growth and policy assumptions that were available at the time the appraisal was carried out. Since we began this process the OBR announced revised forecasts (November 2011), and the Government has announced that rail fares are capped at RPI+1% in 2012. We have used the above sensitivity tests to understand the implications of these changes for the economic case.

Figure 5 – **Impact on BCR of Different Assumptions on Demand and GDP Growth**



Source: HS2 Ltd

We conclude overall that the BCR would fall to around 1.3 for London to West Midlands with these latest assumptions.

10.3 Alternative forecasts

10.3.1 A key issue raised in the consultation was that HS2 Ltd's forecasts did not use the latest evidence on the relationships between growth in demand and economic growth, fares and other factors. For the impact of economic growth on demand we use PDFH version 4.1, with elasticities capped in-line with WebTAG guidance. A new version of PDFH (5.0) has been issued which changes some key relationships. The Department has not incorporated this into its definitive guidance, although some elements are currently being consulted on. This issue is discussed further in *The Economic Case for HS2: Value for Money Statement*.

10.3.2 Our central case continues to use the Department's existing guidance. However, we have undertaken sensitivity tests of this. The parameters in PDFH 5.0 differ in a number of ways, but the key differences for HS2 are:

- overall growth in demand is slightly lower;
- the reduction in growth is bigger over longer distances. PDFH 4.1 assumes faster growth the longer the distance of the trip. PDFH 5.0 has no such relationship; and
- there are minor changes to growth assumptions on non-London trips.

10.3.3 We have applied the same principle on capping demand – at the same level of total long distance rail demand – which gives a cap year of 2043. The result is a significant redistribution of benefits towards shorter distance trips on HS2 (e.g. to the West Midlands) and an overall reduction in the BCR to 1.

10.3.4 A significant reason for this reduction is the fall in crowding on long distance services from the North West and Scotland as a result of lower forecast growth. We have not sought to optimise the service pattern in this test to reflect the changes in demand associated with PDFH 5, which would lead to a significantly different distribution of demand. However, if a revised train service pattern reflecting reduced long distance demand were to reduce operating costs by 25% the BCR would be 1.2.

10.4 Demand and pricing across modes

10.4.1 The pattern of demand across modes can be important for the economic case. The case is, however, mainly driven by the number of passengers on the railway in the future. This reflects the facts that:

- In the appraisal, rail passengers benefit most – those using HS2 get the value of faster, less crowded journeys; but even passengers who remain on classic rail would get the benefits of lower crowding and released capacity

- More demand means more crowding without HS2. This means the impact of HS2, and the extra capacity provided, will make the scheme more attractive and lead to a greater degree of mode shift and revenue growth.

10.4.2 One of the key drivers of rail demand is the cost and journey time of alternative modes; if these rise then people shift from road or air to rail. If we assume the effect of this is to permanently increase rail demand then this will have a significant impact on the business case. For example, under these circumstances a 20% rise in air fares would encourage more air passengers onto rail even without HS2 and would push the BCR up slightly while a 50% higher road fuel duty would push the BCR up by as much as 0.5.

10.4.3 The absolute size of the air and road markets is however less critical to the business case. Assuming the rate of mode shift remains unchanged, then even if there were no air or car growth the BCR would only reduce to 1.3 for HS2 London to West Midlands.

10.4.4 The interaction of mode shift and rail demand is particularly important for understanding the impact of future rail fares (without HS2). If we assume that increasing rail fares results in a slower growth in rail demand but does not lead to mode shift in long term, then eventually the same number of people would be forecast to use HS2 but the cap year will be reached slightly later. With higher fares these passengers would increase revenues and therefore improve the BCR. However, if we assume that higher fares lead to a shift towards road or air travel – and this is a permanent shift that results in a lower long term level of rail demand – then this will reduce the benefits and the revenues generated by the scheme and also the BCR.

10.5 Valuation of benefits

10.5.1 Arguments were presented in several consultation responses suggesting the benefits of HS2 were overstated. The main concern was that people can do other things on trains. Improvements in information and communication technology mean that business people can work, or undertake other useful activities that are to their benefit, or that of their business.

10.5.2 The current WebTAG guidance uses a simplifying assumption that any time spent travelling is not productive, and saving time will mean workers will be able to do more. Therefore the cost of employment is used as a proxy for the value of time for business travellers.

10.5.3 This is a complex area. Research for the DfT *Productive Use of Rail Travel Time and the Valuation of Travel Time Savings for Rail Business Travellers* (Mott MacDonald) does indeed suggest that people work on trains.[20] It also suggested that people may use a proportion of the time saved as leisure, rather than to work more – though this appears to be a short term response.

