LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

Alternatives Report (CT-002-000)

November 2013

ES 3.5.0.18

VOL 5

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Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

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1 Introduction

1.1.1 Parliamentary Standing Order 27A requires the hybrid Bill to be accompanied by an environmental statement (ES) containing the information referred to in Part II of Schedule 4 of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations, 1999. The information includes:

> "An outline of the main alternatives studied by the applicant or appellant and an indication of the main reasons for his choice, taking into account the environmental effects".

1.1.2 This report describes the evolution of the High Speed Two (HS2) proposal. It summarises the objectives and requirements of the new high speed line, the options considered and choices made from the highest level strategic alternatives to the elements of the scheme and the route between London and the West Midlands. In each case it explains why the decisions were made. It does not describe local route options which are reported elsewhere in the ES.

Evolution of the proposals

1.1.3 Having considered the long-term travel and transport challenge following the Eddington Transport Study in December 2006[1], the then Government concluded that in the longer-term (post 2020s) further investments will be needed to serve the growing demand and it committed itself to long-term transport planning to serve this demand. It set up the National Networks Strategy Group in October 2008 to consider the infrastructure requirements for future growth, focusing on how to make best use of existing networks and longer term solutions for strategic corridors, including new rail lines. HS2 Ltd was set up in January 2009 with an initial remit to consider and provide advice to Government on a new high speed line from London to the West Midlands, and in August 2009 Atkins was commissioned to consider strategic road and rail upgrade options.

HS2 Ltd reported to Government in December 2009 on its initial proposals for a new high speed line between London and the West Midlands and the options considered[2], though there were some issues that were left for later consideration including direct access to Heathrow and the locations for the maintenance depots. In March 2010 the Government considered the options and HS2 Ltd's proposals[3]. It endorsed the recommendation for a 'Y' network, the proposed stations and the proposed route, subject to refinement, mitigation and consultation.

1.1.4 Further work was undertaken on these and other aspects of the Proposed Scheme and a more definitive proposal was presented for public consultation in February 2011, including further options considered since March 2010, together with economic appraisals for both HS2 and the rail upgrade options and various supporting documents. The comments received were then considered by Government which

[1] The Eddington Transport Study The case for action: Sir Rod Eddington's advice to Government, HM Treasury & DfT, December 2006
[2] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009
[3] High Speed Rail, DfT, March 2010 (Cm.7827)

published its conclusions in High Speed Rail: Investing in Britain's Future – Decisions and Next Steps[4]. The economic analysis of HS2 and rail upgrade options were refreshed again at this stage.

1.1.5 In January 2013 the Government published its preferred route for HS2 Phase Two to Manchester and Leeds. These proposals are the subject of public consultation which concludes in January 2014. HS2 Ltd's initial preferred route for the spur from the main line to Heathrow T5 was also published with the January statement, though the Government has not indicated any preference on this option and the Secretary of State has suspended further work on any direct connection to Heathrow pending the report of the Airports Commission.

1.1.6 Also during 2013 the Government consulted the public on a draft of the ES for Phase One and on some refinements to the design of the Proposed Scheme, including revised proposals for Euston Station. Meanwhile, work continued on the EIA and on updating the economic appraisals.

Objectives, requirements and choices

1.1.7 A wide range of options were considered in both the development of the HS2 scheme and the analysis of strategic alternatives. They were assessed against selection criteria derived from three sources:

- the Government's transport and economic objectives to provide for long term demand;
- the Treasury Green Book requirements to ensure "that public funds are spent on activities that provide the greatest benefits to society, and that they are spent in the most efficient way"[5].
- national sustainability objectives and environmental policies and requirements.

The Government's objectives

1.1.8 The Government's most important task is to build a stronger, more balanced economy capable of delivering lasting growth and widely shared prosperity[6]. The transport strategy must play its part and so the Government's objectives for the HS2 project are[7]:

- to provide sufficient capacity to meet long term demand, and to improve resilience and reliability across the network;
- to improve connectivity by delivering better journey times and making travel easier.

1.1.9 Any solution must:

[4] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012
[5] The Green Book: appraisal and evaluation in central government, HM Treasury, 18 April 2013 Preface
[6] "The Coalition: together in the national interest". Government Mid-term Review
[7] The Strategic Case for HS2, Dft, October 2013

- minimise disruption to the existing network;
- use proven technology that we know can deliver the desired results;
- be affordable and represent good value to the taxpayer;
- minimise negative impacts on local communities and the environment.

Scheme elements

1.1.10 The original remit to HS2 Ltd in 2009 included the following requirements for the elements of a high speed railway from London to the West Midlands:

- "a proposed route with any options as appropriate;
- options for a Heathrow International interchange station on the Great Western Main Line with an interchange also with Crossrail;
- options for access to central London and the other cities served;
- options for linking with HS1 and the existing rail network, including the potential for services to continental Europe;
- options for providing an intermediate parkway station between London and the West Midlands. Any such station should not be detrimental to the overall business case, and should support economic and spatial strategies;
- ...potential development of a high speed line beyond the West Midlands, at the level of broad 'corridors'...[and] to consider in particular the potential for HS2 to extend to the conurbations of Greater Manchester, West Yorkshire, the North East and Scotland."[8]

1.1.11 These remain the list of elements for which options have been prepared and choices made. The options for routes north of the West Midlands are not part of the Phase 1 scheme, but they were considered at strategic level because the choice of route or routes has implications for Phase One. This is discussed in Section 4.

1.1.12 Since 2009 HS2 Ltd's remit has been modified on several occasions. The main change to the remit affecting the elements of the Proposed Scheme was in 2010 when provision for direct access to Heathrow was added[9]. For reasons set out in paragraphs 10.1.17-10.1.26 of this report it was decided not to include an intermediate parkway station between London and the West Midlands.

Selection criteria

1.1.13 For the more specific choices of options for the HS2 scheme design HS2 Ltd's appraisal criteria are grouped under eleven headings:

- Strategic fit;

[8] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.13 paras. 1.1.10-11
[9] See Secretary of State for Transport letters to HS2 Ltd 11 June 2010 and 4 October 2010.

- Construction feasibility;
- Operational feasibility – trains (HS2 and Network Rail (NR);
- Operational feasibility – operations (stations, depots etc.);
- Operational feasibility – passengers;
- Demand;
- Costs;
- Environment (using Environmental Impact Assessment (EIA) topic areas);
- Safety;
- Commitments; and
- Development opportunities.

The report

1.1.14 Part I of this report describes why the Government concluded that serving demand for travel in the middle of the century must be addressed now, why a network of high speed lines between London, the midlands and the north is the only option to meet the objectives comprehensively, and why other modes, new classic lines or upgrading the existing main lines would not be reasonable or effective alternatives to meet the requirements.

1.1.15 Part II then explains chronologically the process through which each of the various elements of the Proposed Scheme were selected, the options considered and the reasons for the decisions on the proposals to be presented for public consultation in 2011 and in 2012 and subsequently for inclusion in the hybrid Bill.

1.1.16 Detailed alignment and other local options considered prior to January 2012 are summarised in Volume 1 of the ES and local options considered since January 2012 are described in the relevant community forum area (CFA) reports in Volume 2.

PART I STRATEGIC ALTERNATIVES

2 The case for action

Doing nothing

2.1.1 A richer and more sophisticated economy offers greater producer and consumer choice and this creates more complex economic and social relationships. These choices are exercised over a wider geographic area, require better communications and lead to demand for longer and faster journeys. Travel in Britain has grown strongly in recent years, especially inter-city rail travel which has increased by 5.2% p.a.in the last ten years[10].

2.1.2 The evidence shows that economic growth and demand for transport go hand in hand. Since 1980 there has been a near doubling in rail demand, a 56% increase in road demand and a 175% increase in domestic aviation[11]. Over this period, the economy has grown by 118%[12]. By investing in transport infrastructure costs to business can be reduced and productivity improved.

2.1.3 Economic growth will continue to drive transport demand. On current projections, real GDP is expected to increase by 56% over the next 20 years to 2032[13]. In addition, the UK population is projected to grow by 11 million people between 2010 and 2035[14]. The combination of these factors will add to demand on roads and railways from passengers and from freight. Successive governments have concluded that it is necessary to provide for the growing demand for travel and that it would not be acceptable simply to allow congestion and crowding to increase.

2.1.4 In 2005 the then Government commissioned Sir Rod Eddington to examine the long-term links between transport and the UK's economic productivity, growth and stability, within the context of the Government's broader commitment to sustainable development. Amongst other findings, the Eddington Study concluded[15]:

- "There is clear evidence that a comprehensive and high-performing transport system is an important enabler of sustained economic prosperity...;
- ...travel demand is growing rapidly due to continued economic success and is densely concentrated on certain parts of the networks at certain times of day. As a result, parts of the system are under serious strain. If left unchecked, the rising cost of congestion will waste an extra £22 billion worth of time in England alone by 2025. By then 13 per cent of traffic will be subject to stop-start travel conditions. Commuter rail lines are forecast to see further increases in overcrowding, and intercity rail services will see many trains at or beyond

[10] Source: ORR
[11] Transport Statistics Great Britain Table TSGB0101
[12] Long-term profile of Gross Domestic Product (GDP) in the UK, Office for National Statistics, 2013
[13] Fiscal Sustainability Report, Office of Budget Responsibility, 2012
[14] Office for National Statistics, 2011, National Population Projections, 2010-based Statistical Bulletin
[15] The Eddington Transport Study The case for action: Sir Rod Eddington's advice to Government, HM Treasury & DfT, December 2006 pp.5-6

seating capacity on the approaches to cities.

- Because the UK is already well connected, the key economic challenge is therefore to improve the performance of the existing network. But there is little strategic case for action in all places. To meet its economic goals for transport, Government should prioritise action on those parts of the system where networks are critical in supporting economic growth, and there are clear signals that these networks are not performing.

- ...the strategic economic priorities for long-term transport policy should be growing and congested urban areas and their catchments; and the key inter-urban corridors and the key international gateways that are showing signs of increasing congestion and unreliability. Government should focus on these areas because they are heavily used, of growing economic importance, and showing signs of congestion and unreliability – and these problems are set to get significantly worse. They are the places where transport constraints have significant potential to hold back economic growth."

2.1.5 In 2008 the Government reiterated its post-Eddington commitment to provide sufficient capacity to serve forecast demand in the long term:

> "The Government remains committed to investment and to tackling the problems of congestion and crowding. The Eddington study warned that congested cities, crowded trains, delays at ports and queues at airports are not just a nuisance to individual travellers. They are also a tax on the productivity of our businesses and a deterrent to inward investment. If we don't tackle them, they will become a brake on economic growth and on employment."[16]

2.1.6 In 2010 the Government concluded that "over the next 20-30 years the UK will require a step change in transport capacity between its largest and most productive conurbations, both facilitating and responding to long term economic growth"[17], and in 2012 the Government accepted Network Rail's assessment that there is a limit to the extent to which capacity enhancements to existing lines can provide for long term demand:

> "These incremental investments on existing lines have provided valuable, but ultimately limited, enhancements to capacity and connectivity, often at a cost of substantial disruption to passengers whilst works take place. And continuing demand growth is set to outstrip the capacity gains that have been achieved. Network Rail has forecast that by the mid-2020s all capacity for additional or lengthened services on the recently modernised West Coast Main Line will have been exhausted.
>
> The Government has considered a range of options for tackling capacity constraints on the UK's key north-south inter-city rail routes. Having reviewed the available evidence on demand forecasts and a range of other issues relating to the

[16] Delivering a Sustainable Transport System: Main Report, DfT, November 2008 p.4
[17] High Speed Rail, DfT, March 2010 (Cm.7827) p.8

> alternatives to high speed rail, we consider that even very major programmes of enhancements to existing lines would be unable fully to accommodate forecast demand growth and would lead to unacceptable levels of crowding on many routes."[18]

2.1.7 The Government also concluded in 2012 that modern communications technologies would have only a modest effect in reducing the demand for long distance rail travel and that increased capacity is necessary for economic prosperity[19]. Better communication technology is an essential part of economic growth, but the evidence shows that modern technology has not significantly reduced demand for rail travel, and indeed in the past travel demand has consistently increased at the same time as advances in communications technology[20]. The Government's assessment of the long-term need for additional rail capacity was supported by an overwhelming majority of business and local government organisations who responded to the consultation.

2.1.8 Having considered the responses to the HS2 consultation in 2012 the Government concluded:

> "The Government's view is that continuing investment in steps to meet rising demand for inter-city travel is necessary, given the importance of these journeys to the success of the UK economy. Measures to address intensifying and more extensive crowding, growing rail congestion and the consequent increasing challenge of running a reliable railway for passengers are vital if the transport system is to continue to support economic growth." [21]

> "There is a compelling case for delivering a step-change in the capacity and performance of Britain's inter-city rail network to support economic growth over the coming decades. Doing nothing is not an option."[22]

2.1.9 The Government has summed up its current position in the Strategic Case for HS2.

> "… not providing for growing demand would not fit with the Government's objectives for economic growth and could significantly constrain the UK's economic potential. Nor is it consistent with the 2011 National Infrastructure Plan's aim 'to improve connectivity and capacity between main urban areas and between them and international gateways, to deal with longer term capacity constraints'[23].
>
> We do not believe it is tenable to do nothing. In addition to the negative economic effects, there would be severe individual impacts either crowding people off the network, or allowing the experience to become so unpleasant that people choose not to travel."[24]

[18] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 pp.16-17 paras.5-6
[19] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.44 para.2.14
[20] The Strategic Case for HS2 2013 p.49 Fig. 2.5
[21] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.18 para.13
[22] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.42
[23] National Infrastructure Plan 2011, DfT, November 2011 p.43 Para.3.36
[24] The Strategic Case for HS2 2013 p.66 paras 3.2.2-3.2.3

2.1.10 The Government has also ruled out using fares to constrain demand:

> "To suppress demand across the network would therefore involve very significant and highly undesirable price rises. It would also not improve connectivity, our other key objective. It would have serious consequences for economic productivity and growth."[25]

3 Alternative modes –air or road

3.1.1 Having decided to focus on the congested networks, inter-city travel and access to international gateways, the previous government considered how best to plan to serve the growing demand. In Britain the most populous and economically significant corridors are from London to the West Midlands and the North-West, and to the cities in the east Midlands and south and west Yorkshire. At its southern end, central London, Heathrow and HS1 are key destinations, but there is a wider choice of cities to serve in the Midlands and the North.

3.1.2 Rail is the obvious mode to serve the long distance market between city centres because it can provide fast and reliable journeys between cities and high capacity access into the centres without requiring wide roads or extensive car parking close to final destinations. However, before drawing any definite conclusions, the Government considered all the generic options for different modes and for new routes and upgrades to existing networks:

- First, how to make best use of the existing key networks and
- Secondly, on longer term solutions for the strategic corridors

3.1.3 There have thus been two strands to the analysis of high level strategic options, with the Department for Transport leading the work on the strategic alternatives and HS2 Ltd examining options for a high speed line between London and the West Midlands and the North. Consistent with the sifting process adopted by HS2 Ltd and described in its publications, the least promising options were discarded, often at an early stage, as soon as it became clear that they could not offer a better solution than the more promising ones. Where questions were raised about the robustness of an early stage decision, the analysis was reviewed and in some cases more work was done subsequently.

3.1.4 Options for building new motorways or serving the demand by expanding domestic aviation were not pursued in detail both because of their implications for climate policy and because they could not serve the city centres. However, all the other potential options have been explored in sufficient detail to demonstrate that a new high speed line offers the best and most cost effective solution to fulfil the economic and transport objectives.

[25] The Strategic Case for HS2 2013 p.66 para.3.2.6

Air travel

3.1.5 Domestic air travel offers advantages such as the opportunity to connect easily with international flights, but is rarely attractive for journeys of less than 200 miles. The environmental impacts of air travel are distributed very differently to those of terrestrial routes. With the exception of emissions at altitude, impacts tend to be concentrated around airports.

3.1.6 The main reasons why domestic air services are not a realistic or acceptable alternative to high speed rail for serving future growth in inter-city travel are:

- air travel is most economically viable for journeys of over 400 miles (640km). For shorter journeys aviation cannot offer door to door journey times comparable to road or rail, due to the time taken for travel to the airport, check in, security etc.;
- the capacity of London's airports is limited and providing for future growth in international travel will be a significant challenge without also serving additional demand from domestic air services; and
- the carbon emissions per passenger kilometre from air travel are significantly greater than those from high speed rail. Whilst reductions in the carbon intensity of air travel per flight up to 2050 are expected, these are likely to be offset in part by the expected growth in passenger miles and hence the number of flights[26].

3.1.7 In view of these considerations, in 2012 the Government stated its desire to maintain the UK's status as an international aviation hub, but to see modal shift away from domestic air services where possible[27], not only because of the significantly lower carbon emissions per passenger kilometre, but also in order to release airport capacity at Heathrow for international services[28].

3.1.8 In March 2013 the Government published its Aviation Policy Framework, reiterating this policy. It summarised the approach to the relationship between aviation and high speed rail:

> "An important part of our approach is to enable more people to take the train, instead of air transport, for domestic and short-haul European journeys, both in order to achieve environmental benefits and to release capacity at airports. However, we recognise that there will always be a need for domestic aviation; for example, for connections to Northern Ireland and the Scottish islands and other parts of the UK not served by rail, for cross-country routes, and for express freight onward journeys."[29]

[26] UK Aviation Forecasts DfT, January 2013
[27] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.18 para 24
[28] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.80 para.4.38
[29] Aviation Policy Framework, DfT March 2013 p.38 para. 1.101

New motorways

3.1.9 New motorways could provide extra capacity between cities and could address other transport issues as cars are very flexible in providing door to door transport at any time. However, new roads are rarely a realistic option for increasing commuter capacity into city centres without entailing unacceptable property destruction and community severance. Nor can cars offer anything like the centre to centre journey times or the reliability of high speed rail especially at times when traffic is most congested. The longer the distance, the greater the journey time advantage that rail has over road.

3.1.10 In 2010, the Government's concluded that "a viable case could not be made for major new motorways as a sustainable solution to the UK's long term inter urban transport needs." At the time a key issue was the increase in carbon emissions attributable to the growth in car travel enabled by an entirely new motorway. However, the Government was also concerned by other aspects of sustainability including local impacts such as landscape, air quality, noise and land take.

3.1.11 High speed rail is preferable in terms both of capacity and connectivity, especially in urban areas. It also tends to have less adverse effect on the environment and produces significantly lower carbon emissions per passenger kilometre than cars. In addition, a new motorway would incur a similar range of local impacts as a high speed line but would require more land. For all these reasons the Government decided not to give further consideration to new motorways as an alternative to HS2. However, it did not discount the possibility that decarbonisation of road transport might alter the case for road infrastructure in the very long term, though not for city centre markets[30].

Selective enhancement of the road network

3.1.12 Most of the disadvantages of new motorways as an alternative to high speed rail for serving inter-city demand also apply to upgrading existing roads. The Government nevertheless commissioned Atkins to explore the potential for a package of road capacity enhancements to accommodate increasing travel between London and the West Midlands[31].

3.1.13 The road network provides for 90% of all passenger travel[32] and 75% of long distance trips (over 100 miles)[33]. Demand is forecast to increase substantially, though not as much as for trains. In order to create a consistent demand growth forecast, Atkins used the road transport forecasts in the PLANET long distance model which predicted an overall increase in demand for road travel between 2008 and 2031 of 44%, including a non-business travel increase of 49% and commuter travel increase 37%[34].

3.1.14 The existing motorways and 'do minimum' enhancements would not provide sufficient capacity for long-term road travel demand without increasing congestion and delay, still less could it accommodate the demand for additional inter-city rail

[30] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.45 para. 2.19
[31] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010
[32] Transport Statistics Great Britain Table TSGB0101, DfT, 2012
[33] National Travel Survey Table NTS0317, Long distance trips within Great Britain by main mode and length: Great Britain, 2008/12, DfT
[34] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.17 Table 3.2

trips. A credible package of upgrades that would be an alternative to HS2 to serve the long distance market would therefore need to be extensive. However, there are limits to how much capacity enhancement is practical, bearing in mind the cost and environmental effects of widening roads, and the problem of dispersal of large volumes of traffic onto smaller roads at junctions. Consequently Atkins prepared proposals mostly comprising 'Managed Motorways' initiatives including variable speed limits and hard shoulder running and some widening within existing highway boundaries.

3.1.15 Atkins examined upgrades to the M1/M6, M40, M25 and M42. The analysis started with existing capacity and flows and a 'do minimum' that assumed implementation of the Highways Agency's 2009-16 Business Plan proposals and a list of schemes in the National Transport Model which was broadly consistent with the Motorways and Major Trunk Roads Paper, January 2009[35].

3.1.16 Four packages of enhancements were assessed, each would require an additional increment on the previous package. They are described in Table 1.

Table 1: Road intervention packages

	Proposal	**Scheme**
Package 1	This is considered the minimum level of intervention that can be provided within existing highway boundaries to maintain traffic flows using Managed Motorways controls.	Hard shoulder running implemented on all sections excluding M25. Widening M42 J3-7 to dual 4 motorway + hard shoulder running.
Package 2	Extends Managed Motorways controls to M25, requiring some land purchase.	Package 1 plus further interventions to provide hard shoulder running and some widening on the M25.
Package 3	Additional capacity would be provided on the M40 corridor to minimise journey time as well as maintain journey time reliability	Package 2 except along the M40. The M40 would be widened to four lanes to a full standard cross section to accommodate peak hour flows.
Package 4	Represents the upper limit on interventions. It assumes all motorway links are widened where feasible.	Hard shoulder running on all sections except M6 junction 4-junction 11, widened giving additional capacity on all study area motorways.

3.1.17 Atkins undertook a high level value for money appraisal of these packages which indicated high benefit:cost ratios (BCRs), though diminishing for packages 3 and 4. The environmental effects would be relatively small as almost all these works could be implemented with little or no extension of the highway boundaries. The packages are also much less expensive than a new high speed line.

[35] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.12 para.3.2.2.3

3.1.18 The four road intervention packages represent an approximation to the realistic maximum potential for increasing capacity on the motorways between London and the West Midlands, but they would provide only a fraction of the additional inter-city capacity of a new rail line and little or none into city centres. Together the four packages would increase the capacity of all the relevant motorways by approximately 20% (which is about the same as the projected increase in population 2010-2035 and should be compared with the Government's current central forecast for an increase in strategic road traffic of 46% 2013-40[36]).

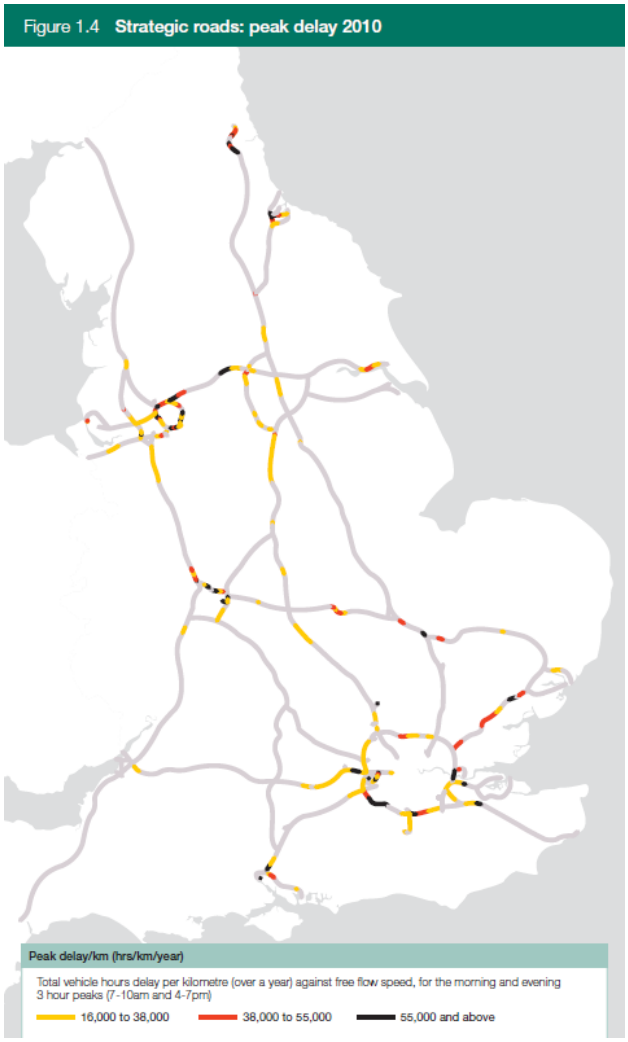
3.1.19 In March 2010 the Government concluded that the motorway network would be unlikely to provide an effective alternative for either passengers or freight, with congestion on the M1 and the M6 increasing significantly over the coming decades even without taking into account the impact of urban congestion on journey reliability[37] (See Figure 1). Reviewing the Atkins analysis the Government concluded that there were still strong gains to be made from further roll out of hard shoulder running, but the scope for incremental improvements that offer high value for money is finite with the returns decreasing substantially as they grow in size and cost[38].

