Appraisal of Sustainability:

A Report for HS2

Non Technical Summary

December 2009

Contents

1. Purpose of the Appraisal of Sustainability report

The appraisal of sustainability (AoS) report describes the extent to which the proposed new high speed railway between London and the West Midlands either supports or detracts from the objectives for sustainable development. The report focuses on a scheme that has been identified by HS2 Ltd as being preferred in overall terms, taking account of different factors including strategic fit, build cost, engineering and economic benefits, as well as sustainability. The AoS also addresses a number of alternatives that were considered in determining the HS2 preferred scheme.

The focus on a route between London and the West Midlands recognises that any new high speed rail line or network in the UK would need to be developed in stages. Consideration of an extension to the scheme from the West Midlands through key cities in northern England and on to Edinburgh and Glasgow has also been included by the AoS, although at a lower level of detail.

2. Objectives of HS2

The objectives for HS2 are to:

- enhance passenger capacity;
- create faster journeys;
- encourage modal shift;
- improve connectivity; and
- support regeneration and growth.

3. Description of the HS2 preferred scheme

Travelling from London to the West Midlands, the HS2 preferred scheme would run from a new and expanded London Euston station to a connection with the West Coast Main Line, allowing high speed trains to join the existing network near Lichfield. Central Birmingham would be accessed via a spur into a new terminus station.

There would also be new stations at Old Oak Common in west London and on the eastern outskirts of Birmingham. The station at Old Oak Common would provide an interchange with services to Heathrow via Crossrail and with other services to South Wales and the west of England via the Great Western Main Line.

The interchange station on the outskirts of Birmingham between Marston Green and Coleshill would provide a connection to the National Exhibition Centre and to Birmingham International Airport.

Between Euston and Old Oak Common the scheme would be in tunnel. The line through Old Oak Common station would be in an open box structure and would then enter a short tunnel to join the Chiltern Line corridor where the route would be on the surface alongside the existing lines. The route would follow the Chiltern Line as far as West Ruislip at which point it would diverge north-westwards across the Colne valley towards the Chilterns.

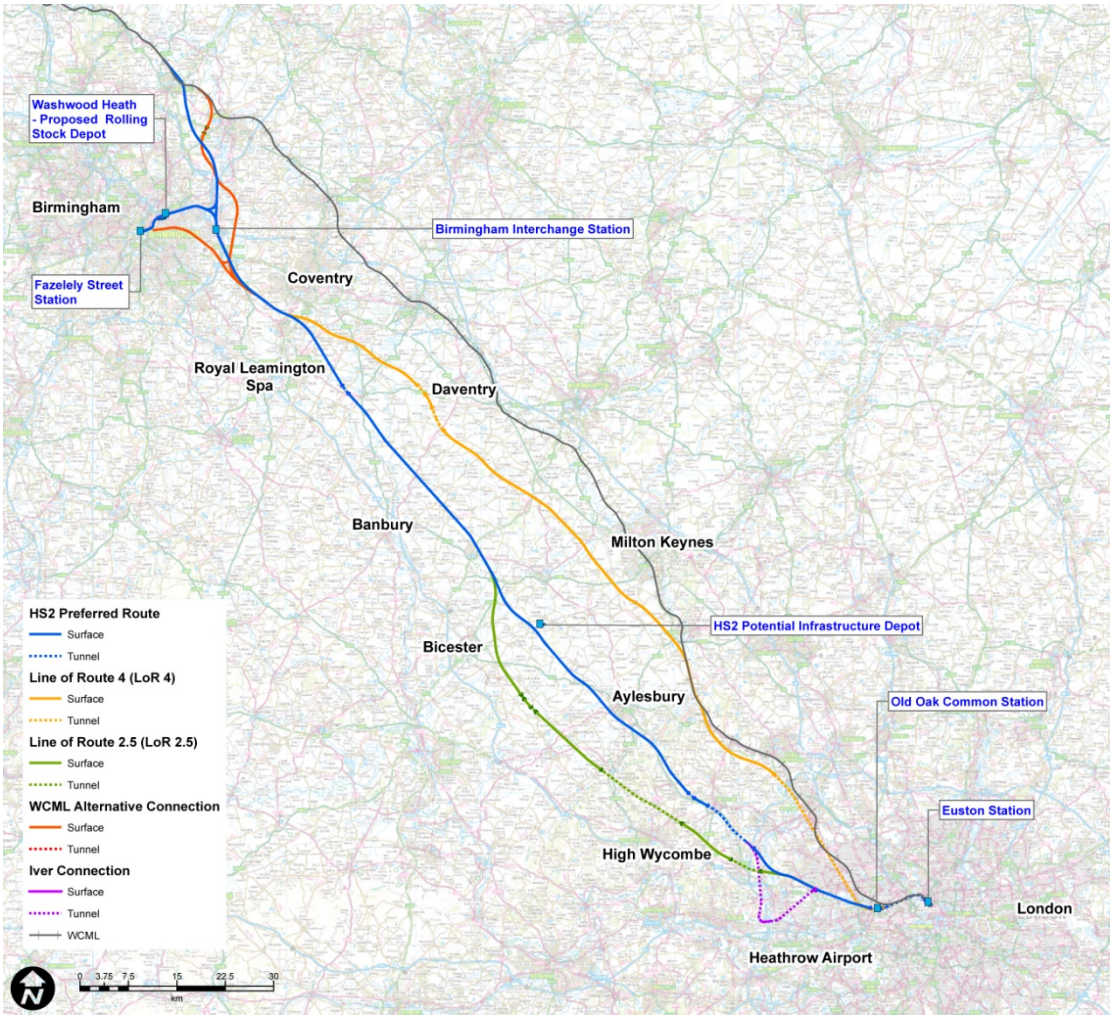
The scheme would be in tunnels under the south-eastern part of the Chilterns, emerging to the west of Amersham. It would follow the A413 corridor mostly in

cutting before passing to the south-west of Wendover and Aylesbury. The surface route would continue across Buckinghamshire and the north-east corner of Oxfordshire into Northamptonshire and would pass to the east of Brackley.