10.5.4 Against this, it is clear that business passengers do value their time. They

20 The DfT are expected to publish this in early 2012.

make choices that demonstrate this. They might choose to fly to their destination because they get to their destination faster. This is despite the fact that they could have taken the train and worked for a larger proportion of their trip. Similarly there is evidence that people value time savings more for longer journeys[21], which would suggest that the potential benefits of a scheme targeting longer distance trips (such as HS2) would be understated

10.5.5 Finally, even if it were correct to adjust values of time to reflect the ability to work on trains, then this would need to be applied consistently across the appraisal. One particular area would be the assessment of crowding. If people are standing on a train it is reasonable to assume that they would be unproductive; and relieving that crowding would have a productivity effect. In our central case we value crowding for business passengers at the same level as for commuters, so that the only impact of crowding is the 'discomfort' factor. No account is taken of the potential lost productivity impact and it would therefore be appropriate to increase this value if we were to assume that some time on a train is productive.

10.5.6 The DfT has reviewed the evidence on the value of business time savings. Its conclusions are summarised in the *The Economic Case for HS2: Value for Money Statement*. While the DfT acknowledges there is a case for further consideration of the evidence base, it believes the recommended values are fit for purpose and the best currently available. For this reason we have continued to use the values of time set out in WebTAG for our central case. However we have repeated the sensitivity tests undertaken in the consultation so that the implications of different assumptions are clear.

10.5.7 The majority (over 60%) of benefits from HS2 accrue to business passengers. Reducing the business value of time alone would clearly have significant impacts for these benefits. For example, halving the value of time would reduce benefits by £4 billion. However, the impact of crowding is also significant. If we use business values of crowding (reflecting productivity impacts) this would give a benefit of £2.7 billion and largely offset the impact of the value of time reduction. Overall, this would reduce the BCR by around 0.1.

10.6 Design tests

10.6.1 We have considered the implications of alternative assumptions on the design of HS2. In particular, concerns were raised in consultation responses over the speed of the line and the capacity of the line. We have also looked at the implications of alternative assumptions on the capacity of HS2 trains in the future.

Speed of the line

10.6.2 Several consultation responses questioned whether the line should be designed to 400kph (250 miles

21 Pedro A.L. Abrantes, Mark R. Wardman, "Meta-analysis of UK values of travel time: An update", *Transportation Research Part A: Policy and Practice*, Volume 45, Issue 1, January 2011, Pages 1-17

per hour). Respondents questioned whether the environmental impacts of the line could be substantially mitigated by a slower line speed – allowing the line to curve more, avoiding environmental features and following transport corridors more closely.

10.6.3 We have considered the issue of line speed and the outcomes are set out the report *Review of HS2 London to West Midlands Route Selection and Speed*. The conclusions were that while some environmental benefits could be achieved, these were marginal over the mitigated route proposed by HS2. However, as set out below the implications for the benefits of the line were more substantial.

10.6.4 A 300kph (186 miles per hour) line would increase the journey times on HS2. This would reduce the benefits (since each passenger would not enjoy as significant a time saving). It would also reduce the demand – and so the revenues – of the line as fewer new passengers were attracted to switch to HS2. Overall, this would reduce the BCR for the first phase (London to West Midlands) to 1.3, and for the Y network to 1.3.

10.6.5 We also updated our analysis of the implications of a new classic speed line. This would have lower costs than HS2. Capital costs would be £3 billion lower (2011 PV and prices) and operating costs would fall by £1.9 billion (2011 PV and prices). However, the speed reduction means lower time savings, attracting fewer passengers onto the new line. This would reduce benefits by £6.2 billion (2011 PV and prices) and revenues by £3.5 billion (2011 PV and prices), which would offset the potential cost savings of a classic line. This would produce a BCR for a classic line of 1.1.

10.6.6 Put another way, spending £1.4 billion to upgrade the new line from classic speed to high speed would deliver benefits of £6.2 billion; a BCR of 4.6.

Track capacity

10.6.7 Another issue raised in consultation responses was that the assumed capacity of 18 trains per hour was unrealistic. The *Summary Report on the Capacity and Capability for the High Speed Network* sets out the evidence base on why we believe that 18 trains per hour is appropriate.[22] We have conducted a sensitivity test assuming a lower capacity (16 trains per hour). This has very little impact on the business case. This is because our current service specification only assumes 17 trains per hour; and one train path can be saved through combining the Heathrow services (both of which are 200m trains) into a single hourly service which splits at Birmingham Interchange station. As a result we can achieve the same level of services to all locations with only a marginal increase in journey times on one train (to reflect the time taken to split or join the Heathrow train).