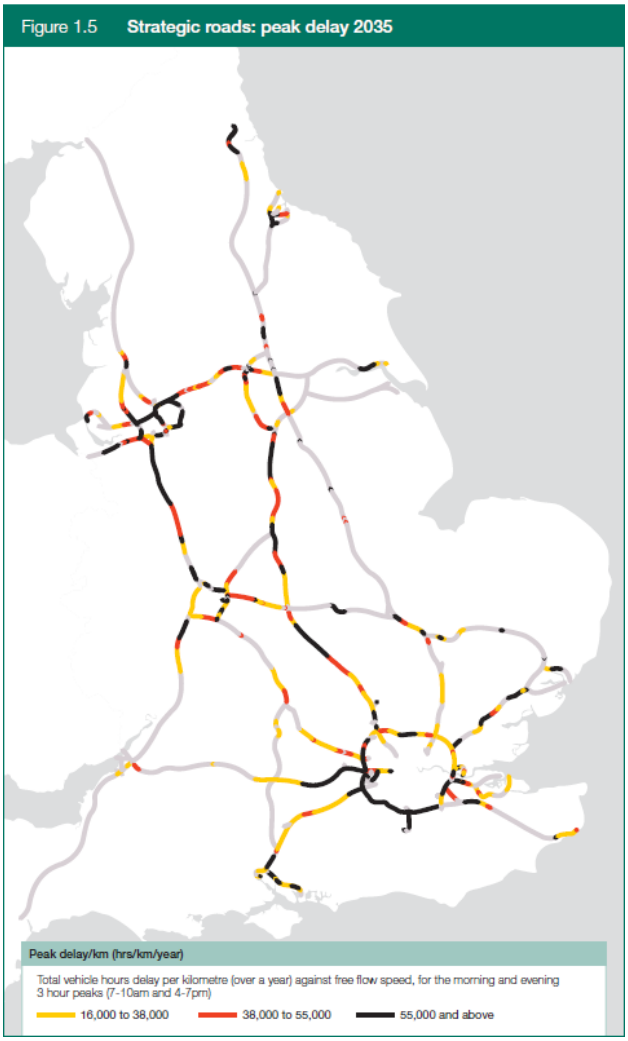
3.1.20 In the 2011 public consultation the Government made it clear that it did not consider roads or domestic aviation would offer an acceptable or effective solution, both because of their relative disadvantages to rail on carbon emissions and because they would not contribute to capacity enhancement on routes into city centres .

3.1.21 Following the 2011 consultation Government noted that relatively few respondents argued for air services or road capacity enhancement as an alternative to rail and confirmed that it "concurs that inter-city rail travel as a means of serving these key routes offers valuable practical and sustainability benefits in comparison to road travel and domestic aviation".

[36] Action for Roads, DfT, July 2013 (Cm.8679) p.16 para.1.22
[37] High Speed Rail, DfT, March 2010 (Cm.7827)p.32 para.1.28
[38] High Speed Rail, DfT, March 2010 (Cm.7827)p.52 para. 2.47

Figure 1: Peak delay on strategic roads 2010-2035[39]





3.1.22 This approach of pursuing incremental enhancements on the road network as well as, but not as an alternative to, high speed rail was reiterated in 2012:

> "In terms of road infrastructure, the Government does not consider that there is a case for major new motorways, and therefore our strategic road strategy focuses on schemes to address key pinch points and improving access to the strategic road network, especially to serve new development, and also the continuing roll-out of the managed motorways programme as a means of enhancing the capacity and performance of the motorway network. "[40]

3.1.23 Even comprehensive upgrading of the motorways would provide less capacity than the forecast growth in road travel demand between cities and would not be an alternative to serve the growth in the long distance rail market as well. It must be concluded that even together these enhancements to the existing motorways would

[39] High Speed Rail, DfT, March 2010 (Cm.7827) pp.34-35 Figs 1.4 & 1.5
[40] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.45 para. 2.18

not be able to serve the unconstrained demand for road travel forecast for the next 20 years, still less to accommodate any additional long distance travel demand transferred from the railways due to lack of rail capacity.

3.1.24 Where schemes can be justified, the Government intends to implement capacity enhancements on the strategic road network. In June 2013 it announced the biggest programme of road investment since the 1970s, including hundreds of miles of extra lanes on the busiest motorways through the use of managed motorways technology[41].

3.1.25 The Government's current view of strategic road capacity as an alternative to Hs2 is:

> "The strategic road network is of vital importance and we have a policy to increase capacity. However, we do not believe that increasing road capacity alone is the solution to meeting our strategic objectives.
>
> ... By 2021, spending on road enhancements will have tripled. This will counter the effects of past underinvestment, maintain the network and add some extra capacity where it is needed to ease congestion on existing motorways.
>
> But, these enhancements do not provide the additional capacity needed to allow roads alone to soak up the predicted increase in passenger demand. Significant as they are, they are only part of the wider transport response. To put into context the scale of road building that would be required, HS2 will deliver capacity roughly equivalent to two new dual three-lane motorways. We also know that roads are not well suited to improving connectivity between city centres, because traffic speeds are limited, or for providing additional commuter capacity into major cities, because of the traffic constraints that exist there."[42]

4 Strategic high speed route options

4.1.1 Though Phase One of HS2 (the Proposed Scheme) is a discrete project that can be justified on its own merits, it has been conceived as part of a long term strategy for a network of high speed lines connecting the major conurbations. In 2009 HS2 Ltd was asked to consider the potential for extension of the core London to West Midlands route specifically to connect Britain's four largest conurbations – London, Birmingham, Manchester and Leeds. The work was motivated by three factors:

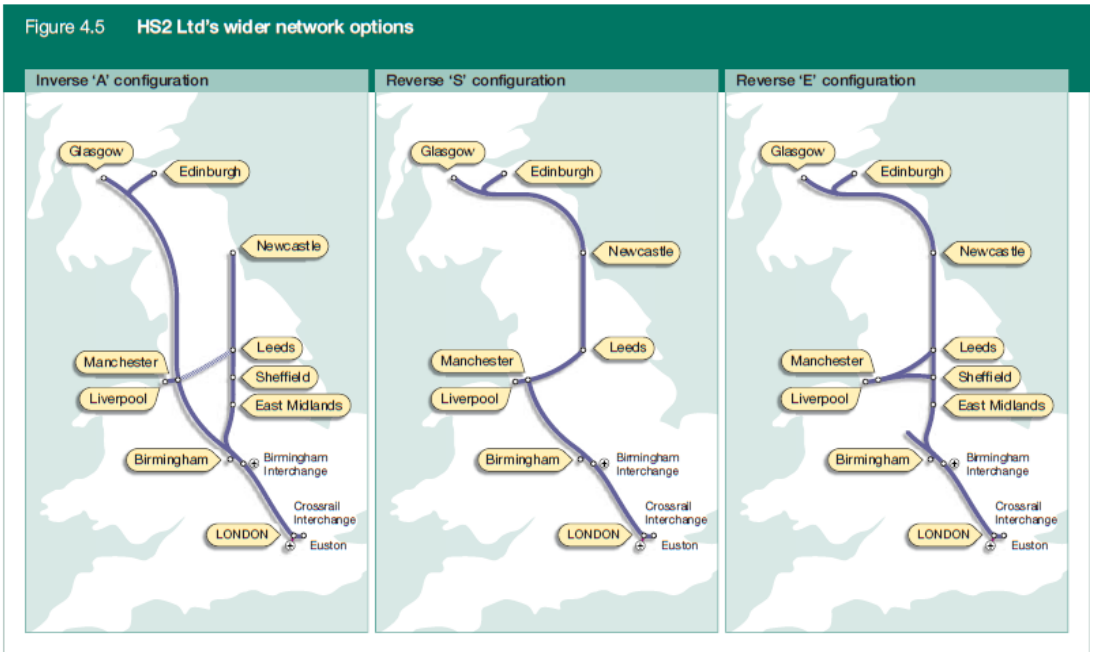
- to 'future proof HS2 Phase One so that it does not close off viable options for further extension at a later date;
- to identify where Government focus and resources might best be targeted;
- to set HS2 in the context of a vision for the future[43].

[41] Investing in Britain's Future, HM Treasury, June 2010 (Cm.8669)
[42] The Strategic Case for HS2 2013 p.67 paras 3.2.9-3.2.11
[43] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.218

4.1.2 The strategic choices are determined by the locations of the major cities. Conceptually there is a western route to Liverpool/Manchester, and an eastern route via some or most of the cities in the East Midlands, and South and West Yorkshire. North of Leeds, Teesside and Tyneside lie on the eastern route, but there are no conurbations in England to the west of the Pennines. In Scotland, there are a number of permutations for serving Edinburgh and Glasgow, but in order to create a like for like comparison of the routes through England, all options considered by HS2 Ltd assumed the same configuration in Scotland. With this geographic context in mind, three families of option were prepared in outline - for route to the west of the Peak District, a route to the east of the Peak District, or both routes together. These options were analysed and compared:

- Inverse 'A' - bifurcate the line near Birmingham with an eastern branch to the East Midlands, Sheffield, Leeds and Newcastle; and a western branch to Manchester and Scotland, with a link between Manchester and Leeds and a spur to Liverpool.
- Reverse 'S' - a single line to Newcastle and Scotland via Manchester and Leeds, with a spur to Liverpool
- Reverse 'E' - a single line to Newcastle and Scotland via East Midlands, Sheffield and Leeds with trans-Pennine branches from Sheffield and Leeds to Manchester and Liverpool.

Figure 2: Comparison of HS2 Ltd's wider network options



4.1.3 In February 2010 HS2 Ltd submitted a report to Government[44] on its demand and business case analysis underlying its Dec 2009 report. The analysis in respect of network configurations is summarised in Table 2[45]. It reflects the following characteristics of the options:

- The Inverse 'A' option would be the most expensive because the total length of route is so much greater. However, it would provide much better value for money because it connects London and Birmingham directly to both sides of northern England, it would be more comprehensive, would offer better overall journey times, particularly to Scotland, and the benefits would be consequently much greater. The link between Leeds and Manchester would need to be justified on trans-Pennine passenger flows because north-south passengers would use the new lines either side of the Pennines[46];
- The Reverse 'E' option could not offer better journey times from London or Birmingham to Manchester/Liverpool than HS2 trains continuing to the north-west from Lichfield via the West Coast Main Line;
- The Reverse 'S', would be the least expensive of the three families of option, but offered the lowest value for money because it could not serve the East Midlands or Sheffield and the time savings to Leeds, the north-east and Scotland would be much less than the other two options.

Table 2: Comparison of HS2 Ltd's Wider Network Options

Route	Inverse A	Reverse S	Reverse E
London-Manchester	1:20	1:20	1:40
London-Leeds	1:20	1:35	1:20
London-Newcastle	2:00	2:07	2:00
London-Glasgow/Edinburgh	2:40	3:17	3:10
Birmingham-Manchester	0:40	0:40	1:28
Birmingham-Leeds	1:05	1:07	1:05
Manchester-Glasgow/Edinburgh	1:45	2:48	3:15/3:30

[44] High Speed Rail London to the West Midlands and Beyond HS2 Demand Model Analysis February 2010 Section 11.8 pp.127-134
[45] High Speed Rail, DfT, March 2010 (Cm.7827) p.73
[46] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.220 para. 6.1.12

Route	Inverse A	Reverse S	Reverse E
Business Case			
Infrastructure Capital Cost	£52.2 bn	£44.3 bn	£49 bn
Benefits	£103 bn	£73.9 bn	£87.3 bn
Indicative Benefit:Cost Ratio	2.3:1	1.8:1	1.9:1

4.1.4 In 2009/10 a high level sustainability appraisal was undertaken. At that stage there was no line of route for any of the options north of Birmingham and so the aim was to ensure that the options were appraised on a consistent basis to identify whether there were any distinguishing environmental considerations that should be taken into account before any decision on the strategic route.

4.1.5 The analysis was undertaken in relation to four priority issues:

- reducing greenhouse gasses and combating climate change. In the absence of demand modelling for Phase Two and beyond, it was assumed that the conclusion of the Booz-Temple report of 2007[47] would be confirmed – that unless HS2 was extended beyond Manchester there would be insufficient modal shift from air to HS2 for the scheme to realise a net reduction in greenhouse gas emissions. However, it was recognised that this conclusion was "very sensitive to the relative delivery of policy measures relevant to reducing carbon emissions". There was little to choose between the options on embedded carbon;
- natural and cultural resources and environmental enhancement . Maps of high status environmental features in northern England and southern Scotland were prepared – there are numerous Grade 1 listed buildings Scheduled Ancient Monuments and sites of special scientific interest (SSSI) on the routes to Manchester and Leeds which a HS2 line would need to negotiate. There are two possible routes across the Pennines the M62 corridor and the A646/Caldervale line corridor. Further north, all options would run east of the Pennines but only the Inverse 'A' would also run to the west where there is only a small corridor between the areas of outstanding natural beauty (AONB) and national parks; and
- creating sustainable communities. In England concentrations of multiple deprivation occur in the conurbations in the east midlands, the north west, south and west Yorkshire and Tyne/Tees. In Scotland they are more in the west than the east.
- Sustainable production and consumption.

[47] Estimated Carbon Impact of a New North South Line, Booz Allen Hamilton, 12 July 2007

4.1.6 Although there are numerous environmental features and issues that could influence detailed route choice, no environmental or sustainability issues were identified that would affect the strategic decision on whether HS2 should be extended on both sides of the Pennines or only on the east or west side.

4.1.7 HS2 Ltd's conclusions, with which the Government agreed in March 2010, were summarised as follows:

- "There is a good case for going on to develop high speed lines beyond the West Midlands and, of the networks we have looked at, a network with two branches either side of the Pennines performs best.
- While there appears to be a good case for continuing High Speed Two on to the North West and Manchester, there looks also to be a particularly strong case for a branch to Yorkshire and Leeds, via the East Midlands. Both appear to be strong candidates for more detailed work as part of the next stage of development.
- Government needs to decide its aspirations for the longer term network before plans for the next stage can be worked up in detail. We have been able to design High Speed Two in such a way that options for the future remain open, but this will not be the case for route sections beyond Birmingham.
- The longer term network should initially be built out from the High Speed Two trunk. If there is further demand in the longer term, a second leg could be provided from the East Midlands to London."[48]

4.1.8 The Government concluded that the potential benefits of an extension to Manchester and Leeds would be sufficiently high to justify their inclusion in the plans for the initial network, that the trans-Pennine link between Leeds and Manchester should be enhanced through consideration of options for upgrade of the existing railway rather than a new high speed line, and that it is imperative that Scotland should also benefit from the outset[49].

4.1.9 This therefore resulted in a 'Y' network to Manchester and Leeds as a first stage of the Inverse 'A' northwards, which was also analysed in the February 2010 report. The 'Y' network to Leeds and Manchester was estimated to cost around £30bn compared with £52.2bn for the complete Inverse 'A', but would deliver the great majority of its benefits. However, following the general election in 2010, the current government asked HS2 Ltd to undertake further work to compare the 'Y' option with the Reverse 'S'[50]. This study concluded that, excluding the cost of the London to West Midlands route, the 'Y' would cost marginally more (£11.2bn) than the Reverse 'S' (£10.4bn), but the benefits would be around £15bn compared with £10bn for the Reverse 'S' (all figures 2009 PV). Not only would the Reverse 'S' not serve the East Midlands and

[48] High Speed Rail, DfT, March 2010 (Cm.7827) p.74 para.4.28
[49] High Speed Rail, DfT, March 2010 (Cm.7827) p.74 paras. 4.30-32
[50] High level assessment of the wider network options – reverse 'S' and 'Y' network, HS2 Ltd, October 2010

South Yorkshire, but journey times would be 15 minutes slower to Leeds and over 20 minutes slower to Newcastle.

4.1.10 Comparing the environmental effects of the two options, it concluded:

> "For the 'S' it is clear that a corridor across the Pennines would create major engineering complexities coupled with a potentially significant impact on the natural environment. Whilst tunnelling could be used to mitigate the impact on the landscape and respect the topography, it would come at a high cost and with the additional vents and shafts necessary for longer tunnels. The 'Y' would potentially encounter engineering complexities between East Midlands and Leeds but we consider that there is greater scope than with the 'S' to mitigate the impact on the natural environment during the more detailed route design phase."[51]

4.1.11 On 4 October 2010 the Secretary of State confirmed his intention to proceed to consultation with the 'Y' network to Manchester and Leeds. During the subsequent consultation relatively few respondents commented on the network configuration and most who did supported the Government's 'Y' proposal. Some alternative configurations were advanced, but none were superior to the 'Y' network in terms of costs and benefits and most had previously been considered and rejected[52]. After considering the consultation responses, in January 2012 the Government confirmed its intention to promote hybrid Bills for the 'Y' network:

> "The construction of a national high speed rail network from London to Birmingham, Manchester and Leeds (the 'Y' network) is the best means for enhancing rail capacity and performance on Britain's key north-south corridors. The 'Y' network should incorporate links to the West Coast and East Coast main lines to enable through-running services to additional destinations, as well as intermediate stations in the East Midlands and South Yorkshire. Such a network will also provide a foundation for potential future expansion."[53]

5 Options for higher or lower design speed lines

Conventional speed (200kph)

5.1.1 Scheme development in 2009-10 included a high level consideration of building a conventional speed version of the proposed London to West Midlands route. This was assumed to comply with the same specification as the high speed option (Phase One of HS2) in all respects except speed; and it would follow the same route and provide the same connections, stations and level of service. The design criteria were also

[51] High level assessment of the wider network options – reverse 'S' and 'Y' network, HS2 Ltd, October 2010 p.3 para.2.8
[52] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.68 para.3.75
[53] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.37

assumed to be similar in that they would comply with the "Technical Specifications for Interoperability", as required by Government[54].

5.1.2 At this stage there was no scheme design for a conventional speed railway to compare with Phase One of HS2. Costs and benefits were estimated as proportions of the costs and benefits of HS2 Phase One. It was estimated that there would be a net cost saving of £1bn (PV), but journeys from London to Birmingham would take 15 minutes longer than Phase one of HS2 and so there would be less revenue and the benefits would also be less. Overall the effect of reducing the speed on revenue and benefits would be much greater than on cost. The marginal benefit:cost ratio of uprating a design specification from 200kph to 400kph was estimated to be over 3:1[55].

5.1.3 The Government concluded that:

> "While entirely new conventional rail lines could address the long-term capacity constraints on the rail network, their net costs would be almost as high as those of high speed rail without delivering anything close to the same journey time benefits."[56]

5.1.4 The economic appraisal was reworked for the February 2011 consultation so it could be compared with the consultation route scheme[57], again without any scheme design. This appraisal estimated that the net construction cost saving would be around 9% and there would be a 24% reduction in revenues, patronage would reduce by 9%, and benefits by 33%. The BCR for a conventional speed line would be around 1:1 compared with 1.6:1 for the Phase One of HS2 consultation route scheme. Potential environmental benefits included:

- lower carbon emissions;
- greater flexibility to avoid sensitive features due to tighter curvature; and
- lower noise impacts (though in both options these could be reduced or mitigated).

5.1.5 In late 2011 the noise assessment was rerun to compare the consultation route at conventional and high speed. It concluded that the consultation route, if unmitigated and running at 360kph, would increase noise levels to such a level that fewer than 1,400 properties would qualify for noise insulation. At 300kph, this number reduces to around 1,100 properties. However, when mitigated and including post consultation route changes, the impacts of the high speed option would be reduced to such an extent that only approximately 60 properties would experience such an increase in noise. The review also concluded that it was likely that this figure would be further reduced during the EIA stage[58].

[54] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.190 para.4.4.17
[55] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 pp. 190-192 (This estimate was revised to >4:1 in the 2012 appraisal)
[56] High Speed Rail, DfT, March 2010 (Cm.7827) p.13
[57] Economic Case for HS2: the Y Network and London to West Midlands, DfT, 2011 pp.45-6
[58] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 4.4

5.1.6 Any environmental advantage of a conventional speed line would be relatively marginal[59], and as the economic and transport benefits of high speed are far greater, a conventional speed line would not constitute a reasonable alternative. In January 2012 the Government concluded that "The additional benefits generated by designing a new line to accommodate high speed services, compared to the only real long term alternative of a new conventional speed line would outweigh the additional costs by a factor of more than four to one"[60].

A higher design speed

5.1.7 As a desk exercise, HS2 Ltd explored the options of a higher design speed (above 400kph) and reviewed the 2011 noise assessment. It concluded that a higher speed would save little time because of the distance taken to accelerate between stations and the effect of features that permanently restrict speed such as tunnels and junctions. It concluded that 400kph represents a reasonable maximum design speed, given likely technology development over the coming decades[61].

Reducing design speed locally to mitigate adverse environmental effects

5.1.8 During the 2011 consultation many respondents questioned whether reduced environmental impact had been compromised in the interests of speed. Consequently, this issue was examined in some depth prior to the January 2012 post consultation route announcement[62]. On only approximately half of the 400 kph route – the section between Amersham and Birmingham Interchange station – could trains reach the maximum design speed. Six areas on this section of the route were identified where environmental concerns had been expressed and where there was potential to alter the route alignment. In other areas a reduced design speed would have led to no change in the route. The six areas were:

- study area 1 – Balsall Common (360kph alignment);
- study area 2 – South Cubbington Wood (360kph and 300kph alignments);
- study area 3 – Chipping Warden to Turweston (360kph alignment);
- study area 4 – Twyford to Chetwode (360kph and 300kph alignments);
- study area 5 – Waddesdon (360kph and 300kph alignments); and
- study area 6 – Wendover to South Heath (360kph alignment).

5.1.9 The analysis concluded that in study areas 1, 3 & 4, any environmental benefits could more advantageously be achieved by realigning[63] and mitigating without the need to reduce design speed, and in the other three areas this effect could be achieved through mitigation only. HS2 Ltd therefore concluded:

[59] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.73 para.3.98
[60] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.72 para. 3.96
[61] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 4.2
[62] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 4.3
[63] In these three areas the route was realigned in January 2012.

"The only environmental improvements delivered by a lower maximum design speed would be a marginal reduction in noise impacts, which would be outweighed by a substantial reduction in economic benefits. We consider that mitigation of the consultation route, the approach we have taken, is a more appropriate way of reducing environmental impacts, particularly noise. This would also be the case for a line designed at a conventional speed."[64]

Alternative routes at 300kph

5.1.10 In addition to this analysis of the consultation route, two of the rejected London to West Midlands route options that were examined in 2009 were re-appraised assuming revised alignment to reduce environmental effects based on a maximum design speed of 300kph. These two routes, the Chiltern Line and M40 route (Route 2) and the M1 alignment (Route 5) are discussed in Section 9 below. On a revised 300kph design speed alignment, their economic and environmental characteristics relative to the HS2 consultation route are summarised in Table 3. The comparison shows that in both cases there is a substantially higher cost and lower BCR compared with the preferred route for very little environmental gain, and so their relative disadvantages compared with the consultation route could not be redressed by redesigning them to a lower maximum speed specification.