The scheme would pass to the east of Banbury and to the south-west of Southam and between Coventry and Kenilworth before passing to the north-east of Balsall Common to join the M42 corridor near junction 6 (A45).

At Water Orton (north of Coleshill), a junction would provide the spur into central Birmingham. The spur line would follow the existing rail corridor into central Birmingham where a new terminus station would be provided at Fazeley Street. It would also provide access to a train maintenance depot in the Washwood Heath area.

The HS2 mainline would continue north from Water Orton to link into the West Coast Main Line north of Lichfield.



4. The Main Alternatives

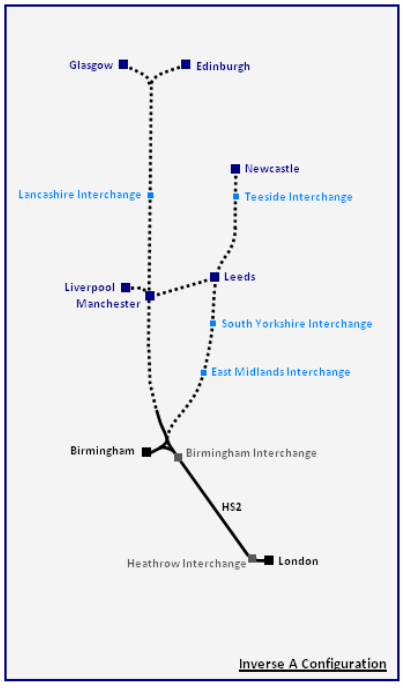
A number of alternatives to this HS2 preferred scheme are presented in the HS2 Report including:

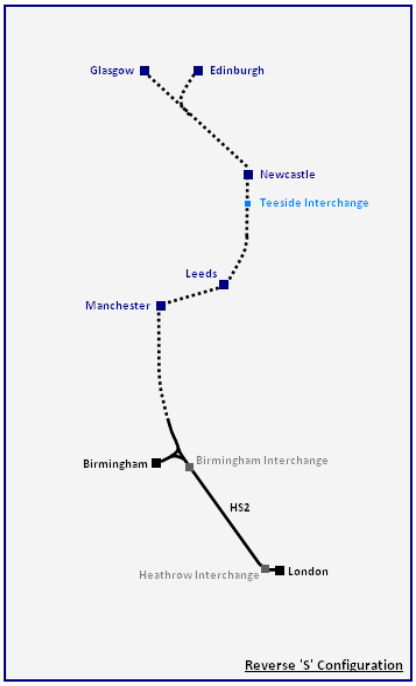
- one further London terminus, namely a differently configured Euston terminus, together with a further possible terminus at King's Cross Lands (though there are drawbacks with both);
- a direct Heathrow connection instead of or in addition to creating a Crossrail interchange at Old Oak Common;
- two other possible route alignments between Old Oak Common and the West Midlands;
- an alternative approach into Birmingham along the West Coast Main Line; and
- an alternative Birmingham terminus at Warwick Wharf.

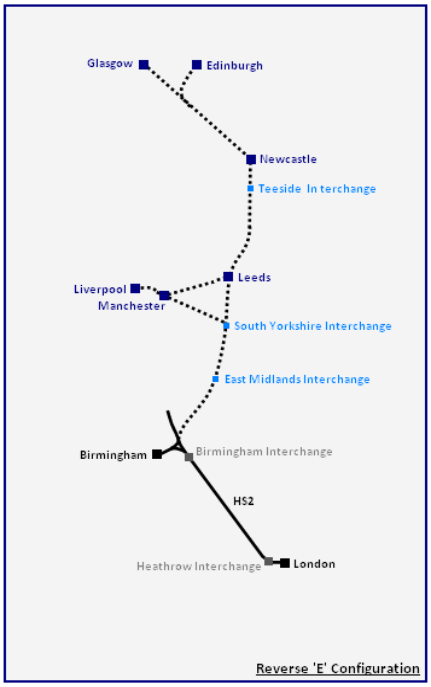
An alternative approach to meeting HS2 objectives has also been explored in the form of a new conventional railway (new classic line), following the same general alignment as the HS2 preferred scheme.

5. Longer Term Strategy

The London to West Midlands section of HS2 could be the initial part of a longer term strategy to extend the high speed network to other major cities in the north of England and Scotland. The focus of the AoS has been on the London to West Midlands section and no mapped routes have yet been prepared for any extensions to this. However, a number of route concepts have been explored. These vary in terms of the cities included along the high speed network and the way these are connected. The three concepts that have been developed are illustrated below.







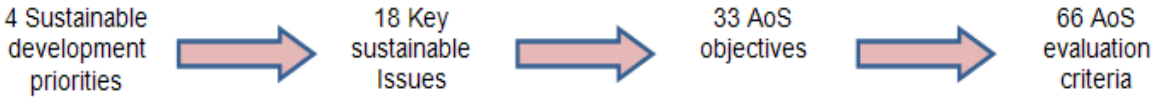
6. The Appraisal of Sustainability process

Defining sustainability

To appraise the extent to which HS2 preferred scheme (and its alternatives) may be considered a sustainable development it has been necessary first to understand the meaning of 'sustainability' as it is relevant to high speed rail. The AoS has used the UK Government's four sustainable development priorities (set out in the UK Sustainable Development Strategy: Securing the Future) as the basis for this. The AoS has been undertaken to establish if and the extent to which HS2 would:

1. reduce greenhouse gas emissions and combat climate change;
2. protect natural and cultural resources and enhance the environment;
3. create sustainable communities; and
4. achieve sustainable consumption and production.

