High Speed Two Phase 2a: West Midlands to Crewe

Working Draft Environmental Impact Assessment Report

# Volume 1 appendix: Alternatives report

September 2016

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September 2016

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 Background

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. Stations in London, Birmingham, Leeds, Manchester, East Midlands and South Yorkshire will be served by high speed trains running at speeds of up to 360kph (225mph).

1.1.2 HS2 will be built in phases. Phase One comprises the section of HS2 between London, Birmingham and the West Midlands, which will become operational in 2026. It was the subject of an Environmental Statement (ES) deposited with the High Speed Two (London – West Midlands) Bill in 2013 and ES deposited with Additional Provisions to that Bill in 2014 and 2015.

1.1.3 Phase Two of HS2 would extend the line to the North West and North East: to Manchester with connections to the West Coast Main Line (WCML) at Crewe and Golborne; and to Leeds with a connection to the East Coast Main Line (ECML) approaching York, completing what is known as the 'Y network'.

1.1.4 Phase 2a, the subject of this report, comprises the first section of the western leg of Phase Two from the West Midlands to Crewe (approximately 60km (37 miles) in length). Phase 2a is referred to in this report as the 'Proposed Scheme'.

1.1.5 EIA Directive 2014/52/EU[1] requires an EIA Report to include:

> "A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."

1.1.6 This report describes the evolution of the High Speed Two (HS2) project. It summarises the objectives and requirements of the new high speed line, the reasonable alternatives considered and choices made from the highest level strategic alternatives, through the route-wide and route corridor alternatives, to the main elements of the Proposed Scheme and the route between the West Midlands and Crewe. In each case it explains why the decisions were made.

1.1.7 The report has been developed for the Proposed Scheme taking into account relevant information included within the Alternatives Report appended to the Phase One ES (November 2013)[2], a study commissioned by the Department for Transport (DfT) on

[1] Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. This Directive has yet to be transposed into UK legislation – Member States are required to transpose it by 16 May 2017. The UK Government had not confirmed a date for the issue of new regulations for implementing this new Directive during preparation of this working draft EIA Report. However, it is anticipated that new regulations will have been introduced by the time the hybrid Bill for Phase 2a is deposited.

[2] Department for Transport and HS2 Ltd (2013), London-West Midlands Environmental Statement, Volume 5 Technical Appendices, Alternatives Report (CT-002-000), November 2013, Available on-line at: https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-alternatives-report

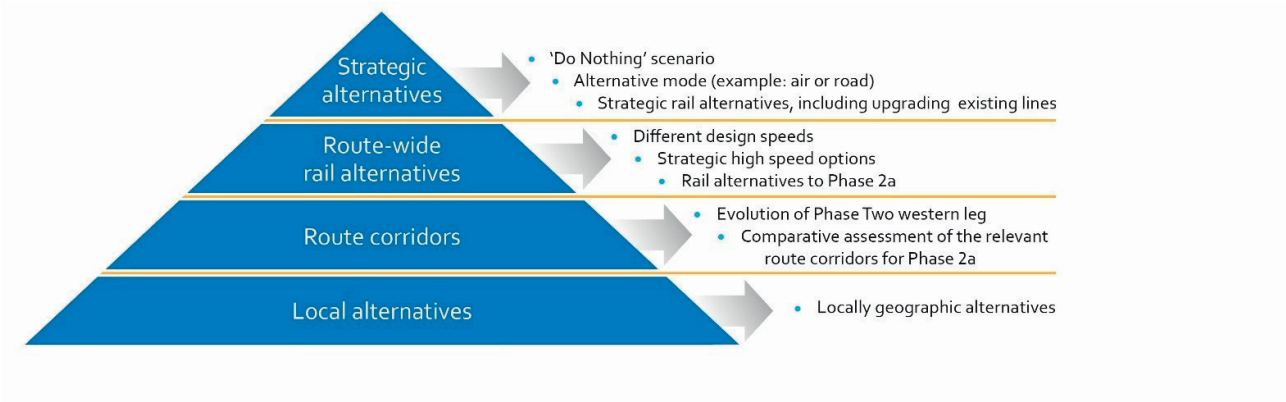
rail alternatives[3], consideration of the Phase 2a route corridor alternatives, and recent Government reports such as the Command Paper[4] and the Supplement to the HS2 Strategic Case[5].

1.1.8 This report forms an appendix to Volume 1 of the working draft EIA Report, which is issued for consultation in advance of the preparation of the formal EIA Report.

## 1.2 Structure of this report

1.2.1 The reasonable alternatives are set out in accordance with the hierarchy shown in Figure 1.

Figure 1: Hierarchy of alternatives considered




1.2.2 Part I of this report discusses the reasonable strategic alternatives and route-wide rail alternatives that were considered. It 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 West 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. It also addresses the consideration of different design speeds, strategic high speed options and rail alternatives to Phase 2a.

1.2.3 Part II then explains chronologically the consideration of reasonable route corridor alternatives to the Proposed Scheme, and the reasons for the decisions taken on the proposals presented for public consultation in 2013 and 2014. It also describes the reasonable local alternatives that have been considered both before and after the route announcement in November 2015.

[3] Atkins, November 2015, *Rail Alternatives to HS2 Phase 2a*. A report for the Department for Transport. Available on-line at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480645/rail-alternatives-to-hs2-phase-2a.pdf
[4] Department for Transport (2015), High Speed Two: East and West – The next steps to Crewe and beyond, Cm 9157 November 2015. Available on-line at: https://www.gov.uk/government/publications/hs2-phase-two-east-and-west-the-next-steps-to-crewe-and-beyond
[5] Department for Transport (2015), Supplement to the October 2013 Strategic Case for HS2, November 2015. Available on-line at: https://www.gov.uk/government/publications/hs2-supplement-to-the-october-2013-strategic-case

# Part I

# 2 Strategic alternatives

## 2.1 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 4.3% per annum (p.a.) in the last 10 years[6] (from 2005-06 to 2015-16).

2.1.2 The evidence shows that economic growth and demand for transport go hand in hand. Between 1980 and the publication of the Strategic Case for HS2 in 2013, there was a near doubling in rail demand, a 56% increase in road demand and a 175% increase in domestic aviation[7]. The economy grew by 118%[8] over this period. 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 (2012) projections, real Gross Domestic Product (GDP) is expected to increase by 56% over the next 20 years to 2032[8]. In addition, the UK population is projected to grow by 11 million people between 2010 and 2035[8]. The combination of these factors will add to demand on roads and railways from passengers and from freight transport. 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[9]:

- "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 inter-city rail services will see many trains at or beyond

[6] Source: Office of Rail and Road.
[7] Transport Statistics Great Britain Table TSGB0101
[8] Long-term profile of Gross Domestic Product (GDP) in the UK, Office for National Statistics, 2013
[9] 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 interurban 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."[10]

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"[11], 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 WCML 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 alternatives to high speed rail, we consider that even very major programmes of

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

> enhancements to existing lines would be unable fully to accommodate forecast demand growth and would lead to unacceptable levels of crowding on many routes."[12]

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[13]. 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[14].

2.1.8 The consultation was undertaken on the proposed high speed rail strategy and a preferred route for Phase One of the Y network from February to July 2011. The consultation was supported by an over-arching consultation document (High Speed Rail: Investing in Britain's Future – Consultation) and various supporting documents, including an Appraisal of Sustainability (AoS) and a review of network-wide strategic alternatives to the Y network[15].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 consultation in 2011. 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."[16]

> "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."[17]

2.1.9 The Government has summed up its 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[18].

[12] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 pp.16-17 paras.5-6
[13] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.44 para.2.14
[14] The Strategic Case for HS2 2013 p.49 Fig. 2.5
[15] Department for Transport (2011), *High Speed Rail: Investing in Britain's Future – Consultation.* Her Majesty's Stationery Office, London.
[16] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.18 para.13
[17] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.42
[18] National Infrastructure Plan 2011, DfT, November 2011 p.43 Para.3.36

> 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." [19]

2.1.10 The Government 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."[20]

2.1.11 Key developments since the publication of the 2013 Strategic Case for HS2 include continuing growth in rail demand, as indicated in the Supplement to the Strategic Case[21]:

> "Since the Strategic Case was published, demand for rail travel has continued to grow at a rate that is well above the long term forecast that underpins DfT's Economic Case for HS2. From 2013 to 2015 (years ending 31 March), the number of rail journeys in Great Britain grew by 10.2 per cent from 1,501 million to 1,654 million. This is an annual growth rate of 5 per cent – more than double the growth of around 2 per cent assumed in the Economic Case for HS2."

2.1.12 There has also been increased focus, since publication of the October 2013 Strategic Case, on the role of high quality transport infrastructure in improving productivity – and therefore the potential of HS2 to help rebalance the economy. A 2014 study for the DfT[22] found that transport investments can deliver economic benefits over and above conventionally measured benefits to transport users because:

> "(a) Transport fosters intense economic interaction that raises productivity; this can occur in clusters within narrowly defined areas or more widely by linking areas.
>
> (b) Transport shapes the level and location of private investment, potentially leading to higher levels of economic activity in some areas."

2.1.13 The Supplement to the October 2013 Strategic Case for HS2 concludes that:

> "...HS2 is critical for Britain's future. It gives the capacity that is needed urgently to keep pace with demand on our most strategically important rail corridors, and it provides the high quality connectivity that will allow the economies of our major cities, particularly those outside of London, to thrive. In doing so, HS2 can contribute to the rebalancing of the national economy and the emergence of a new Northern Powerhouse."

[19] The Strategic Case for HS2 2013 p.66 paras 3.2.2-3.2.3
[20] The Strategic Case for HS2 2013 p.66 para.3.2.6
[21] Supplement to the October 2013 Strategic Case for HS2, DfT, November 2015, p.11 para 2.1
[22] Venables, Anthony J; Laird, James; and Overman, Henry 2014, Transport Investment and Economic Performance, Paper commissioned by UK Department for Transport.

## 2.2 Alternative modes – air or road travel

### Introduction

2.2.1 Having decided to focus on the congested networks, inter-city travel and access to international gateways, the 2005-2010 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.

2.2.2 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
- second, on longer term solutions for the strategic corridors.

2.2.3 There have thus been two strands to the analysis of high level strategic options, with the DfT 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.

2.2.4 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.

### Air travel

2.2.5 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.

2.2.6 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 and so on;

- 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. While 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[23].

2.2.7 In view of these considerations, in 2012 the then 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[24], 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[25].

2.2.8 In March 2013 the then 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."[26]

## New motorways

2.2.9 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.

2.2.10 In 2010, the then Government 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

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

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.

2.2.11 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 of 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[27].

## Selective enhancement of the road network

2.2.12 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 2005-2010 Government commissioned Atkins to explore the potential for a package of road capacity enhancements to accommodate increasing travel between London and the West Midlands[28].

2.2.13 The road network provides for 90% of all passenger travel[29] and 75% of long distance trips (over 100 miles)[30]. 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%[31].

2.2.14 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 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' (now Smart Motorways) initiatives including variable speed limits and hard shoulder running and some widening within existing highway boundaries.

2.2.15 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

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

National Transport Model, which was broadly consistent with the Motorways and Major Trunk Roads Paper, January 2009[32].

2.2.16 Four packages of enhancements were assessed. Each would require an additional increment on the previous package. They are identified 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 Smart Motorways controls. | Hard shoulder running implemented on all sections excluding M25.<br>Widening M42 J3-7 to dual 4 motorway + hard shoulder running. |
| Package 2 | Extends Smart 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.<br>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. |

2.2.17 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 of 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.

2.2.18 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[33]).

2.2.19 In March 2010 the then 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

[32] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.12 para.3.2.2.3
[33] Action for Roads, DfT, July 2013 (Cm.8679) p.16 para.1.22

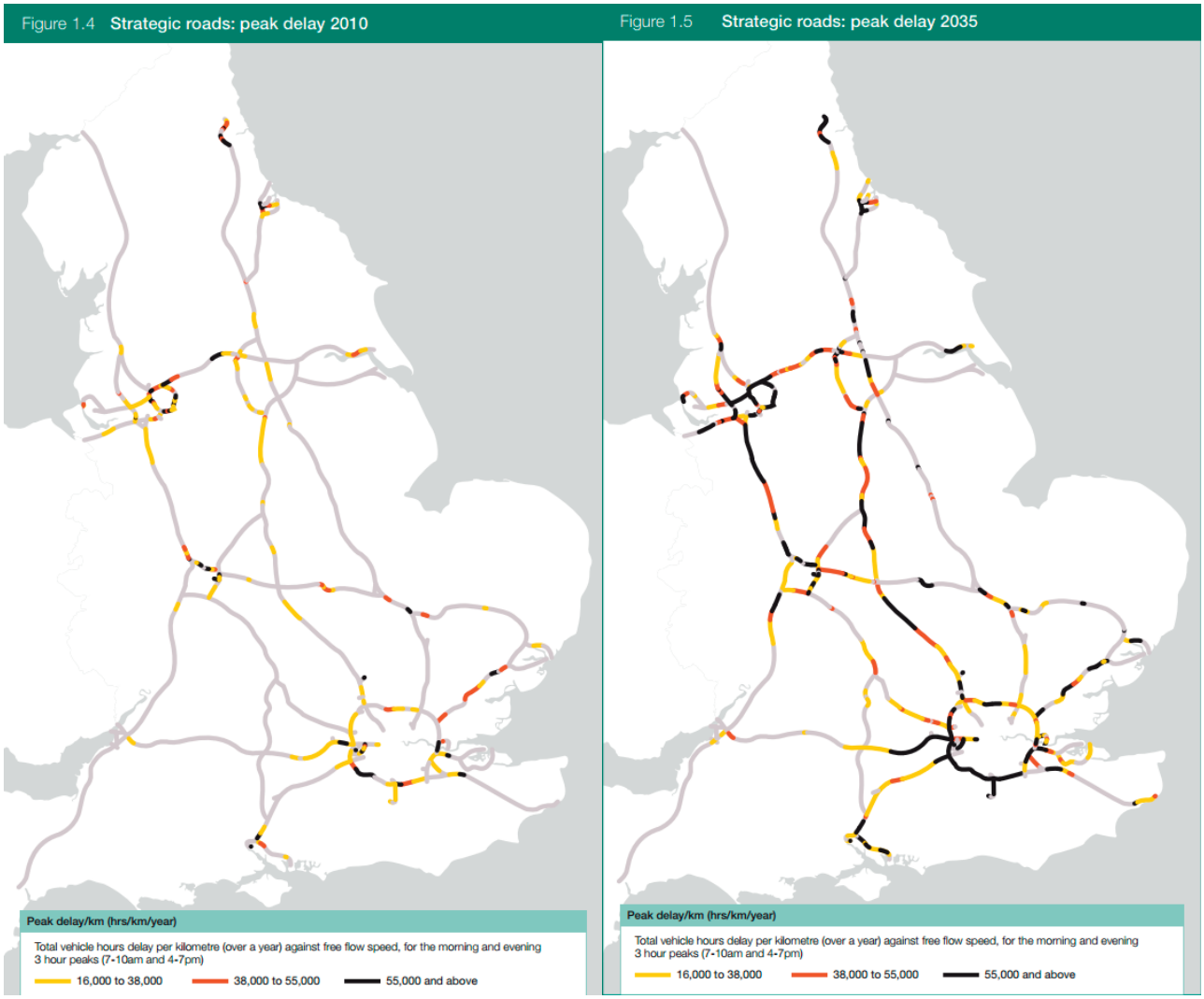
reliability[34] (see Figure 1). Reviewing the Atkins analysis, the Government concluded that there were still strong gains to be made from further roll out of hard shoulder running (via Smart Motorways), but the scope for incremental improvements that offer high value for money is finite with the returns decreasing substantially as they grow in size and cost[35].

2.2.20 In the 2011 public consultation[36] 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.

2.2.21 Following the 2011 public 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".

[34] High Speed Rail, DfT, March 2010 (Cm.7827)p.32 para.1.28
[35] High Speed Rail, DfT, March 2010 (Cm.7827) p.52 para. 2.47
[36] Department for Transport (2011), *High Speed Rail: Investing in Britain's Future – Consultation.* Her Majesty's Stationery Office, London.

Figure 2: Peak delay on strategic roads 2010-2035[37]




2.2.22 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."[38]

2.2.23 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 not be able to serve the unconstrained demand for road travel forecast for the next 20

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

years, still less to accommodate any additional long distance travel demand transferred from the railways due to lack of rail capacity.

2.2.24 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 smart motorways technology[39].

2.2.25 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."[40]

[39] Investing in Britain's Future, HM Treasury, June 2010 (Cm.8669)
[40] The Strategic Case for HS2 2013 p.67 paras 3.2.9-3.2.11

# 3 Route-wide rail alternatives

## 3.1 High speed rail configurations

3.1.1 The Proposed Scheme is a discrete project that can be justified on its own merits. However, it has been conceived as part of a long-term strategy for a network of high speed lines connecting 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' Phase One of HS2, 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; and
- to set HS2 in the context of a vision for the future[41].

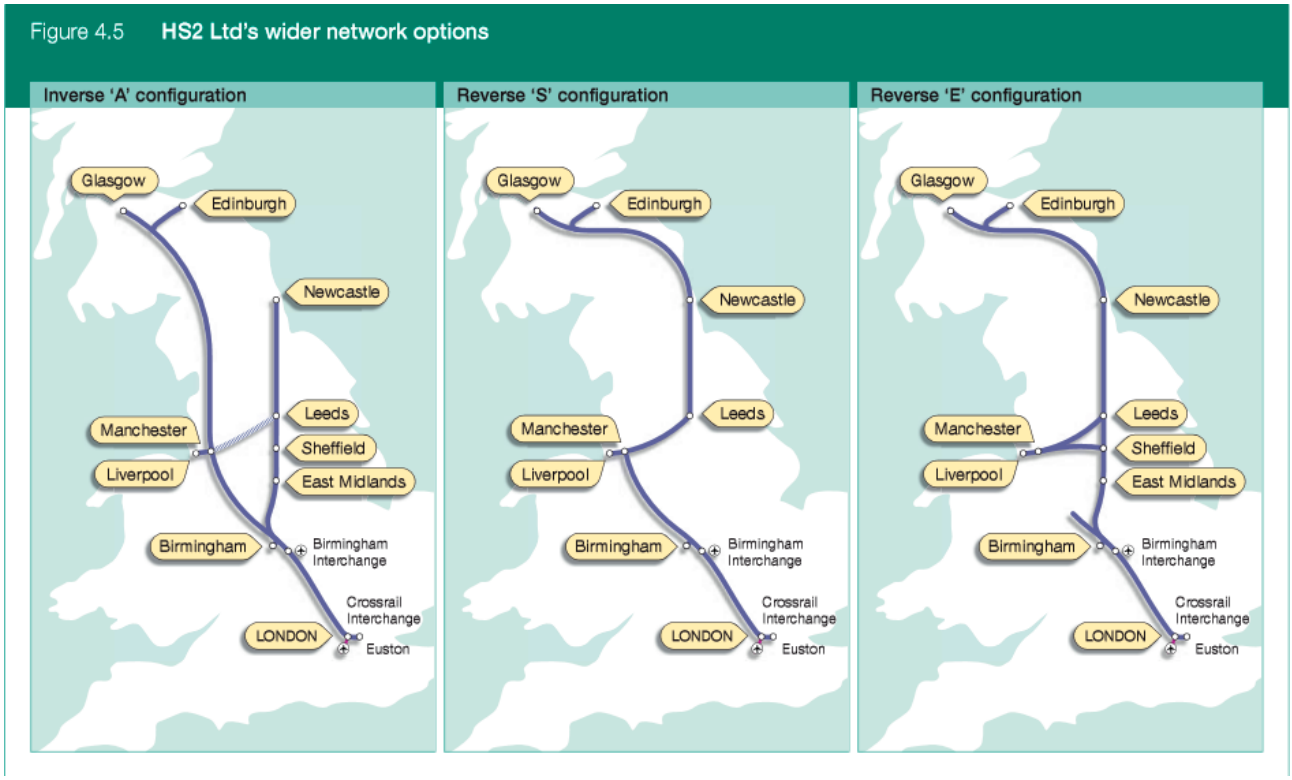
3.1.2 The strategic choices are determined by the locations of the major cities. Conceptually there is a western route to Liverpool and Manchester, and an eastern route via some or most of the cities in the East Midlands, and South and West Yorkshire. North of Leeds, Teesside and Tyneside lie on the 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.

3.1.3 With this geographic context in mind, three families of option were prepared in outline (as shown in Figure 3): for a 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.

[41] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.218

Figure 3: Comparison of HS2 Ltd's wider network options




3.1.4 In February 2010 HS2 Ltd submitted a report to Government[42] on its demand and business case analysis underlying its December 2009 report. The analysis in respect of network configurations is summarised in Table 2[43]. 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[44];
- The Reverse 'E' option could not offer better journey times from London or Birmingham to Manchester/Liverpool than HS2 trains continuing to the northwest from Lichfield via the WCML; and
- 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.

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

Table 2: Comparison of HS2 Ltd's wider network options – from 'High Speed Rail', DfT, March 2010 (Cm.7827)

| Route | Inverse A | Reverse S | Reverse E |
|---|---|---|---|
| **Journey times (hours:minutes)** | | | |
| 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 |
| **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 |

## Sustainability appraisal

### *Introduction*

3.1.5 A high level sustainability appraisal of HS2 was undertaken in 2009/10. There was no line of route for any of the options north of Birmingham at that stage. 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 was made.

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

- reducing greenhouse gases and combatting climate change;
- natural and cultural resources and environmental enhancement;
- creating sustainable communities; and
- sustainable production and consumption.

### *Reducing greenhouse gases and combatting climate change*

3.1.7 In the absence of demand modelling for Phase Two and beyond, it was assumed that the conclusion of the Booz-Temple report of 2007[45] 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*

3.1.8 Maps of high-status environmental features in northern England and southern Scotland were prepared. There are numerous Grade I 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. However, 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.

### *Creating sustainable communities*

3.1.9 In England concentrations of multiple deprivation occur in the conurbations in the East Midlands, the North West, south and west Yorkshire and the Tyne/Tees region. In Scotland they are more in the west than the east.

### *Sustainable production and consumption*

3.1.10 The appraisal indicated that the route between London and the West Midlands would require large quantities of material resource and involve substantial land take. Opportunities to limit adverse impacts would be sought through the use of modern construction techniques that seek to use sustainable materials and reduce waste.

### *Conclusions*

3.1.11 There were numerous environmental features and issues that could influence detailed route choice. However, 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 either the east side or the west side.

3.1.12 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

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

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."[46]

3.1.13 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[47].

3.1.14 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 Government asked HS2 Ltd to undertake further work to compare the 'Y' option with the Reverse 'S'[48]. 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 present value (PV)). Not only would the Reverse 'S' not serve the East Midlands and South Yorkshire, but journey times would be 15 minutes slower to Leeds and over 20 minutes slower to Newcastle.

3.1.15 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. While 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."[49]

[46] High Speed Rail, DfT, March 2010 (Cm.7827) p.74 para.4.28
[47] High Speed Rail, DfT, March 2010 (Cm.7827) p.74 paras. 4.30-32
[48] High level assessment of the wider network options – reverse 'S' and 'Y' network, HS2 Ltd, October 2010
[49] High level assessment of the wider network options – reverse 'S' and 'Y' network, HS2 Ltd, October 2010 p.3 para.2.8

3.1.16 On 4 October 2010 the Secretary of State confirmed his intention to proceed to consultation with the 'Y' network to Manchester and Leeds. Relatively few respondents commented on the network configuration during the subsequent consultation[50]. Most of those who did supported the Government's 'Y' proposal. Some alternative configurations were advanced, but none was superior to the 'Y' network in terms of costs and benefits and most had previously been considered and rejected[51]. After considering the consultation responses, in January 2012 the Government confirmed its intention to promote hybrid Bills for the 'Y' network, incorporating links to the West Coast and East Coast main lines[52].

## 3.2 Design speeds

### Conventional rail speed (200kph)

3.2.1 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 assumed to be similar in that they would comply with the "Technical Specifications for Interoperability", as required by Government[53].

3.2.2 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 BCR of uprating a design specification from 200kph to 400kph was estimated to be over 3:1[54].

3.2.3 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."[55]

3.2.4 The economic appraisal was reworked for the February 2011 consultation so it could be compared with the Phase One consultation route scheme[56], 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

[50] Department for Transport (2011), *High Speed Rail: Investing in Britain's Future – Consultation.* Her Majesty's Stationery Office, London.
[51] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.68 para.3.75
[52] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.37
[53] High Speed Rail London to the West Midlands and Beyond, HS2 Ltd, December 2009 p.190 para.4.4.17
[54] 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.)
[55] High Speed Rail, DfT, March 2010 (Cm.7827) p.13
[56] Economic Case for HS2: the Y Network and London to West Midlands, DfT, 2011 pp.45-6

around 1:1 compared with 1.6:1 for the Phase One of the HS2 consultation route scheme. Potential environmental benefits of a conventional speed line 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).

3.2.5 The noise assessment was rerun in late 2011 to compare the Phase One 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. This number reduces to around 1,100 properties for a speed of 300kph. 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[57].

3.2.6 Any environmental advantages of a conventional speed line over a high speed line would be relatively marginal[58], 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"[59].

## A higher design speed

3.2.7 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[60].

## Reducing design speed locally to mitigate adverse environmental effects

3.2.8 During the 2011 consultation on Phase One, 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[61]. On only approximately half of the 400kph 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

[57] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 4.4
[58] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.73 para.3.98
[59] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.72 para. 3.96
[60] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 4.2
[61] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Section 4.3

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).

3.2.9 The analysis concluded that in study areas 1, 3 and 4, any environmental benefits could more advantageously be achieved by realigning[62] 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:

> "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."[63]

## Alternative routes at 300kph

3.2.10 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. 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 route option alignments at 300kph compared with Route 3 (the consultation route)[64]

| | **Chiltern route (Route 2)** | **M1 alignment (Route 5)** |
|---|---|---|
| Maximum design speed | 300kph | 300kph |
| Additional journey time | +7 minutes | +6 minutes |

[62] The route was realigned in these three areas in January 2012.
[63] Review of HS2 London to West Midlands Route Selection and Speed: Report to Government by HS2 Ltd, January 2012 Executive Summary para.8
[64] 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

| | | |
|---|---|---|
| Relative cost | +£3bn | +£2.2bn |
| Relative BCR | -25% or more | -25% or more |
| Comparative environmental advantages | Fewer people affected but more severance.<br>Little sustainability difference. | Would not affect Chilterns AONB.<br>More property demolition and/or severance.<br>Relatively small overall environmental gain. |

3.2.11 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 operating speeds to increase to 400kph as high speed technology develops. If designed to 360kph only, this opportunity would be permanently foregone[65].

3.2.12 Having reviewed all this work the Government concluded that the new line should be high speed[66] not conventional speed, that 400kph is the appropriate maximum design speed for the line[67] and that the route should not be realigned to a lower design speed[68].

## 3.3 Upgrading existing rail lines

### Introduction

3.3.1 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.

3.3.2 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.

3.3.3 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

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

inter-relationships of different geographic areas, and in terms of short, medium, long and very long term time horizons.

3.3.4 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.

3.3.5 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." [69] In coming to this conclusion the Government took into account the environmental implications though environmental issues were not the determining factor[70].

3.3.6 However, in order to explore the options as thoroughly and fairly as possible, the Government appraised the rail upgrade options on four occasions during Phase One scheme development: 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 in the Strategic Alternatives Study reports prepared by Atkins[71].

3.3.7 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

3.3.8 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

[69] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.17 para. 6
[70] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 pp.71-71 paras.3.91-2
[71] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010.
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: Update following Consultation, Atkins, January 2012.
High Speed 2 Strategic Alternatives – Final Report, Atkins, October 2013.

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 Passenger Demand Forecasting Handbook 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[72] 2008-33** | **February 2011 growth[73] 2008-43** | **January 2012 growth[74]** | |
|---|---|---|---|---|
| | | | **2010-37** | **2010-43** |
| PLANET Long Distance | +62% | +60% | +44% | +60% |
| PLANET Midlands | +43% | +43% | +29% | +43% |
| PLANET South | +46% | +55% | +46% | +55% |

3.3.9 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

3.3.10 There are four main lines from London to the midlands and the north – the CML, the WCML, the Midland Main Line (MML), and the ECML. 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.

3.3.11 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.

3.3.12 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

[72] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.12 Table 3.1
[73] High Speed 2 Strategic Alternatives Study: London to West Midlands Rail Alternatives: Update of Economic Appraisal, Atkins, February 2011 Table 2.1
[74] High Speed Rail Strategic Alternatives Study: Update following Consultation, Atkins, January 2012 p.13 Tables 3.1 & 3.2

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

3.3.13 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 15-16 trains per hour (tph) 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.

3.3.14 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 that has been experienced over the last five years on London commuter lines. However, it could not also provide additional freight paths or sufficient capacity for demand growth in the long term.

## Midland Main Line

3.3.15 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.