Table 3: Chiltern and M1 alignments at 300kph compared with Route 3[65]

	Chiltern route (Route 2)	**M1 alignment (Route 5)**
Maximum design speed	300kph	300kph
Additional journey time	+7 minutes	+6 minutes
Relative cost	+£3bn	+£2.2bn
Relative BCR	-25% or more	-25% or more
Comparative environmental advantages	Fewer people affected but more severance. Little sustainability difference.	Would not affect Chilterns AONB. More property demolition and/or severance. Relatively small overall environmental gain.

5.1.11 Lastly the assessment considered the effect of reducing the design speed from 400kph to 360kph. This reduction would have no effect on the HS2 value for money appraisals because the journey times and quantified benefits are based on a maximum speed of 360kph. The main disadvantage relates to the future opportunity to allow the

[64] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Executive Summary para.8

[65] Data summarised from Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 sections 3.2 and 3.3

operating speeds to increase to 400kph as high speed technology develops. If designed to 360kph only, this opportunity would be permanently foregone[66].

5.1.12 Having reviewed all this work the Government concluded that the new line should be high speed[67] not conventional speed, that 400kph is the appropriate maximum design speed for the line[68] and that the route should not be realigned to a lower design speed[69].

6 Options for upgrading existing rail lines

Introduction

6.1.1 In parallel with the evolution of the proposal for a new high speed line the Government has explored the options for upgrading the existing rail network to test whether the additional capacity and connectivity to serve long term demand could more effectively be provided through a package of enhancements to existing lines. Options for upgrading the WCML and the Chiltern Main Line (CML) were considered as well as scenarios for enhancement of all the main lines.

6.1.2 Comparing new lines and upgrade packages is not straightforward as the effects are very different. A new line can provide much greater and more concentrated extra capacity both on the new line and the existing lines that it is relieving as well as substantial journey time savings, whereas there are numerous possibilities for combinations of upgrade packages, each with its own transport and spatial effects, advantages and disadvantages. A new line unequivocally provides net new capacity and connectivity, whereas the quantum of extra capacity and journey time reduction from upgrading existing lines depends on the mix of services, station stops, intensity of use of the various sections of the route and its effect on safety and reliability.

6.1.3 The timeframes are also different as upgrades are usually implemented incrementally, whereas a new railway takes at least fifteen years to plan and build. The comparison needs to be strategic as well as quantitative – both spatially in terms of the effects and inter-relationships of different geographic areas, and in terms of short, medium, long and very long-term time horizons.

6.1.4 From an environmental point of view, new lines cause adverse environmental impacts to residents and businesses not previously affected by transport corridors including noise, visual intrusion and community severance, though they generally also present more opportunity for comprehensive mitigation. On the other hand, upgrading existing lines generally requires less additional land, resulting in fewer impacts on habitats, landscape and farmland, but existing lines pass through built-up areas and most were built with little or no mitigation. Where additional land is required in urban areas, upgrades often necessitate property demolition. During construction large scale upgrades cause disruption to train services and roads over a long period.

[66] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 para.4.3.3
[67] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.23 para.38
[68] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.86 para.5.14
[69] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.86 para.5.19

6.1.5 The key issue for successive Governments has been the extent to which upgrading existing lines could cost effectively provide the necessary capacity and connectivity to serve growing demand in the middle of the century in pursuit of economic growth and a balanced economy. In 2012 it concluded that: "Having reviewed the available evidence on demand forecasts and a range of other issues relating to the alternatives to high speed rail, we consider that even very major programmes of enhancements to existing lines would be unable fully to accommodate forecast demand growth and would lead to unacceptable levels of crowding on many routes[70]." In coming to this conclusion the Government took into account the environmental implications though environmental issues were not the determining factor[71].

6.1.6 However, in order to explore the options as thoroughly and fairly as possible, the Government has appraised the rail upgrade options on four occasions, prior to the decision to proceed to consultation in March 2010, prior to the consultation in February 2011, following consultation prior to the decision in January 2012 to promote a hybrid Bill, and in 2013 prior to Bill deposit. The details of these appraisals are set out Strategic Alternatives Study reports prepared by Atkins.

6.1.7 In the following narrative, it is important to understand that not only did the options considered change at each stage, but the models and modelling evolved, and the base year, demand forecasts, costs and other inputs were updated. Thus at each stage the appraisals were, so far as is possible, consistent with those for HS2, but the results of the successive appraisals are not directly comparable with their predecessors.

Demand

6.1.8 As with the road upgrade options, the appraisals used three related models, PLANET long Distance (all day), PLANET Midlands (peak) and PLANET South (peak). Forecast demand comprises two components, the exogenous background demand and the demand generated by better, faster or more frequent services. The exogenous demand forecasts used for each of these models in 2010, 2011 and 2012 is set out in Table 4. In each case it is assumed that demand ceases to grow at the end of the forecast period (the "final year"). These demand forecasts were then put into the rail industry standard PDFH[72] model to forecast the additional demand that would be attracted by additional, higher capacity, faster or more convenient services.

Table 4: Demand forecasts

	February 2010 growth[73] 2008-33	**February 2011 growth[74] 2008-43**	**January 2012 growth[75]**	
			2010-37	**2010-43**
PLANET Long	+62%	+60%	+44%	+60%

[70] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.17 para. 6
[71] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 pp.71-71 paras.3.91-2
[72] Passenger Demand Forecasting Handbook
[73] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.12 Table 3.1
[74] High Speed 2 Strategic Alternatives Study: London to West Midlands Rail Alternatives: Update of Economic Appraisal, Atkins, February 2011 Table 2.1
[75] High Speed Rail Strategic Alternatives Study: Update following Consultation, Atkins, January 2012 p.13 Tables 3.1 & 3.2

	February 2010 growth[73] 2008-33	February 2011 growth[74] 2008-43	January 2012 growth[75]	
			2010-37	2010-43
Distance				
PLANET Midlands	+43%	+43%	+29%	+43%
PLANET South	+46%	+55%	+46%	+55%

6.1.9 In each of the modelling exercises to compare HS2 with options the demand forecasts, the base and final years have been revised and the models updated and refined. The final year has been varied between 2033 and 2043 and in the latest appraisals is assumed to be 2036. Final year PLANET long distance all day growth in the 2013 economic appraisal is assumed to be around +76%, PLANET Midlands peak growth +58% and PLANET South peak growth +76%.

Capacity overview

6.1.10 There are four main lines from London to the midlands and the north – the Chiltern Line, the West Coast Main Line, the Midland Main Line, and the East Coast Main Line. All four routes are intensively used by a wide variety of long and short distance passenger services and freight trains running on different sections of the route and at different speeds. The current mix of services on these three lines utilises available capacity to run trains into London, Birmingham, Leeds and Manchester and utilisation is at or near capacity for some sections of the routes between these cities. This intensity of use has had an increasingly adverse effect on the reliability of services, as each time a train is delayed it causes delay to the following trains.

6.1.11 In the peak hour the trains are also full on many services. At Euston in 2012 over 40% of trains in the morning and evening peak periods had passengers standing, and 10% of peak hour passengers on trains approaching Birmingham, Leeds, Manchester and Sheffield are standing.

6.1.12 There is a tendency for successive enhancements to existing lines to show diminishing returns as the more cost effective projects are identified and implemented first. All four lines have undergone upgrading programmes in recent years and as the most obvious and cost effective schemes are implemented, the opportunities for further enhancement have become increasingly limited and/or expensive. Phases one and two of HS2 will provide substantial released capacity on the WCML, the MML and the ECML. The opportunities for major enhancement on these routes can be summarised as follows.

West Coast Main Line

6.1.13 Following completion of the West Coast Route Modernisation in 2008 the WCML is mostly grade separated between London and the West Midlands. It is now effectively a six track railway as far north as Watford Junction and four tracks to the North-West. There are few bottlenecks left to address south of Birmingham to provide increases in

capacity. Thirteen trains run on the fast lines in the evening peak hour (14 on Friday) and this could be increased to 15-16tph though this may require some infrastructure works. Any further increase in long distance train path capacity would require an additional pair of tracks to Watford for commuter services and to the West Midlands for medium and long distance services, as well as grade separation and other enhancements further north.

6.1.14 A programme to maximise upgrade capacity could address passenger crowding pressures on the fast and slow line trains to the late 2020s assuming that future growth rates are at least 2.5% annually which is lower than the 4.5% growth rate which has been experienced over the last five years on London commuter operators. However it could not also provide additional freight paths or sufficient capacity for demand growth in the long term.

Midland Main Line

6.1.15 In recent years, use of the MML has been dominated by the growth of commuter services on Thameslink and the resulting crowding is being addressed, in part, by the Thameslink upgrade. Although historically there was capacity for a large number of commuter trains to use the fast lines to access London, the increase in both the fast and slow line trains has made this more difficult.

6.1.16 A realistic maximum programme of upgrades could include, inter alia, additional platforms at St. Pancras, Nottingham and Chesterfield, electrification of the Erewash Valley Line, a tunnel and four-track approach to Sheffield from the south:

- better journey times to Leeds, Nottingham and Sheffield;
- more fast and slow line capacity to reduce commuter crowding;
- some additional fast line capacity.

East Coast Main Line

6.1.17 The East Coast Main Line has been undergoing a programme of enhancements that have included, amongst others, upgrading track and station works at Kings Cross, Finsbury Park, and Peterborough and a fly-over at Hitchin. Other schemes are programmed or are under construction. However, capacity is severely constrained at the southern end and through Welwyn where there is a two track section of tunnel and viaduct and four-tracking would be extremely expensive.

6.1.18 Following the new timetable planned for 2018/19, the East Coast route will be already full for both inter-city and suburban trains, and between now and then there is no further capacity for freight trains between London and Peterborough. The kinds of upgrades that might therefore be proposed are more substantial in nature including:

- extension of all platforms at Kings Cross to permit 12 car operation (but losing one of the platforms in the process);
- a long tunnel from near Alexandra Palace to North of Hitchin, bypassing the Welwyn Viaduct, complete with a new spur to the Cambridge line;

- upgrading of the ECML to 360kph (from 200 kph today) ;
- grade separation of the railway at Peterborough, Newark and Doncaster;
- a new tunnel from near Wakefield into Leeds to provide better access; and
- creation of a new line bypassing Durham partly using the former Leamside line alignment.

6.1.19 This might permit an increase of ECML capacity up to 10-11tph from today's 7-8tph. However, trains would still need to interact with today's East Coast route since it will not be entirely physically separated. The scale of this project itself would be very substantial, in the order of £11bn.

Chiltern Main Line

6.1.20 The Chiltern Main Line (CML) runs between London and Birmingham via High Wycombe, Banbury, and Leamington Spa. There is also a branch to Aylesbury via Harrow-on-the-Hill and Amersham. The "Evergreen 2" upgrade was completed in 2006, including works to increase line speeds from 40 mph to 75 mph and two platforms at Marylebone to increase the station's capacity to 20tph.

6.1.21 The 'Evergreen 3' project is partially implemented and includes increasing line speeds, additional platforms at Birmingham Moor Street and a new half hourly service from Oxford to Marylebone via Bicester. Following these upgrades the opportunities for further enhancement are now much more limited and, despite the enhancements, journey times from Birmingham to London on the CML are significantly slower than on the WCML.

Strategic Rail Alternatives 2010

6.1.22 In March 2010 the analysis was confined upgrades to the WCML and the CML and it focussed on the London to West Midlands corridor. In selecting rail upgrade packages to compare with HS2, it was assumed that there would be no reductions to existing services and that additional trains would not be permitted to compromise their reliability.

6.1.23 The do-minimum 'Reference Case', with which enhancement options were compared, included schemes highly likely to be implemented within ten years such as Thameslink, Crossrail, increasing the length of all remaining Pendolino trains on the WCML from nine to eleven cars, and planned infrastructure enhancements. On the CML the Reference Case included train lengthening in the peaks[76].

6.1.24 The upgrade options to serve post 2021 demand growth comprised five packages. Rail Package 1 (RP1) to provide additional capacity by lengthening the trains was a stand alone option. The other four rail packages were a series of incremental enhancements, each assuming implementation of the previous one. The infrastructure works assumed necessary and the train service enhancements are listed in Table 5.

[76] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.10 para.3 2 2 1

Table 5: Rail packages infrastructure works

Package	Infrastructure components	Service outputs
Rail Package 1 (RP1)	Longer long distance trains. Extensive platform. Station and other works not specified in detail	Longer long distance trains on the WCML (14-car and 17-car options).
Rail Package 2 (RP2)	Increase in train service frequencies on the WCML effectively providing four tracks throughout and grade separation as far north as Crewe - Stafford area by-pass - Grade-separation between Cheddington and Leighton Buzzard - 3 new platforms at Euston Station - 3 extra platforms at Manchester Piccadilly (with grade-separation at Ardwick) - 4-tracking Attleborough – Brinklow (including freight capacity works at Nuneaton) - Northampton area speed improvements - 4-tracking Beechwood Tunnel to Stechford (the 'Coventry corridor')	Increase in train service frequencies on the fast lines at the southern end of the WCML (from 13-14tph) to a maximum of 16tph[77].
Rail Package 3 (RP3)	RP2 + Chiltern Line capacity enhancement Package 2 West Coast Main Line enhancements except 4-tracking Beechwood Tunnel to Stechford, plus enhancements on the Chiltern Main Line: - Electrification throughout - line speed increase to 125 mph maximum - provision of extra platforms at Birmingham Moor Street - Kenilworth (Leamington – Coventry) track doubling - 4-tracking Tyseley – Dorridge - Extended (freight) loop at Fenny Compton - Banbury by-pass line - Improvements at Princes Risborough - New 2-track tunnel Saunderton – Seer Green (avoiding High Wycombe) - 4-tracking Seer Green – South Ruislip (Northolt Junction)	RP2 plus: Four fast WCML London to Birmingham trains to be diverted via the Chiltern Main Line to Paddington, releasing capacity on the WCML for additional services to Liverpool, Glasgow and Warrington[78].

[77] HS2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p.17 para.5.1.1
[78] High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p.28 para.6.1.1

Package	Infrastructure components	Service outputs
	- 2-tracking South Ruislip – Paddington (via Park Royal and Old Oak Common)	
Rail Package 4 (RP4)	RP3 + further upgrades to the Chiltern Main Line to reduce London to Birmingham journey times. Package 3 WCML enhancements plus: - 2 track alignment from Berkswell to the Chiltern Main Line near Harbury including a Parkway station South of Coventry - 4-tracking Berkswell-Stechford - extra platforms at Birmingham Moor Street served by the WCML Chiltern line Package 3 enhancements except 4-tracking Tyseley-Dorridge, 2-tracking Kenilworth-Coventry and extra Chiltern Line platforms at Birmingham Moor Street	RP3 plus: Journey times on the Chiltern Line between London and Birmingham reduced to approximately 1 hour[79].
Rail Package 5 (RP5)	Additional capacity between Birmingham and Stafford to enable WCML services between London and the North West to be diverted to the Chiltern route Package 4 infrastructure enhancements plus on the Chiltern Line: - 4-tracking the remainder of the route - Grade-separation of Aston Junction - 4-tracking Aston - Stafford via Bescot, Wolverhampton avoiding line, and Penkridge.	RP4 plus: Divert two north of Stafford WCML trains via Chiltern Line[80].

Rail Package 1

6.1.25 Lengthening the 9-car Pendolino trains to eleven cars was assumed to be implemented in any event and was therefore included in the Reference Case. Rail Package 1 – lengthening the WCML Pendolino trains – comprised options for 14-car and 17-car trains. It was concluded that the 17-car (400m) platform extensions would be "hugely disruptive and expensive to implement", would not be feasible at Birmingham New Street and Liverpool Lime Street and would be extremely difficult at Coventry. Major investment would also be needed for power supply, junction alterations, depots and enhancements to avoid overcrowding in stations[81].

6.1.26 The fourteen car option comprised 14-car trains to Birmingham, Manchester and Glasgow, but only 11-car trains to Liverpool. This option would also require very

[79] High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p.49 para.7.2.1
[80] High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p.53 Para.8.1
[81] High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 pp. 12-13 para.4 3.1.1

substantial, costly and disruptive platform lengthening and additional expenditure on power supply, depots and sidings, and it could have a negative effect on train performance and reliability. In the absence of any journey time savings and very high expected costs, the option would not be economically viable[82].

6.1.27 It was concluded that RP1 would be unlikely to be significantly less expensive or disruptive than providing the infrastructure for more train services and would be unlikely to represent a viable alternative to HS2. Consequently, this option was not taken forward. The other four packages were appraised[83].

Rail packages 2-5

6.1.28 Rail Package 2 would provide a moderate increase in rail capacity on the WCML by increasing the fast line service to 16tph throughout the day. There would be no change in services on the slow lines.RP3-5 are incremental enhancements to the CML to improve line speed and so that WCML services can be transferred to the CML to release paths on the WCML for additional services.

6.1.29 The analysis indicated that implementation of RP5 (which includes RP2-4) would, at least in theory, double the combined capacity of the two routes and be sufficient to ensure that crowding in 2033 would not on average be worse than on current services. It also showed that Package 2 on its own would provide enough extra seats on the WCML to ensure that crowding would be broadly in line with 2008 levels until around 2033, and that on the Chiltern Line the planned longer peak trains in the reference case should be sufficient[84].

6.1.30 On implementation of Package 2, crowding would increase somewhat over 2008 levels unless the demand can be diverted to the Chiltern Main Line through implementation of Packages 3-5. However, the analysis also showed that the RP3-5 enhancements to the CML would offer relatively small crowding relief on the West Coast Main Line in relation to their very substantial cost.

6.1.31 Overall, the appraisal concluded that RP2 would reduce journey times (by 12 minutes to Birmingham and 6.5 minutes to Manchester) and have an indicative BCR of between 3.6 and 2.9 depending on costs and assumptions. It would have only moderate environmental impacts, but implementation would be disruptive to existing services[85]. RP5 would cost more than HS2 without the benefit of reduced journey times and this is reflected in the low BCR.

6.1.32 Two additional variants were also appraised[86] - RP2A which added performance resilience to RP2 to reduce delay to following trains from breakdowns etc., and RP3A which was the RP3 package to the CML without the RP2 enhancements to the WCML (See Table 6). RP2A had a lower BCR than RP2 because costs would be marginally higher and the benefits would be lower due to the slower journey times. RP3A would

[82] High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p. 24 para.4 3.1.2
[83] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p. 28 para.3.3.3.2
[84] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p. 38 Table 3.7
[85] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 pp.73-75 Section 8.1
[86] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 pp.59-61 Section 4.8.3

have a higher BCR than RP3 because the costs would be much lower without any works to the WCML. Even so its BCR was less than 1.2:1.

Table 6: Additional rail upgrade packages

Package	Infrastructure components	Service outputs
Rail Package 2A	As for RP2 The current timetable includes additional time to assist recovery from delays and incidents. Package 2 assumed removal of this performance cushion whereas it is reinstated in Package 2A	Journeys to Manchester would be only 3.5 minutes faster instead of 6.5 minutes faster in Package 2
Rail Package 3A	In order to assess the effects of upgrading the Chiltern Line only, there are no WCML infrastructure enhancements in Package 3A and the WCML recovery time has been reinstated as in Package 2A.	Train services would be similar to Package 3, but with some modifications to WCML services

6.1.33 Reviewing the analysis of the rail upgrade options, the Government in 2010 decided to continue to prepare proposals for a new high speed line because the upgrade packages would together cost more than a new line but would offer only marginal reductions in journey times and at best only half the capacity benefit, as well as being very disruptive to implement (the cost of which was not included in the appraisal)[87].

Strategic Rail Alternatives update – February 2011

6.1.34 Later in 2010 Atkins were re-engaged to update their and expand their study of rail upgrade alternatives for the public consultation. The packages assessed previously were unchanged. For this 2011 round of appraisals, the baseline capacity was updated. Demand was forecast to grow more slowly, partly to reflect the impact of the recession. The final year was put back from 2033 to 2043 at which time the West Midlands final demand would be broadly the same as in the 2010 appraisal, but the WCML long distance forecast was 2% lower and the London commuter (Chiltern) forecast was 9% higher. It should also be noted that the actual current patronage and crowding in 2011 was by this time significantly higher on both routes, but that was not reflected in the modelling[88].

6.1.35 Compared with the 2010 appraisal, changes to the modelling approach, the lower reference case crowding and lower demand forecasts produced lower BCRs for HS2 and all the upgrade options but particularly for Rail Packages 3-5[89].

6.1.36 These five rail packages focussed on the London to West Midlands corridor, but the Y network to Manchester and Leeds provides capacity and time saving directly to the

[87] High Speed Rail, DfT, March 2010 (Cm.7827) P.46 Para. 2.22 and p.50 2.40-6
[88] High Speed 2 Strategic Alternatives Study: London to West Midlands Rail Alternatives - Update of Economic Appraisal, Atkins, February 2011 pp.6-8 Sections 2.3 & 2.4
[89] High Speed 2 Strategic Alternatives Study: London to West Midlands Rail Alternatives: Update of Economic Appraisal, Atkins, February 2011 pp.28-29 Section 7

North-West, the East Midlands and Yorkshire. In October 2010 the Government commissioned Atkins to assess three rail upgrade alternatives to the proposed 'Y' network[90]. These new scenarios included enhancement to the Midland and East Coast and West Coast Main Lines, but not the CML.

- Scenario A, which explored the effects of lengthening trains on all three main lines;
- Scenario B, examined providing more long distance trains, based on RP2 for the WCML and additional trains on the MML and ECML; and
- Scenario C, based on RP3 and further increases in East Coast long distance trains.

6.1.37 Scenarios A, B and C were evaluated assuming the same exogenous demand forecasts as for Rail Packages 2-5.

Scenario A

6.1.38 WCML inter-city services would be lengthened to eleven cars Liverpool and fourteen cars to Manchester, Glasgow and Birmingham, to eleven cars on the MML and twelve cars on the ECML.

Table 7: Scenario A components

Package	Infrastructure components	Service outputs
West Coast Main Line	Longer platforms and associated enabling works at the following stations -Euston, Watford Junction, Milton Keynes, Nuneaton, Lichfield, Stafford, Warrington, Wigan, Preston, Lancaster, Oxenholme, Penrith, Carlisle, and Lockerbie. In addition the throat at Euston would need to be re-modelled, this would require land acquisition and property demolition Depot modifications for longer trains Power supply strengthening for overhead line equipment.	11-Car Trains To Liverpool 14-car trains to Birmingham, Manchester and Glasgow 21% seated capacity increase into London
Midland Main Line	Longer platforms and associated enabling works at the following stations – Luton Airport Parkway, Luton, Bedford, Wellingborough, Kettering, Corby, Market Harborough, Loughborough, East Midlands Parkway, and Chesterfield	11-car long distance trains 16% seated capacity increase into London
East Coast Main	Longer platforms and enabling works at the following stations –	12-cars on all intercity long distance

[90] High Speed Rail Strategic Alternatives Study: Strategic Alternatives to the Proposed 'Y' Network, Atkins, February 2011

Package	Infrastructure components	Service outputs
Line	Peterborough, Grantham, Newark, Retford, Doncaster, Wakefield Westgate, York, Durham, Alnmouth, and Berwick. Additional infrastructure enhancements include: – Kings Cross throat re-modelling; – Depot modifications for longer trains; and – Power supply strengthening for overhead line equipment.	trains 31% seated capacity increase into London

Scenario B

6.1.39 Scenario B explores the potential of increased services on the main lines. On the WCML it assumes the RP2 enhancements and services, but it also includes additional long distance trains on the Midland and East Coast Main Lines.