The AoS used a series of increasingly more detailed issues, objectives and criteria around these four priorities that further defined the concept of sustainability and helped to appraise the impacts and benefits of different options.



These were consolidated within an appraisal framework, a part of which is shown below for illustrative purposes, and set out in Volume 2 of the AoS Report. The AoS objectives provide the sustainability aspirations for the HS2 scheme; the AoS criteria are the measures used to determine the extent to which these aspirations would be achieved.

Sustainability issue	AoS objective	AoS criteria
Reducing greenhouse gas emissions and combating climate change and its effects		
1. Climatic factors & adaptability	1a. Improve resilience of rail network against extreme weather events	Length of (cutting and retained cut) line in cutting through geology vulnerable to landslip
		Length of line at risk of flooding in Flood Zone 3.
2. Greenhouse gases	2a. Contribute to the reduction of greenhouse gas emissions by facilitating modal shift from road and air to rail	Change in CO2 equivalent (CO2e) emissions released as a result of modal shift achieved from conventional rail/road and flights to high speed rail.
	2b. Reduce relative contribution made by rail to greenhouse gas emissions by applying energy efficient technologies	Relative efficiency in operations between high speed trains and rolling stock & classic trains
Natural and cultural and resource protection and environmental enhancement		
3. Landscape and townscape	3a. Maintain and enhance existing landscape character	Impacts on the coherence and distinctiveness of landscape resources of national importance crossed by surface or cut and cover sections,
		Impacts on the coherence and distinctiveness of landscape resources of regional importance crossed by surface or cut and cover sections,
	3b. Maintain and enhance existing townscape character	Impacts on the coherence and distinctiveness of townscape resources crossed by surface or cut and cover sections
		Strategically important views and/or key vistas directly affected
4. Cultural heritage	4a. Preserve and protect archaeological assets	Impacts on World Heritage Sites and other assets of acknowledged international importance

The need for Appraisal of Sustainability

There are a variety of tools that are designed to help decision makers understand the implications for sustainability of different plans and projects. The requirement for undertaking an AoS comes from the Planning Act 2008 and relates to National Policy Statements, which are prepared in the UK for different types of nationally significant infrastructure sectors. As one such piece of infrastructure, an AoS has been carried out for HS2 to inform the decision making process on whether or not to proceed with the HS2 preferred scheme or main alternatives.

Related appraisal techniques

Strategic environmental assessment (SEA) is a related tool, required for certain types of plans and programmes, with the objective of providing a high level of protection of the environment, integrating environmental considerations into the plan and programme preparation process, with a view to promoting sustainable development. The AoS for HS2 has sought to apply the principles of the European SEA Directive.

The Department for Transport has its own overarching New Approach to Appraisal (NATA) for transport schemes and related transport analysis guidance (WebTAG) which have also informed the way the AoS has been undertaken.

There are a number of other specific appraisal techniques that have been incorporated within the AoS to help understand the impacts of HS2 on specific issues and determine what future detailed studies may or may not be required; for example: habitats regulations assessment of impacts on internationally recognised nature conservation sites; and equality impacts assessment of groups vulnerable to discrimination and social exclusion.

7. The AoS and its role in scheme development

Sustainable design aims

As well as providing a statement on the overall sustainability of HS2, the AoS has provided input to identifying the HS2 preferred scheme and the main alternatives and in guiding aspects of scheme alignment, location and design. The AoS has enabled sustainability issues to be considered alongside other considerations, such as 'fit' with transport objectives, build costs, engineering feasibility, user demand and overall benefits in coming to decisions about which options were progressed.

At a fundamental level, the AoS has helped in the development of sustainable design aims. These are principles that support the four AoS priorities and have been used to provide general guidance on sustainability matters within the design as the scheme has been developed. In practice, the adoption of measures to meet these aims would need to be considered alongside other factors such as strategic fit, cost, journey times and other environmental considerations. However, their consideration has been fundamental to scheme design.

Table 1 – HS2 Sustainable Design Aims

UK priority 1: reduce greenhouse gas emissions and combat climate change

1. Managing energy	The project shall consider the energy efficiency of the operation of trains and rail infrastructure (commensurate with the detail of design), as well as the energy requirements of construction and materials, as a means of establishing low energy priorities within the scheme as a whole.
2. Managing flood risk	The project shall aim to ensure no increase in flood risk. This will be achieved by maintaining overall flood storage capacity (through, in order of priority, option selection that avoids flood plains, infrastructure design and flood compensation) and minimising disruption of flood flows

UK priority 2: protect natural and cultural resources and enhance the environment

3. Protecting environmental resources	The project shall where reasonably practicable seek to avoid direct or indirect harm to valued landscape, water and ecological resources, to mitigate adverse impacts where necessary, and to enhance such resources where practicable. Measures to achieve this will be commensurate with the sensitivity of the resource and the level of protection afforded such resources through relevant laws and policies.
4. Protecting historic cultural resources	The project shall seek to avoid direct or indirect harm to valued historic cultural resources, to mitigate adverse impacts where necessary, and to enhance such resources where practicable. Measures to achieve this will be commensurate with the sensitivity of the resource and the level of protection afforded such resources through relevant laws and policies.

UK priority 3: create sustainable communities

5. Controlling noise and vibration	Where reasonably practicable, the operation of HS2 infrastructure shall result in no significant adverse noise and vibration impacts (by reference to relevant guidance and precedence) to residents and other sensitive receptors near the route or proposed stations. Measures to mitigate potential impacts will be introduced, but where such impacts are unavoidable and cannot be appropriately mitigated, the project shall define circumstances under which residential properties shall be eligible for sound insulation.
6. Minimising property impacts	The project shall seek to avoid or, where this is not practicable, to minimise demolition of properties and, in particular, to minimise residential land-take and demolition.
7. Protecting communities	The project shall seek to maintain the health and amenity of residential communities potentially affected by the scheme. This shall include, where practicable, maintenance of access to services (such as health facilities, schools and places of worship) and shops, and maintenance of environmental conditions such that significant adverse effects on health and amenity are mitigated.
8. Safety	The project design shall seek to ensure that the travelling public and general public are not subject to increased risk of death or injury as a result of the operation of HS2 services.