3.3.16 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, resulting in:

- 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

3.3.17 The ECML has been undergoing a programme of enhancements that have included, amongst others, upgrading track and station works at King's Cross, Finsbury Park, and Peterborough and a flyover 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.

3.3.18 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 King's 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 200kph 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.

3.3.19 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

3.3.20 The 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 40mph to 75mph and two platforms at Marylebone to increase the station's capacity to 20tph.

3.3.21 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 – March 2010

### *Introduction*

3.3.22 In March 2010 the analysis of rail alternatives was based upon upgrades to the WCML and the CML and it focused 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.

3.3.23 The do-minimum Reference Case, with which enhancement options were compared, included schemes highly likely to be implemented within 10 years such as Thameslink, Crossrail, increasing the length of all remaining Pendolino trains on the WCML from

nine to 11 cars, and planned infrastructure enhancements. On the CML the Reference Case included train lengthening in the peaks[75].

3.3.24 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 standalone 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.

Table 5: Rail packages infrastructure works

| Package | Infrastructure components | Service outputs |
|---|---|---|
| RP1 | Longer long distance trains.<br><br>Extensive platform, station and other works not specified in detail. | Longer long distance trains on the WCML (14-car and 17-car options). |
| RP2 | Increase in train service frequencies on the WCML effectively providing four tracks throughout and grade separation as far north as Crewe:<br><br>- Stafford area bypass<br><br>- grade-separation between Cheddington and Leighton Buzzard<br><br>- 3 new platforms at Euston Station<br><br>- 3 extra platforms at Manchester Piccadilly (with grade-separation at Ardwick)<br><br>- 4-tracking Attleborough – Brinklow (including freight capacity works at Nuneaton)<br><br>- Northampton area speed improvements<br><br>- 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[76]. |
| RP3 | RP2 + CML capacity enhancement<br><br>Package 2 WCML enhancements except 4-tracking Beechwood Tunnel to Stechford, plus enhancements on the CML:<br><br>- electrification throughout<br><br>- line speed increase to 125mph maximum<br><br>- provision of extra platforms at Birmingham Moor Street<br><br>- Kenilworth (Leamington – Coventry) track doubling<br><br>- 4-tracking Tyseley – Dorridge<br><br>- extended (freight) loop at Fenny Compton<br><br>- Banbury bypass line | RP2 plus:<br><br>Four fast WCML London to Birmingham trains to be diverted via the CML to Paddington, releasing capacity on the WCML for additional services to Liverpool, Glasgow and Warrington[77]. |

[75] High Speed 2 Strategic Alternatives Study Strategic Outline Case, Atkins, March 2010 p.10 para.3 2 2 1
[76] HS2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p.17 para.5.1.1
[77] High Speed 2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010 p.28 para.6.1.

| | | |
|---|---|---|
| | - improvements at Princes Risborough<br><br>- new 2-track tunnel Saunderton – Seer Green (avoiding High Wycombe)<br><br>- 4-tracking Seer Green – South Ruislip (Northolt Junction)<br><br>- 2-tracking South Ruislip – Paddington (via Park Royal and Old Oak Common). | |
| RP4 | RP3 + further upgrades to the CML to reduce London to Birmingham journey times.<br><br>Package 3 WCML enhancements plus:<br><br>- 2 track alignment from Berkswell to the CML near Harbury including a Parkway station South of Coventry<br><br>- 4-tracking Berkswell-Stechford<br><br>- extra platforms at Birmingham Moor Street served by the WCML.<br><br>CML Package 3 enhancements except 4-tracking Tyseley-Dorridge, 2-tracking Kenilworth-Coventry and extra CML platforms at Birmingham Moor Street. | RP3+:<br><br>Journey times on the CML between London and Birmingham reduced to approximately 1 hour[78]. |
| RP5 | Additional capacity between Birmingham and Stafford to enable WCML services between London and the North West to be diverted to the Chiltern route<br><br>Package 4 infrastructure enhancements plus on the CML:<br><br>- 4-tracking the remainder of the route<br><br>- grade-separation of Aston Junction<br><br>- 4-tracking Aston - Stafford via Bescot, Wolverhampton avoiding line, and Penkridge. | RP4 +: Divert two north of Stafford WCML trains via CML[79]. |

### *Rail Package 1*

3.3.25 Lengthening the nine-car Pendolino trains to 11 cars was assumed to be implemented in any event and was therefore included in the Reference Case. RP1 – 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[80].

3.3.26 The 14 car option comprised 14-car trains to Birmingham, Manchester and Glasgow, but only 11-car trains to Liverpool. This option would also require very substantial, costly and disruptive platform lengthening and additional expenditure on power

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

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[81].

3.3.27 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[82].

### *Rail packages 2-5*

3.3.28 RP2 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.

3.3.29 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 RP2 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 CML the planned longer peak trains in the reference case should be sufficient[83].

3.3.30 On implementation of RP2, crowding would increase somewhat over 2008 levels unless the demand can be diverted to the CML through implementation of RP3-5. However, the analysis also showed that the RP3-5 enhancements to the CML would offer relatively small crowding relief on the WCML in relation to their very substantial cost.

3.3.31 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[84]. RP5 would cost more than HS2 without the benefit of reduced journey times and this is reflected in the low BCR.

3.3.32 Two additional variants were also appraised[85]: RP2A, which added performance resilience to RP2 to reduce delay to following trains from breakdowns and so on; 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 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.

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

Table 6: Additional rail upgrade packages

| Package | Infrastructure components | Service outputs |
|---|---|---|
| RP 2A | As for RP2<br><br>The current timetable includes additional time to assist recovery from delays and incidents. RP2 assumed removal of this performance cushion whereas it is reinstated in RP2A. | Journeys to Manchester would be only 3.5 minutes faster instead of 6.5 minutes faster in RP2. |
| RP 3A | In order to assess the effects of upgrading the CML only, there are no WCML infrastructure enhancements in RP3A and the WCML recovery time has been reinstated as in RP2A. | Train services would be similar to RP3, but with some modifications to WCML services. |

3.3.33 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)[86].

## Strategic Rail Alternatives update – February 2011

### *Introduction*

3.3.34 Later in 2010 Atkins were re-engaged to update 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[87].

3.3.35 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[88].

3.3.36 These five rail packages focused on the London to West Midlands corridor, but the Y network to Manchester and Leeds provides capacity and time saving directly to the 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[89]. These new scenarios included enhancement to the MML and ECML and WCML, but not the CML:

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

- 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.

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

### *Scenario A*

3.3.38 WCML inter-city services would be lengthened to 11 cars to Liverpool and 14 cars to Manchester, Glasgow and Birmingham, to 11 cars on the MML and 12 cars on the ECML.

Table 7: Scenario A components

| Package | Infrastructure components | Service outputs |
|---|---|---|
| WCML | 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.<br><br>In addition the throat at Euston would need to be re-modelled, this would require land acquisition and property demolition.<br><br>Depot modifications for longer trains.<br><br>Power supply strengthening for overhead line equipment. | 11-car trains To Liverpool.<br><br>14-car trains to Birmingham, Manchester and Glasgow.<br><br>21% seated capacity increase into London. |
| MML | 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.<br><br>16% seated capacity increase into London. |
| ECML | Longer platforms and enabling works at the following stations – Peterborough, Grantham, Newark, Retford, Doncaster, Wakefield Westgate, York, Durham, Alnmouth, and Berwick.<br><br>Additional infrastructure enhancements include:<br><br>– King's Cross throat re-modelling;<br><br>– depot modifications for longer trains; and<br><br>– power supply strengthening for overhead line equipment. | 12-cars on all inter-city long distance trains,<br><br>31% seated capacity increase into London, |

### *Scenario B*

3.3.39 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 MML and ECML.

Table 8: Scenario B components

| Package | Infrastructure components | Service outputs |
|---|---|---|
| WCML | RP2 enhancements | RP2 service enhancements |
| MML | Electrification from Bedford to Sheffield;<br>A freight loop facility between London and Bedford;<br>Re-instatement of four-tracks between Bedford and Kettering;<br>Re-instatement of two-tracks between Kettering and Corby;<br>Station area re-modelling at Corby;<br>Re-modelling and four-tracking in the Leicester area; and<br>Electrification and increased stabling capacity at depots. | 8tph north of Bedford |
| ECML | Re-modelling and re-instatement of a third tunnel and six-track approach at King's Cross;<br>Four-tracking Digswell – Woolmer Green;<br>Four-tracking Huntingdon – Peterborough;<br>Werrington flyover at Peterborough;<br>Four-tracking Stoke Junction–Doncaster;<br>A flyover for Nottingham to Lincoln route at Newark;<br>Works to address low-speed turnouts and restrictive signalling at Retford;<br>Electrify and upgrade Retford–Sheffield;<br>Re-modelling and extra platforms at Doncaster; and<br>Electrification of Hambleton Junction to Leeds. | 10tph long distance timetable with 10-car inter-city train |

### *Scenario C*

3.3.40 Scenario C assumes implementation of 16tph on the WCML and the RP3 CML enhancements in order to transfer four WCML Birmingham services, as well as an additional 2tph on the ECML. The enhancements to infrastructure and services are set out in Table 9.

Table 9: Scenario C components

| Package | Infrastructure components | Service outputs |
|---|---|---|
| WCML | RP2 upgrades with the exception of the<br>4-tracking of Beechwood Tunnel to Stechford. | RP3 on CML<br>RP2 on WCML but four Euston-Birmingham services transferred to CML to release 3tph WCML paths for enhanced services to Liverpool, Glasgow and Warrington. |

| | | |
|---|---|---|
| CML | RP3 upgrades | RP3 |
| MML | No additional works beyond Scenario B | As Scenario B |
| ECML | As Scenario B, plus the extra infrastructure enhancements:<br>– Grantham – Nottingham – electrify and upgrade; and,<br>– Peterborough area – new 140mph 15-mile electrified bypass line with grade-separations at each end. | 12tph Long Distance Timetable (i.e. Scenario B + 2tph to Nottingham |

3.3.41 In the 2011 pre-consultation appraisals, only RP2, RP2A 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."[90] The conclusions that the Government drew from these 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[91];
- achieve smaller improvements in journey times in comparison to those delivered through high speed rail[92];
- be likely to deliver comparatively few 'wider economic benefits' as these are mainly generated through improved commuter services[93];
- 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[94]; and
- not enhance interchange opportunities as they would rely on the same stations and interchanges as are currently in place[95]; and
- cause significant disruption to passengers as works are carried out[96].

3.3.42 The 2011 consultation document acknowledges that the disruption would not be as serious on any single line as the previous WCML upgrade, but it would still be

[90] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.60 para 2.92
[91] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.58 para 2.87
[92] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.58 para 2.88
[93] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.59 para 2.90
[94] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.59 para 2.91
[95] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.59 para 2.91
[96] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.60 para 2.93

significant, not least because the network is now more heavily used than when that project was completed.

3.3.43 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'[97].

## Strategic Rail Alternatives Review – January 2012

### *Introduction*

3.3.44 During the 2011 consultation, over 7,000 respondents (13.7% of all respondents) expressed a preference for upgrading existing lines[98]:

- 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
- the 51M group of local authorities put forward an optimised variant of RP2, the 'Optimised Alternative' (OA) designed to maximise the capacity potential of the WCML.

3.3.45 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 RP2 and RP2A, 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*

3.3.46 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.[99]

### *The 51m Group Optimised Alternative*

3.3.47 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

[97] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.61 para 2.94
[98] High Speed Rail: Investing in Britain's Future – Consultation Summary Report, Dialogue by Design, November 2011 p.60
[99] High Speed Rail Strategic Alternatives Study: Update following Consultation, Atkins, January 2012 p.6

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.

3.3.48 The proposed service changes are:

- lengthening long distance trains to 12 cars (except Liverpool Lime Street 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.

3.3.49 The Optimised Alternative built on Atkins' work on RP2, but provided 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 WCML inter-city trains to standard-class. It also made 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.

3.3.50 The Optimised Alternative assumed 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.

3.3.51 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)[100].

### *Network Rail conclusions on January 2012 options*[101]

3.3.52 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. It also 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. Finally, it carried out its own analysis of the likely crowding impacts of each scheme, using modelling tools designed to replicate a detailed peak timetable and

[100] 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
[101] Review of Strategic Alternatives to HS2, Network Rail, November 2011

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).

3.3.53 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[102]. 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:

- the Optimised Alternative proposal omitted the costs associated with platform-lengthening works to enable 12-carriage Pendolino trains to operate (with Network Rail estimating that these works would cost approximately £345 million, excluding any works at Euston)[103];
- 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[104];
- 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[105];
- no allowance was made for potential increases to maintenance costs associated with a more intensive service pattern[106]; and
- the costs of works at Euston station were likely to have been significantly underestimated[107].

3.3.54 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'[108]. 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

[102] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.27 3.3.2
[103] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.9 2.2.2 and p.10 2.3.1
[104] Review of Strategic Alternatives to HS2, Network Rail, November 2011 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.13 2.3.2
[107] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.5 2.1 and p.10 2.3.1
[108] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.22 3.2.1

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"[109].

3.3.55 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 southern end of the WCML[110];
- 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)[111];
- the high utilisation of the fast lines in both proposals would negatively impact on route performance[112];
- 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[113]; 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[114].

3.3.56 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[115]. 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[116]. 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 by 2035[117].

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

[109] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.10 2.3.1
[110] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.14 2.3.3 and p.28 3.3.3
[111] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.10 2.3.1 and p.24 3.3.1
[112] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.27 3.3.2 and p.13 2.3.2
[113] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.5 2.1 and p.19 3.1
[114] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.5 2.1 and p.19 3.1
[115] High Speed Rail: Investing in Britain's Future – Consultation , DfT, February 2011 p.60 para 2.92
[116] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.30 3.4
[117] Review of Strategic Alternatives to HS2, Network Rail, November 2011 p.17 2.4

- 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 WCML given the fewer diversionary routes available on these corridors); and
- 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.

## Appraisal of January 2012 options

3.3.58 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.

3.3.59 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.

3.3.60 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 WCML 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.

3.3.61 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.

3.3.62 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.

3.3.63 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 BCR 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."[118]

3.3.64 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[119].

## October 2013 review

3.3.65 The previous Government 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; and
- 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.

3.3.66 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 11 cars, conversion of one first class car to standard class, and extending all slow line services into Euston to 12 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

[118] High Speed Rail: Investing in Britain's Future – Decisions and Next Steps (Cm.8247), DfT, January 2012 p.72 para.3.92
[119] 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

and service changes on all three lines and consequential changes to cross country services.

3.3.67 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 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 WCML;
- fail to offer a robust solution to the problem of resilience and performance, particularly on the WCML, 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."[120]

## 3.4 Rail alternatives to the Proposed Scheme

### Background

3.4.1 The DfT commissioned Atkins in May 2015 to design and assess potential alternatives to building HS2 Phase 2a[121]. These alternative options sought to improve journey times and capacity specifically between the northern end of HS2 Phase One and Crewe as an alternative to Phase 2a. The remit excluded the development and analysis of options that provided:

- alternative high speed alignments for Phase 2a, as this was examined by HS2 Ltd as part of their own consulted option development work;
- improvements to routes north of Crewe or to any routes not serving Crewe, as this would not provide an alternative to Phase 2a;
- opening Phase 2a at a different date, as DfT do not consider this to be sufficiently alternative from the core Phase 2a proposal; and

[120] The Strategic Case for HS2, DfT, October 2013 p.135 para. 6.4.2
[121] Atkins, November 2015, *Rail Alternatives to HS2 Phase 2a*. A report for the Department for Transport. Available on-line at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480645/rail-alternatives-to-hs2-phase-2a.pdf

- doing nothing, as this option has been separately analysed by HS2 Ltd.

3.4.2 The Department specified that any rail alternative to Phase 2a had to be capable of delivering the HS2 programme wide objectives as set out in the 2013 HS2 Strategic Case. These are to:

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

3.4.3 To be consistent with the HS2 Strategic Case, any solutions should:

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

3.4.4 Further to this, the DfT specified that any rail based alternative to HS2 Phase 2a also needed to meet the following Phase 2a specific objectives:

- improve connectivity and journey times for cities north of Birmingham;
- deliver benefits to northern cities earlier than originally planned under HS2 Phase Two; and
- enable the efficient delivery of the remainder of HS2 Phase Two.

3.4.5 To meet both these network wide and Phase 2a specific objectives, the Department specified that any Phase 2a rail alternatives must be capable of delivering:

- the Phase 2a train service specification;
- a similar level of capacity to Phase 2a; and
- an environmental impact that is no worse than Phase 2a.

3.4.6 The Department asked Atkins to develop three alternative options for assessing against HS2 Phase 2a. Within the scope of the remit above, the three shortlisted options were required to represent as wide a range of costs and solutions as possible. The Department remitted that each option should be analysed against an agreed set of criteria in order that the alternative options could then be compared to HS2 Phase 2a. These were as follows:

- economic objective: assessing the BCR for each option using an appraisal approach consistent with the appraisal of HS2 Phase 2a;
- capacity objective: assessing the potential route capacity each option can deliver both for high speed services, and residual classic line services, including freight; and
- supplementary objectives: assessing the level of disruption to rail services

during construction, assessing the operational performance, and undertaking a high level assessment of the environmental impact of each option.

3.4.7 Each alternative option was required to be assessed against these objectives under two different network scenarios. Both of these scenarios are consistent with the way HS2 Ltd has assessed Phase 2a:

- Full Y Scenario: the alternative option forms a permanent part of the long term Full Y network. In this scenario the alternative option opens in 2027, from Handsacre to Crewe. From 2027 to 2033 high speed services run on the WCML north of Crewe, but from 2033 with the opening of the rest of Phase Two from Crewe to Manchester, the alternative option operates as an integral part of the Full Y network.
- Crewe Standalone Scenario: the alternative option is assessed on the basis that the Full Y high speed network north of Crewe is not constructed. In this scenario, the alternative opens in 2027, with high speed services using the WCML north of Crewe thereafter. This allows an appraisal of the alternative option to be undertaken as a pure increment to Phase One, with only the costs and benefits of the alternative itself captured.

## Alternatives considered

### *Background*

3.4.8 To design alternative options to Phase 2a, Atkins began by developing a long list of options that all tried to various degrees to overcome capacity and journey time limitations on the WCML. All of these long list options required constructing some sections of new alignment away from existing rail corridors, in order to bypass the most constrained sections of the WCML through Colwich Junction and Stafford. Many of the routes for these sections of new alignment were either developed from proposals originally considered as part of the West Coast Route Modernisation Programme delivered in 2009[122], or by using elements of the proposed HS2 Phase 2a alignment. Extensively upgrading the existing route entirely within the existing rail boundaries was not considered a feasible option, as the nature of the existing alignment would likely make it very difficult and costly to develop suitable alternatives that could deliver the necessary improvements to capacity and journey times, as well as avoiding disrupting existing services during construction.

3.4.9 Some high level analysis of the long list's journey times, costs and capacity was undertaken to help discard options with either low benefits and high costs, or which could not be expected to provide enough capacity to robustly support the indicative HS2 service pattern proposed to run under the Full Y. Through workshops with the DfT, Network Rail and HS2 Ltd, the long list of high level options was sifted to a shortlist of three options for further development and analysis.

3.4.10 The shortlisted options were deliberately chosen to provide a wide range of costs. As such they represent a range of approaches to meeting the criteria set out in the remit,

[122] https://www.networkrail.co.uk/StrategicBusinessPlanRoutePlan2008/Route_2018_West_Coast_Main_Line.pdf

and offer different cost solutions involving new high speed track, new conventional track or a combination of both.

### *High Cost Alternative Option: 44km of new high speed alignment*

3.4.11 The high cost alternative option would involve constructing roughly two-thirds (44km) of the Phase 2a high speed alignment as proposed by HS2 Ltd, from Streethay Junction to a point near the village of Baldwin's Gate. At this point the Phase 2a alignment comes within less than 1km of the WCML, which provides a four track railway all the way to Crewe. An additional length of high speed alignment would link the Phase 2a route to the WCML fast lines (which run to the east of the slow lines at this point) via a flat junction.

3.4.12 The key elements of this option can be summarised as follows:

- 42.5km of HS2 Phase 2a alignment (from Streethay Junction to near Baldwin's Gate);
- 1.4km of new HS alignment to WCML, including one small bridge crossing a minor brook;
- new flat junction onto WCML fast lines near Baldwin's Gate, which would also need to facilitate parallel movements from the fast to the slow lines on the WCML; and
- 18.3km running on existing WCML from Baldwin's Gate to Crewe – this section has the potential to allow 125mph running, and under normal operation, to allocate HS2 services exclusively to the fast lines.

### *Low Cost Alternative Option: 18km of new conventional speed alignment*

3.4.13 The low cost option was originally developed by the West Coast Route Modernisation Team for inclusion in the West Coast Route Modernisation programme delivered between 2000 and 2009. This option deliberately limited the design of the new alignment to 140mph in order to provide a relatively low cost option that operates at conventional line speeds.

3.4.14 This option was designed to bypass the capacity constraints of Colwich Junction, the two track section through Shugborough Tunnel, and the flat junctions immediately to the north of Shugborough Tunnel and at Stafford, as well as the speed restrictions known as the "Stafford wheel" curve.

3.4.15 The key elements of this option can be summarised as follows:

- 6.8km of new 140mph alignment from Rugeley to Hixon;
- upgrade of 6.5km of existing WCML line between Hixon and Sandon to 140mph;
- 10.8km of new 140mph alignment from Sandon to WCML near Norton Bridge. Key features would include:
  - crossing of Trent and Mersey Canal and the River Trent;

  - three major bridges crossing the A34 dual carriageway, the M6 and the existing railway line between Norton Bridge and Stone; and
  - four small bridges crossing minor roads.
- a total of three new flat junctions at Hixon, Sandon and Norton Bridge, and one new grade separated junction at Colwich; and
- 26.1km running on existing WCML from Norton Bridge to Crewe – this section has the potential to allow 125mph running and, under normal operation, to allocate HS2 services exclusively to the fast lines.

### *Medium Cost Alternative Option: 15km of new high speed and 11km of new conventional speed alignment*

3.4.16 This medium cost alternative option is similar to the low cost option. However, rather than using new conventional speed alignment to bypass Colwich, it uses roughly one third of the HS2 Phase 2a high speed alignment from Streethay Junction to a point near Moreton Farm. From this point an additional 5km of high speed alignment is built to join the WCML Stone line via a flat junction near the site of the former level crossing at Hixon, approximately 15km from Streethay Junction.

3.4.17 From this point north the design is the same as low cost option. The Stone Line would be upgraded to 140mph, and a new conventional 140mph line built to link the Stone line to the WCML Crewe route just north of Norton Bridge.

3.4.18 The key elements of this option can be summarised as follows:

- 15.2km of Phase 2a alignment from Streethay Junction to Great Haywood;
- 4.8km of high speed alignment from Great Haywood to existing Stone line at Hixon, including three small bridges crossing minor roads and tracks;
- upgrade of 6.5km section of Stone line between Hixon and Sandon to 140mph;
- 10.8km of new 140mph alignment to WCML near Norton Bridge, including:
  - a major crossing of Trent and Mersey Canal and the River Trent;
  - three major bridges crossing the A34 dual carriageway, M6 and the existing railway line between Norton Bridge and Stone; and
  - four small bridges crossing minor roads.
- 26.1km running on existing WCML from Norton Bridge to Crewe – this section has the potential to allow 125mph running, and under normal operation, to allocate HS2 services exclusively to the fast lines; and
- requires three flat junctions.

## Environmental assessment

3.4.19 A high level environmental assessment was undertaken for each of the alternative options. The assessment only included consideration of the environmental impact of new alignment that is not part of the Phase 2a route. The methodology used to assess

the potential environmental impact of the alternative options is high level, and is not the same as the approach used for the EIA of the Proposed Scheme.

3.4.20 The high cost option would use the Phase 2a infrastructure as far as Baldwin's Gate, where a new 1.4km spur would be constructed to re-join the WCML. The high level environmental assessment of the spur identified the loss of woodland and ecological impacts in Meece valley, and visual and noise impacts due to the proximity to the hamlet of Shelton-under-Harley.

3.4.21 The medium cost option would utilise a section of the Phase 2a infrastructure, part of the existing WCML branch from Hixon to Sandon, and the northern section of the Stafford bypass scheme, with a short section of additional alignment near Hixon. For the route sections away from the Phase 2a alignment, the high level environmental assessment identified the following potential environmental impacts:

- visual and noise impacts in the Hixon area with some property demolition likely;
- visual impact of a new bridge over the Trent and Mersey Canal and River Trent near Sandon, and proximity to listed buildings;
- impact on a golf course driving range; and
- impacts related to the junction with WCML near to Meece Brook.

3.4.22 The low cost option would replicate the Stafford bypass scheme alignment which was developed and assessed as part of the WCML upgrade. The high level environmental assessment of the new sections of alignment near Colwich and north of Stafford has identified the following environmental impacts:

- visual and noise impact of the grade separated junction near Rugeley and Colton, proximity to Cannock Chase, and possible requirement to realign overhead power lines north of Colwich;
- visual and noise impacts in the Hixon area with some property demolition likely;
- visual impact of a new bridge over the Trent and Mersey Canal and River Trent near Sandon, and proximity to listed buildings;
- impact on a golf course driving range; and
- impacts related to the junction with WCML near to Meece Brook.

3.4.23 The proposed alignments of the low and medium cost options would run approximately 1km to the north of the Pasturefields Salt Marsh Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). Although this was considered some time ago as part of the West Coast Route Modernisation, more recent work by HS2 Ltd with the Environment Agency and Natural England showed that effects on the Pasturefields SAC could not be ruled out due to complex hydrological issues. This led HS2 Ltd to reject potential routes in this area in advice to Government because of the high risk associated with ensuring compliance with the Habitats Directive. If this alternative option was to be considered further, more

analysis would be needed to understand the detailed impacts of the proposed alternative alignment, whether those were acceptable or what mitigations would be needed. Any solution would need to be consistent with the Habitats Directive and European Regulations.

## Conclusions

3.4.24 All three of the shortlisted alternative options provide an operable alternative to Phase 2a, either as a standalone scheme or as part of the Full Y network. However, the Government concluded[123] that the alternative options:

- do not provide the same level of connectivity benefits for the major cities of the Midlands and the North due to lower journey time improvements;
- do not provide as much additional capacity to meet the long term needs for the north-south railway as Phase 2a;
- do not provide as much additional released capacity for commuters and freight on the WCML as Phase 2a, limiting the potential of the WCML to cope with increases in demand;
- offer a less robust solution to the problem of resilience and performance, particularly on the WCML which suffers from relatively high levels of unreliability;
- could have a greater impact on services on existing lines as construction work is carried out (the low and medium cost options only); and
- might be worth considering if the objective was only to improve journey times to Crewe, but do not provide as a good a step towards the full HS2 network.

3.4.25 The Atkins report[124] concluded that the alternative options save between £1.1bn and £1.8bn (2011 prices) in their capital costs of construction compared to Phase 2a, but they do not provide the same level of journey time improvements. This means their economic benefits and revenues are lower than Phase 2a.

3.4.26 When assessed as part of the Full Y, the alternative options have broadly similar BCR to Phase 2a. The alternative options deliver between £1.5bn and £3.3bn (2011, PV) less benefits than Phase 2a, while the net costs to Government range from being £200m lower to £100m (2011, PV) higher. The result is that all the options have marginally lower BCRs compared to Phase 2a. The Net Present Value (NPV) for the Full Y with any of the options is lower than the NPV for the Full Y with Phase 2a.

3.4.27 When assessed as a standalone incremental scheme, the difference in benefits and revenues between the alternative options and Phase 2a is much lower. The result is that all the options have a higher BCR than Phase 2a, although only the high cost option has a higher NPV.

[123] Department for Transport (2015), HS2 Phase 2a Strategic Outline Business Case – Strategic Case, November 2015, p. 36.
[124] Atkins, November 2015, *Rail Alternatives to HS2 Phase 2a*. A report for the Department for Transport. Available on-line at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480645/rail-alternatives-to-hs2-phase-2a.pdf

3.4.28 All of the alternative options provide sufficient capacity to allow the full operation of the indicative train service specification proposed for the Full Y scenarios. Beyond this indicative train service specification, all of the options provide some spare capacity to run additional HS2, residual or freight services, although this varies between options. None of the options provide the same overall capacity as Phase 2a, which together with the WCML effectively provides a six track railway between the end of HS2 Phase One and Crewe. This inevitably provides more capacity than the alternative options, which to different degrees all have sections with four tracks. As well as allowing more easily for future growth, this much greater amount of potential additional capacity available with Phase 2a, is also likely to provide performance and resilience benefits compared to the alternative options.

3.4.29 Construction of the high cost option is not expected to cause more disruption than the construction of Phase 2a. Construction of the medium and low cost options will cause greater disruption, although given the lightly used nature of the lines being upgraded this is not expected to impact a large number of services. A high level assessment of the environmental impact suggests that the high cost option is likely to have a lower environmental impact than Phase 2a. The low and medium cost options have some environmental risks in respect of the Pasturefields SAC and SSSI as discussed above.