Table 8 Scenario B components

Package	Components	Service outputs
West Coast Main Line	Rail package 2 enhancements	Rail package 2 service enhancements
Midland Main Line	Electrification from Bedford to Sheffield; A freight loop facility between London and Bedford; Re-instatement of four-tracks between Bedford and Kettering; Re-instatement of two-tracks between Kettering and Corby; Station area re-modelling at Corby; Re-modelling and four-tracking in the Leicester area; Electrification and increased stabling capacity at depots.	8tph north of Bedford
East Coast Main Line	Re-modelling and re-instatement of a third tunnel and six-track approach at King's Cross; Four-tracking Digswell – Woolmer Green; Four-tracking Huntingdon – Peterborough; Werrington flyover at Peterborough; Four-tracking Stoke Junction–Doncaster; A flyover for Nottingham to Lincoln route at Newark; Works to address low-speed turnouts and restrictive signalling at Retford; Electrify and upgrade Retford–Sheffield;	10tph long distance timetable with 10-car inter-city trains

Package	Components	Service outputs
	Re-modelling and extra platforms at Doncaster; and Electrification of Hambleton Junction to Leeds.	

Scenario C

6.1.40 Scenario C assumes implementation of 16tph on the WCML and the RP3 Chiltern Line enhancements in order to transfer four WCML Birmingham services, as well as an additional 2tph on the East Coast Main Line. The enhancements to infrastructure and services are set out in Table 9.

Table 9: Scenario C components

Package	Components	Service outputs
West Coast Main Line	Rail Package 2 upgrades with the exception of the 4-tracking of Beechwood Tunnel to Stechford.	Rail Package 3 on CML RP2 on WCML but four Euston-Birmingham services transferred to CML to release 3tph WCML paths for enhanced services to Liverpool, Glasgow and Warrington.
Chiltern Line	Rail Package 3 upgrades	Rail Package 3
Midland Main Line	No additional works beyond Scenario B	As Scenario B
East Coast Main Line	As Scenario B, plus the extra infrastructure enhancements: – Grantham – Nottingham – electrify and upgrade; and, – Peterborough area – new 140 mph 15-mile electrified bypass line with grade-separations at each end.	12tph Long Distance Timetable (i.e. Scenario B + 2tph to Nottingham

6.1.41 In the 2011 pre-consultation appraisals, only Rail Packages 2, 2A and Scenario B had benefits greater than costs. The Government accepted that an environmental analysis would broadly favour enhancements to existing lines over new alignments: "the sustainability impacts of enhancing existing networks would be more favourable than those of new high speed lines – particularly in respect of factors such as visual impact, land take and noise."[91] The conclusions that the Government drew from these

[91] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.60 para 2.92

appraisals were that, as an alternative to HS2, upgrading the existing main lines would:

- generate only a relatively small increase in overall capacity in comparison to new lines – and this would be particularly small in relation to the commuter, regional and freight markets, because much of the new capacity generated would be used for long-distance services[92];
- achieve smaller improvements in journey times in comparison to those delivered through high speed rail[93];
- be likely to deliver comparatively few 'wider economic benefits' as these are mainly generated through improved commuter services[94];
- not support job creation to the same degree as high speed rail, and nor could they match the regeneration opportunities associated with new high speed rail stations[95];
- not enhance interchange opportunities as they would rely on the same stations and interchanges as are currently in place[96]; and
- cause significant disruption to passengers as works are carried out[97]. The 2011 Consultation Document acknowledges that the disruption would not be as serious on any single line as the previous West Coast Main Line upgrade, but it would still be significant, not least because the network is now more heavily used than when that project was completed.

6.1.42 The Consultation Document set out the Government's overall conclusion, having taken into account the environmental advantages of enhancing existing lines, the economic assessments made by Atkins, and the broader factors set out above, that such enhancement scenarios 'would not provide a strategic value for money alternative to high speed rail'[98].

Strategic Rail Alternatives Review – January 2012

6.1.43 During the 2011 consultation, over 7,000 respondents expressed a preference for upgrading existing lines[99]:

- some respondents maintained that the demand forecasts were too high and criticised the economic comparison of HS2 with the rail upgrade alternatives;
- many argued in favour of enhancing existing lines rather than building new infrastructure, many of them citing RP2 as the best approach to enhancing capacity; and

[92] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.58 para 2.87
[93] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.58 para 2.88
[94] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.59 para 2.90
[95] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.59 para 2.91
[96] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.59 para 2.91
[97] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.60 para 2.93
[98] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.61 para 2.94
[99] High Speed Rail: Investing in Britain's Future Consultation Summary Report, Dialogue by Design, November 2011 p.61

- the 51M group of local authorities put forward an optimised variant of Rail Package 2, the 'Optimised Alternative' (OA) designed to maximise the capacity potential of the West Coast Main Line.

6.1.44 In response to these comments the Government decided to commission further work on the strategic rail upgrade options before taking any decisions. It commissioned Atkins to update their value for money modelling and to appraise Rail Packages 2 and 2A, Scenario B and the 51m OA proposal. At the same time it commissioned Network Rail to undertake a technical review of these options.

Rail Package 2

6.1.45 In 2012 some of the infrastructure that was included in the February 2011 appraisal to support the additional RP2 services was no longer considered necessary. Network Rail advised that it would not be necessary to grade separate Ardwick Junction or provide additional platforms at Manchester Piccadilly station following the Government decision to fund the Ordsall Chord connecting Manchester's Piccadilly, Oxford Road and Victoria stations. The Stafford bypass scheme was also reduced in scope. A consequence of these changes is that infrastructure costs would be substantially reduced but journey times between Crewe and Colwich would not be reduced.[100]

The 51m Group Optimised Alternative

6.1.46 The Optimised Alternative is based on the RP2 option, but with additional capacity and reduced infrastructure. The 51m proposal did not include additional platforms at Euston or four-tracking between Beechwood and Stechford, but it did include works to increase line speed at Northampton. Compared with RP2, there would be more capacity enhancement on outer suburban services and less on long distance services.

6.1.47 The proposed service changes are:

- lengthening long distance trains to twelve cars (except Liverpool Lime St. trains);
- reconfiguring one first class carriage to standard class;
- running additional peak long distance services; and
- running four fast line services to outer suburban destinations.

6.1.48 The Optimised Alternative builds on Atkins' work on RP2, but provides an additional increase in capacity through using 12-car Pendolino train sets for the majority of long-distance services in contrast to the 11-car trains in RP2 and by converting one first-class carriage on West Coast Main Line inter-city trains to standard-class. It also makes some alterations to the service pattern used by Atkins, for example including one fewer long-distance service to Birmingham and one extra service to the North West.

[100] High Speed Rail Strategic Alternatives Study: Update following Consultation, Atkins, January 2012 p.6

6.1.49 The Optimised Alternative assumes that some of the infrastructure works proposed in RP2 would not be necessary:

- Works to the Coventry corridor into Central Birmingham;
- The additional platforms and associated works at Manchester Piccadilly - on the basis that other schemes would free up the necessary capacity; and
- The additional platforms at Euston.

6.1.50 51M concluded that by running additional services and increasing seating capacity through longer and reconfigured trains, the Optimised Alternative could increase all day total capacity by roughly 150% over 2008 levels. Total peak capacity would be increased by approximately 90% over 2008 levels on both inter-city and fast commuter services (i.e. services to locations such as Milton Keynes and Northampton which used the fast lines for a portion of their journey)[101].

Network Rail conclusions on January 2012 options[102]

6.1.51 Network Rail's analysis focused on RP2 and the Optimised Alternative, and also Scenario B. For RP2 and the Optimised Alternative, it:

- reviewed the adequacy and cost of the infrastructure proposals to deliver the service specifications. In relation to the Optimised Alternative, Network Rail used the cost estimates in the 51M Appendix, which drew directly on Atkins' analysis;
- considered the scale of the infrastructure works and the level of disruption that would be likely to be caused, and made a high level assessment of the impacts of each scheme on the reliability of the network; and
- carried out its own analysis of the likely crowding impacts of each scheme, using modelling tools designed to replicate a detailed peak timetable and carried out an assessment of the network's capacity following the completion of each proposal to accommodate aspirations for additional passenger and freight services (identified, for example, through its engagement with Train Operating Companies and others as part of the Route Utilisation Study process).

6.1.52 The analysis concluded that the service specifications and timetables provided for the Optimised Alternative and RP2 would be broadly deliverable on completion of the proposed infrastructure, although the report expressed some scepticism about removing timetabling allowances as proposed in RP2[103]. Consequently, Atkins' updated economic analysis included an assessment of RP2A as well as RP2. However, Network Rail also advised that the following costs had not been included:

[101] 51m Response to HS2 Consultation Appendix 1 Optimised Alternative to HS2 - The Scope for Growth on the Existing Network, 51m Consortium of Local Authorities, 2011
[102] Review of Strategic Alternatives to HS2, Network Rail, November 2011
[103] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.27 3.3.2

- the Optimised Alternative proposal omitted the costs associated with platform-lengthening works to enable 12-carriage Pendolino trains to operate. (Network Rail estimated that these works would cost approximately £345 million, excluding any works at Euston)[104];
- Neither RP2 nor the Optimised Alternative included costs to upgrade or enhance depot facilities to service the additional rolling stock needed to operate the proposed timetables. This would be a particular issue for the Optimised Alternative if existing depots proved unable to accommodate the longer 12-car trains[105];
- the cost allowances for compensation to Train Operating Companies relating to disruption caused by infrastructure works appeared low in comparison to those incurred on the previous WCML upgrade[106];
- no allowance was made for potential increases to maintenance costs associated with a more intensive service pattern[107]; and
- the costs of works at Euston station were likely to have been significantly under-estimated[108].

6.1.53 In relation to Euston station, the RP2 proposal had included a low-cost approach to providing more platform capacity by incorporating three additional platforms into the area currently occupied by Platforms 16-18 and the parcel deck. The Optimised Alternative had assumed that no works would be required at Euston. Network Rail's analysis did not support either of these conclusions. In relation to RP2, it found that new platforms would be likely to be required and that the proposed low-cost option for delivering these would not be feasible, meaning a major remodelling would be required, which would be 'expected to cost several hundred million pounds'[109]. In relation to the Optimised Alternative, it found that this would be likely to require significant platform lengthening works, and the need for additional platforms could not be ruled out, with platform lengthening alone necessitating "a major remodelling of London Euston station, including the phased closure of sections of the station with major demolition and rebuilding programmes"[110].

6.1.54 In addition to its assessment of the cost estimates for these schemes, Network Rail's report also raised a number of concerns in respect of the operational impact on the network of RP2 and the Optimised Alternative:

- Neither proposal would provide sufficient capacity to meet forecast demand on the suburban commuter services at the south end of the West Coast Main Line[111];

[104] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.9 2.2.2 and p.10 2.3.1
[105] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.10 2.3.1
[106] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.10 2.3.1
[107] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.13 2.3.2
[108] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.5 2.1 and p.10 2.3.1
[109] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.22 3.2.1
[110] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.10 2.3.1
[111] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.14 2.3.3 and p.28 3.3.3

- the proposals would all result in long periods of disruption along the route while the infrastructure interventions were constructed (the report notes that this disruption would be "on routes that are more popular and are being used more intensively than ever before" and across all three main lines could be similar to that arising from the West Coast Route Modernisation)[112];
- the high utilisation of the fast lines in both proposals would negatively impact on route performance[113];
- both service specifications would increase long distance connectivity on some flows, however, this would be at the expense of other intermediate distance flows, where connectivity would severely worsen[114]; and
- both schemes would limit the network's capacity to accommodate growth in regional markets, particularly on the line into Manchester Piccadilly and, for the Optimised Alternative which included no upgrade to this route, on the Coventry corridor into Birmingham[115].

6.1.55 A number of these concerns, notably their effects in relation to commuter and regional demand, and the potential disruption impacts, had been foreshadowed in Chapter 2 of the Consultation Document[116]. Network Rail used its own modelling to estimate commuter crowding and concluded that, under the RP2 scheme, the number of passengers standing on commuter services out of Euston in the evening high peak hour would rise from roughly 800 currently to 2,000 by 2035[117]. The increase in standing passengers under the Optimised Alternative would be higher again, as a result of the slightly reduced service pattern into Euston, with this proposal seeing the number of standing passengers during the evening high-peak hour increase to around 2,200 by2035[118].

6.1.56 On Scenario B, Network Rail concluded that Scenario B "is not a suitable long-term strategy for the corridors in question". Amongst other things:

- significant, and expensive, additional infrastructure works would be required on both lines over and above those included in the proposals and cost estimates in order to deliver the service specifications proposed
- the disruption to services during construction would be very substantial (perhaps worse than on the West Coast Main Line given the fewer diversionary routes available on these corridors);
- on the East Coast corridor in particular the proposals did not appear to provide a long-term solution to forecast capacity issues on outer suburban commuter services.

[112] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.10 2.3.1 and p.24 3.3.1
[113] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.27 3.3.2 and p.13 2.3.2
[114] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.5 2.1 and p.19 3.1
[115] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.5 2.1 and p.19 3.1
[116] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.60 para 2.92
[117] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.30 3.4
[118] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.17 2.4

Appraisal of January 2012 options

6.1.57 For the January 2012 business case analysis Atkins revised the demand forecasts, reviewed the assumptions and added greater detail to the modelling. Demand was rebased to 2010 so that the growth in long distance patronage between 2008 and 2010 (+4%) following completion of the WCML Route Modernisation and the growth in commuter travel (+7%) were included in the baseline.

6.1.58 The final year forecast was revised so that, compared with the 2011 appraisal, PLANET long distance was reduced by 6%, PLANET Midlands by 4% and PLANET South was approximately the same, but the final year of the forecast would occur earlier, in 2037 instead of 2043.

6.1.59 In the light of Network Rail's analysis, the infrastructure costs relating to works at Manchester Piccadilly were removed by Atkins from the costs of RP2 (and hence also of the West Coast Main Line element of Scenario B) and the costs relating to works at Stafford were reduced. This led to a significant overall reduction in infrastructure costs. In relation to costs at Euston, given that Network Rail's report did not include a specific cost estimate, a decision was taken to retain the costing estimated by Atkins, but to note the potential for these costs to increase significantly was noted as a key risk.

6.1.60 For the Optimised Alternative, Atkins used the infrastructure costs set out in the 51M Appendix (which drew directly from Atkins' earlier work on RP2). In addition, the £345 million cost identified by Network Rail for platform lengthening and other works along the route was included. As with RP2, the potential costs of works at Euston were noted as a key risk.

6.1.61 In addition, a review of operating costs was carried out covering both HS2 and the Strategic Alternatives. This process led to a number of changes, both upwards and downwards, to specific cost items, with the overall effect of reducing operating costs in comparison to Atkins' previous analysis.

6.1.62 When it reviewed the evidence on the upgrade options, including the Optimised Alternative, in January 2012, the Government noted that the appraisals of upgrade options showed strong benefit:cost ratios and significantly lower capital costs. It noted Network Rail's reservations on capacity and crowding, operational issues, unquantified additional costs and disruption to services over a long period during construction. It also accepted that upgrades would tend to have lower environmental and sustainability effects on landscape, townscape and noise. On carbon emissions it weighed the advantage of lower emissions against the opportunities for a new high speed line to attract passengers from domestic aviation. However, the key issue was that even an extensive package of upgrades would not address demand, capacity and crowding in the long-term. It concluded:

> "The Government's view is that any sustainability and cost advantages are outweighed by the substantial disbenefits of enhancing existing lines. Furthermore, even if some options may offer good value for money, they fail to offer an effective long-term solution to crowding issues and therefore cannot be considered a viable

alternative to new lines. There is a significant risk that an approach of this kind would simply create years of delay and disruption for passengers and freight services, and even after that only give rise to a railway that it is still overcrowded, delaying but not avoiding the need for new lines. For these reasons, the Government does not favour this strategic approach to addressing the long term rail capacity constraints."[119]

6.1.63 A number of further issues relating to the main Strategic Alternatives were considered in the Review of the Government's Strategy for a National High Speed Rail Network. These included the distribution of any additional capacity provided, the inability of such alternatives to address the historic limitations of the current rail network in respect of poor connectivity between regional cities, their failure to improve rail access to the key international gateways or to Crossrail, and their comparatively low wider economic impacts[120].

October 2013 review

6.1.64 Prior to deposit of the hybrid Bill the Government has reconsidered the potential for upgrading the ECML, MML and WCML as an alternative to implementing HS2. The purpose of the analysis was:

- as a robustness check to ascertain whether packages of enhancements not previously explored might affect previous conclusions on the potential of the existing network to provide capacity to serve growing demand after the 2020s;
- to ensure that the conclusions drawn from previous appraisals remained valid in the light of the most recent WCML timetable changes, demand forecasts, PLANET modelling and economic appraisal framework;

6.1.65 Packages of enhancements were prepared to address three scenarios:

- as an alternative to HS2 Phase One without Phase Two - this option was for the WCML only and was based on RP2 with a 16tph service on the fast lines, but also included extending all Pendolino trains to eleven cars, conversion of one first class car to standard class, and extending all slow line services into Euston to twelve cars throughout the day;
- As an alternative to HS2 Phase Two assuming Phase One has been built;
- as an alternative to both phases of HS2 including frequency enhancements and service changes on all three lines and consequential changes to cross country services.

6.1.66 The Government concluded that " The alternatives to Phase One and the full HS2 scheme would each offer ways of providing some additional capacity on the network. Some of the upgrade schemes are likely to be taken forward as part of Network Rail's

[119] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.72 para.3.92
[120] Review of the Government's Strategy for a National High Speed Rail Network, DfT, 2012 paras 5.3.13-18, 5.4.3-4, 5.8.1-4

normal forward planning process to modernise the network. However, they do not deliver satisfactorily against the objectives set for HS2. In particular, they:

- "do not provide sufficient additional capacity to meet the long term needs for the north-south railway;
- do not provide significant additional released capacity for commuters and freight on the West Coast Main Line;
- fail to offer a robust solution to the problem of resilience and performance, particularly on the West Coast Main Line which suffers from unacceptably high levels of unreliability;
- would significantly disrupt services on existing lines as construction work is carried out over a period of many years. In the case of the full 'Y' alternative, there would be large scale disruptive work on the three main north-south lines. Network Rail has estimated that this could result in up to 14 years of service disruption which the Government considers is not acceptable; and
- fail to provide the scale of connectivity benefits for the major cities of the Midlands and north and this, together with limited capacity gains in the longer term for commuters, freight and long distance travel, means that they would not achieve the overarching economic aim set for HS2. "[121]

[121] The Strategic Case for HS2, DfT, October 2013 p.135 para. 6.4.2

PART II SCHEME COMPONENTS

6.1.67 The original elements of the Proposed Scheme are set out in HS2 Ltd's report High Speed Rail London to the West Midlands and Beyond . This included operational and technical specifications and geographic requirements comprising a London terminus, an interchange with the Great Western Main Line, Crossrail and Heathrow, the feasibility of a connection to Hs1 and the potential for an intermediate parkway station.

6.1.68 In 2009 HS2 Ltd approached the task of identifying and selecting options by dividing the scheme into four components:

- London stations
- Heathrow/Crossrail interchanges
- Lines of route
- West Midlands stations and routes

6.1.69 For each component a long list of options was prepared, then sifted to determine a short list of the more promising ones, from which the best option was then selected. The four components were subsequently reconciled and amalgamated to form the preferred Scheme. An amended version of the proposed route and scheme elements was published by the Secretary of State in March 2010. Since then the Scheme has been augmented, refined and reviewed, both before and after the public consultation in 2011. The main route and scheme component options considered during this process are described below.

7 London terminus

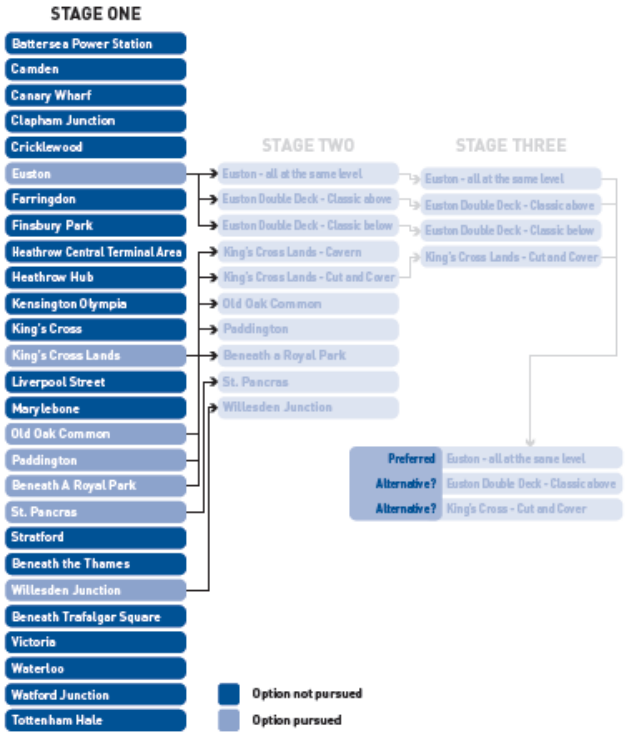
7.1.1 The Government's remit to HS2 Ltd in January 2009 included consideration of options for access to central London. A terminus station would need to be large enough to accommodate up to 18 trains per hour. With this in mind a long list of potential sites was prepared[122]. The consideration included not only a surface station, but also cut and cover or deep underground solutions. This long list was then narrowed down by applying the following high-level appraisal criteria:

- overall fit with the remit;
- operational/engineering feasibility;
- demand;
- cost; and

[122] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 Section 3.2 pp.53-68

- other relevant factors, including potential planning and environmental constraints.

Figure 3: London terminus station options



7.1.2 Nine station locations (eight in central London and Canary Wharf) were eliminated because there was little or no existing capacity or space at the existing station and so an entirely new station would need to be built alongside the existing one requiring unacceptable land take in highly built up areas. Eleven locations outside central London (mostly in inner London but as far away as Heathrow and Watford) were considered. These were not reviewed further because the majority of existing rail passengers from London to Birmingham and destinations beyond start their journey in inner London. Locating a terminal station outside Central London would jeopardise access to this market since it would impose significant interchange and journey time penalties for the majority of existing rail passengers. However, the two most promising options in this category, Old Oak Common and Willesden Junction, were taken forward to the next stage.

7.1.3 This left ten station options for more detailed analysis at Stage 2 where the criteria also included the four sustainability priorities – reducing greenhouse gas, natural resource protection and environmental enhancement, creating sustainable communities, and sustainable consumption and production. Three Euston options and one for a cut and cover station on Kings Cross railway lands were taken forward for a third stage of sifting and the others were eliminated for the following reasons:

- building a cut and cover station under a Royal Park with minimal surface structures following reinstatement would present relatively few engineering issues, but Royal Park options were not taken forward as the parks have been safeguarded for public enjoyment for nearly 200 years and are London landmarks;
- building a deep tunnelled cavern under Paddington or on the Kings Cross railway lands was also considered. The ground conditions under Kings Cross are not suitable for such a large structure, at Paddington there would be a significant settlement risk under Brunel's Grade 1 listed station, and in any event the possible cost of a station cavern could be over £5bn;
- two variants for St. Pancras, either above the Midland Main Line platforms or on the west side north of the British Library were eliminated – the former because it would require complete closure of the station during construction and the latter because it would entail extensive demolition; and
- the demand analysis for Willesden Junction and Old Oak Common suggested that the journey time penalties for most central London passengers would severely reduce the benefits of HS2.

7.1.4 At the third stage of sifting, it was concluded that Kings Cross railway lands would be impractical for a cut and cover station because the site is heavily constrained below ground by the Thameslink station and tunnels and the Camden sewer; and above ground by Regents Canal and numerous railway lines. In addition an HS2 station would have severely affected the extensive regeneration plans for the area.