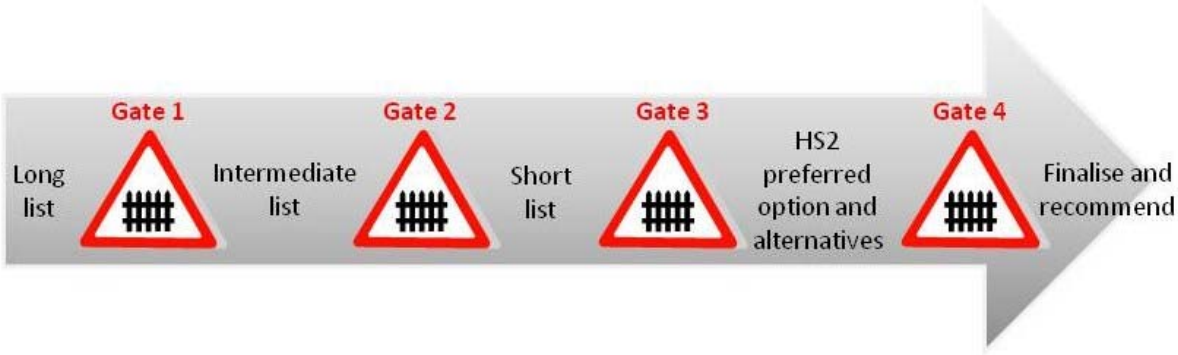
UK priority 4: achieve sustainable consumption and production

9. Optimising the land resource	The project shall seek, where practicable, to use land with planning designation appropriate to development for high speed rail and its infrastructure. The project shall seek to maintain and enhance land use, so long as this does not compromise other sustainability design aims.

Support in option development

A large number of possible options were developed for HS2, including termini in London and the West Midlands and approaches to these, lines of route between them, and stations in between. Work on HS2 to date has culminated in the identification of a scheme between London and the West Midlands, which HS2 Ltd prefers because it is considered to offer the clearest overall benefits. A number of possible alternatives and additions to this HS2 preferred scheme have also been proposed.

However, to get to this stage, a detailed sifting of options was required. This involved a successive reduction in the number of options over three stages, via a series of 'gates' at which HS2 Ltd agreed on options which merited further appraisal.



The AoS has provided input to the evaluation of options at each stage by highlighting their relative performance against stated sustainability objectives.

It was important to feed in appraisal information to the design at the right level of detail and at the right time. At the outset, designs amounted to a large number of lines on maps. The AoS provided fundamental information about environmental and social features along the notional routes and gave some information about the relative importance of the main features and the relative risks of affecting them. As a result, sustainability considerations contributed to the decisions about which routes and station options should be taken forward for further appraisal.

At the next stage more detailed designs were developed showing more precisely where the routes passed, whether these were on embankment, viaduct, cutting, tunnel or at grade. This supported a more detailed appraisal of most of the sustainability issues where information was available. Some of the 18 sustainability issues (for example some of the economic welfare and prosperity issues and climate change) were considered unlikely to help distinguish options since they mostly considered the scheme as a whole rather than what route it took, and these were not used therefore to help in the options sifting.

During the options development and sifting process, the AoS helped to bring about specific changes to different options. For example, speed considerations on the approaches into London, avoidance of key features such as listed buildings and SSSIs along the line of route and through the Chilterns where routes were modified to reduce possible adverse impacts on landscape. It is expected that continued refinement would enable these and other impacts to be reduced further.

Mitigating impacts

Where adverse impacts have been identified, the AoS has enabled the introduction of mitigation into the design: for example by prompting shifts in the alignment of route options away from sensitive features; and by outlining possible mitigation options that might be considered as design detail increases: for example the use of noise barriers.

Some specific examples of measures introduced into the scheme to avoid impacts are given below. These have been taken into account in appraising the different sustainability impacts of the scheme.

- Surface routes across flood plain or other land at highest risk of flooding (Flood Zone 3) are on viaduct to ensure their protection and to minimise loss of flood storage and impacts on flood water flows
- Particular focus has been given on the section of the line running through the Chiltern Hills, with use of tunnels and cuttings where practicable, and the positioning of the alignment to tie in with existing transport corridors.
- Landtake requirements for the route have been reduced to a practicable minimum and impacts on surrounding landuses have been considered when developing the alignment. This has included narrowing of the rail corridor as far as possible with the use of retaining walls, particularly in urban areas, to avoid impacts on property, buildings and other sensitive areas. For example, in West London, the use of retaining walls to narrow the rail corridor reduced the number of potential demolitions from hundreds to around 20.
- Avoidance where possible of large areas of open water to minimise impacts on wildlife, as well as the water resource and use of clear span bridges to avoid intrusion into rivers that are crossed.
- Where necessary, rivers are to be diverted but using new natural river profiles which present better opportunities to incorporate channels with soft banks, planted with indigenous flora and generally improving habitats for wildlife. Where culverts are necessary, they would be designed to reduce erosion. For example, the River Tame in North-east Birmingham would be re-aligned from its current concrete channel under the elevated M6 to a more natural alignment with the HS2 preferred scheme taking over the current river alignment.
- It is assumed that access routes across the scheme would be maintained, including roads, footpaths, cycle routes, pedestrian walkways etc. Disturbance during the construction period would be kept as low as possible.
- The route alignment has sought to use previously developed land (brownfield sites), with a total of some 230 hectares of such areas used.