3.4.30 Of the three alternative options developed in this study, the high cost option offers the closest capacity and journey times to Phase 2a. Despite being the most expensive of the alternative options, it offers the greatest benefits and returns the highest BCR of the options, both when it is assessed as part of the Full Y and when it is assessed as a standalone scheme. Its construction cost is £1.1bn less than Phase 2a, while its journey time is 2.5 minutes slower than Phase 2a.

3.4.31 If HS2 services are able to operate on straight sections of the WCML between Baldwin's Gate and Crewe at enhanced permissible speed of 125mph, then there is the potential for this journey time differential to Phase 2a be reduced to around 2 minutes. This would increase the benefits and revenues of this option, and given that trains are already currently operating at that speed on those sections would not be expected to require significant investment. To increase the line speeds to 140mph is likely to require much greater level of investment (with additional costs) but would also offer even greater time savings and benefits.

3.4.32 The key capacity constraint for all the alternative options are the sections that involve running on the existing WCML. For the high cost option, this requires using around 18km of the existing WCML route between Baldwin's Gate and Crewe. This section of route needs to operate the proposed 11 HS2 services, five to seven residual classic line services and what is assumed to be four freight trains per hour. Operating on a four track railway, the high cost option has the spare capacity to run around five additional HS2 services on the fast lines above the level currently proposed in the Full Y HS2 train service specification. The slow lines, however, will be operating at close to maximum capacity during the peaks, and the ability to operate additional residual or freight trains is more limited.

3.4.33 The operational performance of high speed services using the high cost option is likely to be similar to Phase 2a, as allowing the fast lines to be used exclusively by HS2 services would remove any conflicts or interface with residual WCML services. The

reliability of residual passenger and freight services operating on the slow lines is likely to be lower than under Phase 2a due to the higher utilisation of these lines. It may be that the reliability of the historic WCML infrastructure used by the alternative options is less reliable than the Phase 2a infrastructure although this is dependent to a large extent on the renewal and maintenance policies.

3.4.34 The medium and low cost options provide a greater cost saving but also provide fewer benefits and a lower BCR than the high cost option. They also both have greater capacity constraints, which reduces both the number of additional services that could be run and also introduces a greater risk of unreliability or poor operational performance.

# Part II

# 4 Route corridor alternatives

## 4.1 Background

### Route development

4.1.1 Part II of this report describes the development of the Phase Two route since autumn 2010.

4.1.2 Having considered the reasonable strategic alternatives and route-wide rail alternatives that do not meet the objectives and requirements of the new high speed line, this section describes the evolution of the western leg of HS2 and the reasonable route corridor alternatives that were considered.

4.1.3 Considerations of sustainability have been integral to the scheme throughout the appraisal process. Since the initial option development, HS2 Ltd has continued to develop route and station proposals that seek to minimise environmental and community impacts within the engineering and financial constraints of the scheme development.

4.1.4 The proposed routes presented for public consultation in July 2013, and post-consultation in 2015 as part of the refined preferred route to Crewe, have emerged from many thousands of kilometres of appraised options. The preferred route is now considered overall to best meet objectives for passenger demand, cost, ease of construction, journey time and sustainability.

### Sifting of options

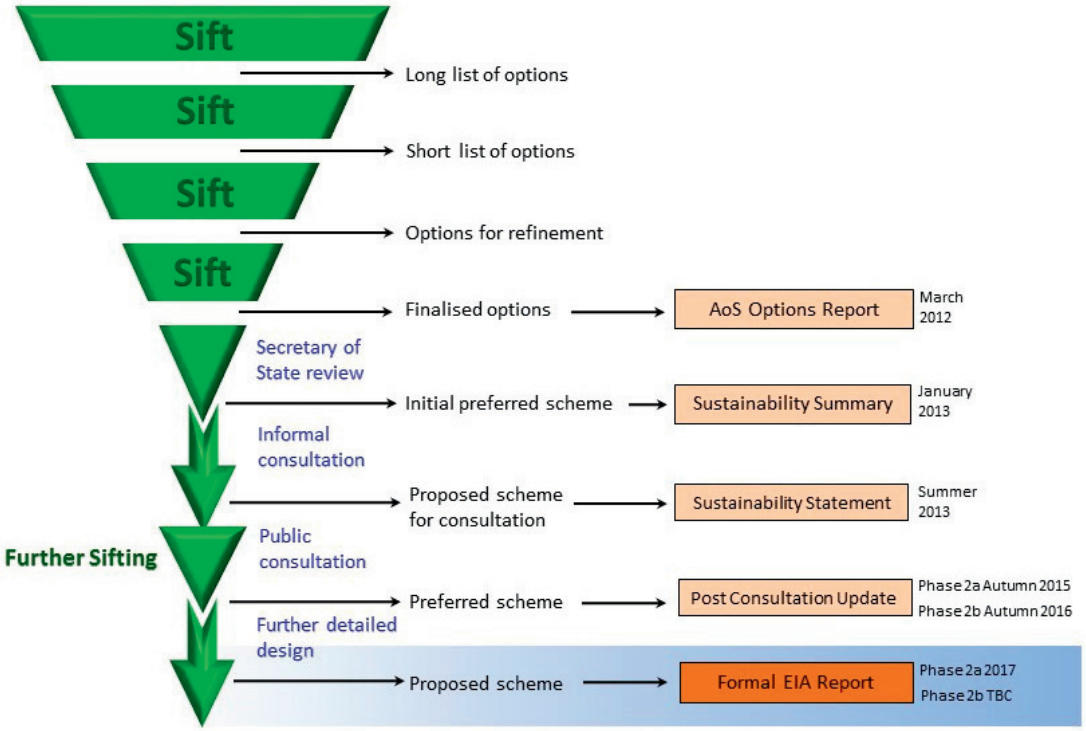
4.1.5 The scheme has evolved through a refinement process resulting in the development of the preferred scheme. This process is referred to as sifting. The sifting process consisted of a sequentially more detailed appraisal of route options. At the end of each appraisal stage or sift, sustainability performance was formally considered alongside other cost, operational and engineering information by HS2 Ltd, who identified preferred options for progression to the next level of design. The selected options then entered the next sift for more detailed appraisal.

4.1.6 A summary of the sifting process and outputs is shown in Figure 4. The process started with a long list of potential options which were subject to appraisal against the initial sift criteria. The sequence of subsequent sifts aimed at reducing the number of options under consideration (e.g. by avoiding centres of population and/or key environmental features). In the later sifts, the predicted impacts of the remaining options were further mitigated by refining the vertical and/or horizontal alignments and by introducing certain structures such as viaducts or cuttings with retained walls. In this way, the route development process has ensured that mitigation is inherent within the designs from the outset.

4.1.7 At the time of publication of the Sustainability Statement in 2013, more than 1,000 route sections (over 16,000km of route) had been sifted, and over 250 potential station and depot locations reviewed. Since then, further route sections have been

appraised as part of the post consultation refinements process, covering a further 9,000km of possible options.

Figure 4: The sifting process



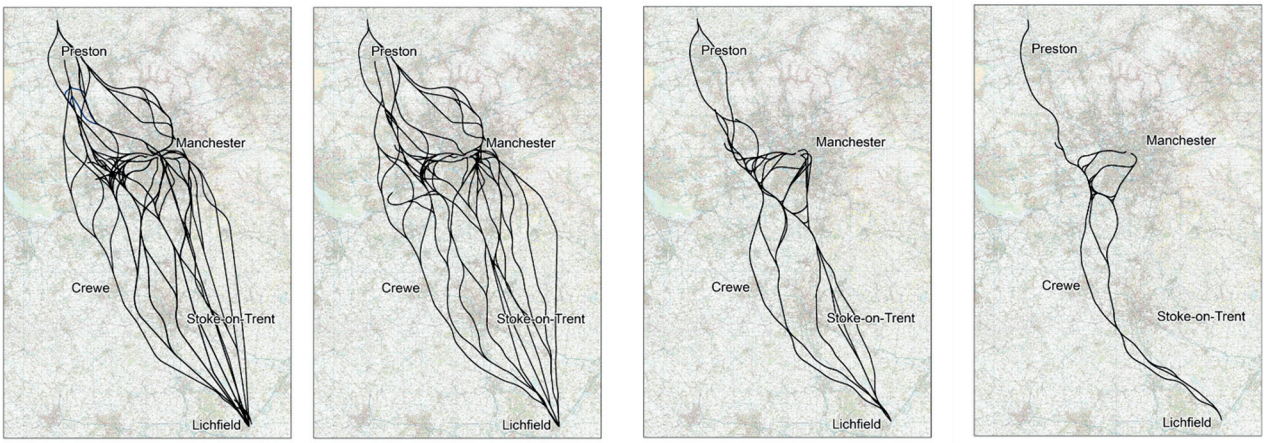

## AoS options report (March 2012)

4.1.8 Following the announcement of the Government's preference for a Y-shaped high speed rail configuration, further work was undertaken to investigate various route, station and depot options that could deliver the western and eastern legs of the network. A process of sifting was utilised to refine a long list of options and route combinations, as shown in Figure 5.

4.1.9 The AoS options report[125] describes the output from the initial sifting process and describes the performance of those options that were considered to best meet HS2 Ltd's remit[126]. The report focused on 42 separate route sections for the western leg and 32 for the eastern leg, which could be used to create up to 144 and 112 possible route combinations for the Manchester and Leeds legs respectively. The 74 route sections presented in the report had been sifted down from several hundred through the earlier route optioneering process described above.

[125] High Speed 2 Ltd. (2012), *Options for Phase 2 of the high speed network – Appraisal of Sustainability*, March 2012. Available online at: https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability
[126] DfT (2010) Remit for HS2 Ltd – letter from the Secretary of State to the Chairman of HS2 Ltd, 17 March 2010. Available online at http://assets.hs2.org.uk/sites/default/files/inserts/HS2%20Ltd%20remit%20170310.pdf

Figure 5: The evolution of the options for the western leg




4.1.10 The report did not make any recommendation as to a preferred route option but provided information on the sustainability performance of different possible route options between common node points on a comparable basis to help Government identify a single initial preferred scheme.

4.1.11 Following the submission of advice to Government, the Secretary of State met with council leaders to discuss station options for the western leg, and separately visited areas potentially affected by the proposals.

4.1.12 This led to further refinement and route development. A number of design reviews were undertaken by HS2 Ltd to consider whether improvements could be made in terms of cost, simplification of construction and sustainability, often prompted by requests from the Secretary of State following the informal engagement. From these design reviews, alternatives to route sections emerged and were subject to a further level of appraisal. A similar exercise was undertaken for the eastern leg. Following this work, the Government selected its initial preferred scheme.

## Sustainability Summary (January 2013)

4.1.13 The Sustainability Summary[127] published in January 2013 described the potential impacts of the initial preferred scheme on people and the environment. It presented the findings of the ongoing AoS work at that point in time.

4.1.14 The western leg of the initial preferred scheme would ultimately connect with the WCML at two locations (Crewe and Golborne). It would include a terminus station in Manchester city centre as well as a further station at Manchester Airport. An Infrastructure Maintenance Depot at Crewe and Rolling Stock Depot near Golborne were also identified as being required. The eastern leg is also described.

4.1.15 Following publication of the initial preferred scheme in January 2013, engagement took place with a number of key stakeholders and MPs, particularly those potentially affected by the route. As a result, a small number of further refinements were made to the route. These refinements culminated in the development of the proposed route

[127] Temple-ERM (2013). HS2 Phase Two Initial Preferred Scheme Sustainability Summary.

for consultation, as described in the Sustainability Statement which was published in July 2013.

## Sustainability Statement (July 2013)

4.1.16 The Sustainability Statement was prepared to assist with public consultation by explaining the potential sustainability benefits and adverse impacts of the proposals and alternatives considered, as well as to explain how sustainability has helped support the scheme selection and design process.

4.1.17 The public consultation ran from July 2013 to January 2014, with a series of consultation events providing an opportunity for engagement with local communities, stakeholders and statutory bodies running between October 2013 and January 2014.

## Sustainability Report Post Consultation Update: West Midlands to Crewe (2015)

4.1.18 In response to the feedback received during consultation and as a result of the experience gained from Phase One, HS2 Ltd investigated a number of areas for possible modifications to the scheme. Further scheme revisions were driven by an initiative to improve the technical performance of the design and to consider cost efficiencies.

4.1.19 In support of the emerging Phase One scheme proposals, HS2 Ltd prepared a series of updated standards that the design of both Phase One and Phase Two were required to meet. The requirements, which reflected developing industry best practice, aimed to ensure that HS2 is designed and built for optimal passenger comfort, as well as long-term operational considerations such as maintainability, safety and durability. The requirements are principally concerned with the camber and gradient of the track alignment, as well as the structural clearance over or under roads, other railways, watercourses and floodplains.

4.1.20 An independent report[128] of the consultation process and a summary of the issues raised were published alongside the decision document[129]. Options were developed to address the issues that were raised during consultation. These were then reappraised and those that were feasible when considered alongside other scheme requirements were progressed.

4.1.21 In addition other minor scheme revisions arose from route 'stitching' changes from consultation and design requirements which focused on different geographical areas. This meant that other small changes were necessary to re-join these areas into adjacent route sections to form a coherent whole scheme.

[128] Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/481570/Response_to_HS2_Phase_Two_consultation_-_Appraisal_of_Sustainability.pdf....pdf

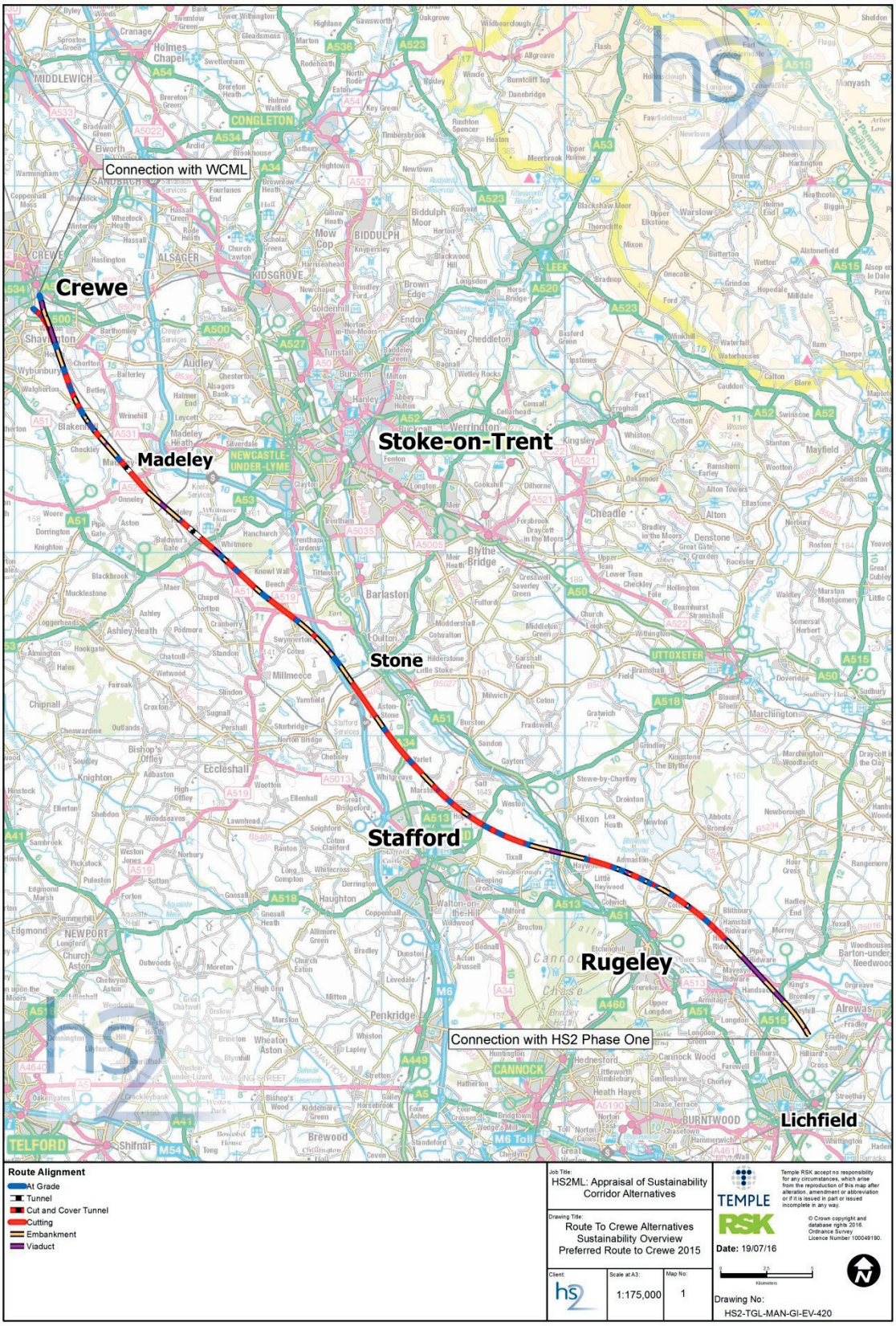
[129] High Speed Rail: investing in Britain's Future – Consultation on the route from the West Midlands to Manchester, Leeds and beyond. A report produced by Ipsos Mori for the Department for Transport and HS2 Ltd: https://www.gov.uk/government/organisations/high-speed-two-limited

4.1.22 In March 2014, Sir David Higgins, the Chairman of HS2 Ltd, recommended bringing forward development of the Phase Two route from the West Midlands to Crewe by 2027.

4.1.23 In November 2015, the Government, having considered a number of options for accelerating the development of part of the route, announced its intention to bring forward the construction of the section of route connecting the West Midlands to Crewe, known as the preferred route to Crewe, shown in Figure 6. An updated Sustainability Report[130] was published documenting the post-consultation changes to the Phase Two section of route from the West Midlands to Crewe – the preferred route to Crewe.

[130] Temple-RSK (2015). Sustainability Report Phase Two Post-Consultation Update: West Midlands to Crewe. A report produced by Temple-RSK for HS2 Ltd.

Figure 6: The Preferred Route to Crewe



## 4.2 Establishment of the Proposed Scheme via Crewe

### Background

4.2.1 HS2 Ltd has undertaken work to describe the evolution, between 2010 and 2013, of the Proposed Scheme via Crewe. A number of different route alternatives to meet the remit were developed and considered during the period between 2010 and 2012. A route to Manchester via Crewe had emerged by early 2013 as the best overall proposition.

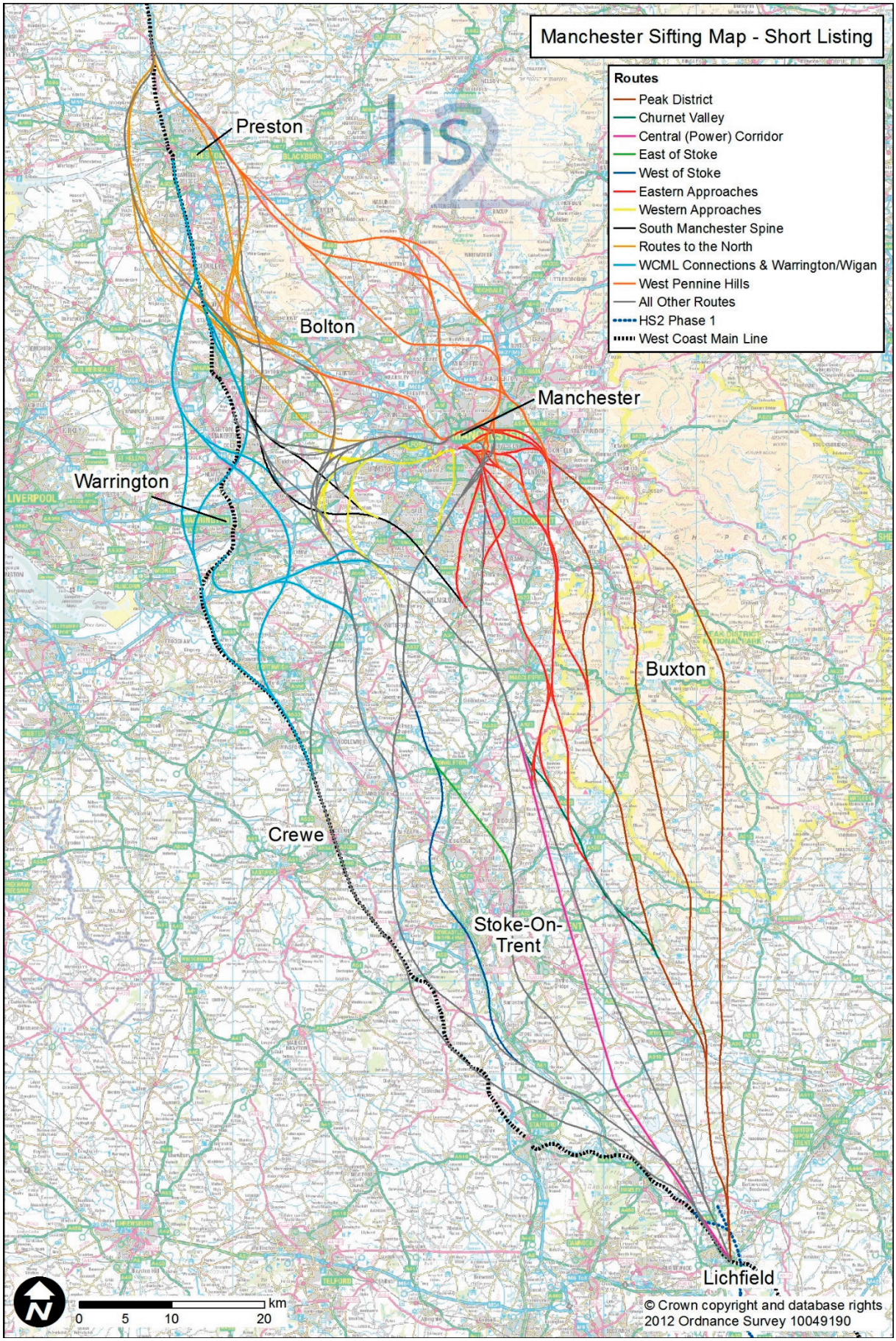
4.2.2 As part of the sift optioneering, western leg routes via Crewe, via Stoke-on-Trent and to the east of Stoke-on-Trent were considered (see Figure 7). These are described below.

### Manchester routes – short listing

#### *Introduction*

4.2.3 The initial short listing of route options to Manchester was broken down into 11 groups, based on the geography and functionality offered. These are outlined below, together with the reasons why they were not progressed further.

Figure 7: Manchester short-listing options



### *Peak District group*

4.2.4 The group comprised three routes (at the most easterly part of the route corridor) connecting Lichfield with Dunkinfield, south-east of Manchester. The group would have had a direct impact on the Peak District National Park, which would have been crossed for a substantial distance by all three routes. Opportunities for mitigation would have been limited and to avoid the National Park would have required a section of tunnel of at least 20km in length. The northern half of the group would have had a direct impact on: one Grade II* registered park and garden (Lyme Park); 14 SSSIs; one SPA (Peak District Moors Phase 1); two SACs (South Pennine Moors, Peak District Dales); and over 20 Grade II listed structures. The southern half of the group would have had significant landscape and visual impacts.

### *Churnet Valley group*

4.2.5 The group connected east of Cheadle with Macclesfield. It would have had a direct impact on three SSSIs (Churnet Valley, Dimmings Dale and Ranger). The group would have required a large viaduct to cross the Churnet Valley SSSI, resulting in significant landscape and visual impacts. Opportunities for mitigation would have been limited.

### *Central (Power) corridor group*

4.2.6 The group comprised one route which connected Lichfield with south of Macclesfield. The group would have crossed one Ramsar site (Midland Meres and Mosses Phase 1); one SAC (West Midlands Mosses); one SSSI and NNR (Chartley Moss); and would have had a direct impact on two scheduled monuments (Blithewood Moated Site and Paynsley Hall Moated Site). The southern half of the route would have had significant landscape and visual impacts.

### *East of Stoke group*

4.2.7 The group comprised a single route connecting the north-east side of Stoke-on-Trent with Brereton Heath, just west of Congleton. This group would have required a high number of residential demolitions, mainly at Biddulph and Norton Green. The group would have had a direct impact on one SSSI (Roe Park Woods) and an indirect impact on six SSSIs (Bagmere, Brookhouses Moss, Ford Green Reedbed, Gannister Quarry, Holly Banks, River Dane); and two Ramsar sites (Midland Meres and Mosses Phase 1 and 2).

### *West of Stoke group*

4.2.8 The group comprised a single route connecting north of Stone with Over Peover, passing partly in tunnel west of Stoke-on-Trent. The group would have required a comparatively high number of residential demolitions and a significant number of properties would have experienced noise impacts; particularly at Stone and Stoke-on-Trent. The group would have required six crossings of, and had a potential impact on, the River Trent (a major river) and would have crossed the Trent and Mersey Canal. It would have also had a direct impact on one SSSI (River Dane); two Grade II registered parks and gardens (Rode Hall, Peover Hall); and an indirect impact on three scheduled monuments; five Grade II* listed structures; and one Grade II* registered park and garden (Trentham Gardens).

### *Eastern approaches group*

4.2.9 The group comprised a number of approaches connecting core route options at Macclesfield with stations in east Manchester. Some of the approaches split to the north to connect with city centre station options. The surface routes would have required a high number of residential demolitions and significant numbers of properties would have experienced noise impacts in south and east Manchester. The group would have crossed the Peak District National Park (two eastern-most routes only) and Reddish Vale Country Park and would have had an impact on two scheduled monuments; three Grade II* listed structures; one Grade II* registered park and garden (Adlington Hall); and two Grade II registered parks and gardens (Philips Park, Philips Park Cemetery).

### *Western approaches group*

4.2.10 The group comprised five approaches, connecting core line of route options with stations in the west of Manchester. These approaches extended north from either Lymm (two approaches), Altrincham (two approaches), or north-east of Holmes Chapel (eastern-most approach), to connect with St. George's. The group would have required a high number of residential demolitions (Urmston, West Didsbury, and Newall Green). As such, some options were also re-designed as tunnel approaches for further refinement in the next development stage. It would have crossed one SSSI (Dunham Park). It would have also had an impact on Dunham Massey National Trust site; two Grade II* registered parks and gardens (Tatton Park, Dunham Massey); three Grade II registered parks and gardens (Alexandra Park, Wythenshawe Park, Manchester Southern Cemetery); one Grade II* listed structure (Barton Bridge), one Grade I listed structure (Church of All Saints) and one scheduled monument (Bowl Barrow).

### *South Manchester spine group*

4.2.11 The group connected Wilmslow with Wigan, linking routes from Birmingham to Manchester and the WCML. The group would have crossed one SAC (Manchester Mosses, which includes Risley Moss SSSI), a SSSI (Brookheys Covert); and would have crossed the Manchester Ship Canal with landscape and visual impacts. The group would also have had landscape and visual impacts where it crossed the Pennington Flash Country Park on viaduct. Mitigation considered included bypassing the country park (the southern-most spine route). However, a high number of residential properties would have experienced noise impacts and there would have been a high number of residential demolitions at Golborne.

### *WCML, Warrington and Wigan connections group*

4.2.12 The group connected Warrington, Wigan and the WCML with the core Birmingham to Manchester routes. The group ran from Northwich to the south, and Altrincham and Knutsford to the south-east, north to Preston. The group would have required residential demolitions in numerous built-up areas including at Euxton, Coppull, Orrell, Abram, Hartford, and Warrington. The group would have crossed two SSSIs (Abram Flashes, Woolston Eyes); and would have had an impact on two Grade II registered parks and gardens (Tabley House, Avenham Park); and three Grade II* listed structures (Lower House Farmhouse, Lightshaw Hall, Church of All Saints).

### *West Pennine Hills group*

4.2.13 The group connected Manchester with north-east of Preston, with the exception of one route which would have followed the M61 corridor to Westhougton. The group would have required a high number of residential demolitions, particularly to the north of Manchester. It would have had a direct impact on two SSSIs, (Rochdale Canal, Red Scar and Tunbrook woods); one SAC (Rochdale Canal); two Grade II registered parks and gardens (Hoghton Tower, Heaton Park); and a National Trust site (Stubbins Estate). Opportunities for mitigation would have been limited in urban areas without extensive tunnelling.