7.1.5 This left Euston as the only viable option. Having reviewed the cost and engineering problems associated with double deck solutions, HS2 Ltd recommended that the London terminus should be on the west side, partly on the existing station and railway and partly on land between the existing station and Cobourg Street.

7.1.6 However, before finally selecting this option HS2 Ltd considered whether the overall cost and extensive impact could be reduced by having two smaller stations. Three options were reviewed including:

- a combination of a through station and a terminus station – rejected because of cost and time penalties;
- a through station with facilities beyond where trains could be turned round and cleaned; and
- two independent stations.

7.1.7 All were rejected because of cost and to varying degrees because they would not significantly reduce demolition and because of lack of suitable sites.

7.1.8 Reviewing this advice in March 2010, the Government agreed with HS2 Ltd's recommendation for extension of Euston Station to the west, subject to mitigation of displacement and construction impacts, and to public consultation[123].

7.1.9 The public were consulted on this option in February 2011. Comments included that the impacts should have precluded its consideration and preferences for St. Pancras, Waterloo, Paddington, Old Oak Common or Stratford. HS2 Ltd were asked to review the decision but came to the same conclusion on the options as previously. It confirmed its view that Euston is the best and only feasible central London location, whilst recognising that further work was needed to reduce the impacts[124]. The Government also remained of the view that Euston is the right site[125].

7.1.10 HS2 Ltd and the Government consider that Euston Station remains the best practicable option for a London terminus, and this forms the basis for the Proposed Scheme. The strategic advantages of Euston include its location on the northern side of central London, its existing use as a terminus for WCML and commuter services and its onward level of connectivity, especially via London Underground lines. In addition, Euston is located within an opportunity area, allowing the planning of the terminus to develop in a way that optimises the local regeneration benefits.

Euston station configurations

7.1.11 In 2009 three station configurations to provide ten 400m long HS2 platforms at Euston were considered. All three envisaged a comprehensive redevelopment of the whole station.

7.1.12 Building the WCML platforms above HS2 would create a 44m high station which would result in a 1km long severance barrier through Camden with Hampstead Road the only route across. Though it would require less land than an all surface option, this solution would be very difficult to build over an operational railway. A second double deck option with the WCML platforms below HS2 in order to minimise the station site and its surface impact was not pursued because it would be even more difficult to build[126]. The preferred option was to rebuild the station at surface level on a site extended to the west as far as Cobourg St..

7.1.13 Successive Secretaries of State concurred with HS2 Ltd's recommendation for a new station with all the platforms at the same level and, following consultation, this option was included in the post consultation scheme. However, further work during 2012 on construction planning and railway systems design revealed that the preferred scheme would take more than twelve years to build and would be considerably more expensive than had been previously estimated.

7.1.14 A revised scheme was therefore prepared. Instead of rebuilding the whole station, it was proposed to retain thirteen existing platforms with only minor modification and build eleven new HS2 platforms to the west on a footprint slightly smaller than the

[123] High Speed Rail, DfT, March 2010 (Cm.7827) p.100 para.6.12
[124] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 5.2
[125] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.90 para.5.31
[126] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 pp.65-66 Paras. 3.2.24-28

post consultation scheme. The two parts of the station would be integrated with a continuous concourse serving all platforms.

7.1.15 At this stage the double deck options were reconsidered. As previously, the HS2 platforms would need to be approximately at or below ground level due to gradients and headroom from the tunnel portal. In the 'double deck up' option, WCML trains would run over Hampstead Road. Though property demolition would be somewhat reduced, this option would take an estimated fifteen years to build and for a five year period WCML services would be reduced by around 50%. A 'double deck down' scheme would require more land than the 'double deck up' design and would take nineteen years to build[127]. In 2013 the Secretary of State re-consulted on these options before deciding to incorporate the revised option - to retain most of the existing platforms and extend the station at approximately ground level - into the Proposed Scheme.

8 Great Western Main Line interchange and Heathrow connections

Evolution of the proposals

8.1.1 In January 2009 the HS2 Ltd remit included consideration of "Options for a Heathrow International interchange station on the Great Western main line with an interchange also with Crossrail."[128] Direct access to Heathrow and the wider question of an interchange with the Great Western Main Line and Crossrail are linked because the GWML/Crossrail interchange station would provide access to Heathrow via Crossrail and Heathrow Express as well as offering HS2 passengers rail connections to and from areas west of London, and for many a faster alternative to Euston to the West End, the City, Canary Wharf and destinations in East London and Essex.

8.1.2 The study of options commenced with a market analysis of how many passengers would use the interchange, then it looked at how best to serve the airport before considering the optimal location for an interchange. Of the two million domestic air passenger travelling between Manchester or Glasgow and London each year, approximately half are 'interlining' – changing planes – and half had an origin or destination in London or the South East. The modelling concluded that interlining passengers would be little interested in HS2 even if there were a station within the airport and that over 80% of HS2 passengers would be travelling to central London. As few as 2000 passengers per day would be travelling to Heathrow.[129].

8.1.3 Whilst the report was being finalised in late 2009, Arup had submitted their 'Heathrow Hub': a proposal for a multi-modal interchange. It comprised an off-airport terminal located on the GWML to the east of the M25 between West Drayton and Iver that would be connected to the other airport terminals via a mass transit people mover and baggage system. One of the options that HS2 Ltd considered for a GWML interchange

[127] Design Refinement Consultation: Consultation Document DfT May 2013 pp.14-15 para 2.3.1
[128] .Britain's Transport Infrastructure High Speed Two (BTI), DfT, January 2009 p.24 para. 63
[129] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009, p70-71 para 3.3.5, 3.3.10

was at Iver. It was assessed on the same basis as the other interchange options but did not incorporate all the features of the Arup proposal.

8.1.4 In March 2010 the Government concluded that a central London terminus would be essential[130], but as Euston has limited east-west connectivity, it accepted HS2 Ltd's recommendation for an interchange station to connect to Crossrail as well as to Heathrow and the west. It announced that the Old Oak Common proposal would be developed in consultation with the local authority and the various transport agencies. However, it also concluded that further assessment was needed before taking any decision on a station at Heathrow[131], and it appointed Lord Mawhinney to assess the options including the proposal for a Heathrow hub.

8.1.5 On 20 December 2010, having considered the reports prepared by Lord Mawhinney and by HS2 Ltd as well as the Heathrow Hub proposal, the then Secretary of State announced his preferred approach. For the Phase One scheme to Birmingham, he proposed that access to Heathrow would be via an interchange at Old Oak Common. But he also announced that a scheme for a spur to an airport station would be prepared for consultation and implementation as part of the HS2 Phase Two extension to Manchester and Leeds. Following the public consultation this approach was confirmed in January 2012.

8.1.6 In autumn 2012 the Government set up the independent Airports Commission to examine the scale and timing of any requirement for additional airport capacity to maintain the UK's position as Europe's most important aviation hub. As a consequence, in January 2013 the Secretary of State announced he was suspending further work on the Heathrow spur until 2015 pending the Airports Commission's report. HS2 Ltd's preferred route for a spur was published at this time.

Interchange station options

8.1.7 The options for an interchange were first considered in 2009. A Crossrail/GWML interchange needs to be located on the Great Western Main Line or at Heathrow in order to provide an efficient location for passengers to change trains. In 2009 HS2 Ltd considered the potential for Heathrow terminal stations to be Crossrail and Heathrow Express interchanges, and also a 'Hanwell' station between the GWML and Heathrow but they did not perform well compared with the GWML locations.

[130] High Speed Rail, DfT, March 2010 (Cm.7827) p.101 para.6.13
[131] High Speed Rail, DfT, March 2010 (Cm.7827) p.124 para.7.18

Figure 4: London Interchange Options

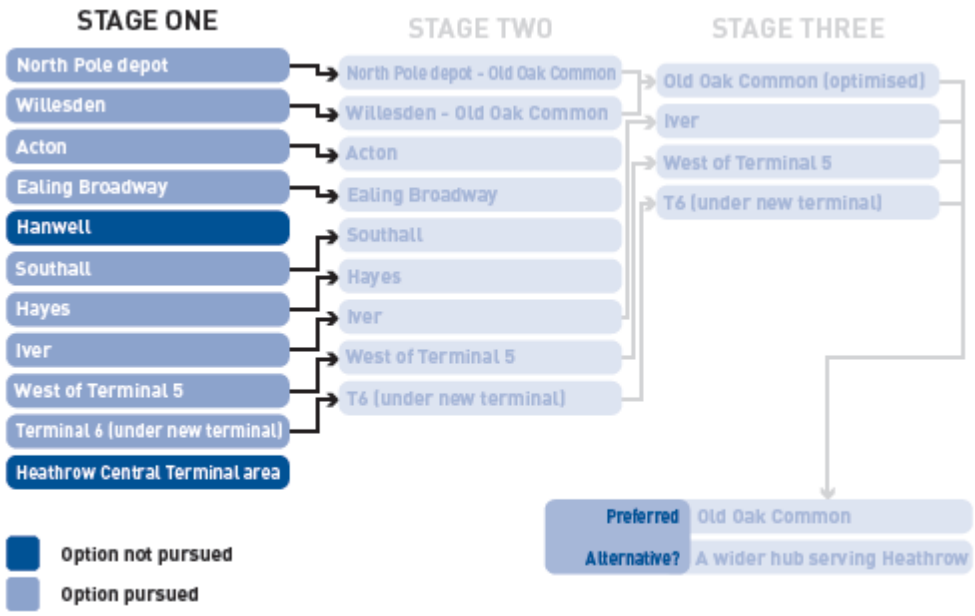


Figure 3.3d Interchange sifting process – Stage One

8.1.8 The GWML options considered included most of the stations between Old Oak Common and Iver. The interchange station options are shown in Figure 4. The initial review concluded:

- North Pole and Willesden should be merged and optimised to become the (preferred) Old Oak Common proposal. This would be the best option for GWML and Crossrail connectivity. It would be connected to all five Heathrow terminals via the 4tph Heathrow Express or the slower 4tph Crossrail service[132].
- Acton was eliminated because it would require relocation of a major freight terminal for which there was no suitable alternative site;
- Hayes was inferior to nearby Southall due to construction and heritage problems;
- at Ealing Broadway there was insufficient land available;
- at Southall there was a largely unused site, but there would be limited scope for onward connectivity and a HS2 station would adversely affect planned redevelopment;
- Hanwell was a site at Osterley Park approximately between the WCML and the M4, but it was not pursued due to its very poor onward connectivity and adverse environmental impact;
- Iver could be connected to Heathrow by a people mover and could be a parkway station potentially attracting park and ride passengers and up to

[132] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.81 Paras. 3.36-37

20,000 GWML passengers per day, but there would be major adverse environmental impacts on the flood plain and riparian habitats[133].

8.1.9 For various reasons Old Oak Common or Iver would be much better locations for a HS2 interchange than any of the intermediate stations, as they would have interchange advantages that none of the others could match:

- Iver could be a parkway station for HS2 and Crossrail l connected by a people mover to the Heathrow terminals. It would take an estimated 8-9 minutes to travel from Iver to the on-airport terminals[134].
- Old Oak Common would be much better for the majority of HS2 Passengers travelling into central London and has much greater potential as a catalyst for realising local regeneration benefits on the adjacent areas. Old Oak Common provides the best options for GWML and Crossrail connectivity. A station at Old Oak Common would be used by approximately one third of HS2 passengers, the remaining two thirds travelling via Euston. Of the Old Oak Common HS2 passengers, most would travel west on Crossrail, and the remainder) would go to Heathrow on the 4tph Heathrow Express (assumed 14 minutes) or the slower 4tph Crossrail service[135].

8.1.10 The demand analysis predicted that relatively few HS2 passengers would be travelling to Heathrow; and the analysis of interchange options established that a station at Old Oak Common would be justified irrespective of any of the options for serving Heathrow because it offers a faster route than Euston to Central London and beyond for a large proportion of HS2 passengers. This would be true even if there were a hub station at Iver, though the case would be weaker than with the other Heathrow station options. In 2012 the Government therefore decided to include Old Oak Common in the proposed scheme. The Old Oak Common interchange would also offer much better access than currently exists from the midlands to Heathrow[136], but is not necessarily an alternative to direct HS2 services to Heathrow.

8.1.11 The Iver option is an exemplar for any Heathrow terminal or parkway interchange station on the GWML east of the M25. The decision to opt for Old Oak Common in preference to Iver was determined on transportation and cost grounds – particularly the low proportion of Heathrow passengers using HS2, the high proportion travelling to central London[137], and the additional high cost of a people mover to connect Iver to the Heathrow terminals. However, there were also regeneration advantages at Old Oak Common and environmental disadvantages at Iver irrespective of the precise location of the site. These include encroachment into the green belt, effect on the water treatment works, and flood risk (which would be difficult to mitigate).[138]

[133] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.79 para. 3.3.30 and P.80 para.3.3.32 & 3.3.34
[134] Compared with 11 and 17 minutes from Old Oak Common via Heathrow Express to the Central Terminal Area and T5 respectively
[135] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.81 Paras. 3.36-37
[136] 65 minutes from central Birmingham to Heathrow CTA compared with 132 minutes currently.
[137] It would take 15-30 minutes longer to travel from the Midlands to central London via Iver compared with Old Oak Common (depending on what GWML and Crossrail service patterns were introduced to serve the interchange).
[138] HS2 London to the West Midlands Appraisal of Sustainability, Booz Temple, February 2011 Appendix 6.5

The strategic advantages of direct access to Heathrow

8.1.12 A high proportion of Heathrow's current air passengers live or work in the south-east. This geographic distribution of origins and destinations in part reflects the relative inaccessibility of other regions and reinforces the locational advantages of the south-east. From the outset successive governments have recognised the strategic importance of high speed rail connectivity to the UK's principal hub airport.

8.1.13 The fact that initially only a small proportion of HS2 passengers would be travelling to the airport does not preclude the possibility that travel patterns will change after HS2 becomes operational. Potential wider benefits of directly linking HS2 and Heathrow include[139]:

- it would improve access to the airport from the major cities of the Midlands and the North, making them more attractive as locations in which to invest and do business;
- combined with other improvements to surface access links to Heathrow, such as Crossrail and the proposals for a GWML western link to the airport, it would help to strengthen Heathrow as a multi-modal transport hub, easing pressure on Euston and central London's transport networks. It could also contribute to addressing local air quality issues;
- high-speed rail services between Heathrow, the North and Scotland could provide an alternative to some domestic aviation services on these routes, potentially freeing up runway slots for additional international services, or they could be left open to improve operational resilience; and
- providing an alternative to domestic aviation would contribute to modal shift from air to rail – generally a less carbon intensive mode.

HS2 main line access to Heathrow – through, loop or spur and station options

8.1.14 At Heathrow passenger destinations are concentrated at the Central Terminal Area (CTA) and the other terminals which are approximately 1.5-2 km apart. In 2009 four location options for a station within the airport were considered:

- under the Central Terminal Area (this option was eliminated at the first stage of sifting because of the difficulty of building a deep underground cavern under an operational airport);
- to the west of Terminal 5; and
- a 'Terminal 6' station for a third runway that was favoured by Government at the time.
- the Heathrow station could be an off-airport hub in the vicinity of Iver such as the Arup Heathrow Hub proposal.

[139] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 pp.77-80 paras. 4.23, 4.29, 4.38

8.1.15 In June 2010, following the General Election, the Secretary of State asked HS2 Ltd to "Develop options for a direct high speed link to Heathrow, to include options for a loop and a spur from your recommended alignment, and for a through route via Heathrow[140]." The third runway proposal was abandoned and with it the Terminal 6 option, but a further location on the northern perimeter of the existing airport was considered 'Heathrow North'. These stations were reviewed by Lord Mawhinney who concluded that " in the early stages of a high speed rail network, there is no compelling case for a direct high speed rail link to Heathrow", but if there were to be a Heathrow station, his preferred location was at the CTA[141].

8.1.16 In 2009 and 2010 options for a direct route were considered in parallel with the analysis of interchange options, both as an alternative to a GWML/Crossrail interchange and in addition to Old Oak Common. The Heathrow options included not only station locations but also whether the station is directly on the HS2 main line, or on a loop or a spur. In summer 2010 there were nine alignment options for providing rail access to serve these stations:

- three route options for the HS2 main line to run through a new station at Heathrow (see Figure 5) – all the HS2 through Heathrow options would be in tunnel from Old Oak Common to Heathrow or Iver. The route preferred by HS2 Ltd in 2010 would continue in tunnel under the M25, then on the surface to Beaconsfield and in tunnel under the Chilterns to Princes Risborough, before continuing to Brackley on the surface. Variants with different configurations of tunnel and surface section were rejected on grounds of extra cost without countervailing additional benefits[142];

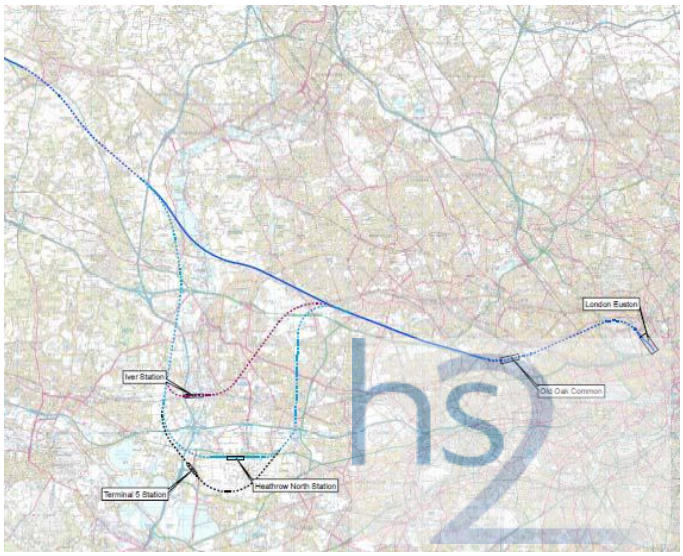
Figure 5: Heathrow through route options

- three options for a loop from the HS2 main line through the airport (see Figure 6) – a long loop to serve the Terminal 5 station, a shorter loop for Heathrow North and the shortest loop for Iver. All three would leave the HS2 main line

[140] Secretary of State for Transport letter to HS2 Ltd 11 June 2010
[141] High Speed Rail Access to Heathrow A Report to the Secretary of State for Transport by Rt Hon the Lord Mawhinney, July 2010 paras. 46 & 58
[142] High Speed Rail London to the West Midlands and Beyond: Supplementary Report: HS2 Ltd, September 2010 p.20 para.1.2.13

north of Denham and rejoin it at Northolt; and

Figure 6: Heathrow loop options



- three options for a spur off the HS2 main line to the airport (see Figure 7) – a spur entirely in tunnel linked from the HS2 main line at Northolt, and two options on approximately the same alignment connecting to the HS2 main line at the Colne Valley, one in tunnel and one with the Birmingham-facing loop on the surface aligned to the west of Denham and Denham Green.

8.1.17 With the exception of an HS2 main line through Terminal 5, any of the route options could serve any of the airport station options. A Terminal 5 station served directly by the HS2 main line was discounted because the station would have to be oriented north-west/south-east to avoid existing rail and Underground infrastructure which would require an expensive and circuitous route affecting all train services[143].

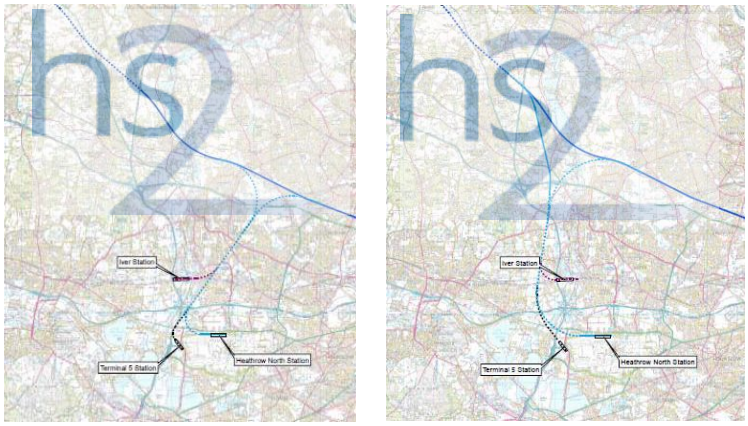
8.1.18 All the generic options for direct HS2 main line access to Heathrow would entail substantial additional cost – in the order of £2.5-£4bn depending on the route and the station. A main line through the airport or a loop would be considerably more expensive than a spur[144].

8.1.19 All the options would offer similar journey times for Heathrow bound passengers from the Midlands and the North and would be faster than Old Oak Common[145]. However, the through route would entail a time penalty to the vast majority of passengers not going to Heathrow of 10 minutes for non-stop trains or 14-15 minutes for trains stopping at Heathrow. Additionally, if some but not all trains stopped at Heathrow, up to one train path per hour into central London could be lost as a result of the stopping trains rejoining the main line. On a loop option there would be no time penalty for most passengers, but London-bound passengers on via-Heathrow trains would lose 9-14 minutes depending on which Heathrow station option were chosen.

[143] High Speed Rail London to the West Midlands and Beyond: Supplementary Report: HS2 Ltd, September 2010 p.21 para.1.2.16
[144] High Speed Rail London to the West Midlands and Beyond: Supplementary Report: HS2 Ltd, September 2010 pp.28-9 Figs. 10 & 11
[145] A through route would be approximately 20-25 minutes (actual time) faster from the Midlands to a station at the CTA than interchanging at Old Oak Common and 10-15 minutes faster to T5.

8.1.20 The three spur options were considered, all in relation to station options at Iver, Terminal 5 or Heathrow north.

Figure 7: Heathrow spur options



8.1.21 The spur options would have no impact on journey time for the majority of passengers who would be travelling to and from central London and would provide direct access to whichever terminal is chosen for the station location (though less advantage to the other terminals). It is thus the quickest and cheapest option. Its disadvantage is that, with very low demand – at least initially – there would be insufficient passengers to justify the Heathrow service, and the Heathrow terminating trains using the spur would take up a train path that could otherwise be used to carry passengers to central London.

8.1.22 The analysis of the options in September 2010 nevertheless indicated that the best of the options in economic terms was likely to be the spur. This was because any additional benefits generated by the loop and through-route options were more than offset by the corresponding reduction in benefits for London-bound passengers due to longer journey times. With regard to the spur options, the additional benefits to Heathrow passengers were smaller, as fewer trains would serve the airport, but there would be less disbenefit to other passengers[146].

8.1.23 The environmental effects of the spur options were summarised in HS2 Ltd's September 2010 report:

> "The environmental impacts of spurs vary depending on whether they are located in a tunnel, where the impacts are similar in nature to the loops described above, or follow a surface route. Each spur option would require grade separated junctions and deceleration lanes at their connections with Route 3, as well open cuttings to house crossover junctions along their respective routes. As a result of these, a small number of dwellings, commercial and community buildings would be at risk of demolition in the Northolt area (option 1) or Ickenham area (option 2 M25 corridor); and, in the case of option 1, approximately 50 dwellings would be at risk in the vicinity of Hillingdon for the junction box. Noise impacts would also be experienced

[146] High Speed Rail London to the West Midlands and Beyond: Supplementary Report: HS2 Ltd, September 2010 p.33 para.1 3 14

> in each of these locations. Further noise and demolition of dwellings would be anticipated in the vicinity of Denham for the M25 surface level alignment, along with impacts to the important flood zone associated with the River Colne."

8.1.24 In late 2010, the Secretary of State also considered the potential station locations under each of the options. The only feasible station option directly linked to an airport terminal would be at Terminal 5, as the Central Terminal Area had been ruled out following a further review by HS2 Ltd who concluded: "We remain of the view that this deep tunnelled option would be exceedingly difficult and prohibitively expensive. However if future re-configuration of the terminals at Heathrow airport were to include partial demolition of the CTA area, then a shallower cut-and-cover station could come under consideration."[147]

8.1.25 As a Terminal 5 station could not be integrated with a through route, this was a further argument against a through-route approach because, if it cannot be at the CTA or T5, and T4 is too small and too far south, passengers would have to transfer to a separate transit system to reach any of the airport's terminals. Consequently any time savings benefits even for airport-bound travellers would be reduced if not eliminated. This would be particularly true for an Iver station, whose location would be approximately 5km from the airport boundary.