If the HS2 preferred scheme is approved further consideration would be given to mitigation and how this is best developed, refined and incorporated into the design and into the way that HS2 is built and operated. Such mitigation options cannot be identified in full or committed to at this stage, since they rely on design detail that has not yet been developed. For example, they might include provision of noise barriers alongside the route, for which more detailed assessments of noise impacts would first be required; or they might involve creation of new areas of habitat to replace any lost to the scheme, which would require detailed site appraisal. However, these options, examples of which are given in the main report, are all measures that have been applied successfully on other rail schemes, including HS1. HS2 Ltd would look to build on this best practice.

8. Key drivers for HS2 and the Appraisal of Sustainability

Sustainable development has become fundamental to land use planning, transport, social and economic policy in the UK. Improvements in rail transport are seen by Government as vital to achieving sustainable development. HS2 is well placed to contribute towards these improvements. Plans for the delivery of sustainable transport infrastructure in order to support planned economic development are set out in national planning policy and guidance and in regional spatial strategies.

Potential route corridors for HS2 pass across several English regions. A policy review for the AoS focused on strategic policies for these regions as well as

determining the extent to which existing and emerging policy is supporting, driving and promoting HS2.

Future national rail policy is outlined in the Government's White Paper – Delivering a Sustainable Railway (2007) of which one of the three long term goals is to increase the capacity of the rail network. HS2 would potentially respond to this goal by delivering a transport system which supports and improves the transport sector's contribution to economic growth and connectivity. It could also support Government's emerging policy framework for planning for sustainable economic development (draft PPS4: Planning for Prosperous Economies, 2009) which is focussed on the contribution that planning can make in helping to deliver jobs, investment and improved productivity.

A key challenge for HS2 is that, as far as possible, it supports objectives on climate change, protection and enhancement of the natural and built environment, sustainable communities and sustainable consumption and production. HS2 could contribute to tackling global warming in the short-term through the provision of increasing rail capacity across the regions, although the extent to which it would achieve this depends on a number of factors outside the control of HS2. Equally, HS2 could support sustainable economic development and contribute to the delivery of prosperous economies in the regions affected.

From a regional context, the corridors examined for an HS2 route between London and the West Midlands pass through the London, South-east, the West Midlands, and in part the East Midlands and East of England regions. A full policy appraisal of the Regional Spatial Strategies for these areas is provided within the main (Volume 1) AoS Report. In summary the findings of this analysis conclude that HS2 generally supports the objectives of regional authorities to improve communications and transport connections as well as maximising the access to public transport. HS2 could facilitate the economic development and attractiveness of regions and improve employment opportunities in line with other regional objectives. Furthermore, HS2 could support business travel and associated economic growth as well as enabling reliance on less carbon-friendly road and air transport to be reduced.

By providing a strategic national rail corridor, HS2 would also be expected to improve inter-regional linkages that could support development in the regions and achieve economic goals. Inevitably there could be conflicts with local policies (although this has been avoided where practicable), for example in relation to station locations and where route options pass close to or directly affect proposed development areas, but these are considered to be outweighed by the benefits of the scheme.

9. Sustainability baseline: now and in the future

Climate change and CO_2 emissions

The future climate in Britain, at the time when HS2 could be built and in operation, is likely to be different from now – with generally drier summers and warmer, wetter winters. The AoS has considered how these changes might affect the design of HS2 especially at river crossings where flood risk is highest.

Equally the AoS has considered how emissions of CO_2 are likely to change in the future. The rail sector is known to be a relatively small contributor to greenhouse

gases and to give rise to some of the lowest per-passenger CO_2 emissions compared with other transport modes. The contribution of HS2 to climate change would depend mostly on how the power to operate the high speed fleet will be generated. With gas and coal expected to have a less significant role and nuclear and renewables a greater role in providing power to the National Grid, electrically powered transport generally is expected to have an increasingly important role in limiting CO_2 emissions. Other changes would also have an impact on the relative contributions of other transport modes, such as engine efficiencies for cars and aircraft, low carbon fuels and changes in travel demand. However, the key benefit of HS2 in reducing CO_2 emissions would be in replacing air travel. If passengers switching from air to HS2 were to be translated into a reduction in flights from UK airports, then HS2 could make a contribution to reducing UK CO_2 emissions, though in overall terms this would be limited.

Natural and cultural resources

Between London and the West Midlands along the route of HS2, there are areas of dense urban development including historic quarters and suburbs. There is the broad valley of the River Colne, the Chiltern Hills, the agricultural expanse of Vale of Aylesbury, the Northamptonshire Uplands that extend north from the Cotswolds and wooded farmland of Dunsmore and Arden around Coventry.

Around Euston, listed buildings and conservation areas reflect the area's long history of settlement and its importance as a railway terminus. In central Birmingham, similar listings reflect the area's industrial heritage.

West of London, the Colne Valley has been extensively quarried for sands and gravels, and its lakes and reservoirs are of importance to wildlife, especially birds. Further north-west, the chalk hills of the Chilterns are designated an Area of Outstanding Natural Beauty. This area of rolling landscape is associated with banks of wildlife-rich beech wood and other habitats, while its long history of human settlement is evident through important monuments such as the Icknield Way and Grim's ditch.

There are several stately homes close to the line of route, and with their extensive grounds represent some of the more notable historic features away from the cities.

Water quality in the various river catchments crossed by the scheme is of variable quality, often compromised by agricultural run-off and sewage. For example, around Birmingham, only 3% of monitored rivers and lakes currently achieve good ecological status. Other areas fare better but none have any more than a third of their rivers and lakes with good ecological status. This is expected to improve over coming years with much focus by the Environment Agency on delivering improvements in water quality.