### *Routes to the north group*

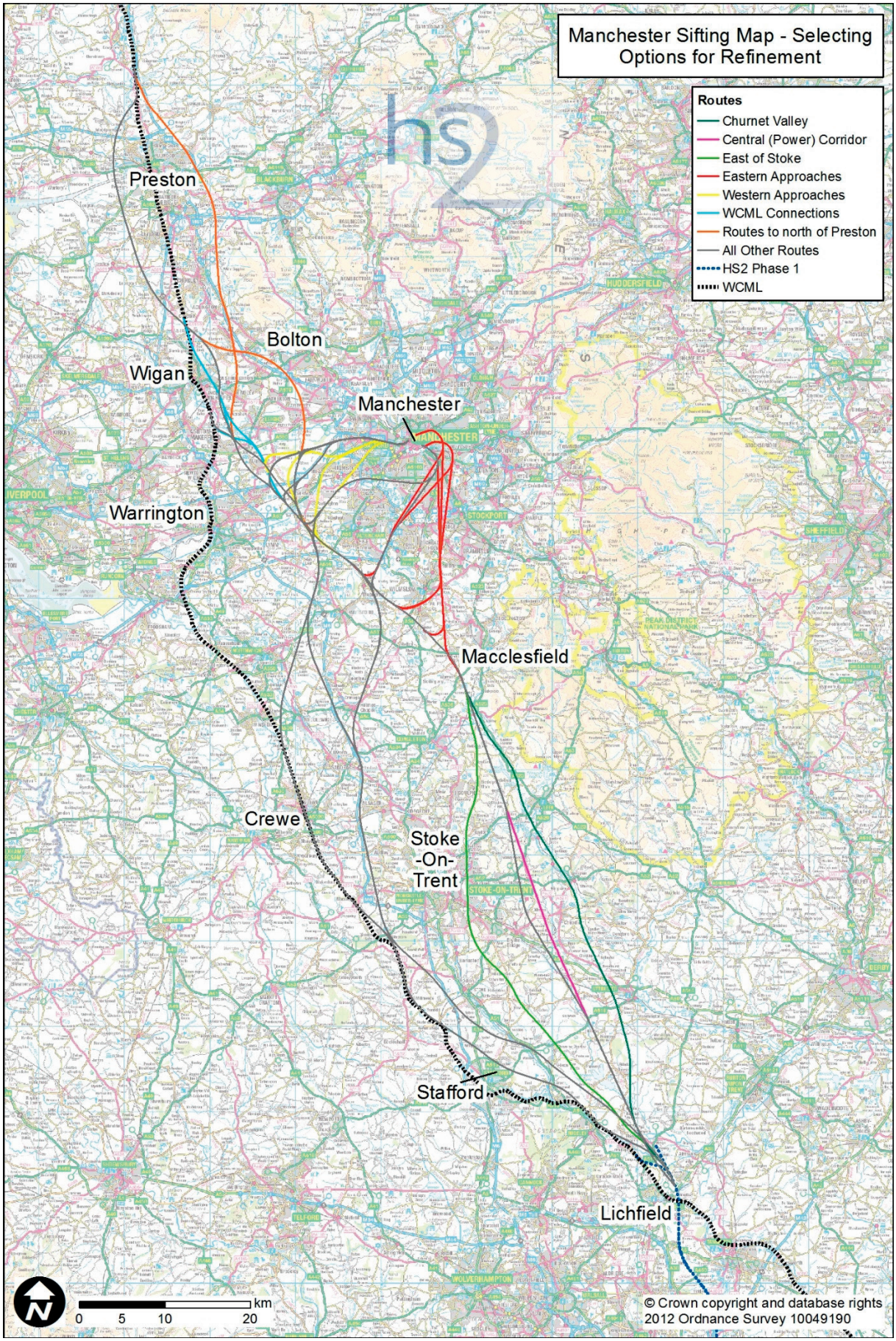
4.2.14 The group connected routes from Golborne and west Manchester to the WCML north of Preston, with some routes skirting around east and west of Preston. The group would have had a direct impact on three scheduled monuments (the Moat House, Bretters Farm, Moated Site at Arley Hall). It would have crossed the River Ribble, at a point 2.2km upstream of the Ribble and Alt Estuaries Ramsar site. It would also have crossed several other major rivers and canals (River Yarrow, Bridgewater Canal, Leeds and Liverpool Canal, Lancaster Canal, Millennium Ribble Link) resulting in visual impacts on users of waterway footpaths. It would have had an indirect impact on one SSSI (Red Moss); one Grade I listed structure; and 13 Grade II* listed structures. From the various route sections presented initially in the 2012 Options Report and through subsequent refinement optioneering, it has been possible to identify a total of three alternative route corridors that provide viability for a connection with the WCML either to immediately to the south or north of Crewe.

## Manchester routes – options for further refinement

### *Introduction*

4.2.15 Route options that were subject to further refinement are shown in Figure 8.

Figure 8: Manchester sifting map – selecting options for refinement



### *Churnet Valley group*

4.2.16 The group comprised a single route connecting Lichfield with Macclesfield passing to the west of Leek. The group would have crossed one SSSI (Churnet Valley), one area of National Trust land (Hawksmoor), two canals (Trent and Mersey Canal, Caldon and Macclesfield Canal); and three major rivers (rivers Dane, Team and Blithe), which may have also required works. The group would have had a major landscape and visual impact on the surrounding area (which includes the Peak District National Park and Churnet Valley).

### *Central (Power) corridor group*

4.2.17 The group comprised a short route passing to the east of Stoke-on-Trent, connecting Gratwich (west of Uttoxeter) to Bradshaw (west of Leek). The group would have directly impacted on several floodplains including crossing the Caldon Canal and River Blithe. It would have had a visual impact on open landscape at its southern extent where it passes through rural countryside.

### *East of Stoke group*

4.2.18 The group comprised a single route connecting Lichfield with Macclesfield, passing in tunnel through Stoke-on-Trent (on the east side). The group would have had an impact on three conservation areas (Hilderstone, Trent and Mersey Canal, Macclesfield Canal); seven biodiversity action plan (BAP) habitats; and five ancient woodlands, and an indirect impact on seven Natura 2000 sites (within 10km). It would have also crossed one abstraction site (at Moddershall; 3,500 cubic metres/day). The group would have had a major visual impact on a National Trust site (Congleton Cloud) a Grade II* registered park and garden (Gawsworth Old Hall); three scheduled monuments (Gawsworth Hall Gardens, Hilderstone Hall, Moated Site at Great Hartwell Farm) and over 40 Grade II listed structures.

### *Eastern approaches group*

4.2.19 The group comprised five approaches into east Manchester. All approaches diverged from a core route option between Macclesfield and Altrincham to terminate at one of three eastern city-centre station options. All of the approaches were tunnelled from the outskirts of Manchester. The group would have required a high number of residential demolitions at Mottram St Andrews and Dean Row, and Alderley Edge; a significant number of properties would have also experienced noise impacts. There would also have been landscape and visual impacts at Alderley Edge. The group would have crossed a National Trust site (Hare Hill), and there would have been impacts on the setting of a Grade II* registered park and garden and scheduled monument (Gawsworth Old Hall).

### *Western approaches group*

4.2.20 The group comprised six approaches to terminus station options located in the west of Manchester. The group diverged from the main route at one of four locations: near the M6 crossover (west of Tatton Park); south-west of Altrincham (north of Rostherne Mere); to the north-east of Lymm; or east of Culcheth. Although all routes in this group included 4-6km tunnels on the approach to the terminals, the group would have

required a high number of residential demolitions including some at Eccles (in an area of high deprivation).

4.2.21 The group would have crossed a National Trust site (Dunham Massey) and would have had a visual impact on the associated Grade II* registered park and garden (Dunham Massey). The group would have had an impact on one scheduled monument (a promontory fort), one Grade II* listed structure (Barton Bridge); and would have passed in proximity to two SACs (Manchester Mosses, Rixton Clay Pits). The group would have also had an indirect impact on two Ramsar sites (Rostherne Mere – also an NNR, and Midland Meres and Mosses Phase 1); and eight SSSIs (Abram Flashes, Rixton Clay Pits, Risley Moss, Holcroft Moss, Astley and Bedford Mosses, Rostherne Mere, Bryn Marsh and Ince Moss, Dunham Massey). Three approach options (the western-most three) would have crossed, and had a major visual impact on, the Manchester Ship Canal.

### *WCML connections group*

4.2.22 The group ran from east of Warrington to south of Coppull, connecting the Birmingham to Manchester line of route to the WCML. The group would have crossed the Pennington Flash Country Park on viaduct and would have had a major impact on the landscape. A number of properties would have experienced noise impacts. The group would have required residential demolitions at Hollins Green and would have had a direct impact on one scheduled monument (Haigh Sough); and an indirect impact on two SACs (Manchester Mosses, Rixton Clay Pits); and five SSSIs (Abram Flashes, Bryn Marsh and Ince Moss, Holcroft Moss, Risley Moss and Rixton Clay Pits).

### *Routes to north of Preston group*

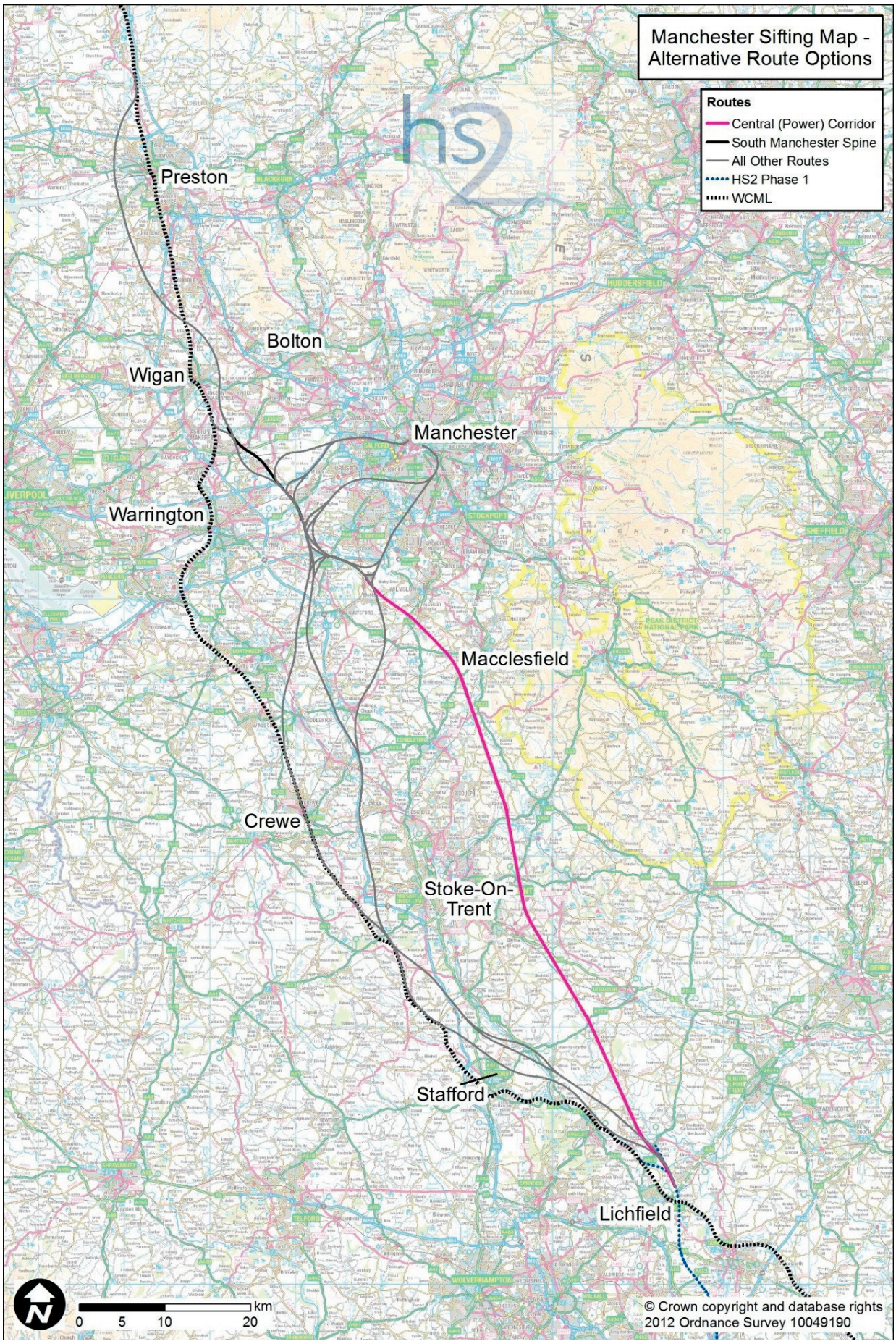
4.2.23 The group comprised three routes connecting with the WCML. Two of the routes originated to the south-west of Altrincham to terminate to the east and west of Aspull. The third route connected Golborne to the WCML north of Preston, running east of the M61. The group would have required residential demolitions at Tyldesley, Horwich, Crankwood and Wheelton. The group would have had a direct impact on one SSSI (Red Scar and Tunbrook Woods); a National Trust site (Dunham Massey); Worthington Lakes Country Park; and would have had an indirect impact on two SACs (Manchester Mosses, Rixton Clay Pits); and an AONB (Forest of Bowland). The group would have also had a visual impact on the Ribble Valley, Dunham Park SSSI and Dunham Massey Grade II* Registered Park and Garden.

## Alternative options not progressed to finalised option stage

### *Introduction*

4.2.24 The two routes outlined below were alternatives to the preferred spine and central (power) corridor route options that emerged at the end of selection process detailed above. These groups were not progressed to a full sift i.e. to the highest level of engineering design detail and appraisal. The routes are shown in Figure 9.

Figure 9: Manchester sifting map – alternative route options



### *Central (Power) corridor route*

4.2.25 This route was the most easterly route remaining at the final options stage and is commonly referred to as the eastern route option. It connected Lichfield to Mobberley, passing to the east of Stoke-on-Trent and to the west of Leek and Macclesfield. The route would have passed within 2km of the Peak District National Park impacting on views from higher ground. There would have been five major river diversions (four affecting the River Blithe, and one affecting the River Dane) and 17km of the route, in cut or tunnel, would have crossed important aquifers. The route would have had a direct impact on approximately 20 ancient woodlands. It would also have required some residential demolitions (with 13 at Key Green). There would have been noise impacts on some residential properties; a visual impact on Dane Valley; and an indirect impact on three scheduled monuments, four Grade II* listed structures and two Grade II* registered parks and gardens (Gawsworth Old Hall, Tatton Park).

### *Spine route (tunnel under Lowton)*

4.2.26 This route was located to the northeast of Lymm and ran north-west to past Pennington Flash Country Park to terminate at Crankwood, northeast of Golborne. The route would have had a direct impact on a zone 1 source protection zone (SPZ) and public borehole at Lowton Common. It would have required 10 residential demolitions; and there would have been vibration impacts for over 200 residents at Lowton Common. It would have had an indirect impact on Manchester Mosses SAC (that part which is Holcroft Moss SSSI).

4.2.27 As the alternative easterly options were discounted, a route to Manchester via a connection to the WCML at Crewe emerged as the preferred route.

## 4.3 Alternative route corridors south of Crewe

4.3.1 From the early work up to 2012, three potential route corridors were identified and considered, including a corridor that now forms the basis of the preferred route to Crewe. These aggregated sections were developed to the same set of engineering standards and subjected to an equivalent level of sustainability appraisal. These route corridors are illustrated in Figure 10.

4.3.2 All three route corridors commence at the proposed HS2 Phase One interface at Fradley and approach Crewe along a similar corridor to the east of both Whitmore and Madeley and passing by Chorlton alongside the existing WCML, south of Crewe.

4.3.3 The main variation between these pre-consultation routes is a 40-45km section of route starting immediately north of the connection point with Phase One and ending at Whitmore. The variations focused around the approach and passing of Pasturefields SAC and SSSI, north of Rugeley. Pasturefields SAC is internationally important and comprises the only significant remaining example in the UK of a natural salt spring with inland saltmarsh vegetation. Avoiding impacts to the marsh and associated surface water and groundwater catchment area was, therefore, one of the key considerations in determining the alignment for this section of the route.

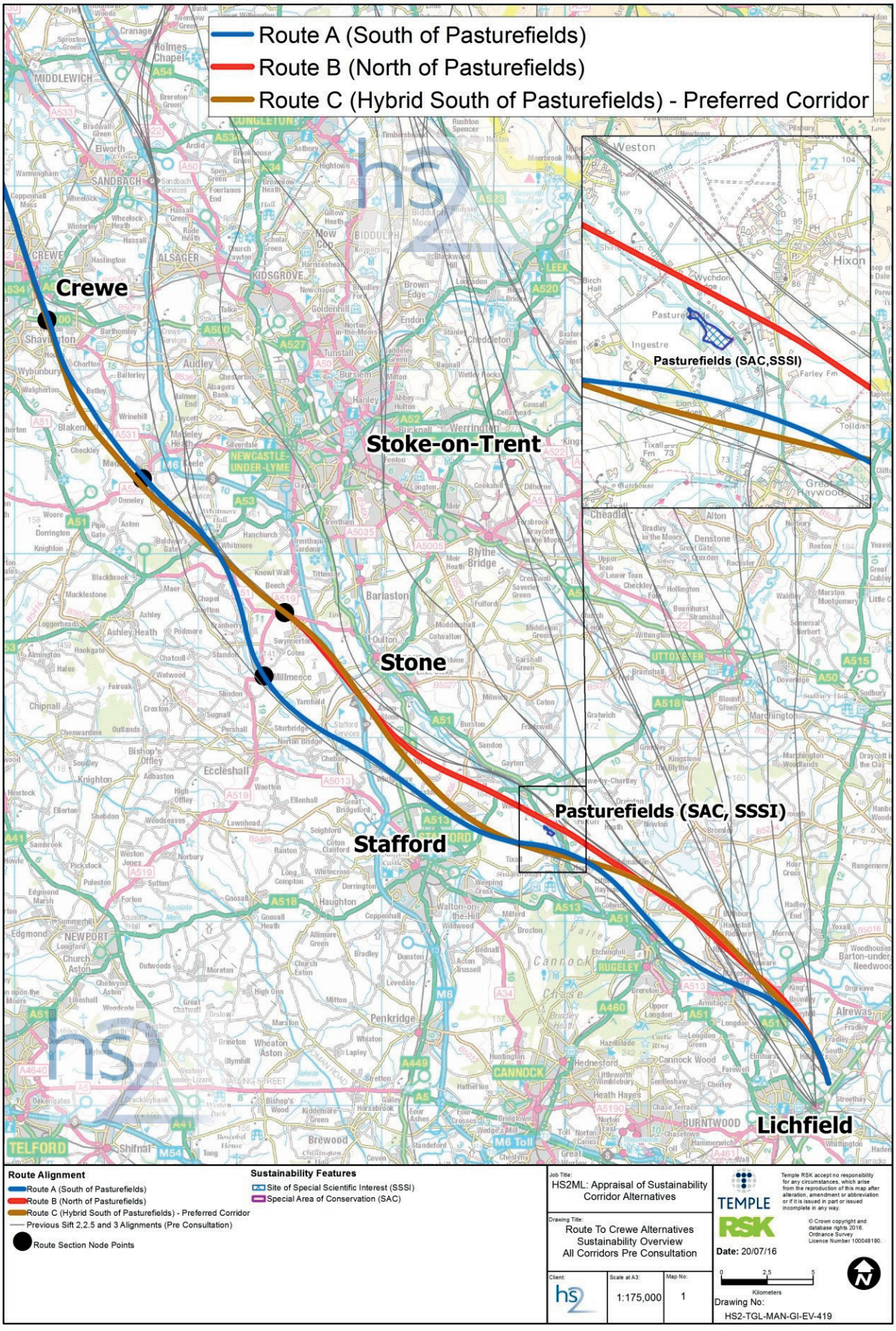
4.3.4 Corridor A provides a route that bypasses Pasturefields SAC to the south, following a similar corridor to that of the existing WCML as it passes Rugeley, approximately 900m north of Cannock Chase AONB, before heading north of Stafford and through

Mill Meece, to the south of Swynnerton. This comprises the following route sections from the March 2012 Options Report: HSM01, HSM04, HSM08, HSM09 and part of HSM10.

4.3.5 Corridor B takes a more northerly approach, up to 2km from Cannock Chase AONB and approximately 300m to the north of Pasturefields SAC. The corridor then continues north of Hopton and Hopton Registered Battlefield, and within approximately 300m of Yarlet School, skirting the south of Stone before heading north of Swynnerton and re-joining the other corridors near to Whitmore. This route is comprised of the following route sections from the March 2012 Option Report[131]: HSM03, HSM06, HSM09, HSM09 and part of HSM10.

[131] High Speed 2 Ltd. (2012), *Options for Phase 2 of the high speed network – Appraisal of Sustainability*, March 2012. Available online at: https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability

Figure 10: Alternative route corridors to Crewe (pre-consultation)



4.3.6 Corridor C similarly takes a more northerly approach leaving the connection point with Phase One at Fradley, but then takes a southerly approach to Pasturefields SAC, passing at a similar position to that of Corridor A, approximately 600m north of Cannock Chase AONB. However, north of Stafford the route heads north-west, to the north of Yarlet and re-joins with Corridor B, passing Swynnerton to the north and merging with the other options that then continue on from Whitmore towards Crewe. This route comprises options from the March 2012 report as well as a further refinement that is essentially a hybrid of options HSM01 and HSM03, MR71, HSM08, HSM09 and part of HSM10. Corridor A and Corridor C were 650m and 930m south of Pasturefields SAC at their closest points, respectively.

4.3.7 Corridor C became the basis for the initial preferred route and later the consultation route. Whilst there were a number of factors that influenced this as the preferred corridor (including engineering and other sustainability related drivers), the avoidance of impact on the northern catchment associated with Pasturefields SAC was a key consideration. This included impact not only through direct habitat loss from Pasturefields itself, but also changes which may impact on the surface water and groundwater catchment dynamics associated with the salt marsh.

4.3.8 HS2 Ltd undertook a Habitats Regulations Assessment (HRA) in 2012. The HRA concluded that only options to the south of Pasturefields SAC would be likely to have no significant impact, due to knowledge gained on the direction of groundwater flow in the area. Natural England and the Environment Agency were consulted and agreed with the findings of the HRA. Consideration of other options which could impact the associated northern catchment would have required an Appropriate Assessment involving considerable ground investigation work potentially over a number of years to investigate and assess potential impacts on the integrity of the internationally important SAC.

4.3.9 Other key sustainability constraints for alternative options to both the north and south of Pasturefields SAC included community impacts (property demolitions around Salt, Cotes Heath and Cranberry), Sandon Park (Registered Park and Garden), the Ministry of Defence Stafford development site, the Norton Bridge Junction upgrade scheme and Hopton Registered Battlefield.

## 4.4 Alternative alignment to Crewe

### Introduction

4.4.1 A number of changes were made to the consultation route on the basis of consultation feedback and other modifications made for engineering reasons. These are reported in Volume 1 and the Sustainability Report for the route to Crewe[132]. In addition to consideration of local alternatives along this section of route, an opportunity arose to consider once again an alternative corridor that proceeded via Stoke-on-Trent in order to respond to the Stoke-on-Trent City Council (STCC) proposal for an alternative alignment to the preferred route to Crewe. This section

[132] HS2 Ltd, November 2015, High Speed Rail: Preferred Route to Crewe Sustainability Report – Phase Two Post-Consultation Update: West Midlands to Crewe. A report by Temple-RSK for HS2 Ltd. Available on-line at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480667/Sustainability_Report_Phase_Two_Post-Consultation_Update_West_Midlands_Crewe.pdf

provides further detail on the development of this alternative corridor and comparisons made against the preferred route to Crewe.

4.4.2 The Stoke-on-Trent alternative was treated the same as any other post-consultation refinement and was compared against the route to Crewe. This is described further below.

## Stoke-on-Trent City Council proposal for route to Stoke-on-Trent

4.4.3 As early as 2012, HS2 Ltd developed route options that had served the Stoke-on-Trent area, including options immediately east and west of the city (see Figure 7 and Figure 8). However, these and the associated intermediate stations serving Stoke-on-Trent were not progressed due to preferential alternative options from a cost, engineering and sustainability perspective.

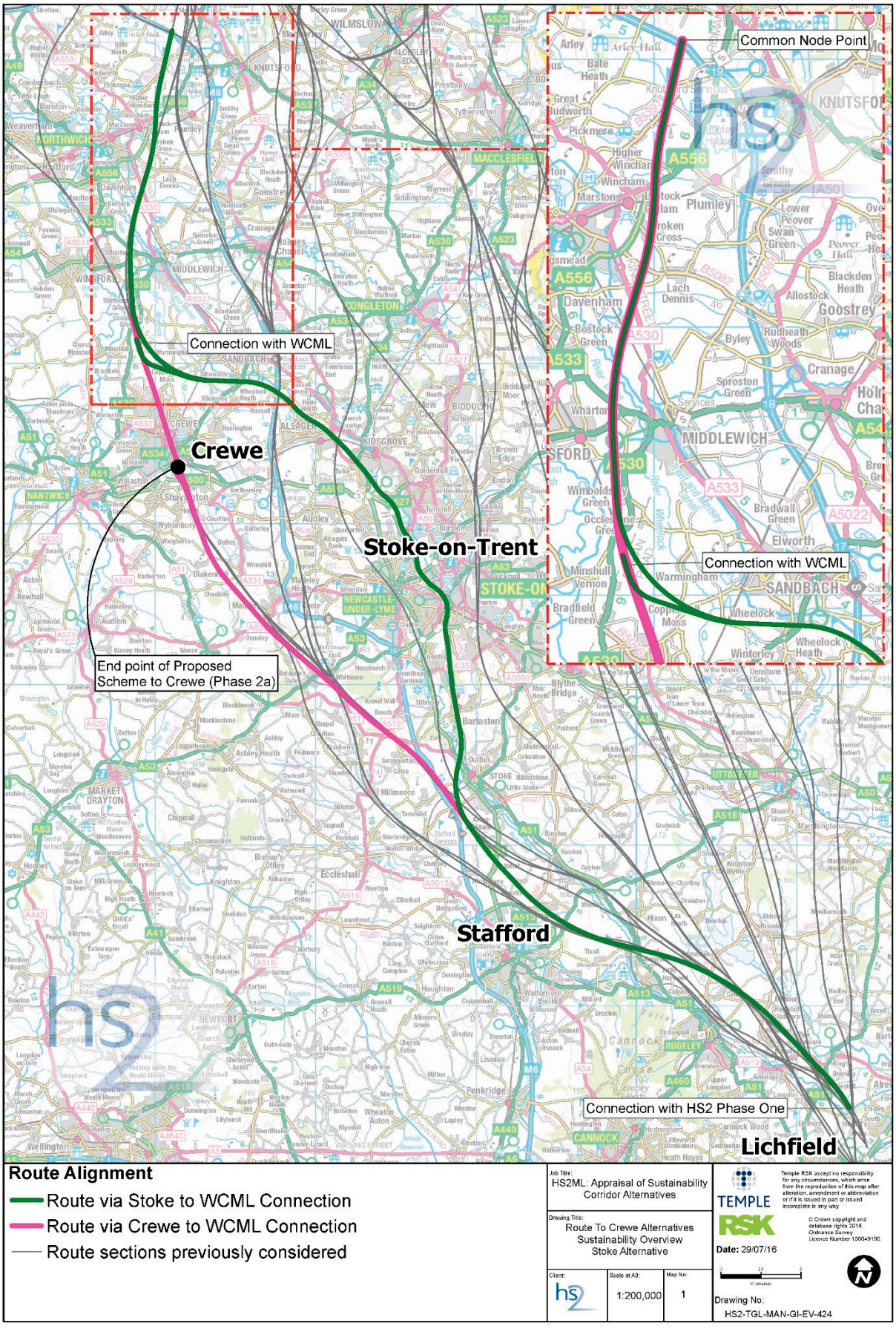
4.4.4 In response to public consultation in early 2014, STCC proposed a route through the city, presenting it to the Secretary of State for Transport in May 2014 and to HS2 Ltd and the DfT in June 2014.

4.4.5 As a result of this, HS2 Ltd applied the Phase Two engineering design standards to the STCC proposal to undertake a full sift level option for a route serving Stoke-on-Trent. The proposed option would serve Stoke-on-Trent directly using a new line through the city providing an alternative to the consultation route (see Figure 11).

4.4.6 The alternative corridor via Stoke-on-Trent was designed and appraised during 2014 as part of a wider refinement and optioneering review, and was subject to a detailed full sift AoS to ensure consistency and comparability with existing consultation route via Crewe.

4.4.7 In order to ensure a full like-for-like comparison with the consultation route, both alignments were designed to end at the same location north of the M6 near Winterbottom. As the route of the Proposed Scheme is shorter than the routes appraised (as shown in Figure 11) there are a number of receptors and resources identified in Table 10 that are now not relevant to the Proposed Scheme.

Figure 11: Alternative corridor – routes to Crewe and Stoke-on-Trent



## Description of the route to Stoke-on-Trent

4.4.8 The STCC option followed a route between Stone and Winsford that uses the existing rail corridor through Stoke-on-Trent, employing a mix of high speed line and alterations to existing lines to accommodate the new route, and including a new Stoke International Station. It would re-join the consultation route alignment north of Crewe, with a junction to the WCML to allow stopping services to Liverpool and Preston. The route would be about 3km longer than the consultation route, and would also have a lower design speed in order to follow the existing corridor through Stoke-on-Trent.