8.1.26 In January 2012, the Secretary of State concluded that "there is a strong strategic case for directly linking HS2 and Heathrow" and set out her approach:

> "Route options for a direct spur link to Heathrow Airport should be developed to form part of Phase 2 of the Y network. Diverting the main HS2 line via or close to Heathrow would be costly and would disadvantage the vast majority of HS2 passengers. The Government therefore favours a direct spur link to the airport, which could radically improve its accessibility from the major cities of the Midlands and the North. The options for such a spur link will be considered by the Government as part of Phase 2."[148]

8.1.27 The Decisions Document noted the Government's announcement that it would be consulting on its aviation strategy, including potential options for maintaining the UK's aviation hub status, and stated that the Government would continue to review its proposals for linking HS2 to Heathrow in the light of that consultation. It remained of the view that the strategic case for linking HS2 to the country's main hub airport would remain strong[149].

Summary

8.1.28 The Government has considered the options for a GWML/Crossrail/Heathrow Express interchange and for direct services to Heathrow including the potential station options. Old Oak Common is by far the best interchange option because it would provide approximately a third of HS2 passengers with a faster and more convenient

[147] High Speed Rail London to the West Midlands and Beyond: Supplementary Report: HS2 Ltd, September 2010 p.17 para.1 2 7
[148] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.37
[149] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.80 para.4.39

route than Euston to or through central London. An interchange station at Old Oak Common would be justified whether or not there is also a Heathrow station – or a hub at Iver. From Old Oak Common, Heathrow bound passengers would also be able to change onto Heathrow Express services and be at the CTA or T5 within 11 and 17 minutes respectively, halving journey times from the Midlands to Heathrow.

8.1.29 As only a small proportion of HS2 passengers will be travelling to or from Heathrow, there will not be sufficient demand to justify direct services, at least initially. However, the Government recognises the strength of the strategic argument for providing high speed surface access to Britain's principal hub airport in order to provide an alternative to domestic aviation and to spread the economic advantages of proximity to Heathrow's international air services more widely in the Midlands and the North. Phase Two of HS2 will strengthen the demand for Heathrow services and in the longer term travel patterns may change.

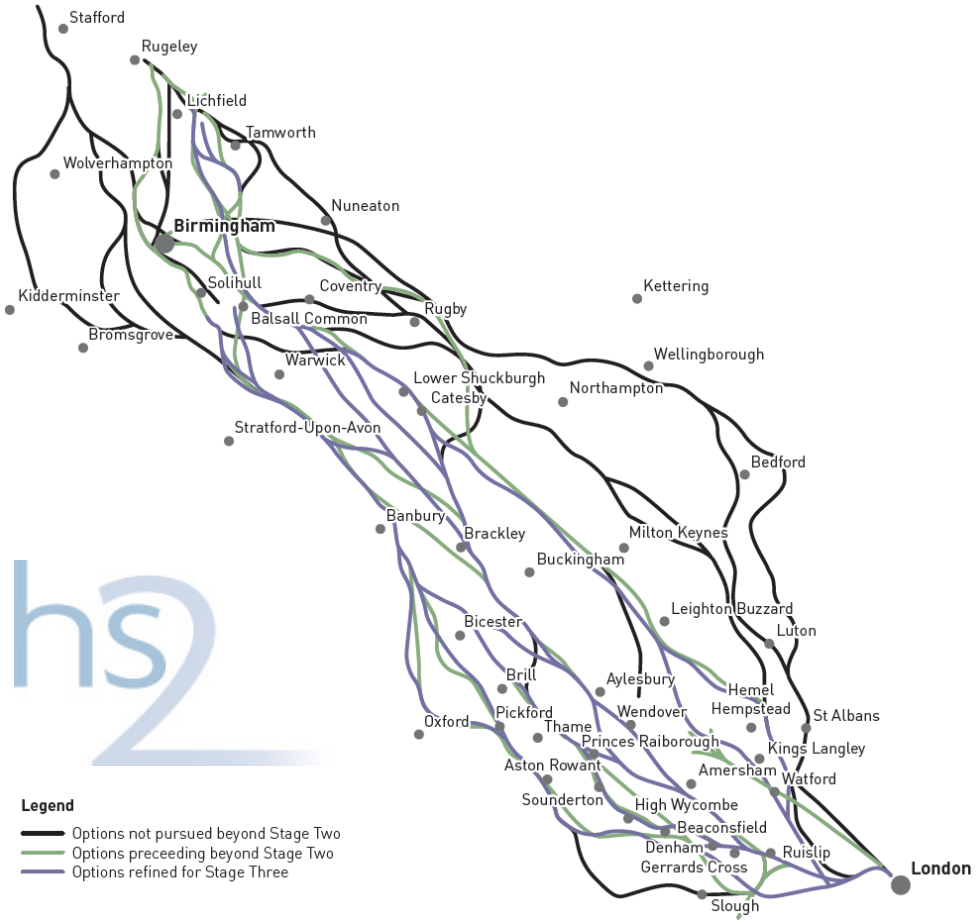
8.1.30 Consequently, whilst for Phase One there is insufficient demand for a direct link, it is proposed to provide access to Heathrow via an interchange at Old Oak Common. Provision is also being made so that a spur from the Colne Valley to the airport can be implemented either as part of Phase Two or at a later date without disrupting operational HS2 train services. The current position is that the Government has suspended work on the Heathrow spur until 2015 pending the Airports Commission's report, and in any event no decisions will be taken until the public has been consulted on the proposals.

9 Route from London to the West Midlands

Alternatives considered

9.1.1 In 2009 HS2 Ltd prepared a long list of numerous route options and sub-options for sifting, selection and refinement. Where possible the routes followed the main transport corridors whilst avoiding urban areas and environmentally sensitive locations. The routes considered are shown on Figure 8.

Figure 8: London to West Midlands route long list options



9.1.2 The selection criteria for the line of route options were more detailed than for station options because there were fewer distinguishing features to differentiate the line of route options. However, they covered the same generic issues:

- engineering and construction feasibility;
- high level cost estimates;
- environmental, social and spatial considerations – simplified sustainability framework; and
- demand –mainly focused on journey time benefits[150].

9.1.3 As a result of this process, six main corridors (and one hybrid) were considered for the route to the north of Old Oak Common. Other options were eliminated where adjacent routes options would be better on environmental and/or cost criteria. Consideration of the effects on the Chilterns Area of Outstanding National Beauty (AONB) was particularly important in this process. However as the Chilterns extends

[150] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.93 Para.3 5 4

westwards from the Hitchin and abuts the North Wessex Downs AONB, there are few options for a route to the West Midlands that would not traverse an AONB.

9.1.4 The Government expressed a preference for Route 3, but all six were presented for public consultation in 2011.

Route 1 M40 corridor

9.1.5 This option originally followed the CML corridor as far as Denham, and then it ran as close as possible to the M40, crossing the Chilterns via a series of tunnels and viaducts. It would pass to the west of Thame and Bicester, to the east of Banbury and west of Warwick as far as Balsall Common[151].

9.1.6 This was the most expensive option and had the longest journey times. In addition, it involved almost 15km (9 miles) of surface route through the Chilterns AONB, and would have given rise to significant impacts on biodiversity as it affects several nationally designated sites and would require demolition and severance affecting communities including Flackwell Heath, High Wycombe and Ickford. There was thus no compelling environmental case to justify the additional cost.

Route 2 Chiltern Main Line corridor – via High Wycombe

9.1.7 This option would follow Route 1 as far as West Ruislip before diverging to the north to stay close to the CML to Gerrards Cross, Beaconsfield and High Wycombe. It would then cross the Vale of Aylesbury past Princes Risborough and Brill, to re-join Route 1 near Bicester.

9.1.8 The southern part of this route offered advantages such as a relatively short surface section through the Chilterns. Further work was therefore done to test whether cost reductions and improved journey times could be achieved, as a result of which a new Route 2.5 was developed. It comprised the southern section of Route 2 and the northern section of the preferred Route 3.

Route 3 A413 Valley and Great Central route – (the preferred route)

9.1.9 This route would follow Routes 1 and 2 as far as West Ruislip, from where it would take a more northerly alignment in tunnel to Amersham. It would broadly follow existing transport corridors (A413, Marylebone to Aylesbury Line) before joining the route of the former Great Central line between Aylesbury and Brackley. It would then run relatively straight, passing to the east of Warwick and between Kenilworth and Coventry towards the National Exhibition Centre (NEC).

Route 2.5 via Princes Risborough

9.1.10 From West Ruislip, this route would follow the Chiltern Main Line. After passing through three tunnels under the Chilterns, it would emerge near Princes Risborough, from where it would remain largely on surface before re-joining Route 3 near Bicester.

[151] The version included in the February 2011 Consultation Report followed the same route except at the London end as it took HS2 directly through Heathrow Airport.

9.1.11 This route offered some localised environmental benefits in comparison with Route 3 including a shorter route across the Chilterns. However, it would be marginally longer than Route 3 and consequently marginally slower and more expensive. Route 2.5 would have resulted in fewer adverse impacts relating to landscape and noise, but would require a visually intrusive long and high viaduct across the Hughenden Valley and would entail more demolition and a greater impact on townscape.

Route 4 WCML corridor

9.1.12 This route would run northwards from Old Oak Common in tunnel, passing west of Watford to re-emerge to the north of the M25 at Kings Langley. It would then run broadly parallel to the M1 corridor to pass to the west of Milton Keynes and between Kenilworth and Coventry.

9.1.13 Route 4 would provide the shortest section through the Chilterns, but its alignment would have potentially greater impacts in relation to biodiversity, vibration and community integrity than Route 3. It would be slightly shorter than Route 2.5 and slightly longer than Route 3, with commensurate implications for journey times. The route would have required much more tunnelling than Route 3 as then envisaged[152] and would be considerably more expensive. Providing a direct connection from Route 4 to Heathrow would be a major undertaking, including crossing the Chilterns AONB on a new corridor in a mix of cutting and viaduct or tunnelling and at significant cost. The reduced impact on the Chilterns AONB was considered to be insufficient to outweigh the tunnelling costs. It would have resulted in fewer adverse impacts for landscape and townscape, cultural heritage, water resources, flooding, construction and operational noise, but greater impacts relating to biodiversity and community severance.

Route 5 M1 corridor

9.1.14 This route would also run northwards from Old Oak Common in tunnel, emerging between St. Albans and Hemel Hempstead. It would then broadly follow the M1 corridor, passing Luton, Milton Keynes and Northampton, before cutting across to the south of Coventry.

9.1.15 Route 5 would have no effect on the Chilterns AONB, but would be significantly more expensive than Route 3 and require substantial tunneling or property demolition in order to traverse residential areas. There would be no feasible way of connecting Route 5 to Heathrow and even a connection via Old Oak Common would be difficult. It would also be 5 minutes slower than Route 3.

Route 6 Midland Main Line corridor

9.1.16 This route would also avoid the AONB, running northwards from Old Oak Common in tunnel and re-emerging near St. Albans parallel to the MML. It would pass around Luton and Bedford,to the east of Northampton and between Kenilworth and Coventry.

[152] Route 4 entailed 28km of tunnel between Euston and Kings Langley. Route 3 as then envisaged included 17.8km of tunnel from Euston to Amersham though the Proposed Scheme, which is on the Route 3 alignment, now includes 34.6km of tunnel through London and the Chilterns.

9.1.17 Whilst notionally along the MML corridor, for most of its length Route 6 would be either in tunnel or close to residential areas. It would have the same shortcomings as Route 5 in relation to cost, Heathrow and Old Oak Common and would be nine minutes slower than Route 3.

Route 1.5

9.1.18 A further option – Route 1.5 – is a variant of Route 1 to provide HS2 main line services through Heathrow (or Iver) as discussed in the previous section. It would run midway between Routes 2 and 3 at the southern end before rejoining Route 3 east of Bicester. It would be longer, slower and more expensive than Routes 2.5 or 3, and would only be considered if a station at Heathrow or Iver were to be served by a through route.

9.1.19 The most easterly routes (Routes 5 and 6) were considered because they would avoid the Chilterns AONB, but they would require substantial tunnelling or property demolition to traverse built up areas, particularly in Luton, and would add around ten minutes to journey times[153]. Route 1 was the most expensive option for no great advantage. Route 2.5 is a better option than Route 2 and was substituted for it.

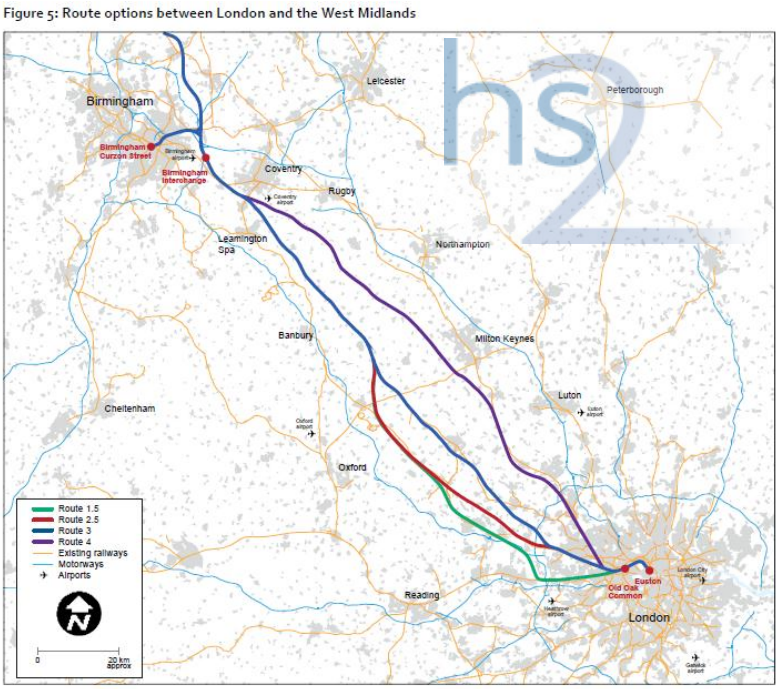
9.1.20 Having stated its preference for Route 3 in 2010 because it offers significant advantages over the other options in terms of cost and journey time and no worse on sustainability grounds, the Government shortlisted Routes 2.5, 3 (a refined version) and 4, together with Route 1.5. Figure 9 illustrates these options. The Government stated its reasons for the preference as follows:

"The Government supports HS2 Ltd's view that Route 3, subject to the refinements that have been made since May 2010, would be the best option. The main reasons are:

- The Government considers that there is a compelling strategic case for being able to link the high speed network to Heathrow. HS2 Ltd's Route 4, following the West Coast Main Line Corridor more closely through the Chilterns, would make this unfeasibly expensive and impractical.
- The alternative route through the Chilterns, Route 2.5, would create a new transport corridor through the Area of Outstanding Natural Beauty and would be very intrusive in the Hughenden Valley. It would also cost more and mean longer journey times, and therefore lower benefits.
- The alternative route via Heathrow would be substantially more expensive and the longer journey times would reduce the benefits. Although it would have less direct impact on the Chilterns, it would adversely affect other sensitive areas."[154]

[153] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.94 Para.3.5.6
[154] High Speed Rail, Investing in Britain's Future – Consultation, DfT, February 2011 (Consultation 2011) p.86 para.5.9

Figure 9: Alternative corridors for the London and West Midlands route



9.1.21 After considering the responses to the public consultation, and HS2 Ltd's further consideration of route options[155], in January 2012 the Government concluded:

- "The proposed route corridor, including the approach for mitigating its impacts, is the best option for a new high speed line between London and the West Midlands. Many people expressed a view on the line of route in their local area. HS2 Ltd looked again at the route in light of the consultation responses and, subject to the alterations noted below, we believe this route remains the best option in terms of its overall benefits and costs, including impacts on sustainability.
- A package of alterations to the proposed route should be made to further reduce its impacts on the local environment and communities. These include additional tunnelling in the Chilterns Area of Outstanding Natural Beauty and in the Northolt area of West London."[156]

9.1.22 Since January 2012 work has continued on the post consultation version of Route 3. There have been further refinements on which the public have been consulted and a comprehensive package of mitigation measures has been prepared in response to continuing work on environmental impact assessment.

[155] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 3
[156] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 page 38, Summary of Decisions

10 West Midlands stations and routes

10.1.1 In 2009 HS2 Ltd approached its optioneering by first considering where the principal station for the West Midlands should be located. The process of option selection, sifting and shortlisting was the same as for the London terminus, with the criteria set out in paragraph 7.1. Initially the key consideration was to establish which location would be most convenient for the majority of passengers. Locations at Wolverhampton, Walsall, Birmingham International and Heartlands were assessed, but the demand analysis clearly showed that the station needs to be in Birmingham city centre in order to capture significant passenger demand[157].

10.1.2 Having established that the station should be in the city centre, the second step was to prepare a long list of options for through and terminus stations in the city centre. In Birmingham this is an issue of construction feasibility as well as business case and environmental criteria.

10.1.3 The site requirements for either option are challenging in a densely developed city. A terminus would need a route into the centre and a station footprint large enough for at least six 400m platforms. The requirements for a through station would be even more extensive. Not only would a route across the city be necessary but also high speed through lines and deceleration tracks for the stopping trains. The station box would be approximately 1km long with secondary boxes approximately 2km either side. HS2 Ltd was unable to locate any surface sites for a through station, so it would need to be in tunnel at both ends.

Birmingham station options

10.1.4 The long list of station locations was reviewed to eliminate those that would be impractical or obviously inferior to better options in the same location:

- a through station at New Street was eliminated on operational grounds as it would have impacted on the junctions at either end of the station, severely restricting regional trains services; and
- the Snow Hill options were not pursued further as the gauge constrained shallow tunnels at either end would have to be rebuilt, which would be unjustifiably costly and disruptive.

[157] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.105 para. 3.6.2

Figure 10: Birmingham Station Options

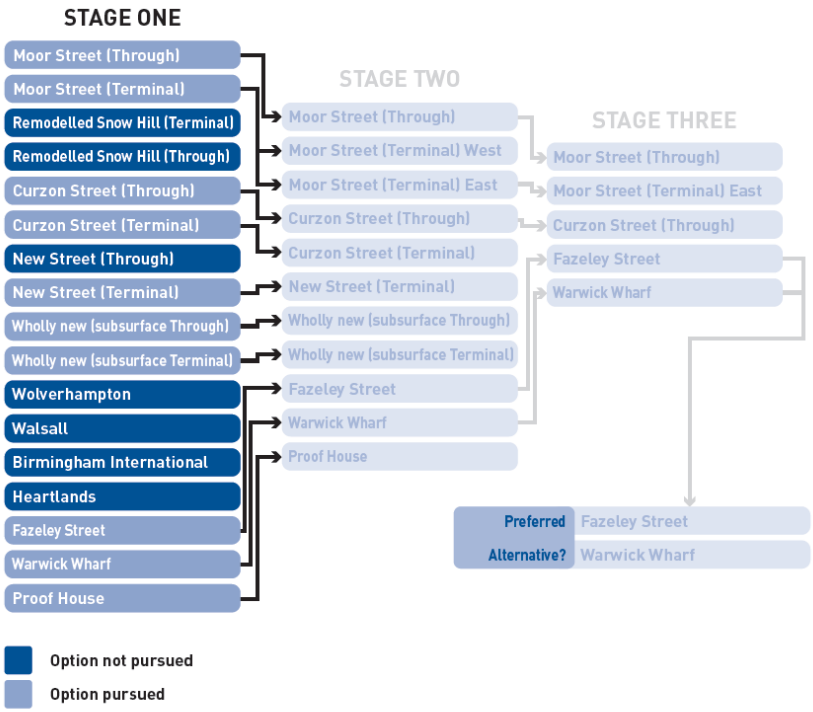


Figure 3.6a West Midlands stations sifting process – Stage One

10.1.5 The remaining options were then subjected to same Stage 2 sifting process described in paragraph 7.3. Five more options were eliminated as a result of this process:

- Moor Street (Terminus West). A terminus on the south-west side of the existing Moor Street station would be more difficult to build than the other Moor Street option on the north-east side which would have more regeneration potential and less environmental impact;
- 'Curzon Street'[158] (Terminus). This option was to the east of Fazeley Street option. Both would be developed on land within the Eastside regeneration area. Although it would be less disruptive to build, it would be significantly further from the city centre, Moor Street and New Street stations;
- wholly new subsurface station options. Options for a new subsurface station in a cavern beneath the city centre would be prohibitively expensive in comparison with the viable surface options;
- Proof House was significantly inferior to the adjacent Warwick Wharf option, especially on heritage grounds;
- New Street (Terminus). For passenger convenience New Street would be the most attractive option and detailed feasibility studies were undertaken. However, the station and the tunnels to the east would need to be completely remodelled, and even then the five HS2 platforms would so severely reduce

[158] This station option was to the east of the preferred option which at this stage was labelled 'Fazeley St.', and was subsequently renamed 'Curzon Street'

the station's existing capacity that a new station, possibly of seven platforms, would need to be built elsewhere to accommodate existing services.

Route options

10.1.6 This process left two through and three terminus station options for Stage 3 appraisal. However, before the final selection HS2 Ltd considered the options for the route into or through Birmingham. As with the route between London and the West Midlands, there were numerous options (See Figure 11) which can be classified into three generic families:

- routes round the east side of Birmingham with a spur into the centre;
- routes round the west side with a spur; and
- direct routes through the centre.

10.1.7 The routes round the west side were not pursued not only because they would be longer and more circuitous, but also because they presented significant environmental and technical difficulties. To varying degrees this also applied to the routes through Birmingham on the western side.

10.1.8 Several routes through the centre were considered for a surface station. Though they offered slightly better journey times into the centre, there would be no advantage to through passengers because the time saving from a more direct route would be offset by the slower speed of the trains in tunnels. However the main reason for discarding the through options was that the demolition and townscape implications of building three large open boxes in the centre of Birmingham were considered unacceptable[159]. An all tunnel option would be unjustifiably expensive when compared with the viable surface options.

[159] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.115 para.3.6.25

Figure 11: West Midlands route long list options

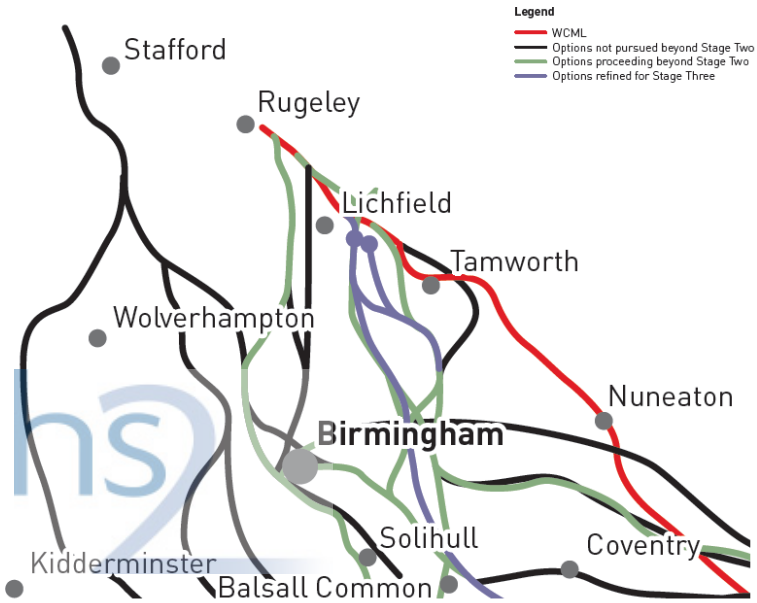


Figure 3.6d West Midlands approach routes considered

10.1.9 It was thus established that there was no credible route through central Birmingham with sites for the station boxes and that all the routes on the west side of the city had significantly greater cost, journey time and environmental disadvantages compared with those to the east. This sifting process also eliminated the remaining through station options – Moor Street and Curzon Street. Routes to the east of Birmingham with a spur into the centre and terminus options for Moor Street East, Warwick Wharf and Fazeley Street remained to be considered.