Sustainable communities

The most densely populated areas occur in London and its north and west outskirts, and in Birmingham and its outskirts. Other key settlements near the HS2 preferred scheme or main alternatives include High Wycombe, Milton Keynes and Coventry.

Considerable growth is planned for the South-east of England, but areas where regional plans have sought to focus this growth include Oxford, Coventry, Birmingham and Solihull, as well as around Milton Keynes. A new eco-town is

planned at Bicester. More local proposals for mixed use developments are also in place; for example around Euston, Old Oak Common and central Birmingham.

Some of the urban areas affected by the scheme, notably in Euston and Birmingham, include more deprived communities; people living in these areas may be relatively more susceptible to adverse environmental, social and economic impacts than others. The existing noise and air quality tends to be poorer in these areas, as it is in other areas which are associated with major roads. Air quality at least would be expected to improve in the future based on stringent European standards.

Land resources

The area between London and the West Midlands contains numerous land resources that have commercial and other land use importance. These include Green Belt (and Metropolitan Open Land in London), high quality agricultural land, minerals planning areas, waste planning areas and contaminated sites.

Highest quality (Grade 1) agricultural land is restricted mostly to the outer parts of the study area, but Grade 2 agricultural land, although generally scattered, occurs in clear bands along the western edge of the Chilterns, along the river valleys of Aylesbury Vale and in broad bands around the fringes of Birmingham.

The main minerals areas comprise sands and gravels, particularly in the Colne Valley, the western side of the Chilterns and around the eastern outskirts of Birmingham. Limestone deposits are found in west Northamptonshire.

10. Summary of sustainability

The next four sections outline the implications of the HS2 preferred scheme for each UK sustainability priority. This is based on the information that has been available to date in terms of scheme design and service demand. Further studies, should HS2 be progressed, would help to determine how any adverse impacts might be reduced or mitigated and how neutral or positive impacts might be improved. It would also allow greater certainty for some issues, based on increased design detail and more in depth assessment of demand for HS2 including other rail services using space released on the West Coast Main Line.

The implications of HS2 for climate change are highly dependent on issues outside the control of the scheme. There is potential for HS2 to support reductions in greenhouse gases, depending primarily on how electricity is generated in the future and the extent to which people opt to use HS2 and rail in preference to cars and planes.

HS2 is less supportive of objectives for natural and cultural resource protection and environmental enhancement, as would be expected given the potential scale and extent of the HS2 works and the relative sensitivity of some areas traversed. However, the AoS has helped to minimise these impacts as far as is possible at this stage, and continued support for scheme development will help to further mitigate impacts on particularly sensitive areas such as the Chiltern Hills, and key features such as Hartwell House and Stoneleigh Abbey.

The implications of HS2 for supporting sustainable communities would vary between different locations and for different measures. Generally HS2 offers great potential for enhancing accessibility and economic prosperity and welfare.

However, it would also be highly disruptive at some locations during construction and would give rise to high operational noise and vibration levels in some areas. One of the most sensitive areas would be at Euston where a large number of residential demolitions would be required, affecting a community in one of the more deprived areas of the UK. Considerable further work would be needed to try to reduce these adverse impacts through mitigation.

Impacts on sustainable consumption and production are generally adverse since HS2 would require large quantities of material resource and involve substantial landtake. Opportunities to limit these impacts would be sought through the use of modern construction techniques that seek to use sustainable materials and reduce waste.

11. HS2 and climate change

The appraisal considered climatic factors in two ways: the impact that a changing climate might have on HS2 and the impact HS2 itself might have on climate change.

Resilience to climate change

As far as possible, HS2 would be designed and built to take full account of any changes to climate predicted over the scheme's operational lifespan. In particular, in areas already likely to flood now and increasingly so in the future, HS2 would be constructed on viaduct. Additional protection would be given to particularly vulnerable parts of the network such as tunnel entrances and electricity supply locations.

Greenhouse gases

The impact of the scheme on climate change would depend on any changes to the amount of CO_2 emissions that it brought about. These would depend on the new emissions caused by HS2, both from construction and operation, and on the savings made by attracting people away from more carbon polluting forms of transport. This is very difficult to predict as it relies heavily on other factors beyond the control of HS2. The most important benefit would be in displacing travel by air to travel by HS2. Reduced journey times between London and the West Midlands would encourage a proportion of travellers from Manchester and Glasgow to use the train, which would join the high speed service near Lichfield, in preference to flying. However, this benefit would only be realised if the number of domestic flights was reduced and the landing and take-off slots were not replaced by other, possibly international, flights. Carbon emissions from international flights are typically an order of magnitude greater than UK domestic flights.

Were HS2 to extend further north, the further reductions in journey times from cities in the north of England and Scotland would encourage more air passengers to switch to high speed rail. As a result the potential carbon benefits of HS2 would be expected to be greater.

The way that electricity used to power the trains is generated is also a consideration. The Government has ambitious plans to increase the contribution of renewables and nuclear generation at the expense of burning fossil fuels, such as coal and gas. Depending on how successful this is, it would have a significant influence on how much CO_2 HS2 produces.

12. HS2 and the natural and cultural environment

Landscape, townscape and cultural heritage

The main landscape impact of HS2 occurs in the Chiltern Hills. These extend for some 75km between Hitchin in the north and the River Thames in the south. Any direct route between London and the West Midlands (which a high speed railway would need to be) would inevitably need to pass through this area. Considerable work has been undertaken during these early stages to ensure adverse changes to this nationally protected landscape are kept low. Some 6.5km of the route would be in tunnel, over 5km is within the same corridor as the A413, and over 9km is in cutting, which would reduce some views of the scheme. Opportunities to further reduce impacts would be sought as design detail increases; for example using natural screening, earthworks, false cuttings and landscape planting.

Within the Chilterns a protected Iron Age bank and ditch known as Grim's Ditch would be directly affected, although further refinement of the scheme alignment is likely to reduce this impact.