4.4.9 West of Stone the route would bear north from the consultation route, using a new alignment across farmland. It would cross on viaduct over the River Trent and the A34 immediately north of Stone and then use an embankment up to about 14m high just to the east of Meaford and alongside the Trent and Mersey Canal. It would join the corridor of the WCML, requiring realignment of this railway as well as the removal of the Barlaston and Wedgwood level crossings. Following the WCML corridor either at grade or on embankment, the route would run alongside the Trent and Mersey Canal for some 5km.

4.4.10 Passing immediately east of Trentham, the route could require demolition of a number of dwellings. STCC proposed a new station on the classic network at Trentham, which was not appraised as part of the study. The route would then rise on to a viaduct across the floodplain to the east of Hanford, requiring the realignment of the canal at this point. Immediately north, STCC proposed a new station on the classic network alongside the Britannia stadium, which again was not appraised as part of the study.

4.4.11 The route would then pass under the A50 and enter the industrialised southern edge of Stoke-on-Trent, east of the A500. It would diverge slightly west from the WCML at this point passing through Axiom rail land and industrial land uses east of the Whieldon Road. The route would run parallel with the WCML, passing immediately west of the existing Stoke-on-Trent station (through the associated car park) and both over and alongside the Trent and Mersey Canal. A new station, with connections to the classic network was proposed in Cliff Vale on now largely derelict industrial land.

4.4.12 The route would then continue northwards, still within the WCML corridor and east of the A500. It would pass under the A5271 at Longport where STCC proposes to relocate the existing Grade II listed station. It would pass over the A527 at Tunstall before diverging west from the WCML and entering a new 2.3km long bored tunnel under Bathpool Park and Coal Pit Hill east of Talke.

4.4.13 The tunnel would emerge west of Butt Lane and then pass in cutting through pockets of woodland and open countryside. The route would pass to the south of Church Lawton and along the north-east edge of Alsager within a valley and partly using a disused rail corridor. Passing under the M6, the route would come alongside the Trent and Mersey canal. It would then pass over the A534 and south of Wheelock, directly affecting the residential community south of this village, on the Crewe Road.

4.4.14 South of Elworth, a grade separated junction would connect with the WCML, while the main high speed route would bear northwards towards Warmingham and

Winsford where it would join the consultation route alignment and continue towards Manchester and WCML connection at Golborne. With Crewe now bypassed, an alternative location for the Basford Hall Infrastructure Maintenance Depot (IMD) would be required. Proposals for this were not developed as part of the study.

## Conclusions

4.4.15 Table 10 summarises the sustainability impacts between the proposed route via Crewe and the alternative via Stoke-on-Trent. The key sustainability constraints are shown on Figure 12.

Figure 12: Alternative corridor to Stoke-on-Trent – sustainability features

Table 10: Route to Crewe and Alternative corridor to Stoke-on-Trent – sustainability features (appraisal based on Appraisal of Sustainability methodology)[133]

| | **Route to Crewe – consultation route with updated design standards applied** | **Alternative route via Stoke-on-Trent – WCML connection north of Crewe (via Stoke-on-Trent)** |
|---|---|---|
| Property and community integrity | Demolitions:<br>Approximately 30 residential<br>3 commercial<br>0 community<br>0 industrial<br>Approximate Total: 33<br>3 residential areas would experience isolation affecting a total of 7 residential properties. | Demolitions:<br>Approximately 100 residential<br>Approximately 50 commercial<br>3 community<br>8 industrial<br>Approximate Total: 161<br>3 residential areas would experience isolation affecting a total of 14 residential properties. |
| Noise (annoyance, unmitigated scheme) | Approximately 675 | Approximately 1,500 |
| Landscape and visual impacts | Moderate to major landscape and visual impacts, with major impacts potentially affecting seven locations. | Moderate to major landscape and visual impacts, with major impacts potentially affecting nine locations. |
| Planning and development | Basford West (direct impact) | Chatterley Valley employment area (direct impact) |
| Cultural heritage | Moderate impact on the setting of 2 Grade II listed buildings | Major impact on the Trent and Mersey Conservation Area<br>Moderate impact on Meaford Conservation Area<br>Moderate to major impact on the setting of 2 Grade II* listed buildings<br>Major direct impact on 2 Grade II listed buildings<br>Moderate to major impact on the setting of 3 Grade II listed buildings |
| Biodiversity and wildlife | 51 Habitats of Principal Importance intersected for approximately 5km<br>3 ancient woodlands directly impacted for a distance of approximately 675m | Sandbach Flashes SSSI lies directly adjacent to the proposed route. The route intersects the surface water catchment for the site potentially resulting in obstruction to the flows from the west. The route effectively separates the southern unit of the site from the rest of the complex and could result in the potential disturbance to the associated breeding bird assemblage. |

[133] Note: this appraisal is based on the Appraisal of Sustainability methodology for the line of route. As stated in paragraph 4.4.7, in order to ensure a full like-for-like comparison with the consultation route, both alignments were designed to end at the same location north of the M6 near Winterbottom. As the route of the Proposed Scheme is shorter than the routes appraised there are a number of receptors and resources identified that are now not relevant to the Proposed Scheme.

| | **Route to Crewe – consultation route with updated design standards applied** | **Alternative route via Stoke-on-Trent – WCML connection north of Crewe (via Stoke-on-Trent)** |
|---|---|---|
| | | 97 Habitats of Principal Importance intersected for approximately 11km.<br><br>5 ancient woodlands directly impacted for a distance of approximately 500m. |
| Water resources and flood risk | 0 diversion of major watercourse<br><br>6 diversions of minor watercourses<br><br>3 navigable waterbody crossings<br><br>1 crossing where line could be at risk of fluvial flooding<br><br>Large public water supply borehole located beneath the line of route at Whitmore<br><br>Approximately 100m of route in cut/tunnel through SPZ 2 | 1 diversion of major watercourse<br><br>13 diversions of minor watercourses of which 4 are EA Main Rivers<br><br>12 navigable water body crossings. At least nine of the Trent and Mersey Canal crossings may require canal re-alignment |
| Land use resources | 1 active landfill site intersected<br><br>1 historical landfill site intersected<br><br>19km of green belt land intersected | 2 active landfill sites intersected<br><br>7 historical landfill sites intersected<br><br>16 km of green belt land intersected |

## Proposed route and alternative route via Stoke-on-Trent conclusion

4.4.16 HS2 Ltd modelled a number of scenarios for services via Crewe or Stoke-on-Trent to compare their performance. This modelling shows a significant reduction in the benefits and revenues generated by the alternative Stoke-on-Trent route in comparison with the consultation route via Crewe. This is driven by a number of factors, including longer journey times to the key markets of Manchester and the North, and loss of the wider regional connectivity delivered by the proposed connection at Crewe. This coupled with a better sustainability performance for the route via Crewe led to the decision not to adopt the alternative Stoke-on-Trent route.

# 5 Local alternatives considered before November 2015

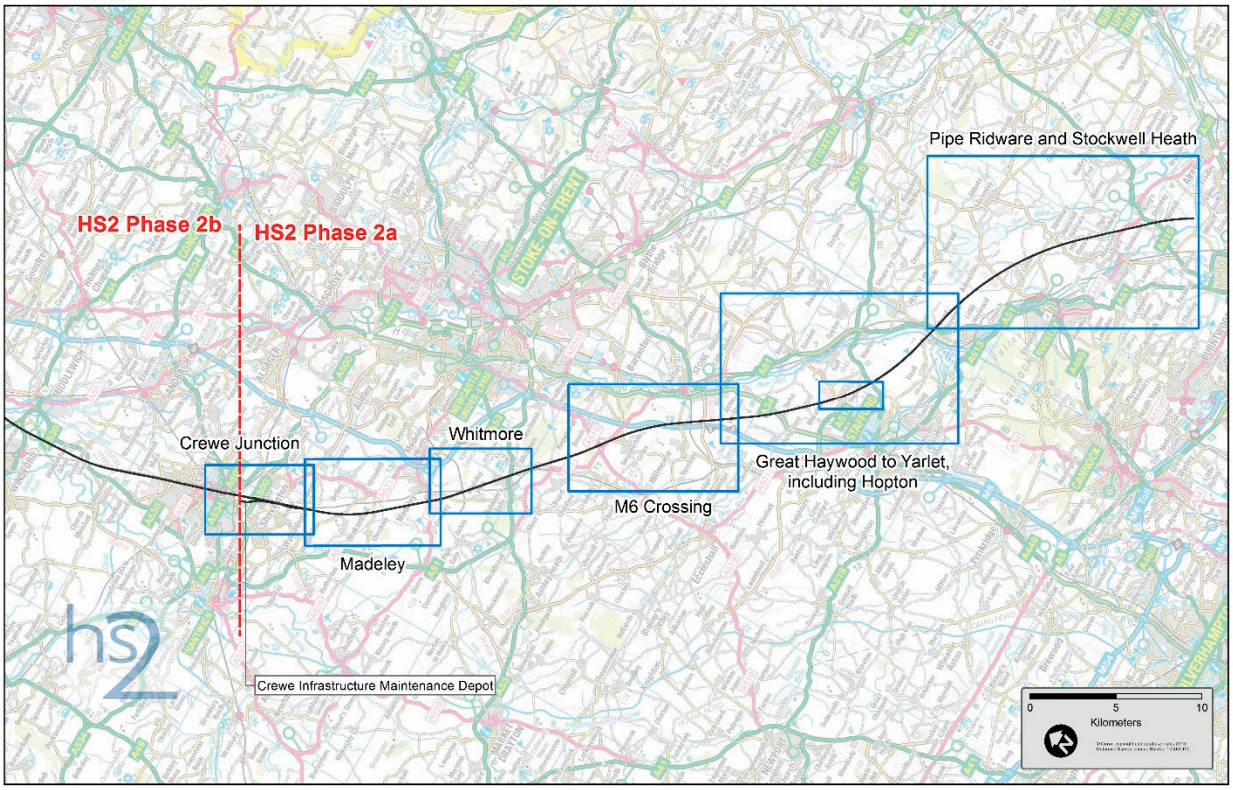
## 5.1 Introduction

5.1.1 Following the period of public consultation between July 2013 and January 2014, there was a phase of route refinements (as described in Section 4.1) which examined in greater detail seven areas along the Phase 2a route.

5.1.2 Refinement areas focused on discrete sections of route, although in totality encompassed almost the whole length to Crewe (as shown in Figure 13). Refinement was focused around the following areas:

- Pipe Ridware and Stockwell Heath;
- Hopton;
- Great Haywood to Yarlet;
- M6 crossing and Swynnerton;
- Whitmore Heath;
- Madeley tunnel; and
- Crewe junction.

Figure 13: Local alternatives considered before November 2015



5.1.3 Across all seven refinement packages, 51 local alternatives or options were considered during the initial sift. Of these, 39 options were progressed to a full sift. Two further options (also considered at full sift) were developed as a response to the full sift for Whitmore Heath.

5.1.4 The remainder of this section provides an overview of the alternatives considered for each refinement area, the option chosen for progression and the reasons to support this decision. A decision tree diagram shows the options progressed to full sift appraisal, with a short description of these options in the summary below.

5.1.5 The preferred refinement option in each case is highlighted in green. Options in grey were proposed but were either not progressed or not considered the preferred option for that appraisal stage.

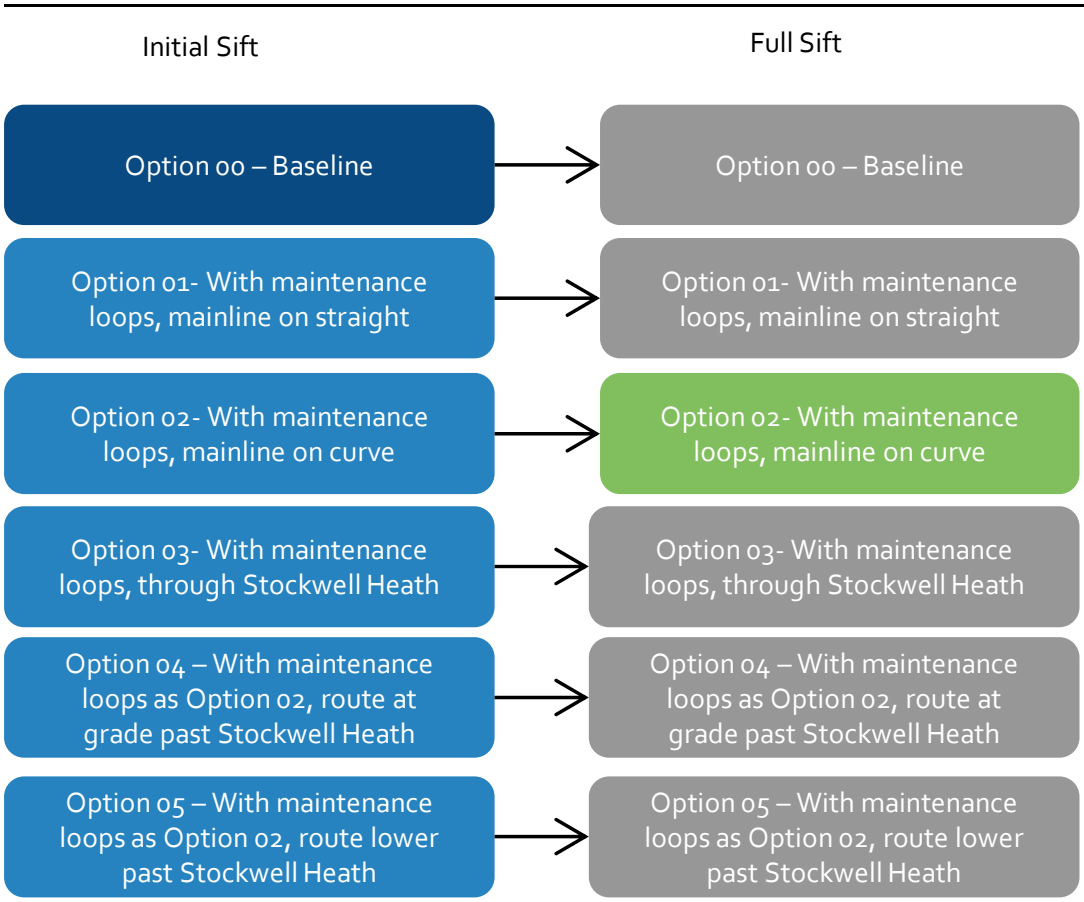
5.1.6 A Route Refinement Baseline option was presented as part of each package of refinements. This was the base case comparison option, which was similar to the consultation route but had been subjected to the updated design standards following consultation.

5.1.7 In each case, the option recommended by HS2 Ltd was taken forward. Minor amendments were subsequently made to the route to enable the 'stitching' together of each of the individual recommended options, or where a specific update was required as identified by HS2 Ltd. The 'stitched' route became the preferred route to Crewe that was published within the Phase Two Post-Consultation Update: West Midlands to Crewe Sustainability Report 2015.

## 5.2 Pipe Ridware and Stockwell Heath

5.2.1 This refinement area covered approximately 16km of the route from the connection with Phase One at Fradley to the east of Great Haywood. The primary refinement considerations were the location and height of the railway past the village of Stockwell Heath, landscape impacts around Pipe Ridware, and the location of the maintenance loops. Refinements for the location of the maintenance loops included more detailed design of the loops and whether, for operational purposes, they could be accommodated on a straight or curved section of the HS2 mainline. The options are summarised in Figure 14. The locations of the options are shown in Figure 15.

Figure 14: Alternatives options considered for Pipe Ridware




5.2.2 The following options were considered during the full sift:

- Option 00: equivalent to the Route Refinement Baseline (RRB). Omits maintenance loops. Alignment runs in a north-easterly direction past Rileyhill, over the Bourne Brook and River Trent floodplains and east of Pipe Ridware on 10m high viaduct. The route then turns eastwards in cutting to a depth of approximately 10m and passes Stockwell Heath on embankment approximately 13m high.
- Option 01: including maintenance loops. A straighter alignment than Option 00, which requires the mainline to be in deeper cutting south of Stockwell Heath and a slight adjustment eastwards at Blithbury. The route past Stockwell Heath remained similar to Option 00.
- Option 02: including maintenance loops. Largely as Option 00 but requires a deeper cutting and increased footprint to the south of Stockwell Heath, although with similar horizontal alignment to Option 00.
- Option 03: including maintenance loops. Follows a straighter alignment to Option 00 and diverges north from Option 00 between Blithbury and Stockwell Heath. Runs at a slightly reduced height and through Stockwell Heath.
- Option 04: including maintenance loops. Similar to Option 02 but significantly lowered past Stockwell Heath, requiring very deep cuttings to both the south and north of Stockwell Heath and running at-grade past the village.

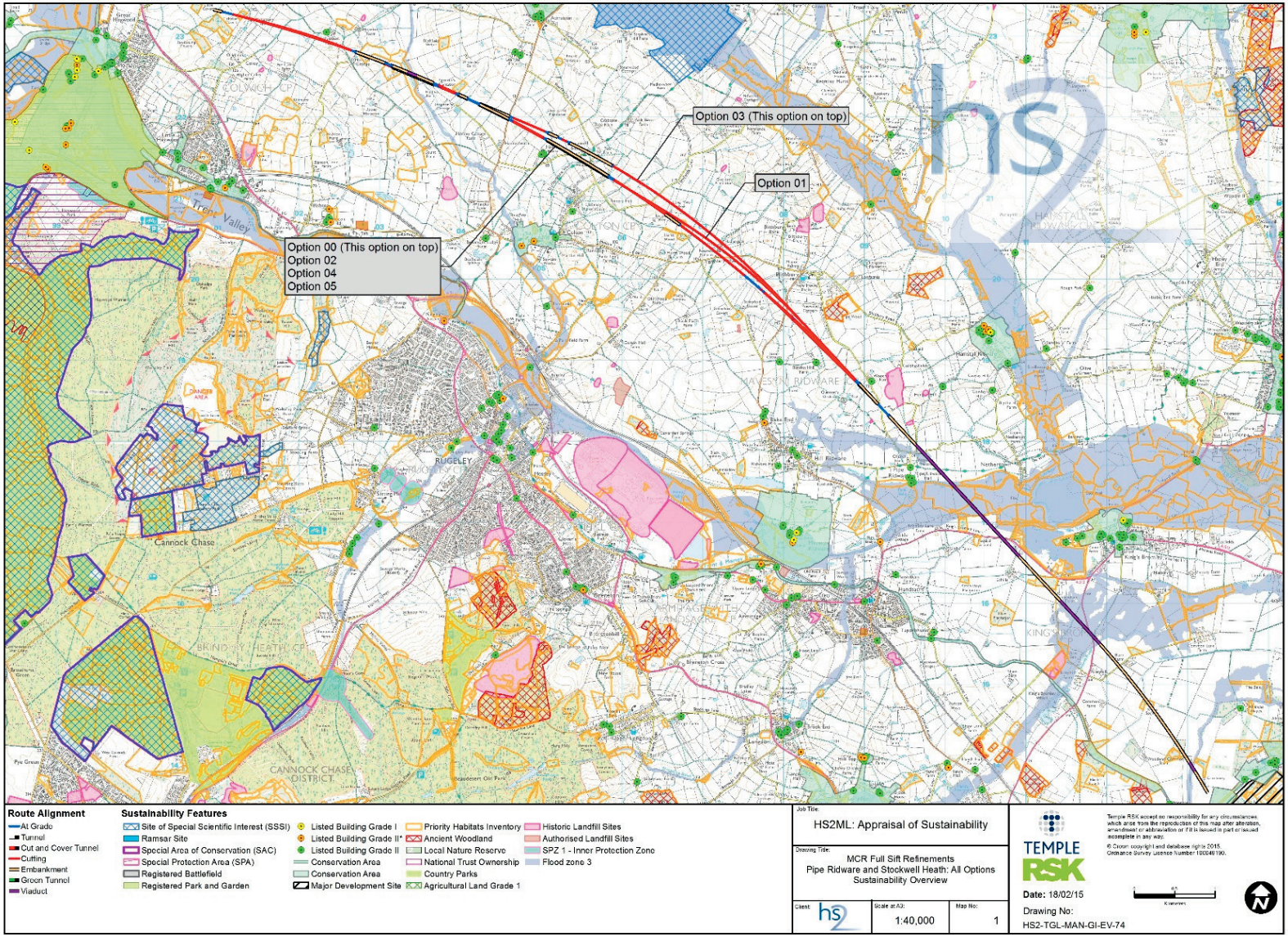
- Option 05: including maintenance loops. Similar to Option 02 with the mainline lowered past Stockwell Heath, higher than Option 04. As with Option 00, requires deep cuttings to both the south and north of Stockwell Heath and on embankment past the village.

5.2.3 HS2 Ltd determined that Option 02 should be taken forward. This option remained closest to the consultation alignment whilst including provision for maintenance loops and required slightly shallower cuttings to the south of Stockwell Heath.

5.2.4 Key sustainability impacts associated with Option 02, when compared with Option 00, include:

- one additional residential demolition is required at Hadley Gate due to the increase in footprint associated with the deep cutting at this location;
- increased landscape and visual impacts due to a higher viaduct over the Bourne Brook floodplain;
- similar landscape impacts at Blithbury due to deep cutting to accommodate the maintenance loops. Landscape and visual impacts also remain at Stockwell Heath. These are associated with the cuttings south and north of Stockwell Heath and the height of the embankments within approximately 100m of the settlement; and
- similar impacts on the setting of the Grade II listed Moreton House.

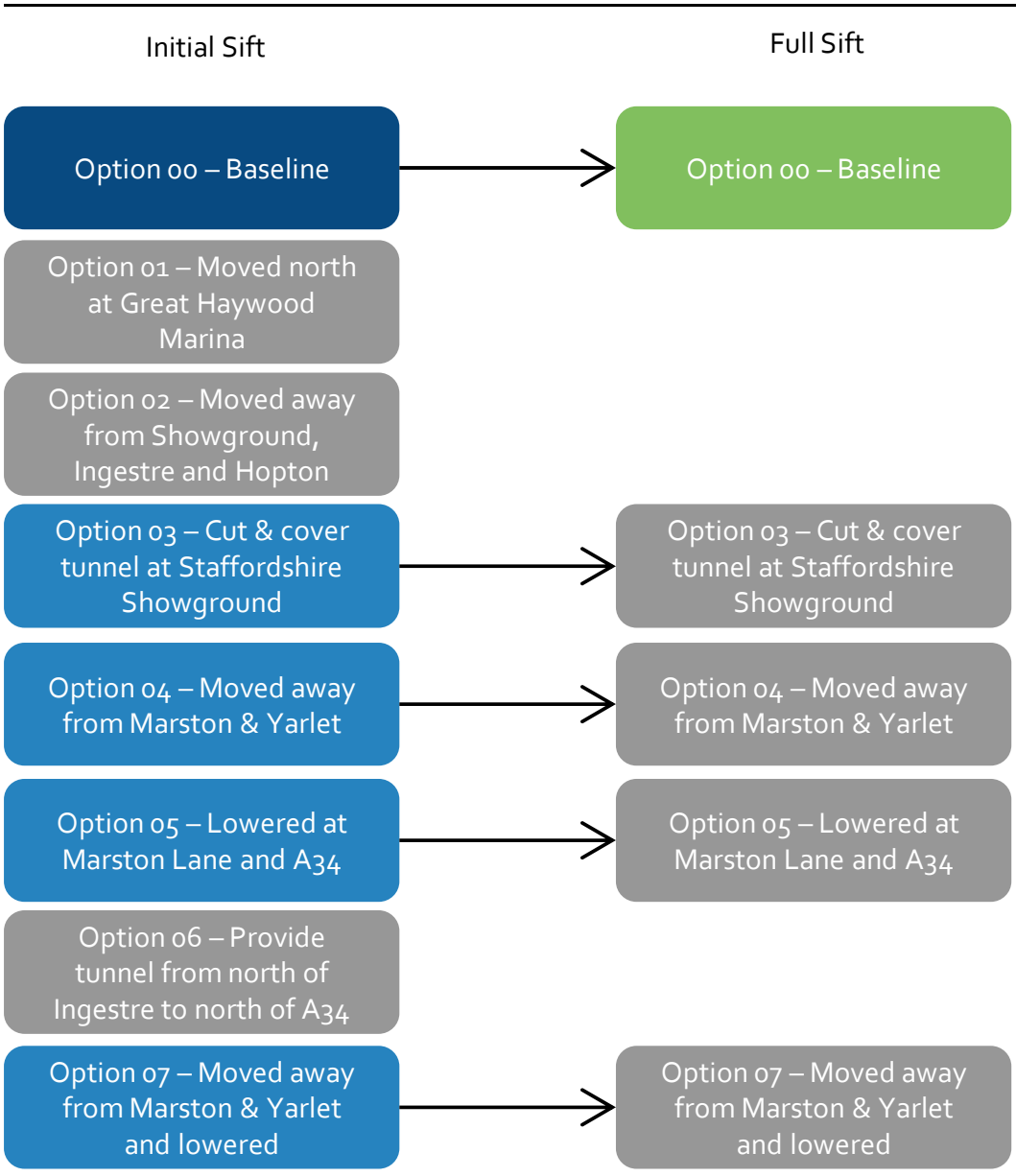
Figure 15: Alternatives considered for Pipe Ridware and Stockwell Heath



## 5.3 Great Haywood to Yarlet

5.3.1 This refinement area covered approximately 14km of the route from Great Haywood to the A34 at Yarlet. The primary refinement considerations were to address the location of the railway past Staffordshire County Showground and through Hopton (which was later further addressed in an additional focused refinement), the location and height of the railway past Marston and Yarlet and the impacts to Great Haywood Marina, Ingestre Conservation Area and on other scattered settlements. Eight options were considered, with three of these not progressed past the initial sift. The options are summarised in Figure 16. The locations of the options are shown in Figure 17.

Figure 16: Alternatives considered for Great Haywood to Yarlet




5.3.2 The following options were considered during the full sift:

- Option 00 is the RRB. This route began on embankment and viaduct across the Trent and Mersey Canal (and Great Haywood Marina) before entering a long stretch of cutting through Ingestre Golf Course and past Staffordshire County

Showground and approaching Hopton. North of the green tunnel at Hopton the route begins to rise, passing east of Marston on a short section of embankment before running east of Yarlet and under the A34 in cutting.

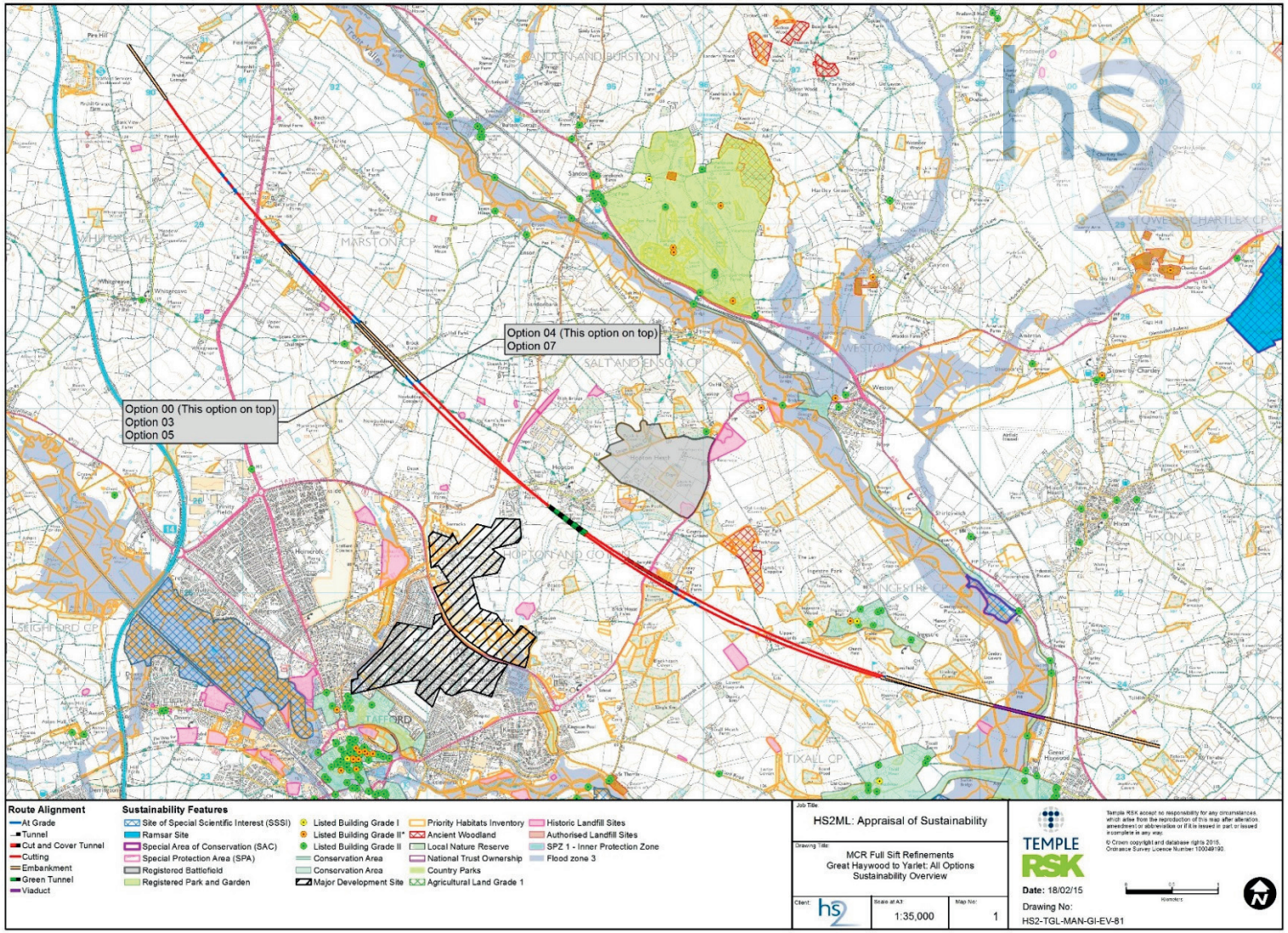
- Option 03 followed the same horizontal and vertical route as Option 00 but introduced a cut and cover tunnel at Staffordshire County Showground.
- Option 04 moved the route slightly east of Option 00 (approximately 60m) at Marston and Yarlet and slightly south (approximately 60m) at Staffordshire County Showground.
- Option 05, in comparison to Option 00, lowered the route north of Hopton, past Marston, Marston Lane and under the A34.
- Option 07 followed the same horizontal route as Option 04, moving the route slightly eastwards (approximately 60m) from Marston and Yarlet, however the route was also lowered past both settlements.