22 See HS2 Ltd, 2011, *Summary Report on the Capacity and Capability for the High Speed Network*, http://hs2.org.uk/publications/Summary-report-on-the-capacity-and-capability-for-the-High-Speed-Network-77735

Train capacity

10.6.8 We have also undertaken a sensitivity test using a train capacity of 450 seats per 200m set, rather than the 550 seats we assume in our business case. This reflects the fact that the actual seat capacity of HS2 trains would be the subject of future commercial discussions with train manufacturers. 450 seats per 200m set reflects the lower end of seat capacity of such trains, and is currently seen on cross-Europe long distance services, a different market from HS2 services.

10.6.9 This test showed that the BCR for the scheme would fall to 1.2 if capacity were limited in this way, as a result of increased crowding on some services. This is likely to be a relatively pessimistic view. If such low seat capacities were used on heavily congested routes, we would look to optimise the service provision. The work for the Y network is already considering the scope for 260m classic compatible trains which would provide increased capacity for locations on the classic network, and there may be scope for increasing frequency to some locations or increasing the use of 400m trains beyond peak hours for trains running on HS2.

10.7 Costs of HS2

10.7.1 Our estimates of costs for HS2 London to West Midlands have been built from the bottom up, including detailed assessment of the needs of the scheme and comparison with costs of constructing HS1 and other rail schemes. We have included an allowance for risk and 'optimism bias' which adds 64% to our infrastructure capital cost estimates. These cost estimates have been tested within HS2 Ltd and with other independent experts. However, there are ranges in our cost estimates to reflect different views of the risks and future performance of the rail network. In particular, on the costs of construction, we report a range of £15.4 billion to £17.3 billion. This is equivalent to a range in the BCR of 1.3 to 1.5.

10.7.2 Including operating costs, the overall provision for optimism bias amounts to £8.4 billion (2011 PV and prices) for London to West Midlands and £16.8 billion (2011 PV and prices) for the Y network. The inclusion of such large allowances for cost increases reflects the past experience of delivering major infrastructure projects in the UK and overseas. However, if our bottom up estimates proved to be accurate (i.e. if optimism bias were excluded), the BCR would rise to 3.7 for London to West Midlands and 4.4 for the Y.

10.7.3 Another area of significant costs for HS2 is the purchase costs of rolling stock. We have made allowances for the degree of complexity in construction of different types of rolling stock. Trains that would operate on HS2 only (the "captive" fleet) are expected to be 'off the shelf' – standard designs that are tried and tested across Europe and therefore lower risk. However, the classic compatible fleet is expected to be a bespoke high speed train design as they would also need to run on UK gauge railways. As such we assume that these would cost around 50% more. In addition, we have more than doubled the allowance for risk and optimism bias for the classic compatible sets. This reflects the greater fixed set up costs in design, and the greater uncertainty. However, with a wider network – potentially leading to larger orders of classic compatible trains – it may be possible to drive cost efficiencies and mitigate risk. We have therefore tested the impact of using the same cost estimates for the captive and classic compatible fleet. With this assumption, the BCR of the Y network would rise to 1.7.

10.7.4 The costs of operating and maintaining the scheme depend on assumptions about growth in electricity costs, wages and productivity across the transport network. Our central assumptions include substantial growth in overall costs, including a doubling of electricity costs (in line with DECC forecasts), and now include further costs to ensure there is an allowance for extra staff for catering and other services.

10.7.5 We have also applied a 41% optimism bias on top of these, which we consider conservative given that there is worldwide experience of operating high speed rail. To better understand this we have also looked at an estimate using optimism bias at 10% and a slower increase in energy costs and greater productivity gains in the rail industry. This would increase the BCR for HS2 London to West Midlands to 1.7. If productivity gains were lower and wage growth higher, there would be no change in the BCR.

11. Conclusions

11.1.1 Our latest analysis demonstrates that there is a strong transport case for a high-speed rail network based on a Y configuration connecting London, Birmingham, Manchester and Leeds. Our assessment of the Y network shows a BCR of 1.8 to 2.5 including an estimate for WEIs. A high-speed line between London and the West Midlands would form the first stage of that network. As a stand-alone proposition this still offers a positive transport case on its own terms as well as in the context of a wider network. It is, however, not as strong a case as for the Y network. This might be expected, as it is bearing the full costs of London terminus and serving a smaller market.