10.1.10 Three route options for a spur off the HS2 main line east of Birmingham were identified, the Solihull corridor, the Coventry corridor and the Water Orton corridor. Warwick Wharf and Fazeley Street could be served by the Coventry or Water Orton corridors, but Moor Street is oriented south-east/north-west and is only compatible with a spur along the Solihull corridor. Though less expensive, this option would entail greater social and environmental impacts and, crucially, it would seriously undermine the case for the Phase Two extension of HS2 as Birmingham trains to Leeds or Manchester would suffer a long detour to the south east before joining the main line[160].

[160] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.115-116 para.3.6.27

Figure 12: West Midlands Route options remaining after Stage 2 Sifting

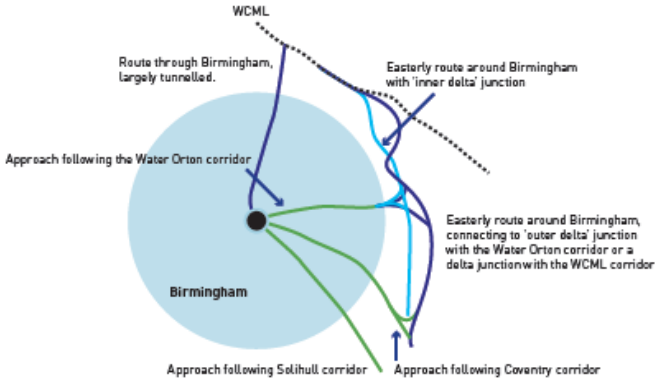


Figure 3.6e West Midlands route options remaining after Stage Two

10.1.11 A spur in the Coventry corridor would entail similar though less severe journey times disadvantages to Leeds and Manchester as the HS2 main line junction would be south of the National Exhibition Centre (NEC). In order to create a sufficiently wide angle for the northbound chord of this junction, the main line would have to be routed in a wide arc to the east of Coleshill (the dark blue line in Figure 12. A consequence of this rerouting of the HS2 main line would be that there would be no obvious location for an interchange station near Birmingham International station and the airport and a greater impact on the environment compared to the inner delta option. This option would cause additional operational problems in Birmingham because the spur would be built alongside the existing operational railway and entail greater severance, noise and water resource effects.

10.1.12 The preferred option was therefore a spur from a junction at Water Orton via the M6 corridor to Bromford and the city centre. This route could serve a city centre terminus at either Warwick Wharf or Fazeley Street. Either would deliver broadly the same passenger benefits, but Warwick Wharf would bisect the Warwick Bar Conservation Area and the local street pattern, would affect a number of listed buildings and would create much greater local severance. It would also be marginally more expensive to build. Fazeley Street was therefore selected in 2010 as the preferred option for consultation. It was subsequently renamed Curzon Street.

10.1.13 During the consultation in 2011, Snow Hill and New Street were raised as potential alternatives to Birmingham Curzon Street, and these were subsequently re-examined. The Snow Hill site is severely constrained by adjoining land uses and the approach tunnels would need to be re-built. In addition to the issue of removing junctions, redevelopment of New Street for HS2 would displace up to half the existing services, for which new station facilities would need to be provided. In view of these constraints, the Government concluded in January 2012 that Birmingham Curzon Street should remain the preferred location[161].

[161] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.115 para.6.47

Birmingham Interchange

10.1.14 An interchange station was not an essential requirement of HS2 Ltd's brief and so the analysis included whether there should be an interchange as well as location options. The principal advantages of an interchange would be if it generated sufficient additional demand for HS2 services or provided additional connectivity to justify the time lost to through passengers and the cost of providing it[162].

10.1.15 Ten locations were identified potentially with strong links to the strategic road network and close to possible HS2 alignments. Consideration of interchange options took place in parallel with route and terminus station options. All but Birmingham Interchange near the NEC and Birmingham International Airport were eliminated for the following reasons:

- four locations to the north-east and north-west of Birmingham (Walsall/Bescot, Wolverhampton, East Sutton Coldfield, and Shenstone south of Lichfield) offered relatively poor demand potential. Some had also been superseded by the choice of alignment;
- Earlswood and Solihull south of Birmingham were superseded by the choice of route;
- Heartlands was too close to Curzon Street to add significantly to the catchment and would add traffic to a constrained road network; and
- a location on a Water Orton inner delta route would be amongst several motorway junctions and was eliminated because it would be very difficult and therefore expensive to build[163].

10.1.16 Two locations near Birmingham International Airport and the NEC were identified for the two route options under consideration. Once the preferred route to Lichfield had been determined, only one NEC/Birmingham International option remained. Its location 2km from the existing Birmingham International station and the airport and 1km from the NEC offers opportunities unique in the West Midlands to serve both interchange and destination demand. In March 2010 the Government concurred with HS2 Ltd's recommendation to include in the proposals an interchange station next to the M42 and M6 motorways and connected to the NEC and Birmingham International station by a people mover. The transport modelling indicated that around half West Midlands passengers on HS2 would use this interchange station[164]. Following public consultation, in January 2012 the Government decided to include the Birmingham Interchange station in the hybrid Bill proposals for Phase One of HS2.

Intermediate stations

10.1.17 The case for intermediate stations between London and the West Midlands was investigated in 2009[165], and re-examined following consultation in 2011. Intermediate

[162] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p127p129, 3.7.4-3.7.7
[163] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.116 para.3.6.28
[164] High Speed Rail, DfT, March 2010 (Cm.7827) pp.117-118 Paras.6.60-6.64
[165] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 Section 3.4, pp.89-92

stations bring a range of potential benefits to the communities they serve, in terms of improved connectivity and congestion relief, especially on commuter services into London. However, these benefits would come at the cost of slower journey times for through passengers and reduced train path capacity. The reduced capacity effect will be particularly significant for the Phase Two proposals to Leeds and Manchester and services to the north because demand pressures would be much greater when the full network is operational.

10.1.18 In 2009 HS2 Ltd analysed existing rail trips from twelve of the largest population centres in the London to West Midlands corridor and identified existing rail demand for a potential long list of intermediate stations. The largest centre was, and remains, Milton Keynes/ Northampton area followed by the Oxford/ Bicester area.

Table 10: Number of rail trips between London and intermediate locations in 2007/08[166]

Location	**Number of rail trips to/from London per annum in 2007/08**
Aylesbury Vale	0.8m
Banbury	0.6m
Bedford	1.8m
Bicester	0.6m
Coventry	0.7m
Kettering	0.5m
Luton	3.3m
Milton Keynes	2.1m
Northampton	1.9m
Oxford	1.5m
Rugby	0.5m
Warwick	0.8m

10.1.19 In 2009 three locations – Aylesbury, Milton Keynes and Bicester (serving Oxford) – were selected for further assessment. This analysis was undertaken prior to consideration of the choice of route between London and the West Midlands because, if an intermediate station were included in the proposals, it might have implications for route selection.

10.1.20 The potential demand at an intermediate station would largely be commuting trips into London, particularly in the case of smaller towns such as Bicester. The 2009 analysis estimated an a.m. peak period demand of 8700 passengers at Milton Keynes, 6400 at Bicester and 1950 at Aylesbury. Assuming there were sufficient capacity on the peak trains and all trains stopped at the intermediate station, the all day benefits

[166] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.90 Fig.3.4a

to passengers using the stations was estimated to be £2.6bn, £3.4bn and £0.6bn respectively (2009 prices PV). At Milton Keynes and Bicester, but not at Aylesbury, it was estimated that the net revenue would cover the cost of the station if there were sufficient capacity on the trains for the passengers.

10.1.21 Against these benefits to the passengers using an intermediate station, there are very substantial costs to other passengers. In 2009 the disbenefit in delay to other passengers on the trains (if all trains stopped) was estimated to be £1.5-3 bn[167]. But of much more significance, the trains would be full of long distance passengers at peak times and so any additional intermediate station passengers would (notionally) have to displace those already on the trains resulting in a net negative benefit because the time savings for longer distance passengers would be greater than they would be for medium distance passengers. Fare revenues would also be lower. In addition a three per hour service to an intermediate station would result in loss of three train paths per hour leading to an overall 20% reduction in the maximum capacity of the route (unless there were extensive delays in the station – see paragraph 10.1.24).

10.1.22 On this evidence HS2 Ltd concluded that an intermediate station would be detrimental to the overall business case for the project, although at Milton Keynes or Bicester there would be significant benefits to users of the station as well as wider economic and regeneration benefits[168]. In March 2010 the Government considered and concurred with HS2 Ltd's analysis[169]. It also noted that towns that would benefit from an intermediate station would in any case see improved train services as a result of investment on the conventional network, and Milton Keynes would benefit from released capacity on the West Coast Main Line as a result of HS2. In January 2012, having considered the responses to the 2011 consultation that suggested intermediate stations, the Government concluded that it did not consider that an additional intermediate station would be appropriate for the London to West Midlands phase[170].

10.1.23 The effect of a train path capacity reduction on the route between London and Birmingham Interchange would mainly impact on Phase Two when all 18 train paths are likely to be required. Even a half hourly service to an intermediate station (losing 2tph) would have a disproportionate effect on train services north of Birmingham. For example, only an hourly service to Newcastle and Scotland would be possible (compared with half hourly service to each city as currently envisaged). Alternatively, services could be reduced to Leeds (from 3tph-2tph), Manchester (from 3tph-2tph), or Liverpool (from 2tph to 1tph).

10.1.24 The only way of avoiding losing a train path for each stopping train would be to timetable a train to leave the station and rejoin the main line at speed to take up the path vacated by the stopping train. However, this would entail very long stops in the

[167] High Speed Rail London to the West midlands and Beyond HS2 Demand Model Analysis, HS2 Ltd, February 2010 p.64 para.6.2.8
[168] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.92 paras. 3.4.15-17
[169] High Speed Rail, DfT, March 2010 (Cm.7827) pp.116-7 paras. 6.55-9
[170] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.90 para. 5.35

station or far to many trains stopping than could be justified by the demand. Either way the disbenefit to through passengers would be unacceptable.

10.1.25 As well as having a very poor business case, there would be environmental effects. Typically, a parkway location entails roads, car parks, visual intrusion and other environmental effects, while a town centre location would require property demolition and disturbance to adjacent occupiers.

10.1.26 Due to the weakness of the business case, the Government remains of the view that the Phase One proposal should not include an intermediate station. From a strategic point of view, if the primary function of the intermediate station is to serve the commuter market to London, then transferring long distance passengers onto HS2 and releasing capacity on the existing main lines is a more cost effective solution than filling long distance trains with commuter distance passengers.

11 HS1-HS2 Link

11.1.1 The Phase One scheme includes a rail link between HS2 and HS1 with a capacity of up to three trains an hour which can be used either for through Eurostar trains to the continent, or to extend Eurostar services to an interchange with HS2 at Old Oak Common, or for Kent trains to interchange with Heathrow Express or Crossrail. Like Eurostar, HS2 has been designed so that international passengers would be segregated at Birmingham Curzon Street, Birmingham Interchange and Old Oak Common.

11.1.2 HS2 Ltd's original remit included an obligation to consider and provide advice to Government on the costs and benefits of "options for linking with Hs1 and the existing rail network, including the potential for services to mainland Europe"[171]. HS2 Ltd's initial assessment in 2009 comprised a review of the main infrastructure options and an analysis of demand in relation to service options[172].

Demand and service options

11.1.3 The demand analysis concluded that journey times compared with air services would be key in determining the likely share of the overall international market to the near continent that could be attracted to high speed rail, and that high speed rail should be able to capture a significant share of the market by offering services from the West Midlands to Paris and Brussels in approximately three hours. Nevertheless demand for trips to mainland Europe from the Midlands and the North was forecast to be low[173]:

- a direct non-stop services from Birmingham to Paris and Brussels could be expected to attract no more than 1050-2200 passengers per day in each direction in 2033 – i.e. sufficient to fill no more than 2-3 trains per day;
- if HS2 does not include any link with HS1, international passengers could walk or go by bus between Euston and St. Pancras, taking approximately ten

[171] Britain's Transport Infrastructure High Speed Two Jan 2009 p.24 para.63(d)
[172] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 Section 3.8 pp.134-9
[173] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.137 paras. 3.8.8-10

minutes. But when the time waiting for trains and the inconvenience of changing trains with baggage is taken into account the 'generalised time'[174] disbenefit would be around 40 minutes. This scenario was estimated to attract 1500-3600 passengers per day. This is more than a through service because there is a frequent Eurostar service from St. Pancras;

- an alternative scenario would be not to run through HS2 services to the continent, but some Eurostar trains would terminate at Old Oak Common instead of St. Pancras so that HS2 continental passengers could change trains at Old Oak Common rather than terminating at Euston with a generalised time penalty of ten minutes for the interchange. Not only would this option avoid the very substantial disbenefit to most London passengers, it would attract more passengers – 2100-4650 per day – because GWML and west London travellers to Paris and Brussels could take advantage of the service. But there would be fewer continental passengers from the Midlands and the North;

- a light rail or people mover link that would reduce the generalised time penalty to 20 minutes would increase the demand to numbers closer to the Old Oak Common interchange option.

11.1.4 HS2 Ltd concluded that the passenger market wishing to use a link would be relatively small, but it recognised the uncertainty in aviation policy and forecasting in the long term. It recommended:

- if a link were built it should be a dual track conventional speed line running in tunnel from Old Oak Common to Primrose Hill and via the NLL to HS1;

- trains should start their journeys to the continent at Old Oak Common;

- further thought be given to the people mover options regardless of whether a HS1 rail link was taken forward.

11.1.5 In March 2010 the Government concluded, in the context of journey times between major British cities and the continent and the opportunity for mode switch from air to rail, that the strategic case for a link was obvious and asked HS2 Ltd to develop options for a direct link via the NLL and for an improved passenger connection between Euston and St. Pancras[175].

11.1.6 In the February 2011 Consultation document the Government summarised the strategic case for the link as follows:

> "The Channel Tunnel and the HS1 line serving it have revolutionised the market for travel between the UK and mainland Europe. Since opening, Eurostar has carried more than 100 million passengers, and air passengers numbers from London to Paris and Brussels have fallen by more than half. Eurostar now holds 80% of the combined rail/air market to these destinations.

[174] "Generalised time" is a weighted measurement of travel time which takes into account the perceived risk and inconvenience of boarding and alighting, walking and waiting.
[175] High Speed Rail, DfT, March 2010 (Cm.7827) pp.125-6 Paras. 7.20-28

International rail connectivity has also grown significantly across mainland Europe. The networks of high speed rail lines being developed by France, Germany Spain, the Netherlands, Belgium and Italy have all been designed to enable international travel. Connecting any UK high speed line to this rapidly growing network will be vital if the UK is not to become isolated from what is already a key mode of travel between major European cities.

However, at present, services on HS1 and the Channel Tunnel are relatively inaccessible for those outside London and the South East. By providing direct access to the wider European network for services from Manchester, Birmingham and other cities, a link between a national high speed rail network and the current HS1 line could address this.[176]

The Government's view is that the strategic case for a direct link between the proposed high speed rail network and the HS1 line to the Channel Tunnel is strong.[177]

Options for a direct link between HS1 and HS2

11.1.7 HS2 Ltd reported on further work on these options in September 2010[178]. Its brief had been expanded by the Secretary of State in June 2010 to include consideration of the impact of linking to Heathrow and of the market for services between Heathrow and the continent[179].

11.1.8 Based on forecast air travel demand in 2010 HS2 Ltd estimated a theoretical market of up to 5000 passengers per day. Even this level of demand would not justify more than seven HS2 trains per day, but such a service would not be frequent enough to capture all this theoretical demand[180].

11.1.9 It was clear from the previous work that minimising cost would be a key factor in determining whether a business case could be made. Revised costing estimated a dual track direct link at £1.5bn and a single track link at £0.9bn. Two options to reduce the length of tunnelling were also considered at this time[181]:

- a shorter single track tunnel that would emerge at Queens Park rather than Primrose Hill, utilising the slow lines on the WCML. However, this option was not pursued because it would have been only slightly cheaper and entailed more train service disruption and compensation to train operators; and
- an underground junction entailing long caverns near Euston for each of the HS2 tracks. This option was not pursued because it would entail a significant settlement risk and would result in very little overall cost saving.

[176] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 pp.67-8 paras 3.24-3.26
[177] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.68 para.3.29
[178] High Speed Rail London to the West Midlands and Beyond Supplementary Report, HS2 Ltd, September 2010 Chapter 2 pp.39-52
[179] Secretary of State for Transport letter to HS2 Ltd 11 June 2010
[180] High Speed Rail London to the West Midlands and Beyond Supplementary Report, HS2 Ltd, September 2010 p.45 paras. 2.2.11-2.2.12
[181] High Speed Rail London to the West Midlands and Beyond Supplementary Report, HS2 Ltd, September 2010 p.43 paras. 2.2.2-2.2.3

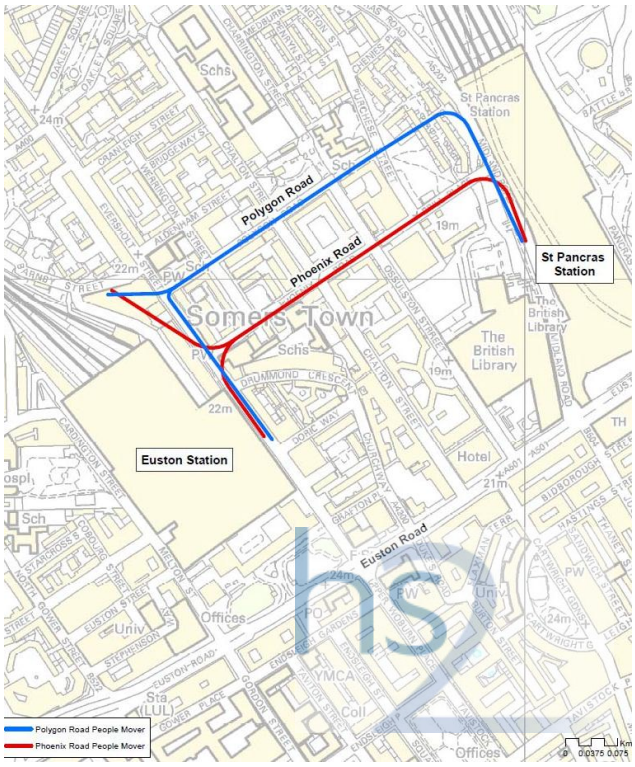
11.1.10 Constructability was also a major issue[182]. A two track link would be more complex to build as it would require more significant works to the North London Line and likely to entail total closure of the line for a period of months. A variant would be to provide a single track initially and then build a second track some time after HS2 becomes operational if it were justified by the demand. However, the disruption for the second track would be the same as if the whole link were built later, with the added disadvantage that Hs1-HS2 services would need to be suspended as well as NLL services. The environmental consequences of the two track option would be similar to a single track link, but the townscape effects of a wider North London Line viaduct would be greater and several more listed buildings would be affected.

Improved Euston-St. Pancras interchange

11.1.11 A travelator would not have sufficient capacity for peak demand and would not be significantly faster than walking, so all remaining options to improve the interchange between Euston and St. Pancras were for an Automated People Mover (APM) – a fixed track train similar to those used between terminals at airports.

11.1.12 A surface link was discounted as it would be too disruptive to road traffic and a link at any level along Euston Road proved not to be feasible. The potential infrastructure options were thus either an elevated or a sub-surface link on two alignments – Polygon Road and Phoenix Road/Brill Place.

Figure 13: Automated People Mover Route Options



11.1.13 A sub-surface link under either of the two roads would be approximately as wide as the street. This would make many of the properties in the street uninhabitable during

[182] High Speed Rail London to the West Midlands and Beyond Supplementary Report, HS2 Ltd, September 2010 p.44 paras. 2.2.5-2.2.8

construction and some demolition might also be necessary. It would not be possible to run east of Midland Road because of the Thameslink tunnels. Construction of a bored tunnel would require large reception and launch shafts at either end which would probably make it impractical[183].

11.1.14 An elevated Automated People Mover option could run above Phoenix Road/Brill Place, where there is a continuous road between the stations; or Polygon Road, where some housing would need to be demolished to create a continuous route. However, the Phoenix Road/Brill Place alignment would adversely affect the then proposed Francis Crick Institute medical research facility (now under construction), as well as the settings of three listed buildings. Both alignments would require felling of established trees and would have adverse noise and visual intrusion to adjacent properties.

11.1.15 In February 2011 the Government consulted on the three generic options for a single or dual track direct link or an elevated people mover. Its view was that the strategic case for a direct link was strong and it favoured a single track link from Old Oak Common via the North London Line[184]. The Government proposed that it should be built as part of the Phase One of HS2, as it concluded that it would not be possible to build the link at a later date without unacceptable disruption to Crossrail services[185].

11.1.16 After having considered the responses to the public consultation, in January 2012 the Government stated its recognition of the potential importance of the wider strategic benefits of seemless connectivity between HS2 and Hs1, its belief that a direct link is an important objective and its intention to implement the link in Phase One[186]. It supported a direct link via a new tunnel and the existing north London Line. However the Government also commissioned HS2 Ltd to continue discussions with Network Rail and Transport for London to consider whether a 3tph service on the link would impede existing services on the North London Line[187].

Alternative alignments

11.1.17 As part of this work on North London Line capacity alternatives, during 2012 and 2013 options for longer tunnels under Camden Town were also considered including three following the NLL alignment and one for a significantly longer tunnel to the north under previously unaffected residential properties. Further options for the alignment and design of the link were considered during 2013 including tunnel portal options. These are described in the CFA 2 report.

11.1.18 A tunnelled option would have advantages in terms of providing full segregation of services from HS1 to HS2, of reducing the need for surface works along the NLL route including viaduct widening, upgrading of Camden Road station and the replacement of eight bridges on the NLL. Nor would there be any risk of a constraint on future enhancements to NLL capacity. However, the construction risks associated with

[183] Supplementary Report Sep 2010 p.48 paras. 2.3.6-2.3.7
[184] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.68 para.3.29-30
[185] High Speed Rail: Investing in Britain's Future Consultation , DfT, February2011 p.68 para.3.34-35
[186] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.81 para.4.41
[187] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 pp.81-82 para.4.45-6

tunnelling in this area (which would in practice be likely to add substantially to the costs), the permanent stopping up of roads, and the substantially increased loss of domestic property for the northern tunnel option, as well as the difficulty of finding suitable sites for vent shafts argue in favour of the surface route.

11.1.19 Following consideration of the issues and options the Government remains convinced of the strategic importance of a link between HS2 and HS1 and is committed to providing it in the Phase One scheme. It has also concluded that the Proposed Scheme is preferable to the alternatives, because it would require demolition of fewer residential properties and no loss of public open space as well as other environmental advantages.

12 Depots and maintenance

12.1.1 In 2009 HS2 Ltd set out the requirements and the approach taken to identify the location of depots and other equipment sites, including a main infrastructure maintenance depot (IMD) and a rolling stock maintenance depot (RSMD). The report noted that depot location decisions were best taken once a preferred line of route is confirmed, but for the preliminary assessment and costing, a site on the intersection HS2 and the Oxford to Bletchley line was selected as a credible location for the IMD and Washwood Heath in Birmingham Heartlands for the RSMD[188]. The choice of location was taken no further at that stage as HS2 Ltd recommended consideration also be given to alternatives.