5.3.3 Option 00 was retained as the preferred option as none of the other options would deliver sufficient sustainability benefits to outweigh the additional cost anticipated at this stage of the process.

5.3.4 Key sustainability impacts associated with the Option 00 include:

- landscape impacts and visual intrusion at Great Haywood Marina, Ingestre (Conservation Area), to the south and north of Hopton, Marston and Yarlet; and
- land required from Staffordshire County Showground car park and Ingestre Park Golf Course.

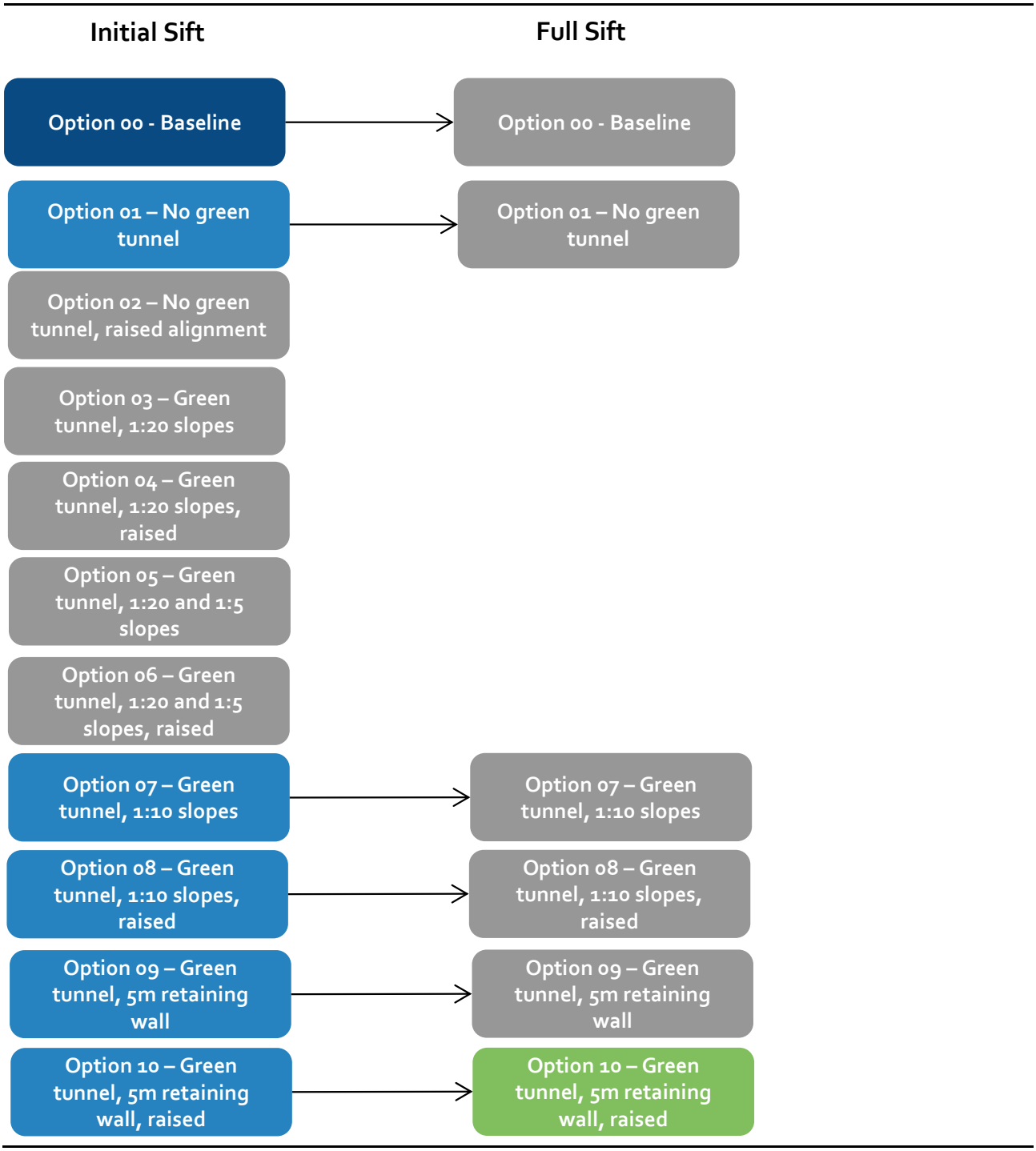
Figure 17: Alternatives considered for Great Haywood to Yarlet



## 5.4 Hopton

5.4.1 This refinement area covered approximately 38km of the route from the connection with Phase One at Fradley to the north of Swynnerton. The primary refinement considerations were to address concerns about the clearance of the existing alignment over Kingston Brook south of Hopton and to understand the options for landscaping and mitigation associated with the green tunnel at Hopton. Eleven options were considered, with five of these not progressed past the initial sift. The options are summarised in Figure 18. The location of the options is shown in Figure 19.

Figure 18: Alternatives considered for Hopton



5.4.2 The following options were considered during the full sift:

- Option 00 was the RRB. The alignment approached Hopton cutting south of Staffordshire County Showground up to approximately 17m deep. The alignment then continued south of Hopton in an approximately 510m long green tunnel (with no associated landscaping) before resuming in cutting under Hopton Lane and Sandon Road, at a depth of up to approximately 20m.
- Option 01 had the same vertical and horizontal profile as the RRB but without the green tunnel south of Hopton. This has the alignment almost at grade passing by to the south of Hopton where the green tunnel was located within the RRB due to the topography in this area.
- Option 07 followed the same horizontal and vertical profile as the RRB and included the 510m green tunnel but also includes indicative 1:10 landscaped mitigation for the green tunnel. A 500m inverted siphon would be required in crossing the Kingston Brook watercourse in this location.
- Option 08 followed the same horizontal and vertical profile as the RRB but the alignment was raised by up to approximately 4m to the south of Staffordshire County Showground and approaching Hopton in order to provide improved clearance over the Kingston Brook watercourse. The green tunnel was also included but due to the raised alignment this mitigation required a greater area of land than Option 07. North of Hopton the alignment continued in cutting but at a reduced depth of up to approximately 16m compared with the RRB.
- Option 09 followed the same horizontal and vertical profile as the RRB. However, south of Hopton the green tunnel was replaced by a 5m high landscaped retaining on the north side of the alignment. This option would also require an approximately 400m inverted siphon associated with the Kingston Brook watercourse.
- Option 10 followed the same horizontal and vertical profile as Option 08, with the alignment raised south of Staffordshire County Showground to navigate the Kingston Brook watercourse. The green tunnel was replaced with a 5m high landscaped retaining wall on the north side of the alignment, similar to Option 09 but required an increased area of land due to the raised alignment. A culvert would be required for the Kingston Brook watercourse crossing.

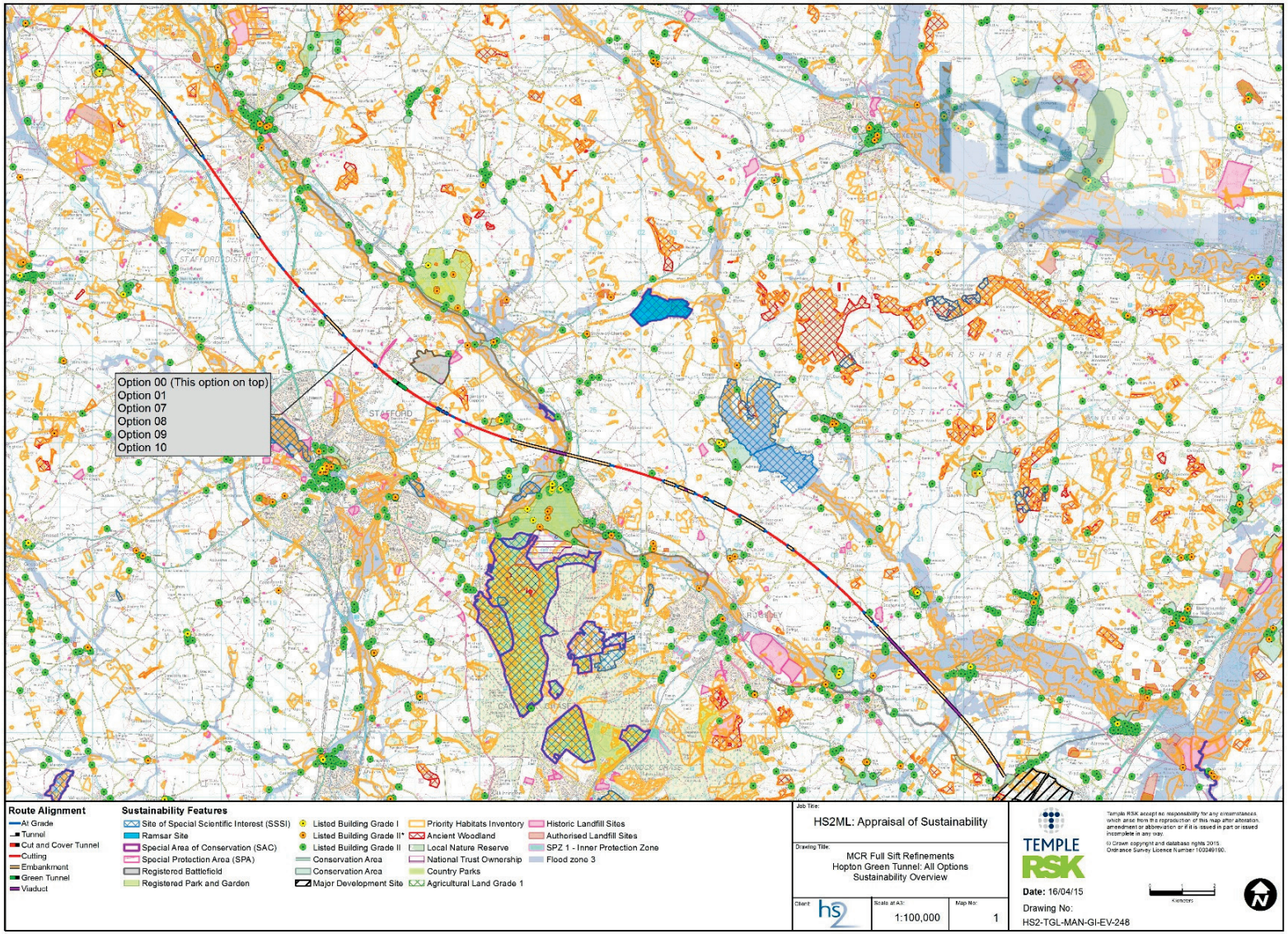
5.4.3 Option 10 was the recommended option. This refinement included a route slightly higher than Option 00 and replaced the green tunnel with a 5m high landscaped retaining wall. This option provided the most viable solution to the Kingston Brook watercourse crossing, with the 5m high retaining wall providing a comparable level of noise and visual mitigation associated with the green tunnel.

5.4.4 The fully landscaped green tunnel options (07 and 08) had increased landscape and visual impacts and required similar property demolitions without providing a suitable solution for the Kingston Brook watercourse crossing.

5.4.5 Key sustainability impacts associated with Option 10, when compared with Option 00, include:

- four additional residential demolitions at Hopton associated with the landscaped retaining wall (similar to Option 07 in this respect);
- increased landscape and visual impacts (similar to Option 07 in this respect);
- slight increase in noise impacts around Hopton, due to the raised alignment past Hopton rather than replacement of the green tunnel; and
- a similar land area required from Staffordshire County Showground.

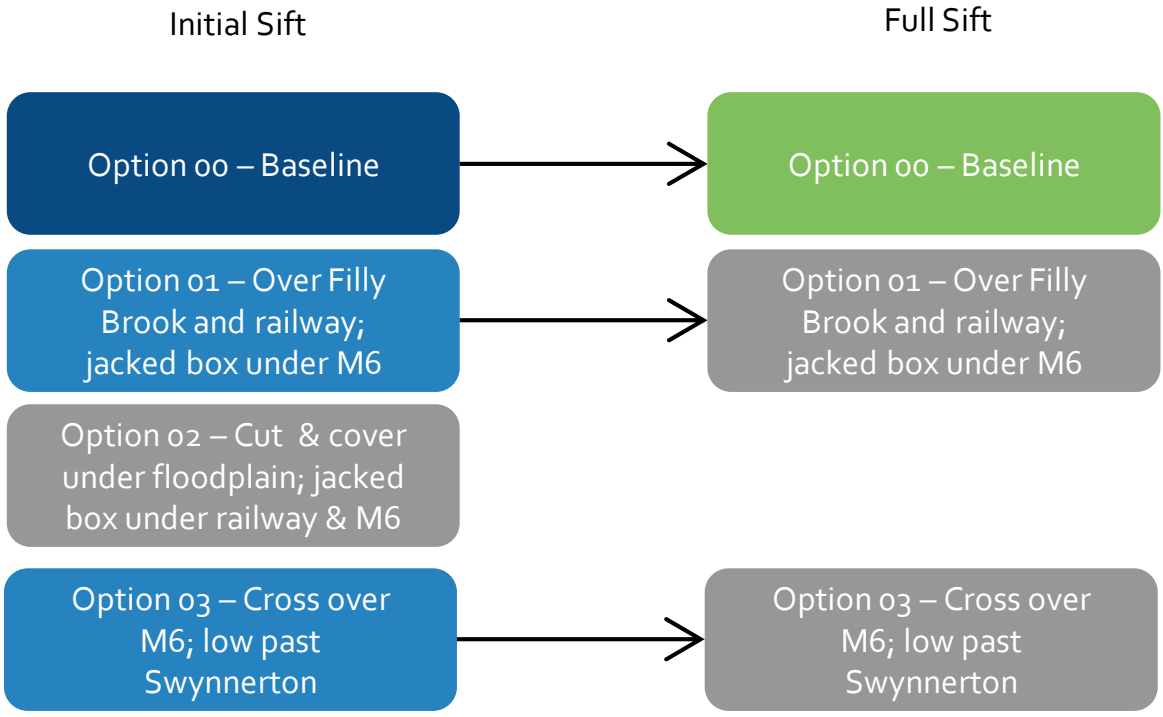
Figure 19: Alternatives considered for Hopton



## 5.5 M6 crossing and Swynnerton

5.5.1 This refinement area covered approximately 10km of the route between a point south of Stone and north of Swynnerton. The primary refinement considerations were to address concerns regarding the height of the route over the M6 and past the village of Swynnerton (conservation area) without impacting on Swynnerton boreholes adjacent to the M6. Four options were considered for this section of the route, with one of these not progressed past the initial sift. The options are summarised in Figure 20. The location of the options are shown in Figure 21.

Figure 20: Alternatives considered for the M6 crossing and Swynnerton




5.5.2 The following options were considered during the full sift:

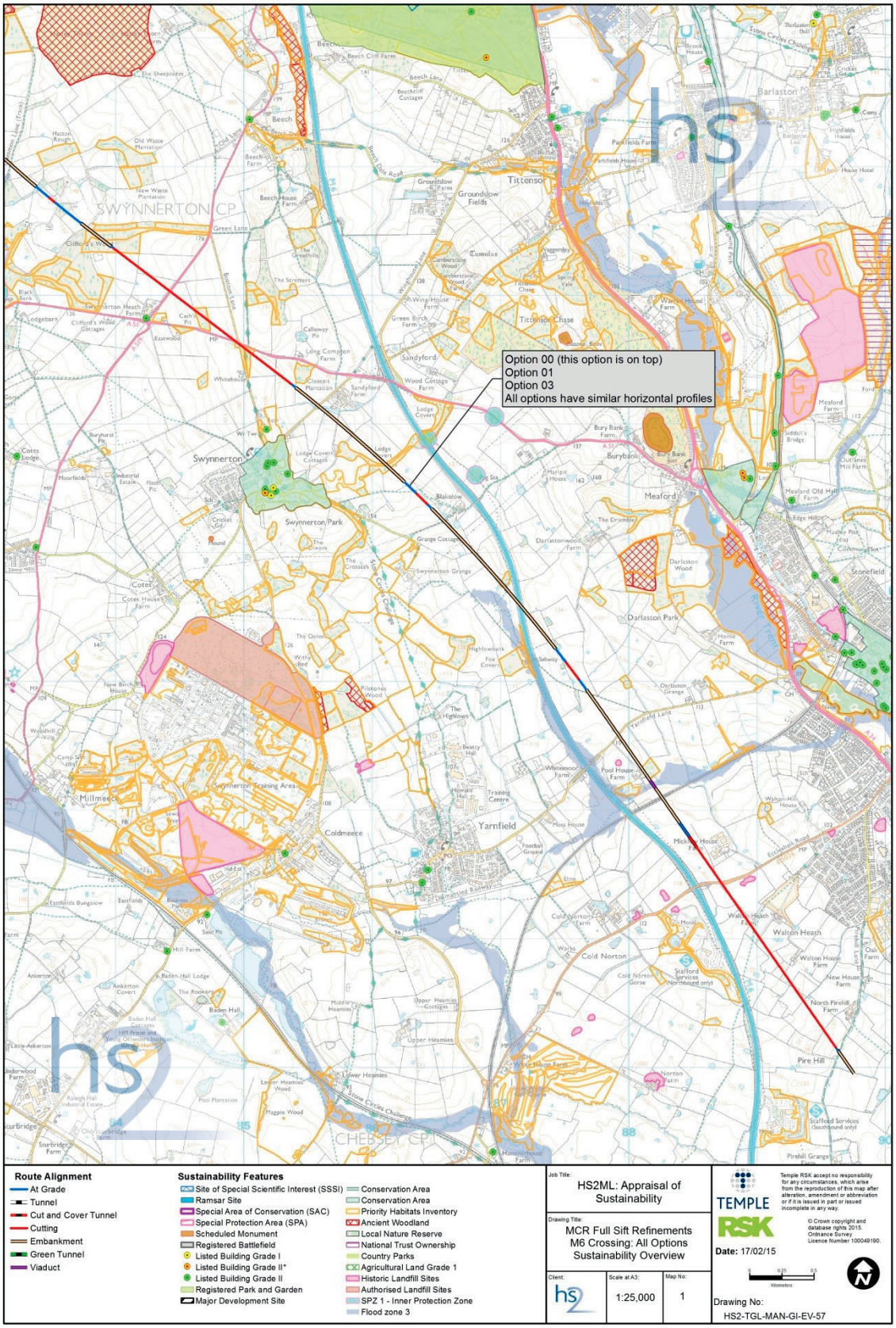
- Option 00 was the RRB, which ran on high embankment to cross the M6, on embankment past Swynnerton and then dropped into cutting further north under the A51.
- Option 01 followed the same route as Option 00 but at a reduced height. It passed over the Filly Brook floodplain before going under the M6, continuing in deep cutting (approximately 27m) through a SPZ 2 associated with Swynnerton boreholes, and continuing past Swynnerton on embankment.
- Option 03 followed the same route as Option 00. It crossed over the both the Filly Brook flood plain and M6, but had a slightly lower route approaching and passing Swynnerton in sections in cutting, at grade and on embankment.

5.5.3 Option 00 was retained as the preferred option as alternative options would increase impacts on the local environment and incur additional cost without resolving the concerns highlighted following consultation.

5.5.4 Key sustainability impacts associated with the chosen option include:

- landscape and visual impacts at Swynnerton (including a conservation area) and Swynnerton Park from the raised M6 crossing and Filly Brook crossing; and
- approximately 120m of shallow cut through SPZ2 associated with Swynnerton boreholes.

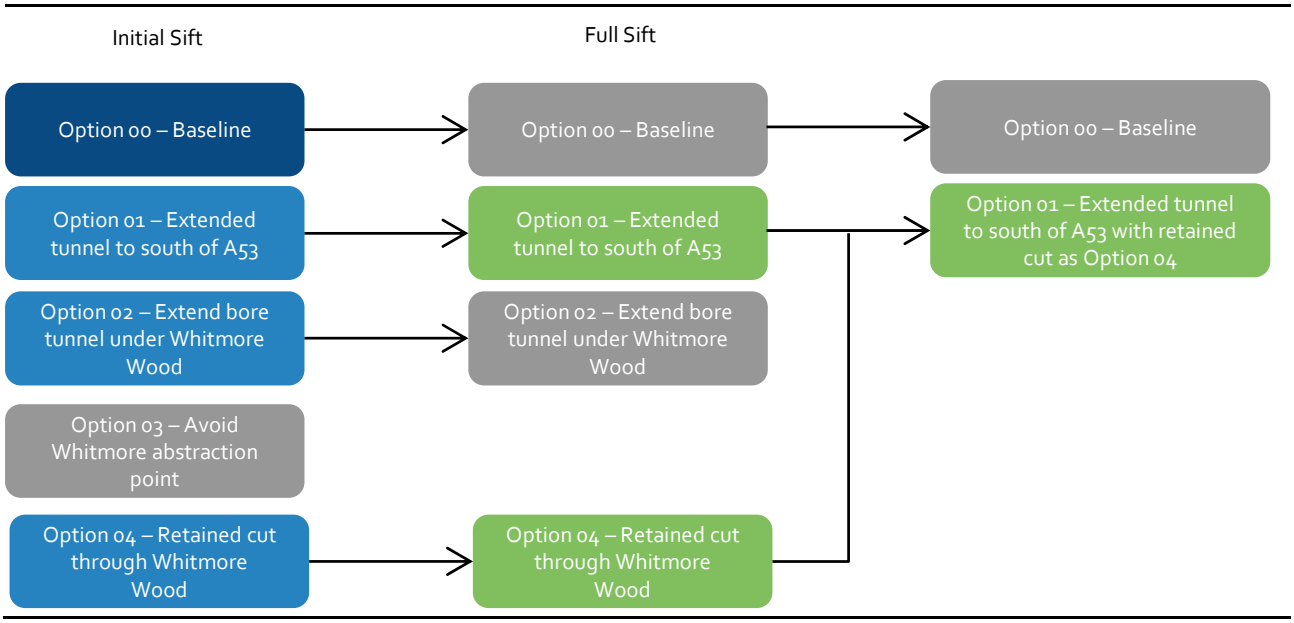
Figure 21: Alternatives considered for the M6 crossing



## 5.6 Whitmore Heath

5.6.1 This refinement area covered approximately 11 km of the route between Swynnerton and Madeley. The primary refinement considerations were to address concerns over the tunnel portal locations and the impacts of the route on Whitmore Wood ancient woodland. Five options were considered with two not progressed from the initial sift. Of the four options progressed to a full sift, a hybrid of two options (Option 01 and Option 04) was progressed to a second full sift. The hybrid proposal was considered against the baseline options. The options are summarised in Figure 22. The locations of the options are shown in Figure 23.

Figure 22: Alternatives considered for Whitmore Heath




5.6.2 The following options were considered during the full sift:

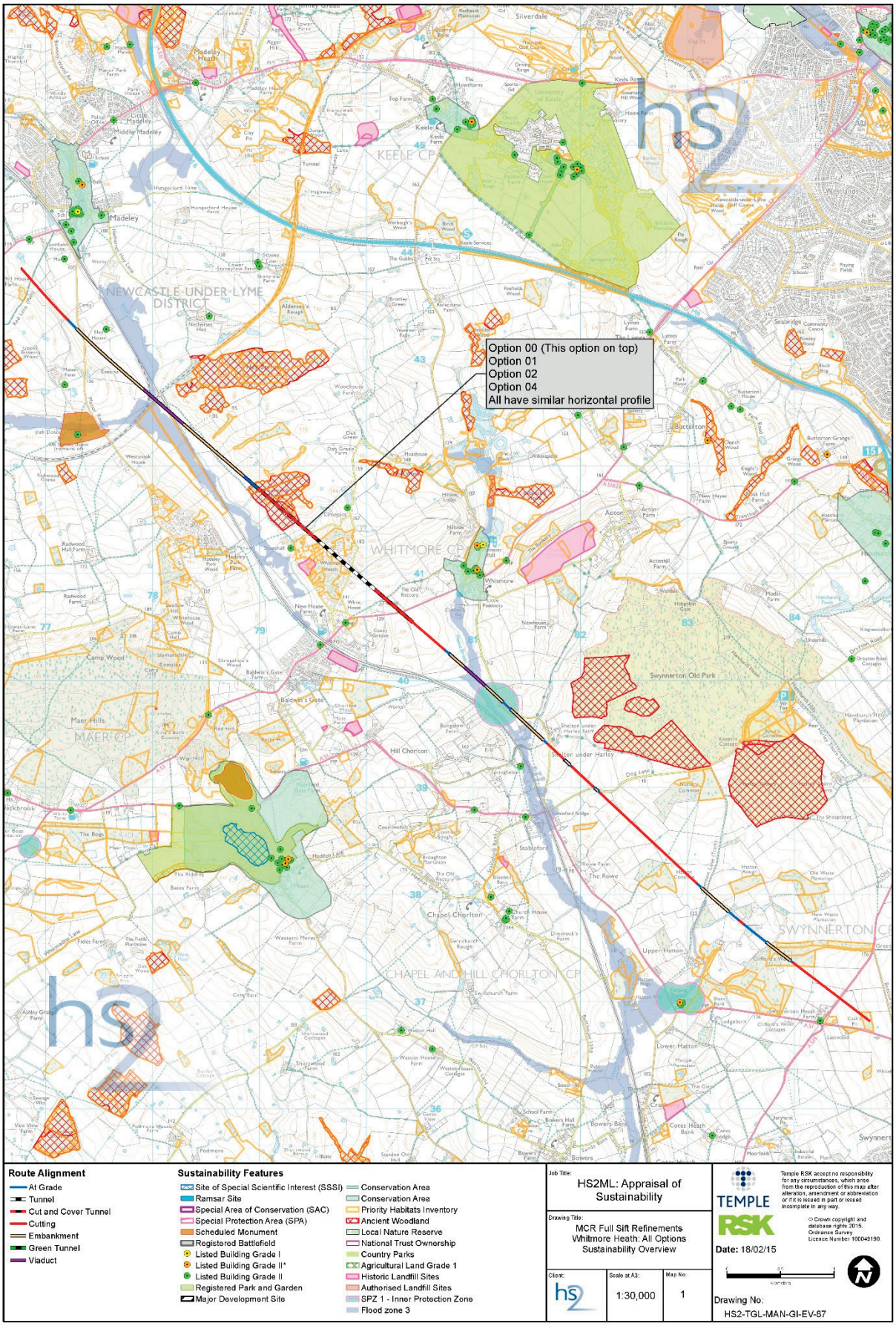
- Option 00 is the RRB. It runs north-west from Swynnerton via a series of cuttings and embankments, close to Whitmore abstraction borehole and under the A53 before entering into a twin bore tunnel under Whitmore Heath, exiting to north of the settlement in cutting through Whitmore Wood (ancient woodland).
- Option 01 (hybrid of previous options 00 and 04) has a reduced length of cut and cover tunnel (by approximately 150m) south of Whitmore Heath approaching the bored tunnel, as a result of a revisiting the associated costs of this infrastructure.

5.6.3 Option 01 (the hybrid of previous options 00 and 04) was taken forward as the preferred option. This was on the basis of the reduced environmental impact through Whitmore Wood (narrower footprint) and slightly reduced noise and visual impacts as a result of an additional section of cut and cover tunnel to the south of Whitmore Heath.