11.1.2 In the context of growing demand for travel, especially over long distances, and hence overcrowding of the rail and road networks, HS2 would bring significant transport user benefits to regions across England and Scotland, served both directly and indirectly (through the link to the classic network and through released capacity). It would also produce benefits to users of the West Coast mainline as well as HS2 passengers. There would, in addition, be wider economic impacts, not all of which have been possible to quantify, and other impacts on economic development, regeneration and employment which are largely positive.

11.1.3 Benefits (including the wider economic impacts and other impacts), converted into monetary terms, have been weighed up against the capital and operating costs of the scheme over 60 years using transport appraisal guidance set out by the DfT. The result of this is a benefit to cost ratio for HS2 London to West Midlands of 1.7. This reflects our central case assumptions. If we exclude the WEIs the BCR is 1.4.

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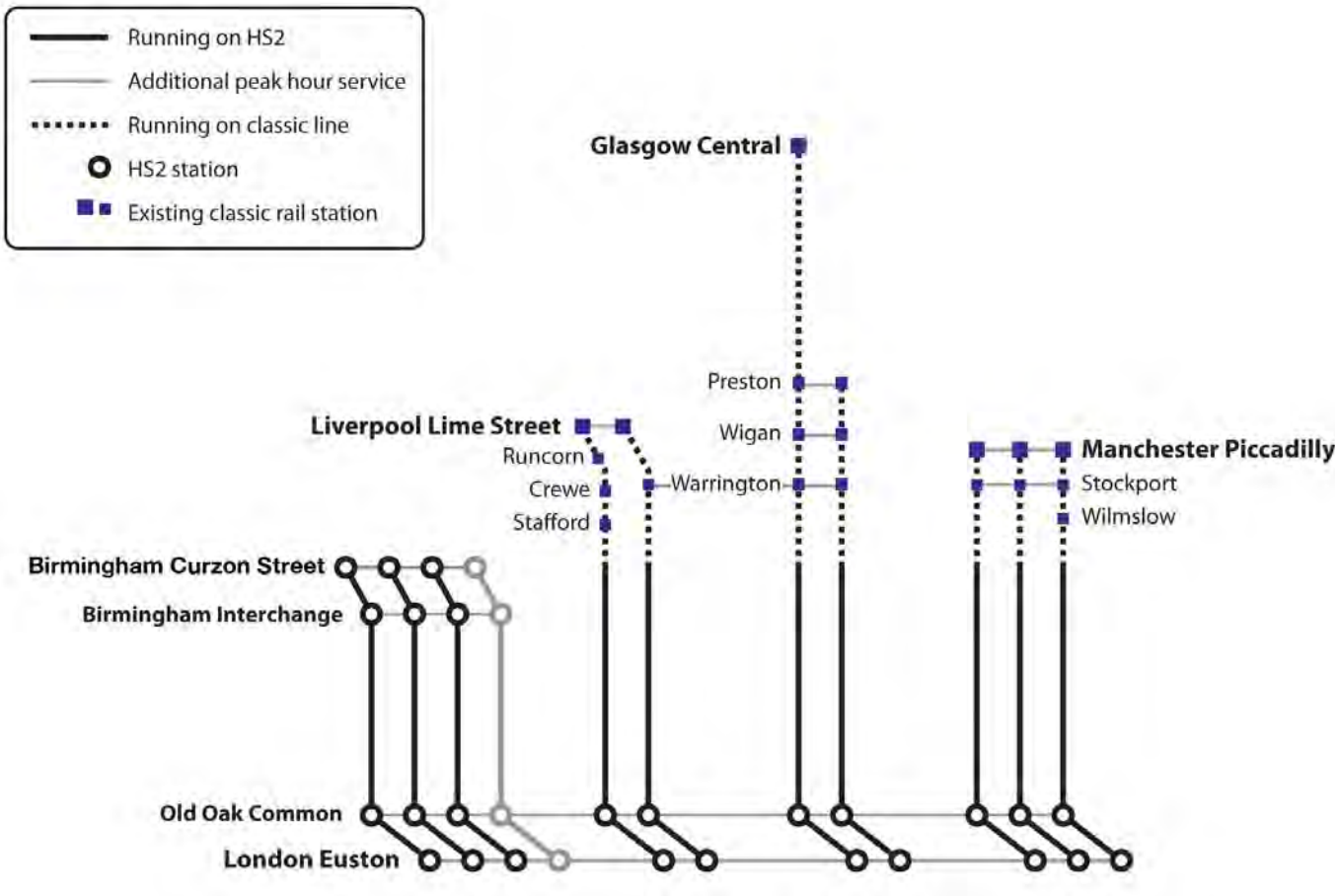
13. Appendix 1

13.1 Service specification assumptions for HS2 (London – West Midlands)

Figure A depicts the proposed train service specification of the dedicated high speed services of HS2 (London – West Midlands), alongside classic-compatible HS2 services on Day One. This illustrates the services available using HS2 in any given hour. The services are grouped together by destination (left to right in the figure) for ease of presentation; in practice services to all destinations would be spread throughout each hour of operation.