12.1.2 In March 2010 the Government agreed that the West Midlands could be an appropriate location for a rolling stock depot but asked HS2 Ltd to do further work on depots before the formal public consultation. This work was undertaken later in 2010. For both facilities it included an assessment of alternatives and led to consultation on depots at Washwood Heath and Calvert in February 2011.

Infrastructure Maintenance Depot

12.1.3 In order to maintain the HS2 route, several infrastructure maintenance depots situated at key points along the line will be required for maintenance of the track, signalling equipment, power systems, cuttings and embankments and other elements of the HS2 infrastructure. The preferred location for the principal maintenance depot for the Phase One route is somewhere midway between London and the West Midlands with access to all parts of the line.

12.1.4 Potential IMD sites were assessed against the four factors summarised in the HS2 Ltd 2009 report[189]:

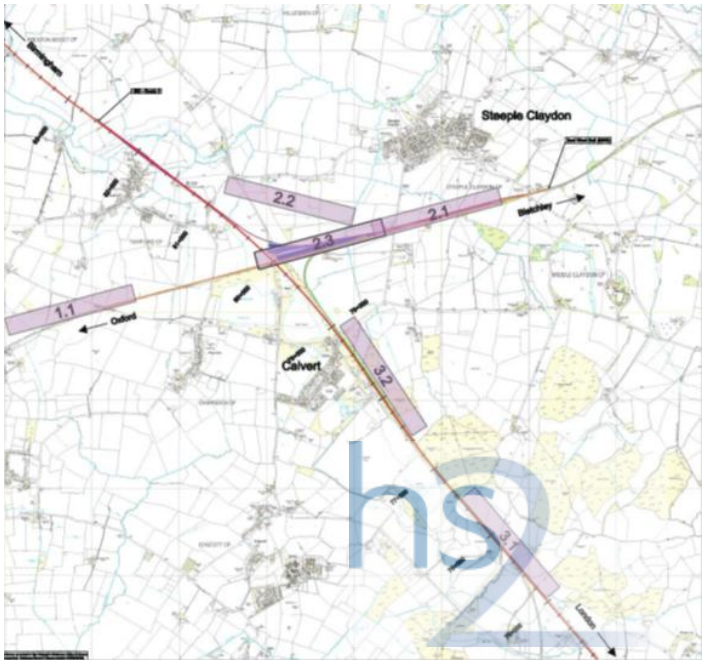
- location – it should be closely connected to the preferred line of route so that all parts of the route can be maintained with the minimum inconvenience to high speed rail users. The location should also accommodate reception tracks connecting the depot to the line in both directions;

[188] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p. 151 para.3.11.1
[189] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.153 para.3.11.6

- site size – for the principal depot a flat site of at least 1000m x 500m[190] would be required, available 24 hours per day, seven days a week. This site would be the centre for all maintenance and renewal activities, and would include offices and workshop facilities, stabling for track plant, locomotives and maintenance wagons and storage of components and materials to repair and maintain the line. It would be used intermittently throughout the day and at night for low level activities, such as plant maintenance, train formation and material deliverables. The depot would need to be lit, though the light impact would be limited as part of the overall design;
- access to rail freight routes, resources and supplies – the site would need to be accessible for supplies delivered by rail, such as ballast and long welded rail, and therefore would require connections to the classic line. Good road access and closeness to an appropriately skilled workforce would be needed. The IMD was estimated to employ approximately 250 people[191]; and
- environmental impacts – to surrounding areas.

12.1.5 Ideally the site should be somewhere midway between London and the West Midlands to provide the most operationally efficient access to the Phase One route. Calvert is towards the southern end, but HS2 would not cross any rail freight routes between Calvert and Kenilworth/Coventry, so along this stretch of the route there is no access for supply trains without building a new connecting line.

Figure 14: Potential infrastructure maintenance depot locations near Calvert



[190] Size of site required was revised to 100-200m wide in 2010. See High Speed Rail London to the West Midlands and Beyond Supplementary Report, HS2 Ltd, September 2010 p.54 para.3 1 3 and High Speed Rail: Investing in Britain's Future Consultation , DfT, February 2011 p.102
[191] The current estimate is approximately 300 jobs.

12.1.6 In September 2010 a short list of six potential sites in the area around Calvert, and a seventh site around 10km further north near Mixbury were identified and sifted using the following criteria:[192]

- Environmental impact to surrounding areas;
- Railway issues (e.g. amount of shunt moves required);
- Geographical issues (e.g. undulating terrain);
- Logistics (e.g. road access); and
- Costs.

12.1.7 The Mixbury site was not taken forward because it would have required a 10km single track line to provide a rail freight connection to the Oxford-Bletchley line[193], the site levels would have necessitated major alteration of the landscape in a prime rural setting[194] and (on a very high level appraisal) was assessed as worse than Calvert in terms of potential noise, visual intrusion and cost with no evident compensating advantage[195]. The options in the area around Calvert are shown in Figure 14.

12.1.8 The six Calvert sites were assessed as follows[196]:

- site 1.1 Twyford Lodge – the site would be very visible from the village of Twyford and relatively inaccessible from HS2. A new west to north chord line would be relatively intrusive because of the angle of the lines in this area;
- site 2.1 Pond Road – the topography of the land in this area would make connections difficult without substantial earthworks. The site would be close to Steeple Claydon and would affect the flood plain. It would also require Pond Lane to be diverted or closed;
- site 2.2 Claydon Junction – The site has less to recommend it than Site 2.3 as it would require more agricultural land and would be closer to Steeple Claydon.
- site 2.3 Thame Road – the preferred option because it offers the best option of minimised land take and minimum environmental impact;
- site 3.1 Greatmoor –would require major earthworks to create a level site and it is environmentally sensitive, with an SSSI immediately to the north. There is also no road access; and
- site 3.2 Great Pond – is close to Calvert village. The road access requirements of the relocated WRG waste transfer terminal could potentially complicate the site layout.

[192] High Speed Rail London to the West Midlands and Beyond Supplementary Report, HS2 Ltd, September 2010 pp.54-6
[193] High Speed 2 Infrastructure Maintenance Depot (IMD), Arup, March 2011 p.19 para.5.6.2
[194] High Speed 2 Infrastructure Maintenance Depot (IMD), Arup, March 2011 p.21 para.7.1.7
[195] High Speed 2 Infrastructure Maintenance Depot (IMD), Arup, March 2011 p.20 Fig.13
[196] High Speed 2 Infrastructure Maintenance Depot (IMD), Arup, March 2011 p.21

12.1.9 Site 2.3 was identified as the most promising because, unlike any of the others reviewed, it was not found to be un-favourable against any of the selection criteria. The site is adjacent to both the HS2 main line and the Bicester to Bletchley railway line, affording excellent access to both lines. The location also offers the least risk of adverse impacts on local communities.

12.1.10 Prior to the Secretary of State's selection of site 2.3 in January 2012, a further six sites between Quainton and Fleet Marsden, north of Aylesbury were considered[197]. These sites are not as well located as Calvert because they are even further towards the southern end of the route. Two preferred options – Option 5, approximately 1.5km east of Waddesdon, and Option 6 which is 0.8km west of Aylesbury Vale Parkway station – were selected for more detailed consideration. Both would be close to a main road, but would entail higher train operating costs and would be more than twice as expensive as the Calvert site.

12.1.11 Since the January 2012 HS2 Ltd has developed a maintenance strategy for the railway to enable the infrastructure to support a reliable service. An additional east-south chord is proposed to improve access to the proposed infrastructure maintenance depot at Calvert. Trains could use this chord instead of having to reverse northwards before joining the southbound HS2 track. Previous proposals envisaged that trains from the depot heading south would reverse northwards into sidings near Twyford before continuing south on HS2 tracks. Access from the depot to the southern part of the route would be relatively slow and could unnecessarily disturb residents of Twyford.

Maintenance Loops

12.1.12 The frequency of the proposed train service limits the opportunity to undertake maintenance during the hours when trains are running and maintenance activity would disrupt services. Thus maintenance must take place during the night closure period or in limited periods at the beginning and end of the day when the service is less frequent. 'Maintenance loops' – parallel tracks alongside the main line – are proposed where maintenance trains can lay up during the daytime in order to reduce the travel distance required and maximise the amount of work that can be undertaken in the night time possession. A subsidiary function of the loops is to provide a safe stopping location for any passenger train that develops a fault, allowing the main railway to remain in operation.

12.1.13 Two maintenance loops are required, one to the south approximately mid-way between Calvert and Euston station, and the other to the north approximately mid-way between Calvert and the triangular junction in the West Midlands. Location options for these loops were included in the Design Refinement Consultation published in May 2013[198].

12.1.14 The maintenance loop sites need to be largely flat, straight and located next to a straight section of the main line with sufficient space for connections to both sides as

[197] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 8
[198] Design Refinement Consultation: Consultation Document, DfT, May 2013 Section 7 p.36 & Section 9 p.43

well as good road access. The length of the loop line needs to be approximately 1.25km long to allow a train to be parked clear of the HS2 line if necessary. The track corridor width at maintenance loops would be about 16m wider than the two track section to allow for the additional loop line on either side. When in use during the night, the site would be lit by low level lighting.

Location options between Euston Station and Calvert

12.1.15 A southern loop located exactly half way between Calvert and Euston would be in the Chilterns tunnel, 40 km from Euston. This tunnel restricts potential sites and so locations were considered near:

- Stoke Mandeville (the preferred option) - between Nash Lee Road and the A4010 Risborough Road;
- Denham, close to the M25 – could not be connected to both sides of the main line, and is also the proposed site for the potential spur connection to Heathrow, pre-empting a future connection to the airport;
- Hyde Heath between the Chiltern tunnel and the South Heath green tunnel in the Chilterns AONB – which also does not allow the loop lines to be connected to both sides of the main line and the tracks in this location are too steep for a maintenance loop; and
- between Grim's Ditch and Wendover Dean in the Chilterns AONB – which could have increased sound and visual effects on homes on Potter Row. There would also be an impact on an area of ancient woodland, Jones' Hill Wood, and there would be additional visual impacts on the AONB.

12.1.16 As a result of sifting these options, HS2 Ltd recommended Stoke Mandeville as this location is the most operationally efficient and has the least impact on the local environment.

Location options between Calvert and Birmingham

12.1.17 The undulating landscape and the curvature of the route between Calvert and the triangular junction in the West Midlands limits the number of sites that can satisfy the requirements for a loop. Three straight sections were identified as potential locations, all are in rural areas:

- near Lower Radbourne – where the route and maintenance loop would be placed on viaducts or on embankment up to 14m high with long access roads to connect to the nearest suitable highway network. This arrangement would cause a visual impact and affect the setting of Hodnell Manor;
- near Wormleighton (the preferred option) - which is a section of deep cutting to reduce the visual, landscape and noise impacts; and
- near Greatworth, only 20km from Calvert which is too close to be operationally desirable.

12.1.18 As a result of the sifting of these options, HS2 Ltd recommended Wormleighton as this location is the most operationally efficient and has the least impact on the local environment.

HS2 rolling stock depot

12.1.19 A rolling stock depot would be required to maintain the dedicated HS2 'captive' train fleet and the classic-compatible fleet of trains that would run on both HS2 and the existing main lines. One maintenance depot is needed to maintain all trains, although other stabling facilities could be located elsewhere and light maintenance depots will be needed for the Phase Two extensions. The depot would be used for rolling stock inspection, repair, internal and external cleaning, light and heavy maintenance, toilet tank emptying, re-watering and the replenishment of consumables.

12.1.20 In 2009 the location factors were[199]:

- location – a depot should be in the middle of a longer term network within 10 minutes (8km) rail travelling time of the high speed route;
- site – a flat site of approximately 2000m by 500m with access to power and services and ideally with space for expansion in an area suitable for an industrial facility with 24 hours working, seven days per week;
- access to high speed routes – a direct connection to the high speed line, with access to an appropriately skilled and available labour force preferably by public transport, with good rail and road access;
- environmental impact on surrounding areas.

12.1.21 Having assessed eight other locations in less detail Washwood Heath was identified by HS2 Ltd as a potential site[200]. It recommended more work on Washwood Heath and the alternatives[201]. In March 2010, the Government concurred that the West Midlands could be an appropriate location and asked HS2 Ltd to do further work[202].

12.1.22 HS2 Ltd reported on 23 September 2010[203]. The location factors and functional requirements included consideration of sites near the north and south ends of the London to West Midlands route. Experience of other rolling stock operators and key stakeholders highlighted the strategic differences between the two areas. This led to a preference to locations in the West Midlands.

Table 11 Comparison of London and West Midlands as the location for the rolling stock depot

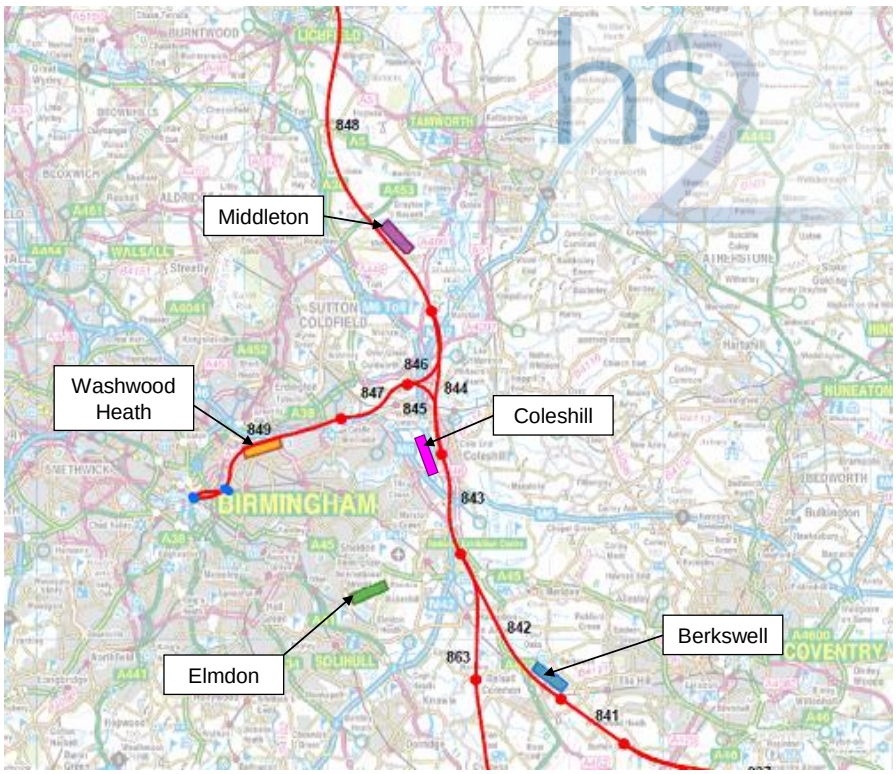
	London area	**West Midlands**
Suitable plot potentially accessible to 'GCgauge'[204] trains	Extremely difficult to identify suitable options	Viable options identified

[199] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.151 para.3.11.3
[200] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.153 para.3.11.5
[201] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.154 para.3.11.11
[202] High Speed Rail, DfT, March 2010 (Cm.7827) p.130 para.8.19
[203] Rolling Stock Maintenance Depot Selection, HS2 Ltd, 23 September 2010 (FoI Response No.2011 338).
[204] For current and future HS2 rolling stock.

	London area	West Midlands
Resource skills base	Skills at premium with number of other existing depots	Good skills match and potential availability
Fit with future long term high-speed strategy	At southern end of potential network	Centrally placed within future long term network likely to be regional hub

12.1.23 Six potential brownfield locations in the West Midlands area were identified. Three rail yards were discounted either because they were in use and unlikely to become available or because they were too small. The Longbridge motor works site would be too far away, so Washwood Heath and the Elmdon Land Rover site were taken forward to the next stage of the site selection process. Review with key stakeholders in October and November of 2009 suggested consideration of other brownfield sites, but on further examination these sites were discounted as they were too small, too remote or did not support sufficient access to the potential HS2 route. Potential green field sites selected were at Middleton, Berkswell, and Coleshill. Middleton and Berkswell were considered as exemplars of any greenfield site pending outcome of route selection process, and Coleshill was the suggestion of stakeholders. Figure 15 shows their locations.

Figure 15: Rolling stock depot options considered in 2010



12.1.24 The Elmdon site was required for continued vehicle production and so could not be considered further. The Berkswell site in the Green Belt did not offer sufficient accessibility for people, materials and rail connections. Appraisal of the three

remaining sites at Washwood Heath, Coleshill and Middleton concluded that Washwood Heath was most advantageous site on both technical and environmental criteria. Washwood Heath was therefore selected as the proposed rolling stock depot. It was presented for public consultation in 2011 and was included in the 2012 post consultation scheme.

12.1.25 However, in November 2012 HS2 Ltd agreed to update the site selection analysis following representations from Birmingham City Council and the main landowners of the Washwood Heath site. A long list of 86 potential sites was identified using the following criteria:

- flat - a one degree change over 1km (i.e. 10 m rise or fall);
- over 1 km^2 total land area;
- within 5 miles of the core route;
- within 1 mile of an A or B road (including motorway junctions) to provide site access;
- outside urban areas;
- outside 1:100 year flood zone.

12.1.26 A short list was prepared of nine sites wholly or partly satisfying additional criteria:

- the site is not presently in commercial/industrial use?
- the site is large enough?
- the site is not bisected by major road or canal?
- the site does not contain a major water feature?
- the site has a clear access route to main HS2 line?

12.1.27 Six sites met some of the selection criteria – at Kings Bromley, Ufton, Ludgershall, Aylesbury Vale, Little Kimble and Birmingham Interchange – and four sites met most or all of the selection criteria – at Newton Purcell, Westcott, Bishopstone and Washwood Heath. These sites were then compared with Washwood Heath applying additional operational feasibility criteria:

- distance from nearest terminal station;
- capable of connection in both directions;
- capable of entrance at main line speed (240 kph max);
- access from Phase Two routes.

12.1.28 The train service specification assumed that there would be train movements to and from the rolling stock depot in the middle, as well as at the start and end, of the day to support the efficient use of rolling stock and operating costs. As a result, the sites along the main HS2 route would need grade separated junctions with acceleration and

deceleration tracks to allow the trains quickly to join or leave the fastest sections of the main line.

12.1.29 The greenfield sites generally entailed long acceleration/deceleration tracks, greater environmental impact, a shortage of skilled labour in the locality and higher operational cost. The two strongest options were at Birmingham Interchange and Washwood Heath. Four options immediately adjacent to Birmingham Interchange station were prepared, one on the west side and three to the east, each with a different configuration of reversing sidings and access to HS2 main line. These five options were appraised against the sift criteria.

12.1.30 This study demonstrated that Birmingham Interchange would be viable, particularly if a direct connection were provided from the north. However, it would entail running empty trains to the depot on the main line and reversing moves would result in additional unit mileage and crew hours. Taking account of the wide range of environmental factors, the setting of the depot at the Birmingham Interchange site is less environmentally favourable than Washwood Heath and would cost more. The additional costs are largely due to earthworks and structures to form grade separated junctions where the tracks cross the M6 and M42. HS2 Ltd concluded that the depot should be located at Washwood Heath as previously proposed.

12.1.31 The access arrangements to the Washwood Heath depot were reviewed in 2013 and showed the existing arrangements created a risk of trains queuing on the main line to/from Birmingham with a resultant knock on impact on the operation of passenger services. The Design Refinement Consultation outlined the western access options and HS2 Ltd proposed one additional track from Duddeston flyover near Curzon Street station in Birmingham to ensure that the railway operates efficiently.

Other equipment sites

12.1.32 The 2009 report noted that the operation of a high speed line would require a number of other sundry equipment locations. These would require smaller sites than the two principal depots and that the business case included notional capital costs for these elements under the following broad categories. These are included in the hybrid bill documentation:

- train stabling to support basic servicing and automated inspection of trains overnight;
- control centre – housing signalling and control staff, communications and power;
- air shafts and intervention shafts which are part of the tunnelled sections;
- auto-transformer feeder stations and approximately four connections to the National Grid using existing connections link by overhead or buried 25kV cables; and
- system equipment sites.

12.1.33 Overnight stabling is proposed at Euston, Washwood Heath and at locations accessible by the classic-compatible fleet operating on the West Coast Main Line. HS2 Ltd undertook a review of the capability of depots used by the Class 390 Pendolino long distance WCML trains and an understanding of the planned replacement of some trains with HS2 services. As a result HS2 Ltd proposes that the HS2 trains are stabled overnight at the existing depots of Edge Hill (Liverpool) and Polmadie (Glasgow). To provide full capacity in Phase One, it is also proposed to bring into use Longsight near Manchester, which is currently owned by London & Continental Railways.

13 References

Pre-consultation

The Eddington Transport Study The case for action: Sir Rod Eddington's advice to Government, HM Treasury & DfT, December 2006

Estimated Carbon Impact of a New North South Line, Booz Allen Hamilton, 12 July 2007

Delivering a Sustainable Transport System: Main Report, DfT, November 2008

Britain's Transport Infrastructure High Speed Two, DfT, Jan 2009

High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009

High Speed Rail, DfT, March 2010 (Cm.7827)

High Speed Rail Access to Heathrow A Report to the Secretary of State for Transport by Rt Hon the Lord Mawhinney, July 2010

High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010

High Speed 2 Strategic Alternatives Study Highway Interventions Report, Atkins, March 2010

High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010

Secretary of State for Transport letter to HS2 Ltd 11 June 2010

High Speed Rail London to the West Midlands and Beyond: Supplementary Report: HS2 Ltd, September 2010

Secretary of State for Transport letters to HS2 Ltd 4 October 2010

High level assessment of the wider network options – reverse 'S' and 'Y' network, HS2 Ltd, October 2010

Consultation

High Speed Rail: Investing in Britain's Future: Consultation , DfT, February2011

High Speed 2 Limited: High Speed 2: Route Engineering Report, Arup, February 2011

Economic Case for HS2: the Y Network and London to West Midlands, DfT, 2011

Analyses of London Interchange Options and Markets: A Report for HS2 Ltd, Atkins, May 2011

High Speed 2 Strategic Alternatives Study: London to West Midlands Rail Alternatives: Update of Economic Appraisal, Atkins, February 2011

High Speed Rail Strategic Alternatives Study: Strategic Alternatives to the Proposed 'Y' Network, Atkins, February 2011

HS2 London to the West Midlands Appraisal of Sustainability, Booz Temple, February 2011

High Speed Rail: Investing in Britain's Future Consultation Summary Report, Dialogue by Design, November 2011

High Speed 2 Infrastructure Maintenance Depot (IMD), Arup, March 2011

51m Response to HS2 Consultation Appendix 1 Optimised Alternative to HS2 - The Scope for Growth on the Existing Network, 51m Consortium of Local Authorities, 2011

Post-Consultation to January 2012

Review of Strategic Alternatives to HS2, Network Rail, November 2011

National Infrastructure Plan 2011, DfT, November 2011

Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012

Review of the Government's Strategy for a National High Speed Rail Network, DfT, 2012

Review of the Technical Specification for High Speed Rail in the UK: A Report to Government by HS2 Ltd, January 2012

High Speed Rail Strategic Alternatives Study: Update following Consultation, Atkins, January 2012

The Economic Case for HS2: Value for Money Statement, DfT, January 2012

Economic Case for HS2: Updated appraisal of transport user benefits and wider economic benefits: A Report to Government by HS2 Ltd, January 2012

Review of possible refinements to the proposed HS2 London to West Midlands Route, A report to Government by HS2 Ltd, January 2012

High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012

January 2012 to Bill Deposit

UK Aviation Forecasts, DfT, January 2013

The Green Book: appraisal and evaluation in central government, HM Treasury, 18 April 2013

Action for Roads, DfT, July 2013 (Cm.8679)

Investing in Britain's Future, HM Treasury, June 2013 (Cm.8669)

Design Refinement Consultation: Consultation Document, DfT, May 2013

The Strategic Case for HS2, DfT, October 2013