5.6.4 Key sustainability impacts associated with the Option 01, when compared with Option 00, include:

- similar landscape and visual intrusion to the south of the A53, with the alignment in open cut creating unrestricted view of high viaduct and embankments crossing the Meece Valley;
- reduced visual impact at Whitmore Heath, better opportunity for re-instatement of woodland habitats, and improved screening on the approach to the bored tunnel under Whitmore Heath due to the extended cut and cover tunnel;
- similar major impact at Whitmore Wood ancient woodland with habitat fragmentation, although with the area of land required reduced by 30% (15% of total woodland) though the partially retained cut on the northern side of the route; and
- similar landscape and visual impacts to the north of Whitmore Heath due to intrusive structures within rural landscape, with associated woodland loss.

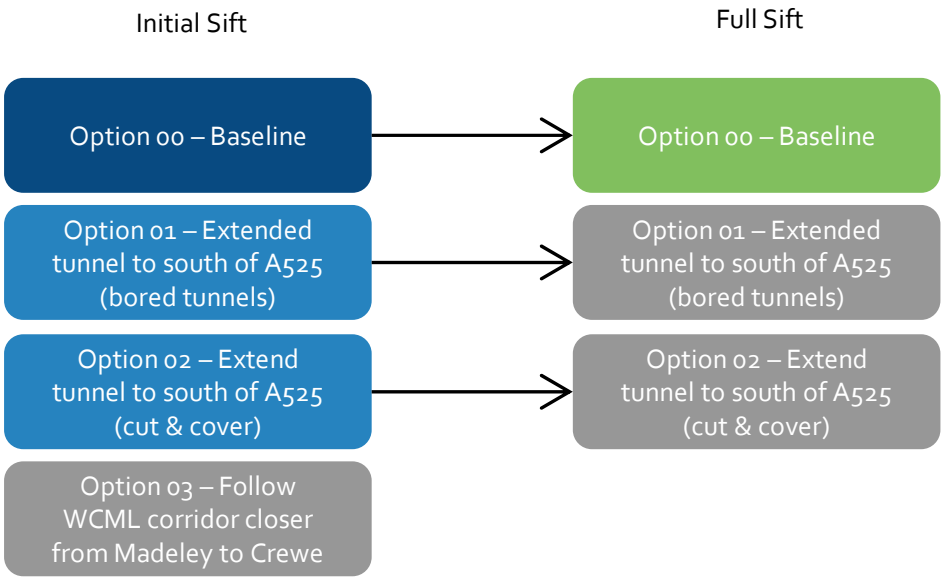
Figure 23: Alternatives considered for Whitmore Heath



## 5.7 Madeley tunnel

5.7.1 This refinement area covered approximately 18km of route from north of Swynnerton to south of Chorlton. The primary refinement considerations were to address concerns over the location of the southern tunnel portal and the proposed realignment of the A525 at Madeley, impacts on properties, Barhill Wood ancient woodland and highways at Bar Hill. A total of four options were considered, with one not progressed past an initial sift. The options are summarised in Figure 24. The locations of the options are shown in Figure 25.

Figure 24: Alternatives considered for Madeley tunnel




5.7.2 The following options were considered during the full sift:

- Option 00 is the RRB, which crossed the WCML and River Lea on a viaduct. The route continued north-west, passing on embankment within approximately 200m of the Grade II listed Hey House; it then descended into cutting under the A525 on the approach to Madeley tunnel.
- Option 01 followed a similar route as Option 00 but extended the tunnel at Madeley by approximately 400m to the south of the A525 through bored tunnel, avoiding Barhill Wood ancient woodland and Bar Hill Lane.
- Option 02 also followed a similar route to Option 00 but extended the tunnel at Madeley by approximately 400m to the south of the A525 using a combination of bored tunnel and cut and cover under the A525.

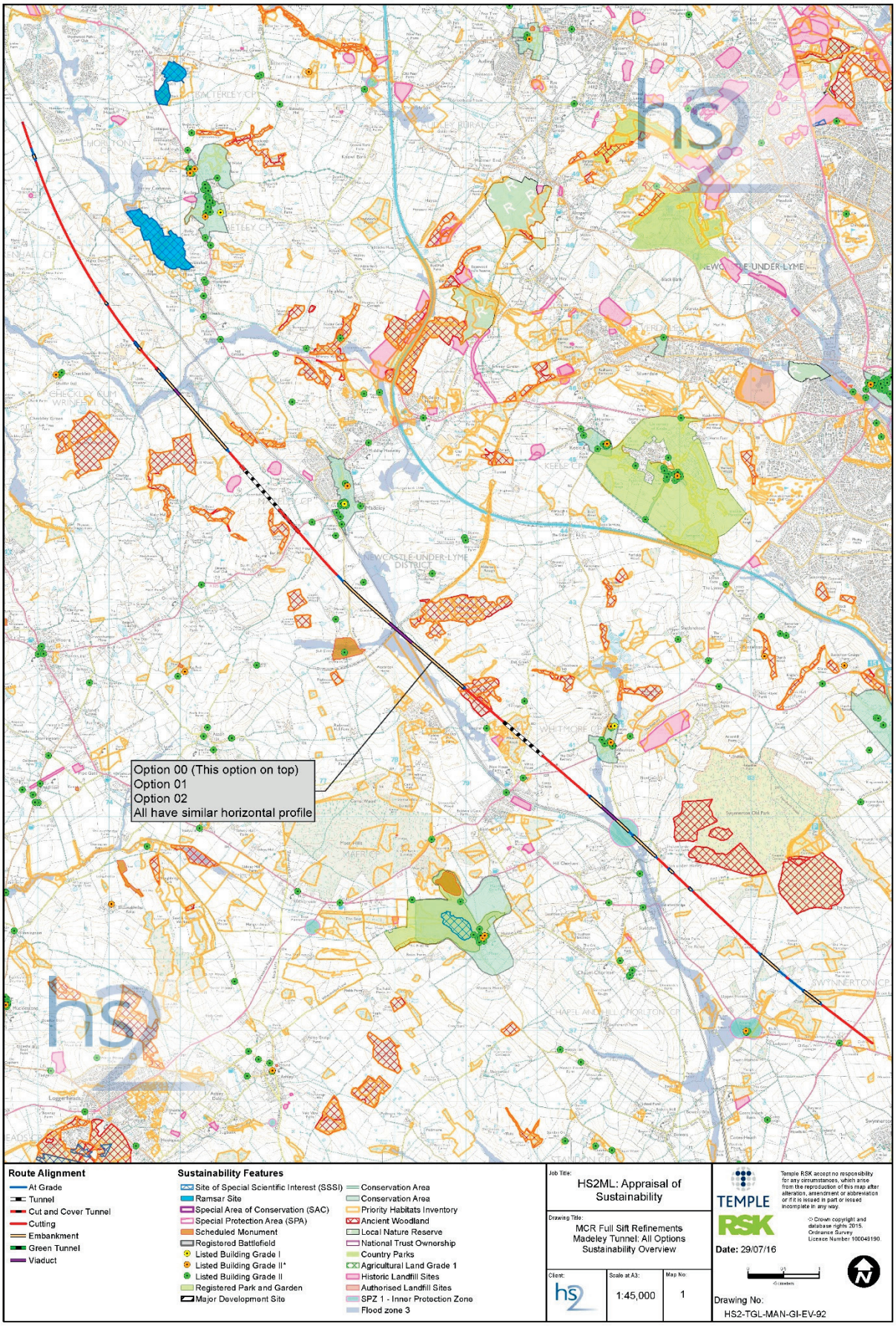
5.7.3 Option 00 was retained on the basis that the current footprint at Bar Hill is amended to avoid direct impact to the ancient woodland. Whilst Option 01 provided a marginal reduction in the sense of isolation at Wrinehill and would reduce residential demolitions by two, these did not justify the additional associated costs.

5.7.4 Key sustainability impacts associated with Option 00 include:

- impact on the setting of the Grade II listed Hey House, south of Madeley, and the associated Hey House Lodge is subject to demolition;

- landscape and visual impacts both south and north of Madeley, with the raised crossings of Meece Brook to the south and Checkley Brook to the north;
- three areas of isolation impacting one property at east Madeley, two properties at Wrinehill and one property at south Chorlton; and
- a total of three residential demolitions remain.

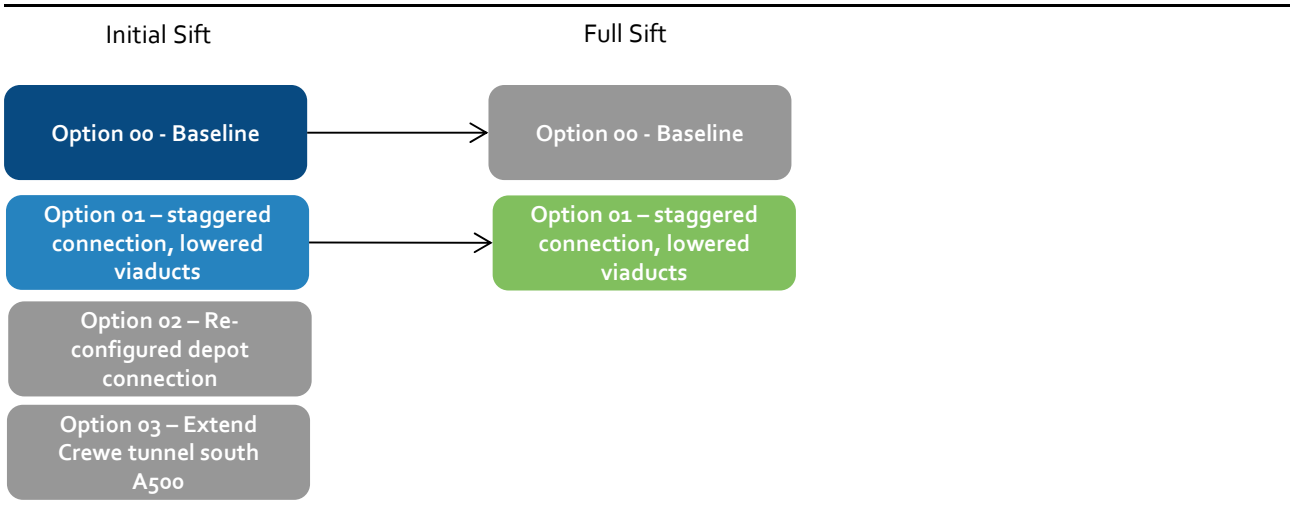
Figure 25: Alternatives considered for Madeley tunnel



## 5.8 Crewe junction

5.8.1 This refinement area covered approximately 6km of the route immediately south of Chorlton to just before the tunnel portal south of Crewe. The primary refinement considerations were to address concerns over the height of the viaducts at Chorlton and to determine the preferred layout of the junction to the south of Crewe and interaction with the proposed IMD. Four options were considered, with two not progressed past the initial sift. The options are summarised in Figure 26. The locations of the options are shown in Figure 27.

Figure 26: Alternatives considered for Crewe junction




5.8.2 The following options were considered during the full sift:

- Option 00 was the RRB, thereby conforming to clearance requirements over/under adjacent infrastructure. This increased the height and extent of embankment and viaducts immediately adjacent to Chorlton. This option followed the existing railway in a north-westerly direction to the west of Chorlton and over the A500 on embankment before continuing in cutting and then tunnel through Crewe.
- Option 01 follows a similar route to that of Option 00 but additionally re-addresses the connectivity with the WCML, staggering the connections and thereby reducing the maximum height of the railway.

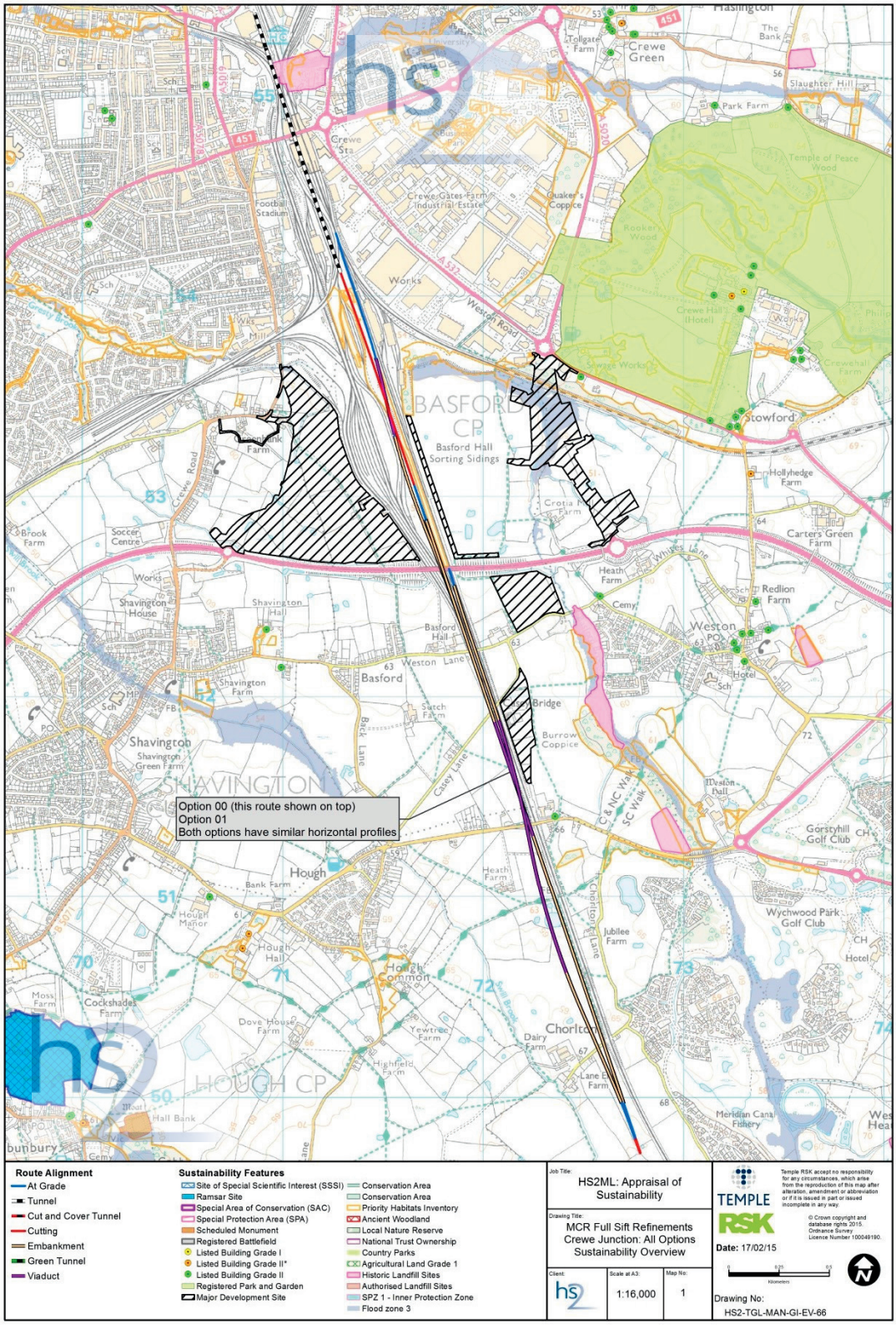
5.8.3 Option 01 was taken forward, subject to the outcome of other work on options at Crewe that could influence the decision. Although Option 01 extends the length of viaducts further to the south, the height of railway structures and associated highways structures means that there are slightly reduced landscape and visual impacts at Chorlton and other nearby rural settlements compared with the RRB.

5.8.4 Key sustainability impacts associated with Option 01, when compared with Option 00, include:

- reduced landscape impacts and visual intrusion at Chorlton;
- similar impact from the cutting through Gresty Brook, and its associated floodplain, with associated flood risk; and

- similar crossing of one historical landfill site (British Railway Tip) south of Crewe.

Figure 27: Alternatives considered for Crewe junction



# 6 Local alternatives considered since November 2015

## 6.1 Introduction

6.1.1 Having considered options before the route announcement in November 2015, the next stage of the process has been to refine and assess the design in further detail in preparation for deposit of the hybrid Bill. Further environmental information, local knowledge and ongoing engagement (e.g. from the AoS consultation) have been used to inform the analysis of options. The potential environmental impacts of each design option have been reviewed. The purpose of the reviews has been to ensure that the Proposed Scheme draws the appropriate balance between engineering requirements, cost and potential environmental impacts.

6.1.2 The following sections provide further detail on the local alternatives considered and include a comparison of the environmental effects associated with each option and the main reasons for selecting the option to be taken forward into the Proposed Scheme. In considering the environmental effects, all topics have been taken into account. However, only those topics where there is a potential for a moderate or major effect are reported below.

## 6.2 Community area 1 – Fradley to Colton

### Bourne Brook viaduct and River Trent viaduct

6.2.1 As part of the design development process, since the announcement of the route in November 2015, consideration has been given to the length of the Bourne Brook and River Trent viaducts. Viaducts are required along this section of the route to enable it to cross over the Bourne Brook and the River Trent and associated floodplain. The route would pass over these watercourses on viaducts which would be approximately 730m and 1.9km in length respectively.

6.2.2 At the time of the comparisons being undertaken, detailed flood modelling was not available. As part of the next phase of design development, hydraulic modelling of the Bourne Brook and the River Trent will be undertaken to better define the flood zone and the potential impacts.

6.2.3 The following options were identified, analysed and impacts assessed against the route announced in November 2015 (Option A1.0):

- Option A1.0 (the route announced in November 2015): two viaducts spanning across the Bourne Brook and the River Trent and associated flood plain. The Bourne Brook viaduct and the River Trent viaduct would be approximately 730m and 1.9km in length respectively;
- Option A1.1a: a single viaduct, approximately 2.8km in length, spanning across both the Bourne Brook and the River Trent. A 230kph crossover would be located on an extended section of embankment at the northern end of the viaduct;

- Option A1.1b: a single viaduct, approximately 3km in length, spanning across both the Bourne Brook and the River Trent. A 130kph crossover would be located on an extended section of embankment at the northern end of the viaduct; and
- Option A1.2: the length of the Bourne Brook viaduct would be reduced from 730m to 720m and the River Trent viaduct from 1.9km to 895m, with a consequential increase in embankment lengths on either side of the respective viaducts.

6.2.4 Option A1.0 would introduce infrastructure into the landscape that would be visible within the low-lying area of the Trent valley and affect the setting of the Kings Bromley Conservation Area. The embankment associated with the viaducts would result in loss of agricultural land and habitat fragmentation, would introduce a barrier to the movement of wildlife and would result in the loss of Tomlinson's Spinney Local Wildlife Site (LWS). There are likely to be noise impacts on the residents of Pipe Ridware. The A513 would be temporarily closed resulting in the need to divert traffic, which could result in congestion and/or delay.

6.2.5 Option A1.1a would remove the need for an embankment between the Bourne Brook and River Trent and as such would reduce the visual prominence of the viaduct and reduce impacts on the setting of Kings Bromley Conservation Area. Loss of agricultural land and habitat fragmentation would be reduced as would the loss of Tomlinson Spinney LWS. This option would also reduce the requirement to divert roads in the area. However, due to the extension of the embankment into the River Trent floodplain, this option would increase flood levels in this location and replacement floodplain storage area compensation would need to be provided.

6.2.6 Option A1.1b would increase the length of the viaduct when compared to Option A1.1a. The impacts would be similar to those reported for Options A1.1a. However, increasing the length of the viaduct would reduce the loss of floodplain.

6.2.7 Option A1.2 would have a greater potential visual impact, as it would comprise a series of embankments and bridges. This would cause fragmentation in the landscape character and affect the setting of Kings Bromley Conservation Area. This option would result in increased loss of agricultural land, fragmentation of habitat and severance of communities as there would be a need to lower the alignment of the existing A513. This option would increase flood levels in this location due to the extent of embankment located in the floodplain.

6.2.8 Option A1.0 has been taken forward into the Proposed Scheme. The preferred environmental option is Option A1.1b, as it would provide greater environmental benefits when compared with the other options. However, on balance it was determined that the environmental benefits of Option A1.1b were not considered sufficient to justify the disproportionately higher cost and the introduction of the environmental impacts of potentially increasing flood levels compared with Option A1.0.

6.2.9 At this time it is considered that retaining the embankment between the viaducts enables flexibility for adjusting viaduct lengths in the future and minimising the flood risk. Any changes in the design will be reported in the formal EIA Report.

## Maintenance loops at Pipe Ridware

6.2.10 As part of the design development process, since the announcement of the route in November 2015, consideration has been given to the route alignment at the location of the maintenance loops within the Proposed Scheme. The Proposed Scheme includes maintenance loops, approximately 1.25km in length located on an embankment adjacent to Pipe Ridware.

6.2.11 A study undertaken prior to the announcement of the scheme considered alternative locations for the maintenance loops at Great Haywood, Marston, Pirehill and Yarlet. The alternative locations were not taken forward into the Proposed Scheme as they were considered to be located too far north to allow for efficient maintenance operations, given the main maintenance facilities would be located at Basford, near Crewe.

6.2.12 The following options were identified, analysed and the impacts assessed:

- Option A2.0: (the route announced in November 2015) maintenance loops, approximately 1.15km in length, located on an embankment, up to 13m in height, adjacent to Pipe Lane;
- Option A2.1a: maintenance loops, approximately 1.35km in length, located on an embankment, up to 13m in height, adjacent to Pipe Lane;
- Option A2.1b: maintenance loops, approximately 1.25km in length, located on an embankment, up to 16m in height, adjacent to Pipe Lane; and
- Option A2.1c: maintenance loops, approximately 1.15km in length, located on an embankment, up to 12m in height, adjacent to Pipe Lane.

6.2.13 Option A2.0 would introduce visual and noise impacts on residents of Pipe Ridware, Rugeley School and isolated farmsteads and affect the overall amenity of the area. There would be an impact on the setting of Woodhouse Farmhouse and Bentley Hall Farmhouse, both of which are Grade II listed. There would be a requirement to realign a number of public rights of way (PRoW) and there would be loss of agricultural land and loss and fragmentation of habitats. A proposed mineral safeguarding area (MSA) for sand and gravel would be sterilised.

6.2.14 Option A2.1a and A2.1b would change the length of the embankment when compared to Option A2.0 and Option 2.1b would change the height. The impacts would be similar to those reported for Option A2.0.

6.2.15 Option A2.1c would reduce the height of the embankment, and therefore, its prominence in the landscape. The depth of the adjacent cutting would be increased which, combined with the lower embankment height, would reduce visual and noise impacts on residents of Pipe Ridware, Rugeley School and isolated farmsteads and the setting of Woodhouse Farmhouse and Bentley Hall Farmhouse. The lower alignment and deeper cutting would generate greater quantities of excavation waste.

6.2.16 Option A2.1b has been taken forward into the Proposed Scheme. The preferred environmental option is Option A2.1c, as it would provide greater environmental benefits when compared with the other options. However, a review of the route as

announced in November 2015 identified that a constant gradient would be required as the route transitions from the River Trent viaduct to the Pipe Ridware embankment.

6.2.17 An option to relocate the permanent maintenance facilities near to Stone, in the Stone and Swynnerton area (CA3), are being considered as part of the design development. Locating the permanent maintenance facilities near to Stone could also mean that the maintenance loops located at Pipe Ridware may not be required.

## Embankment at Stockwell Heath and Colton

6.2.18 Prior to the route announcement in November 2015, options were reviewed to reduce the impact of the route on the village of Stockwell Heath. Options considered the location and height of the route and the impact this would have on the village, including assessments of the required cutting depth to the north and south of Stockwell Heath, the presence of the maintenance loops at Pipe Ridware and a straighter route alignment.

6.2.19 As part of the design development process, since the announcement of the route in November 2015, consideration has been given to the form of structure which would carry the route between Stockwell Heath and Colton. The route would pass between Stockwell Heath and Colton on an embankment of approximately 900m length with a height of up to 11m and a number of culverts located within the embankment.

6.2.20 The sensitivity of the residential areas of Stockwell Heath and Colton, in terms of visual impacts, noise and community severance, has been instrumental in considering the form of structure.

6.2.21 The following options were identified, analysed and impacts assessed against the route announced in November 2015 (Option A3.0):

- Option A3.0 (the route announced in November 2015): embankment of approximately 900m in length and up to 10m in height;
- Option A3.1a: multi-span viaduct of approximately 540m in length and up to 11m in height;
- Option A3.1b: multi-span viaduct of approximately 540m in length and up to 13m in height; and
- Option A3.2: embankment of approximately 580m in length and up to 8m in height.

6.2.22 Option A3.0 would act as a physical and visual barrier between Colton and Stockwell Heath and would be likely to result in permanent isolation for residential properties. Access would be reduced to a single crossing under the route, with the diverted Moor Lane and Newlands Lane being permanently realigned and combined. Changes to the local road network would also potentially result in congestion and delays. This option would result in noise impacts on the residents of Stockwell Heath. This option would also sever the historic landscape and result in the loss of agricultural land and loss and fragmentation of habitats. The culverts required for this option would result in hydraulic and hydro-geomorphology impacts and there would be an impact on an upstream tributary of the Moreton Brook.

6.2.23 Option A3.1a and A3.1b would both reduce the severance between Colton and Stockwell Heath and avoid the need to divert Moor Lane and realign Newlands Lane. In Option A3.1a Moor Lane would, however, need to be lowered, which could result in severance during construction. The viaduct would reduce the loss of agricultural land and also reduce severance of the historic landscape. Option A3.1b would increase the height of the viaduct when compared to Option A3.1a. However, there would be no requirement to lower Moor Lane. Increasing the height of the viaduct would increase the height of the embankments on the approach to the viaduct, which would require more land and have a greater visual impact during construction.

6.2.24 Option A3.2 would reduce the length and height of the embankment when compared to Option A3.0. The impacts would be similar to those reported for Option A3.0. This option would reduce visual impacts; however, there would be a need for a higher noise barrier due to the reduction in embankment height (all other matters remaining equal, the taller an embankment (or viaduct), the smaller the noise barrier required on the shoulder of the embankment (or viaduct parapet) to provide the same noise reduction for a receptor at ground level).

6.2.25 Option A3.0 has been taken forward into the Proposed Scheme. The preferred environmental option is Option A3.1b, as it would provide greater environmental benefits, most notably in reducing severance, when compared with the other options. However, an earthwork embankment is more cost effective than a viaduct and the method of construction is easier. There is also less maintenance required. On balance, the potential environmental benefits of Option A3.1b were not considered sufficient to justify the additional complexity, length of construction and significant increase in cost.

## 6.3 Community area 2 – Colwich to Yarlet

### Route alignment at Moreton House

6.3.1 As part of the design development process since the announcement of the preferred route to Crewe in November 2015 consideration has been given to the proximity of the route to Moreton House, a Grade II listed building, which is used as a residential home for Rugeley School. Rugeley School is a specialist school for young people with autism and learning difficulties. As the Proposed Scheme passes Moreton House it is located in a cutting approximately 100m wide and up to approximately 20m in depth. The closest edge of the cutting is approximately 40m from Moreton House.

6.3.2 A preliminary options appraisal was undertaken and the following four options were not taken forward for further consideration:

- Options A4.1b and A4.2 were slight variations on the alignment of Option A4.1a (which was taken forward and described below), but required an increase in the height of an adjacent embankment, and therefore, were not taken forward for further consideration;
- Option 4.3a used a technique known as 'soil nailing' to steepen the slopes. There were concerns that this technique may not be effective for the whole lifetime of the project, which would lead to increased risk, so this option was not taken forward for further consideration; and

- Option A4.4 included a green tunnel approximately 35m in length to Moreton House. However, further analysis indicated that the area of land between the green bridge and Moreton House would be insufficient to integrate the green bridge into the surrounding landscape. It was, therefore, considered that it would be preferable to consider landscape mitigation associated with the other options, so this option was not taken forward for further consideration.

6.3.3 The following options were identified, analysed and the impacts assessed:

- Option A4.0: (the route announced in November 2015) a cutting approximately 115m in width and up to approximately 20m in depth, approximately 40m from Moreton House at the closest point. A re-aligned access road to Moreton House would cross the cutting on an overbridge and run parallel to the route resulting in the demolition of one building associated with Moreton House. An auto-transformer station would be located on the southern side of the route;

- Option A4.1a: a cutting approximately 115m in width and up to approximately 20m in depth, approximately 60m from Moreton House. A realigned access road to Moreton House would cross the cutting on an overbridge and run parallel to the route and adjacent to a building associated with Moreton House. An auto-transformer station would be located on the northern side of the route; and

- Option A4.3b: a cutting approximately 100m in width and up to approximately 20m in depth, approximately 40m from Moreton House at the closest point. A retaining wall would be provided on the northern side, approximately 200m in length and approximately 8m in height, to reduce the width of the cutting to the south-east of Moreton House. A realigned access road to Moreton House would cross the cutting on an overbridge and run parallel to the route and adjacent to the building associated with Moreton House. An auto-transformer station would be located on the northern side of the route.

6.3.4 Option A4.0 would result in noise, vibration and visual impacts on vulnerable residents of Moreton House and impacts to the setting of the listed building. There would be visual impacts on the residents of Moreton Grange due to the location of the auto-transformer station. It would also result in the demolition of a building associated with Moreton House.