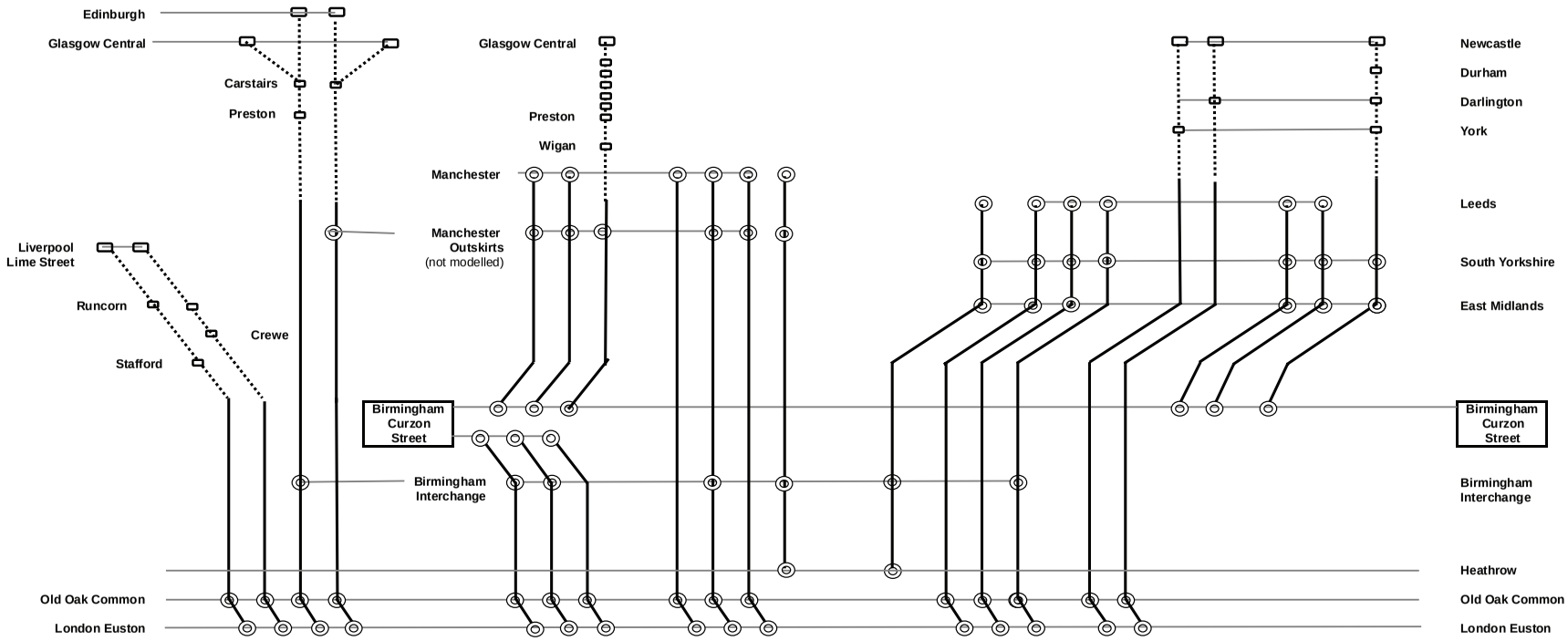
Figure 6 – **Service specification assumptions for HS2 (London – West Midlands)**



13.2 Service specification assumptions for the Y network

Figure A2 depicts the train service specification assumptions used to calculate the costs and benefits of the Y network. This illustrates the services potentially available using the Y network in any given hour when the Y network opens. The services are grouped together by destination (left to right in the figure) for ease of presentation; in practice services to all destinations would be spread throughout each hour. The service specification assumptions for the Y network are shown in Figure 7.

Figure 7 – **Service specification assumptions for the Y network**



Key

- ntermediate station on existing network
- Destination station on existing network
- HS2 station
- HS2 service on HS2 network
- HS2 service on existing network
- Peak Hours Only HS2 service on HS2 network
- Peak Hours Only HS2 service on existing network