Impacts on townscape are generally avoided and few areas of particular note would be affected. However, at Euston the large new station would involve a major change within some historic areas. A large number of demolitions would be required and this, together with the new station building, would result in townscape change that could adversely affect views from conservation areas, although this would depend on detailed designs. Direct impacts would include loss of some locally important features, such as the majority of St James Gardens and six Grade II listed buildings and structures. However, the Euston Square Gardens in front of the existing station would be retained. The Grade II* listed 194a Euston Road would also be retained, but would be very close to the new station and, as it is attached to the Grade II listed 9 Melton Street which would be demolished, would require very careful protection. The London Borough of Camden has set out a vision for wider change in this area, and there are clear opportunities to ensure that HS2 develops in harmony with these. With further architectural development of the station design and a coordinated response with Camden proposals, there is a clear opportunity to enhance large parts of this townscape.

West of Old Oak Common the new surface route would run on the north side of the existing Chiltern Line. The widening of the rail corridor has been kept as low as is feasible, but a number of demolitions between here and West Ruislip would still be required.

A number of stately homes with protected buildings and grounds lie near to the route. Three would be directly affected, at Shardeloes near Amersham, Hartwell House near Aylesbury and Stoneleigh Abbey near Kenilworth. The grounds of Hartwell House are directly impinged by the scheme which would also intrude greatly into views from the house. Impacts at Stoneleigh could hopefully be avoided altogether through further changes to the alignment. Direct, although less significant impacts are likely at Shardeloes.

A Grade II* listed farmhouse at Hampton in Arden would potentially be demolished to make way for the car park serving Birmingham Interchange Station. Continued design would seek to avoid this impact, although, were this possible, impacts on the setting of this building would remain.

In Birmingham the Fazeley Street terminus lies within a townscape whose character has declined in recent years. HS2 would result in some major demolitions, including three Grade II listed buildings, as well as some modern structures. However, the area is subject to extensive redevelopment as part of the Birmingham Eastside proposals. These would be significantly affected by HS2, but this could result in improvements to the townscape were the two schemes to be coordinated.

Wildlife and biodiversity

Early route development has managed to avoid most potential impacts on designated habitats and sites. No international sites would be adversely affected and impacts to nationally protected sites are restricted to just a few locations: landtake at Long Itchington and Ufton Wood SSSI has mostly been avoided by tunnelling beneath it, but some landtake at its northern edge would be result where the tunnel emerges; river crossings at the Colne Valley and River Blythe would have small impacts on SSSIs here, but designs would seek to minimise these.

A number of impacts on local and regional sites are also likely including some loss of ancient woodland in the Chilterns. However, considerable effort would be made to further reduce these effects and to seek opportunities, where possible, for enhancements through habitat creation and extension.

Water and flooding

Water resources include rivers, streams and lakes, as well as underground supplies. Much has been done to avoid direct impacts on these features, but they are widespread between London and the West Midlands so considerable further works would be required to ensure that national objectives for improving water quality are not compromised. It is possible that adverse impacts may arise at numerous locations where rivers are crossed and where the route potentially impedes flows into rivers. Where these impacts could be highest, river diversions would be undertaken; for example for short sections of the Colne, the Cole, the Tame and the Rea, although this introduces its own risks to water quality.

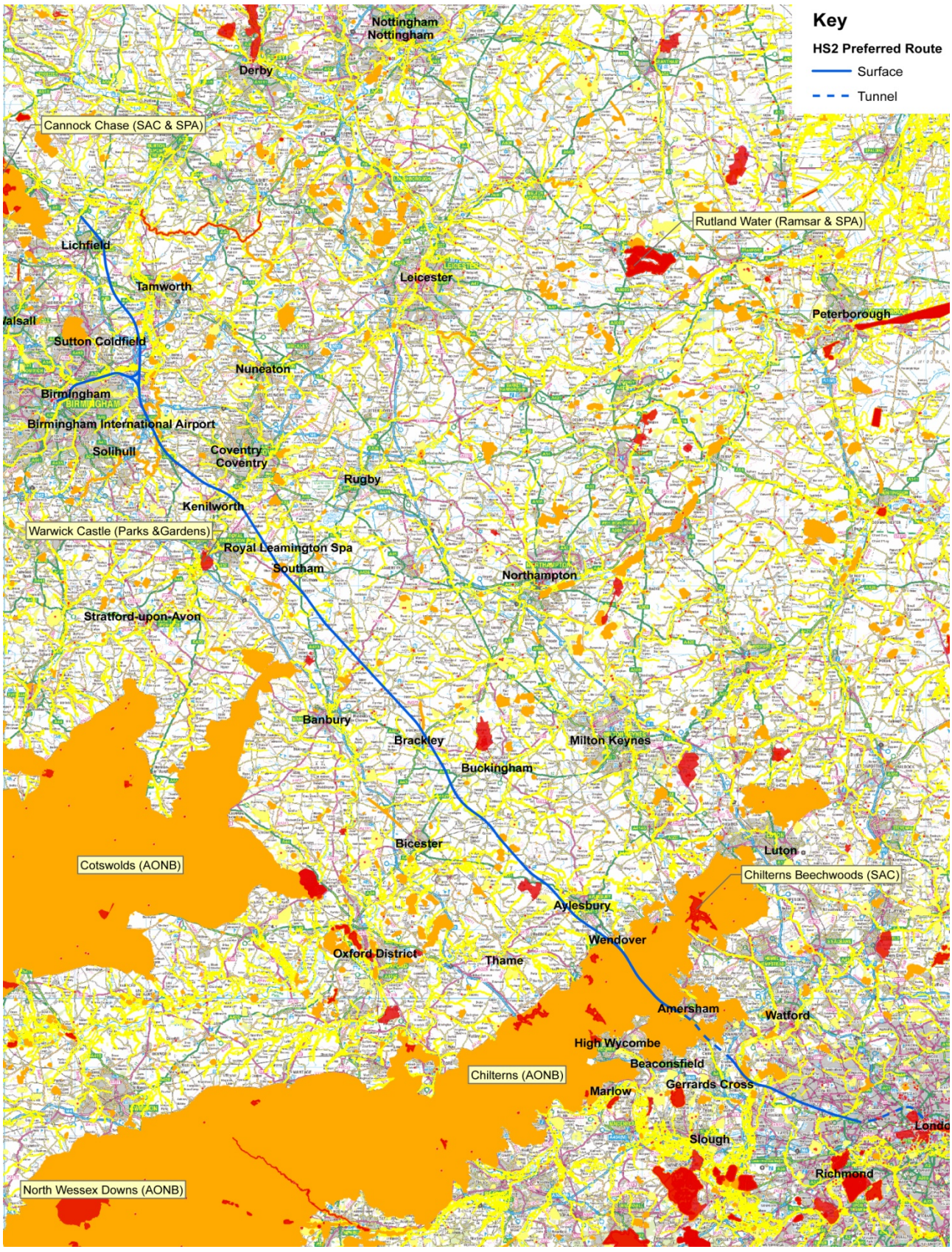
Equally, passage of the scheme over or through aquifers or areas with vulnerable groundwater would present major risks and would require mitigation to be put in place. This is the case in particular across the Colne Valley where the majority of vulnerable groundwater occurs, and between Brackley and Kenilworth, where high quality aquifers are prevalent.