6.3.5 Option A4.1a would result in noise, vibration and visual impacts and impacts to the setting of the listed building, but these would be reduced as the cutting is further away from Moreton House than in Option A4.0. This option would bring the route closer to Moreton Grange which would introduce visual and noise impacts on residents. Impacts would however be reduced by locating the auto-transformer station on the northern side of the route. This option would also avoid the demolition of a building associated with Moreton House.

6.3.6 Option A4.3b would also result in noise, vibration and visual impacts and impacts to the setting of the listed building, however, these are considered to be slightly reduced compared with Option A4.0 by moving the south-east section of the cutting away from Moreton House. The location of the auto-transformer station on the northern

side of the route would reduce visual impacts on residents of Moreton Grange. This option would also avoid the demolition of a building associated with Moreton House.

6.3.7 The option taken forward into the Proposed Scheme is Option 4.3b. This is also the preferred environmental option as it would provide greater environmental benefits when compared with the other options.

## Route alignment at Ingestre Park Golf Club

6.3.8 As part of the design development process since the announcement of the preferred route to Crewe in November 2015 consideration has been given to the route as it passes through Ingestre Park Golf Club. There is a deep cutting in this location, and opportunities to reduce the depth and width of the cutting were considered in order to reduce the impact on the golf club and the wider landscape. The Proposed Scheme passes through Ingestre Park Golf Club, approximately 500m to the south of Ingestre Hall, on an embankment, approximately 1.1km in length and up to 10m in height, before entering a cutting, approximately 1.4km in length, approximately 108m in width and up to approximately 14m in depth.

6.3.9 The following options were identified, analysed and impacts assessed:

- Option A5.0 (the route announced in November 2015): a cutting approximately 1.5km in length, approximately 110m in width and up to approximately 15m in depth;
- Option A5.1: a green tunnel approximately 1.5km in length, including portals, and up to approximately 21m in depth;
- Option A5.2: a cutting approximately 1.6km in length, approximately 85m in width and up to approximately 12m in depth; and
- Option A5.3: a cutting approximately 1.4km in length, approximately 108m in width and up to approximately 14m in depth.

6.3.10 Option A5.0 would result in the loss of agricultural land, woodland and severance of the golf course and historic landscape associated with Ingestre Hall. This option would require a section of an unnamed stream to be diverted into a drop inlet culvert or inverted siphon.

6.3.11 Option A5.1 would enable part of the golf course to be reinstated over the tunnel, albeit with some reconfiguration, or the land to be returned to another use. This has the potential for improvements to landscape, visual and cultural heritage effects and would remove community severance. Option A5.1 is the most complex of all options to construct, and would result in noise, health, community and traffic impacts over a longer construction period.

6.3.12 Option A5.2 would result in the loss of agricultural land, woodland and severance of the golf course and historic landscape, although this would be reduced due to the narrower width of the cutting. The impacts on hydro-morphology and groundwater in this area would be reduced compared to option A5.0, as an unnamed stream would not require a drop inlet culvert or inverted siphon with this option. It is likely that the

overhead line equipment would remain visible with this option, leading to visual impacts.

6.3.13 Option A5.3 would result in the loss of agricultural land, woodland and severance of the golf course and historic landscape. The impacts on hydro-morphology and groundwater in this area would be reduced compared to option A5.0 as an unnamed stream would not require a drop inlet culvert or inverted siphon.

6.3.14 Option A5.3 has been taken forward into the Proposed Scheme. Option A5.1 would provide greater environmental benefits during operation when compared with the other options. However on balance these potential environmental benefits were not considered sufficient to justify the additional complexity, the length of construction and the increased duration of environmental impacts and the significant additional cost, compared with Option A5.3. Whilst Option A5.1 would potentially enable the golf course to be reinstated the effects from construction would mean that the club would be unable to function in its current arrangement.

### Route alignment at Hopton

6.3.15 In this area the route of the Proposed Scheme would pass in a cutting, south-west of the majority of properties located in Hopton, then would continue onto an embankment, which would support landscape earthworks and a retaining wall forming a false cutting.

6.3.16 As part of the design development process since November 2015, consideration has been given to the impact of the Proposed Scheme on residents of Hopton and to ensure there is sufficient clearance over an unnamed watercourse.

6.3.17 Further consideration will be given to the construction and engineering options in this area. Further detailed engineering studies are ongoing and will be reported in the formal EIA Report.

### Route alignment between Staffordshire County Showground and Yarlet

6.3.18 During the design development process following the announcement of the preferred route to Crewe in November 2015, further consideration has been given to the route of the Proposed Scheme between Staffordshire County Showground and Yarlet. Options to realign the route as it passes through Hopton and close to the settlements of Marston and Yarlet have also been considered. The route of the Proposed Scheme would be located approximately 30m from the majority of properties located in Hopton, approximately 40m from Marston, approximately 30m from Yarlet and approximately 30m from the Staffordshire County Showground. This option covers a distance of approximately 11km.

6.3.19 A preliminary options appraisal was undertaken and two options were not taken forward for further consideration:

- Option B5-7.2b included a bored tunnel from Ingestre to Hopton, approximately 4.25km in length. The tunnel portal would be located in Ingestre Park Golf Club, which would result in the loss of the golf club and loss of historic landscape and would add significant additional cost to the Proposed Scheme, so this option was not taken forward for further consideration.
- Option B5-7.4a was very similar to Option B5-7.4b, but would be approximately 100m closer to Pasturefields SAC and SSSI. As there was no significant difference between the impacts of the two options, Option B5-7.4a was not taken forward for further consideration.

6.3.20 The following options were identified, analysed and impact assessed:

- Option B5-7.0: (the route announced in November 2015) the route of the Proposed Scheme would run through the settlement of Hopton, with the majority of properties located to the north-east, adjacent to the settlements of Marston and Yarlet and through an area of the Staffordshire County Showground;
- Option B5-7.1: the route would be located approximately 30m from the south-west edge of the majority of the properties in Hopton, approximately 40m from the north-eastern edge of Marston, approximately 30m from the north-eastern edge of Yarlet, and approximately 30m from the south-eastern boundary of Staffordshire County Showground. This option covers a distance of approximately 11km;
- Option B5-7.2a: the route would pass under Hopton and Staffordshire County Showground in a bored tunnel approximately 2km in length. The route would then be located directly adjacent to the settlements of Marston and Yarlet. This option covers a distance of approximately 11km;
- Option B5-7.3a: the route would be located away from Hopton, Marston and Yarlet, and would be located approximately 100m north of Little Ingestre. The route would then pass through Hopton Heath Registered Battlefield and would be located approximately 700m to the south-west of Salt. This option covers a distance of approximately 21km;
- Option B5-7.3b: the route would be located away from Hopton, Marston and Yarlet, and would be located approximately 100m north of Little Ingestre. The route would pass under Hopton Heath Registered Battlefield in a bored tunnel of approximately 2km in length and would be located approximately 700m to the south-west of Salt. This option covers a distance of approximately 21km; and
- Option B5-7.4b: the route would be located away from Hopton, Marston and Yarlet, and would be located approximately 50m north of Little Ingestre. It would then pass under the north-east corner of Hopton Heath Registered Battlefield in a bored tunnel of approximately 500m in length and would be

located approximately 50m to the south-west of Salt. This option covers a distance of approximately 21km.

6.3.21 Option B5-7.0 would result in the need to demolish a number of properties and would introduce visual, noise and community impacts, due to the proximity of the route to residential properties at Hopton, Yarlet and Marston. This option would also result in the loss of land from Ingestre Park Golf Club and two other businesses. The loss of part of the Staffordshire County Showground may affect the viability of some of the businesses located with the showground and events at this location.

6.3.22 Option B5-7.1 would result in the need to demolish a number of properties and would introduce visual, noise impacts and community impacts to residential properties at Hopton, Marston and Yarlet, but these would be reduced by moving the route up to 40m further away from these communities. The land required permanently within the Staffordshire County Showground would be reduced and the businesses located within it would be retained.

6.3.23 Option B5-7.2a would reduce the number of properties requiring demolition and reduce the amount of land permanently required from the Staffordshire County Showground, so the businesses located within it would be retained. This option would lead to increased impacts during the construction period, due to the formation of the tunnel and porous portals and associated infrastructure. The increase in excavated material associated with the tunnel would be likely to lead to increased waste generation. There would also be an increase in greenhouse gas emissions and energy use. However, once constructed this option would reduce impacts on the settlements of Hopton, Marston and Yarlet.

6.3.24 Option B5-7.3a would run to the north of Moreton House, Moreton Grange, removing visual and noise impacts at these properties and retaining the setting of these buildings and Shugborough Hall in their existing landscape. Impacts on the setting of Ingestre Conservation Area would also be removed. This option would move the route away from Hopton, Marston and Yarlet and as such would reduce noise, visual and community impacts and the number of properties requiring demolition. It would also avoid Ingestre Park Golf Club and reduce the amount of land required permanently within the Staffordshire County Showground, so the businesses located within it would be retained. However, this option would result in the partial loss of Hopton Heath Registered Battlefield, a nationally significant asset. The setting of the remainder of the battlefield would also be affected. This option would increase the loss of ecological habitats and as the route would be closer to Pasturefields SAC and SSSI and there is the potential for the existing surface and groundwater flow regime to alter the salinity of the springs that support Pasturefields SAC saltmarsh vegetation.

6.3.25 Option B5-7.3b would run to the north of Moreton House, Moreton Grange, removing visual and noise impacts at these properties and retaining the setting of these buildings and Shugborough Hall in their existing landscape. Impacts on the setting of Ingestre Conservation Area would also be removed. This option would move the route away from Hopton, Marston and Yarlet, and by doing so, would reduce noise and visual impacts during operation and the number of properties requiring demolition. The route would also avoid impacts to several local businesses, including Staffordshire

County Showground and Ingestre Park Golf Club. Transport impacts would be reduced, as there would be less severance of Hopton and fewer impacts on the A518 Weston Road and PRoW. The loss of agricultural land would be reduced. However, its location close to Little Ingestre and Salt would potentially result in visual and noise impacts on residential properties during construction. This option would lead to increased impacts during the construction period, due to the formation of the tunnel, porous portals and associated infrastructure, and in particular, would have an impact on Hopton Heath Registered Battlefield and the site of a medieval deer park in Ingestre Park. The construction of a tunnel would result in increased energy use, greenhouse gas emissions and generate more waste material. This option would increase the loss of ecological habitats, and as the route would be closer to Pasturefields SAC and SSSI, there would be potential for the surface and groundwater flow regime to alter the salinity of the springs that support Pasturefields SAC saltmarsh vegetation.

6.3.26 Option B5-7.4b would avoid the impact on the setting of Moreton House and Tixall Gatehouse, reduce the number of demolitions required and avoid impacts on Ingestre Park Golf Course. However, this option would increase the impacts on farm holdings. It is also close to Little Ingestre and Salt, which would potentially result in visual and noise impacts on residential properties. The construction of a longer viaduct and tunnel would result in increased energy use, greenhouse gas emissions and waste generation.

6.3.27 Option B5-7.1 has been taken forward into the Proposed Scheme. Option B5-7.2a would provide greater environmental benefits when compared with the other options, by reducing the number of demolitions required and the amount of land required at Staffordshire County Showground. However, the construction of Option B5-7.2a would be significantly more complex than Option B5-7.1 due to the introduction of a bored tunnel. This would lead to a significant increase in cost, would increase the risk of hazards during construction and would lengthen the construction programme. On balance, the environmental benefits were not considered sufficient to justify these disbenefits.

## 6.4 Community area 3 – Stone and Swynnerton

### Stone railhead and Stone railhead main compound

6.4.1 As part of the design development process, since the announcement of the scheme in November 2015, consideration has been given to the location of a temporary railhead and associated compound. The railhead, and associated compound, would be required to accommodate rail systems construction works, as well as allow receipt and stabling of full construction trains. The introduction of a railhead is required to facilitate efficient construction of the Proposed Scheme so as to maintain the proposed programme. The introduction of a railhead in this area would not require a change to the route in any of the options considered.

6.4.2 A preliminary options appraisal was undertaken and four options were not taken forward for further consideration. A railhead located near Madeley was discounted due to the engineering practicability of being located between the Madeley and Whitmore tunnels. Two different locations to the west of Stone and east of the route

of the Proposed Scheme, which would connect into the Norton Bridge and Stone railway, were discounted for their proximity to the community of Stone and the impact on the local road network. A railhead location that would connect into the route of the Proposed Scheme, crossing the M6 and connecting into the Norton Bridge to Stone Railway, was discounted due to the proximity to the community of Yarnfield and the requirement to take a large area of agricultural land.

6.4.3 The following options were identified, analysed and the impacts assessed:

- Option 2 Stone North-West: a railhead, and associated compound, located to the west of Stone, on severed land between the M6 and the route of the Proposed Scheme. This option would enable a southbound connection into the route of the Proposed Scheme, as well as a connection into both directions of the Norton Bridge to Stone Railway, on the northern side, via an approximately 700m long railway siding in the direction of Stone. The land required for the railhead and associated compound extends approximately 1.6km north of the Norton Bridge to Stone Railway, with a width of approximately 300m;
- Option 3 Stone South-West: a railhead, and associated compound, located to the south-west of Stone, on severed land between the M6 and the route of the Proposed Scheme, connecting into both directions of the Norton Bridge to Stone Railway, on the northern side, via an approximately 700m long railway siding in the direction of Stone. This option enables a connection into the route of the Proposed Scheme in both directions. The land required for the railhead, and associated compound would extend in a south-easterly direction from the Norton Bridge to Stone Railway for approximately 2.5km;
- Option 5 Basford Hall, Crewe: a railhead, and associated compound, located in the proposed area of the HS2 Crewe IMD in the South Cheshire area (CA5). This option provides a southbound connection into the route of the Proposed Scheme and a connection into the WCML in both directions via approximately 2.2km railway sidings. The land required for the railhead and associated compound has an approximate length of 1.3km and a width of approximately 300m at its widest extent; and
- Option 8 Stone Hybrid: a railhead, and associated compound, between the M6 and the route of the Proposed Scheme, utilising land both north and south of the Norton Bridge to Stone Railway. The railhead would connect into both directions of the Norton Bridge to Stone Railway, on the southern side, via an approximately 700m long railway siding in the direction of Stone. This option enables a connection into the route of the Proposed Scheme in both directions. The land required for the railhead and associated compound utilises severed land between the M6 and the Proposed Scheme.

6.4.4 Option 2 would require the temporary closure of Yarnfield Lane with traffic being diverted onto Eccleshall Road, which has the potential to result in congestion and delays. There are historic landfills and former quarries within the land required and there would be loss of agricultural land, impact on land holdings and a degrading of the open rural landscape character in the area. The railhead and associated compound

would be visible from Stone. Filly Brook and its associated floodplain would be directly impacted and there would be a loss of ecological priority habitats and biodiversity.

6.4.5 Option 3 would result in considerable waste impacts due to the earthwork excavation quantities required to construct the railhead and associated compound at this location. There would be a loss of agricultural land and commercial agricultural holdings would be severely impacted. The railhead and associated compound would be visible from Stone and there would be a degrading of the open rural landscape character. A tributary of the Filly Brook and its associated flood plain would be directly impacted.

6.4.6 Option 5 would impact on an approved planning application for general industry, storage and distribution and a separate application for residential development, offices and local amenity facilities. This option would result in an impact on the community due to the location within an urban and residential context. This option is less environmentally sensitive in comparison with alternative locations with regard to water and flood risk, as well as overall landscape impacts, due to its location within a more urban context and the landscape character of the surrounding area.

6.4.7 Option 8 would result in the likely sterilisation of a MSA for sand and gravels. There would also be a loss of ecological priority habitats and biodiversity and an area of floodplain associated with the Filly Brook. This option may require the temporary closure of Yarnfield Lane with traffic being diverted onto the B5026 Eccleshall Road, which has the potential to result in congestion and delays. Agricultural land would be impacted due to the large amounts of land required in a largely rural landscape; increasing the visual disturbance in the area.

6.4.8 Option 8 has been taken forward into the Proposed Scheme. The location of the railhead in Option 8 would enable access to the route of the Proposed Scheme in both directions, considerably reducing the programme and constructability risk through the ability to serve the construction of the Proposed Scheme in two directions. This option is also strategically positioned in the middle section of the route of the Proposed Scheme and would require considerably less excavation, transportation and storage of material than Option 3. The preferred environmental option is Option 5, as it would have less environmental impacts when compared with the other options. However, Option 8 incurs only a minor worsening for environmental issues when compared to Option 5.

6.4.9 As part of the next phase of design development, further consideration will be given to the location of permanent maintenance facilities in the Phase 2a area, including locations at Crewe (the HS2 Crewe IMD) and the Stone railhead. These facilities would be a permanent feature of the Proposed Scheme, operating 24 hours a day, seven days a week, and are likely to include the following facilities:

- a two-track siding for plant train stabling, approximately 140m in length;
- a two-track siding for ballast train stabling, approximately 250m in length;
- a siding for refuelling and water provision;
- workshop area with associated siding;

- secure compound and covered and open store areas for rail systems parts;
- laydown area for track and overhead line equipment;
- ballast storage area;
- lighting;
- administration building and staff welfare facilities; and
- car parking.

6.4.10 The footprint of permanent maintenance facilities at Stone would be unlikely to require an increase in land from that which has been identified for the railhead and associated compound.

6.4.11 The proposed location and design of the permanent maintenance facilities will be reported in the formal EIA Report.

## Bent Lane (North) diversion

6.4.12 As part of the design development process, since the announcement of the scheme in November 2015, consideration has been given to the diversion of Bent Lane, south-west of Swynnerton Old Park. The Proposed Scheme would result in the creation of Bent Lane (North) passing south of Shelton under Harley, maintaining access to Whitmore, which would otherwise be severed by the route of the Proposed Scheme.

6.4.13 The following options for Bent Lane (North) were identified, analysed and impact assessed:

- Option 1: (Route announced in November 2015) Bent Lane (North) diversion would continue from Dog Lane on the northern side of the route of the Proposed Scheme in a westerly direction for approximately 400m before passing approximately 150m north of Shelton under Harley. The diversion would then continue in a south-westerly direction into the Whitmore Heath to Madeley area (CA4) for approximately 450m before reconnecting into the existing Bent Lane; and
- Option 2: Bent Lane (North) diversion would continue from Dog Lane on the northern side of the route of the Proposed Scheme in a westerly direction for approximately 500m before passing adjacent and to the south of Shelton under Harley. This option would then continue on the existing Bent Lane alignment for approximately 250m into the Whitmore Heath to Madeley area (CA4), remaining north of the Proposed Scheme.

6.4.14 Option 1 would sever the Shelton under Harley farm buildings from their wider land use through both the construction and operation phases. With this option the open rural landscape character would be impacted, including the historic context of Swynnerton Old Park, and would be visible from both Shelton under Harley and the park.

6.4.15 Option 2 would directly affect surface water flow paths and is likely to impact on groundwater quality during construction due to the proximity of the Severn Trent

Water boreholes and a SPZ1. This option negates the severance of Shelton under Harley Farm, limiting agricultural land and connectivity loss, whilst also reducing the amount of land required as a result of the Proposed Scheme. Option 2 would require less land; construction activities would be located further away from Swynnerton Old Park, and it would reduce the potential to impact on ecological priority habitats and biodiversity within the park. Severance of Shelton under Harley Farm would be avoided and the loss of agricultural land would be reduced.

6.4.16 Option 2 has been taken forward into the Proposed Scheme. Option 2 is also the preferred environmental option, as it would provide greater environmental benefits than Option 1. Mitigation against the outstanding environmental issues of this option will be addressed, where practicable, within the topic chapters.

## 6.5 Community area 4 – Whitmore Heath to Madeley

6.5.1 In this area, the route of the Proposed Scheme would be in tunnel in two locations, one passing to the west of Whitmore and one passing to the south-west of Madeley.

6.5.2 As part of the design development process since November 2015, consideration has been given to the impact of the Proposed Scheme on residents of Whitmore Heath to Madeley, environmental receptors including Whitmore Wood and Barhill ancient woodlands and the impact on roads, including the A53 Newcastle Road.

6.5.3 Further consideration will be given to the construction and engineering options in this area, including the length of tunnels, design and construction methods, and alternative engineering options. Further detailed engineering studies are ongoing and will be reported in the formal EIA Report.

## 6.6 Community area 5 – South Cheshire

### HS2 spurs crossing of and connection to the WCML

6.6.1 As part of the design development process since November 2015, further consideration has been given to where the HS2 spurs would need to cross the WCML and connect into the existing WCML infrastructure. This has included consideration of positioning the HS2 spurs in the optimum location and options relating to the best layout to connect into the WCML. This process has taken into consideration engineering requirements and impacts on the existing railway infrastructure and the surrounding road network, watercourses and drainage, and local communities.

6.6.2 The route announced in November 2015, consisted of a retained cut (which would connect into a tunnel portal and a tunnel (part of the proposed HS2 Phase 2b)), up to approximately 20m in depth and approximately 750m south of where Nantwich Road crosses the WCML. It would be located within a complex arrangement of rail sidings between Crewe South Junction and Basford Hall Junction. The HS2 main line is positioned to the west of the existing WCML. An HS2 spur would therefore need to cross from west to east over the HS2 main line to connect in to WCML. The connection into the WCML would be north of where the A500 Shavington Bypass/Newcastle Road crosses the WCML. As the HS2 southbound spur would also need to connect into the easternmost WCML tracks a grade separated crossing over the WCML would be required, which would be located adjacent to Chorlton. The HS2

main line would approach the retained cut on viaduct, approximately 1.3km in length and up to 12m in height, crossing over the Basford Hall sidings and Basford Hall Junction tracks. The bridge carrying the A500 Shavington Bypass/Newcastle Road would be re-constructed over the proposed viaduct carrying the HS2 main line at a high level. The bridge carrying Weston Lane over the HS2 main line would similarly be required to be re-built at a higher level.

6.6.3 In reviewing this part of the design in further detail it was considered that there were complex engineering and interfacing operational issues associated with the route announced in November 2015 which required additional assessment. The proposed location of the crossing and connection into the WCML would result in an impact, during construction of the Proposed Scheme, on the operation of the WCML and Network Rail's regionally important freight and maintenance operations at Basford Hall and would result in the permanent loss of land and loss of rail access to some sidings. These sidings and associated rail connections into WCML are one of Network Rail's primary maintenance hubs for the entire WCML and are of great importance for regional freight operations. The proposed location would additionally require major changes to the surrounding road network.

6.6.4 The importance of the interface with existing railway infrastructure, including Network Rail's freight operations at Basford Hall, and the need to reduce disruption, during construction and operation on the WCML, has been instrumental in considering the design in this area. Disruption to the surrounding road network and the proximity of the Proposed Scheme to Chorlton has also been an important consideration.

6.6.5 As part of the development of the design an alternative option has been developed which seeks to limit the disruption to the existing rail infrastructure as well as minimising the land required for construction and operation by keeping the HS2 main line as close to the WCML as possible.

6.6.6 The retained cut would be relocated approximately 650m south of the A500 Newcastle Road/Shavington Bypass, which is approximately 2.1km further south than the route announced in November 2015. This would mean that the existing Basford Hall sidings would be largely unaffected by construction of the Proposed Scheme. The western track of the WCML would be diverted to the west of the existing WCML and two additional lines would run closely parallel to it, which would primarily carry freight traffic separating this from HS2 services coming from the HS2 spurs, where the spurs connect to the WCML. This diversion of the WCML western track and the additional two freight tracks would run parallel to and between the HS2 main line and the WCML. The three tracks would connect back to the WCML, at the south end, 900m south of Den Lane Bridge over the WCML. The three tracks connect back to the WCML and Basford Hall Junction and sidings close to the A500 Newcastle Road/Shavington Bypass, at the north end of the diversion. The diverted WCML track and the two additional tracks enables the HS2 spurs to cross from west to east over the WCML track on a lower alignment and significantly further away from Chorlton. As the new section of the WCML would be built offline (for the majority of the diversion length) the effects of construction on the WCML and disruption to WCML passenger and freight is reduced. As such safety during construction is significantly improved.

6.6.7 The HS2 spurs would divert from the HS2 main line near Checkley Lane, which is approximately 2km south of the location in the route announced in November 2015. This would enable the required grade separated crossing of the HS2 main line by the HS2 northbound spur to be on a lower alignment and further away from Chorlton. This would also allow sufficient space for a neutral track section which would allow for trains to switch between HS2 and WCML operating systems.

6.6.8 The Newcastle Road/Shavington Bypass Bridge and Weston Lane Bridge would still need to be reconstructed but the height of the road crossings would be significantly reduced compared to the November 2015 route.

6.6.9 The location and reduction in height of viaducts and crossing structures would reduce visual impacts and noise for residential properties located within Chorlton. Construction activities would be predominantly limited to the west side of the WCML which would also reduce visual and noise impacts on residential properties. The layout of this option accommodates safe electrical separation between the traction systems of the HS2 main line and the WCML and improves access to Basford Hall junction for freight operations when compared to the existing layout.

6.6.10 The connection of the HS2 spurs into the WCML is the subject of ongoing detailed engineering and operational studies as part of the development of the design. These studies will consider engineering, environmental and operational impacts, and will be informed through continued engagement with Network Rail and other stakeholders. The outcome of these studies and any change to the design will be reported in the formal EIA Report.

### HS2 Crewe IMD

6.6.11 As part of the design development process since November 2015, consideration has been given to the location of permanent maintenance facilities within the Phase 2a area in conjunction with the overall HS2 maintenance strategy.

6.6.12 The Proposed Scheme would include an IMD at the northern end of the South Cheshire area, which would operate as a base for maintenance activities to support the railway infrastructure.

6.6.13 As part of the development of the design, further work is being undertaken to consider the location and operating requirements of the permanent maintenance facilities so as to optimise the maintenance of the Proposed Scheme. A potential alternative location near Stone, at the site of the proposed temporary railhead in the Stone and Swynnerton area (CA3), has been identified but not assessed as yet. This is at the current location of the proposed, temporary Stone railhead. The re-use of the railhead site would remove the cost of restoring the Stone railhead to its previous state and provide further economies through on-going use of the facilities during the post-construction phases. Permanent maintenance facilities near Stone could also mean that the maintenance loops located at Pipe Ridware, in the Fradley to Colton area (CA1) may not be required.

6.6.14 Further studies will be carried out to consider the location and the facilities to be included in the Proposed Scheme and the outcome of these studies will be reported in the formal EIA Report.

# 7 References

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

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

Aviation Policy Framework, DfT March 2013

Delivering a Sustainable Transport System: Main Report, DfT, November 2008 p.4

Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment

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

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

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

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

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

High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond. Sustainability Statement. Volume 1: main report of the Appraisal of Sustainability. Temple-ERM, 2013.

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

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

High Speed Rail: Investing in Britain's Future – Consultation, DfT, February 2011

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

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

HS2 Ltd (2014), HS2 Plus – A report by David Higgins

HS2 Phase Two Initial Preferred Scheme Sustainability Summary, Temple-ERM, 2013.

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

High Speed 2 Strategic Alternatives – Final Report, Atkins, October 2013.

High Speed Rail: Preferred Route to Crewe Sustainability Report – Phase Two Post-Consultation Update: West Midlands to Crewe. A report by Temple-RSK for HS2 Ltd, November 2015.

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

HS2 Strategic Alternatives Study Rail Interventions Report, Atkins, March 2010

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

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

High Speed Two: East and West – The next steps to Crewe and beyond, Cm 9157, November 2015, DfT

Investing in Britain's Future, HM Treasury, June 2010 (Cm.8669)

London-West Midlands Environmental Statement, Volume 5 Technical Appendices, Alternatives Report (CT-002-000), November 2013, Department for Transport and HS2 Ltd

Long-term profile of Gross Domestic Product (GDP) in the UK, Office for National Statistics, 2013

National Infrastructure Plan 2011, DfT, November 2011

National Travel Survey Table NTS0317, Long distance trips within Great Britain by main mode and length: Great Britain, 2008/12, DfT

Office of Rail and Road statistics.

Options for Phase Two of the high speed rail network. A report to Government by HS2 Ltd, 2012

Options for Phase 2 of the high speed network – Appraisal of Sustainability, HS2 Ltd, March 2012.

Rail Alternatives to HS2 Phase 2a. Atkins, November 2015. A report for the Department for Transport.

Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/481570/Response_to_HS2_Phase_Two_consultation_-_Appraisal_of_Sustainability.pdf....pdf

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

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

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

The Strategic Case for HS2, DfT, October 2013

Supplement to the October 2013 Strategic Case for HS2, DfT, November 2015

Sustainability Report Phase Two Post-Consultation Update: West Midlands to Crewe. A report produced by Temple-RSK for HS2 Ltd, Temple-RSK, 2015.

Transport Statistics Great Britain, DfT

UK Aviation Forecasts DfT, January 2013

Venables, Anthony J; Laird, James; and Overman, Henry 2014, Transport Investment and Economic Performance, Paper commissioned by UK Department for Transport.

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