HS2 would also cross areas whose periodic flooding occurs relatively frequently in comparison to other areas (at least once every 100 years). It is important that, in doing this, the scheme does not increase flood risk to other areas and communities. In total the HS2 preferred route passes across 17km of the highest risk flood areas. Scheme design here would be critical to ensuring that impacts are effectively managed and avoided.

Key features map

The key features of very high (red) and high importance (yellow) near to the HS2 preferred scheme are shown below.

Key sustainability features along the HS2 preferred scheme



13. HS2 and Sustainability Communities

Air quality

HS2 would be electrically powered and so it would not directly result in air pollution. There is a risk that, at HS2 stations, increases in road traffic might cause more local air pollution, but this is not expected to be significant as most stations would have good public transport links.

Preliminary demand model outputs indicate that there is the potential for some modal shift from road to rail (both HS2 and released capacity). However, the reduction in the number of road trips is not expected to be significant when considering overall traffic flows on the wider motorway network.

Noise and vibration

Noise impacts from the HS2 preferred route would result in up to about 350 dwellings experiencing high noise levels (≥ 73dBLAeq). Some 21,300 dwellings could experience a noticeable increase in rail noise (≥3dB LAeq compared with existing rail noise levels and >50dB LAeq). Some 200 non residential receptors (community; education; healthcare; and recreational/social facilities) within 300m of the HS2 preferred route have the potential to experience significant noise impacts.

However, in practice, a significant proportion of these potential impacts could be mitigated. A preliminary appraisal of additional mitigation has indicated that the number of dwellings subject to high noise levels could be reduced to fewer than 50, with those dwellings experiencing a noticeable noise increase reduced to about 9,700. Further detailed modelling and assessment would be required in order to identify how these impacts could best be reduced.

An estimated 9,400 houses over tunnel sections could experience vibration impacts. However, based on experience with HS1, mitigation measures, once developed and appraised, would be expected to remove the majority of these impacts.

Community impacts

Other impacts on people would arise from the physical impacts of HS2. The main area of potential demolition would be at Euston with about 220 residential dwellings in the Regents Park Estate affected by the loss of five blocks of flats. Some further 30 dwellings and a community hall in the area would also be demolished and a large part of St James Gardens would also be lost. Residents of some further 170 dwellings would become newly exposed to the railway environment. People living here are in a relatively more deprived part of the country and this is likely to make them and the communities they live in particularly vulnerable to these impacts. As mentioned earlier, the London Borough of Camden has set out its vision for improvements to the area around Euston and HS2 would be planned and designed to fit in with this, potentially resulting in wider social, environmental and economic benefits.

Other communities affected by potential demolitions include those along the route between Old Oak Common and West Ruislip where a total of around 20-30 residential properties would be demolished. Works at the Hanger Lane road

system in Ealing are likely also to require a number of demolitions. This would need to be reviewed during further scheme development.

In Birmingham, some 30 dwellings would be demolished to make way for a new depot. Five student accommodation blocks would be demolished within central Birmingham to make way for the new station.

In a few places the route of HS2 could increase the sense of isolation of residents where properties become 'islanded' by HS2 in combination with other roads and railways, although physical access to these areas would be maintained. Locations so affected include the northern edge of Little Missenden, the southern edge of Wendover and an area south of Stoke Mandeville.

Accessibility

A number of footpaths and cycleways would be severed by the route, but it is anticipated that all will be reinstated where feasible, so permanent effects would be limited. During construction, however, severance may result in some temporary impacts.

In terms of access to public transport, households in London, Birmingham Liverpool, Manchester and Glasgow are less likely to own cars than the population as a whole and so would benefit from the new services brought about by HS2. Other households in the West Midlands and Warwickshire tend to have quite high levels of car ownership. Although they would benefit from additional services introduced onto the West Coast Main Line to take up the space vacated by intercity trains, they are unlikely to experience many constraints on accessibility currently. Having said that, places such as Coventry, Milton Keynes and Northampton also include large areas of deprivation and their populations would be expected to benefit from increased accessibility on the West Coast Main Line.

Interchange from HS2 to other public transport services is catered for at the terminus stations. Old Oak Common station would provide links with other rail lines. It is also proposed to include a light rail type 'people mover' to provide a direct link between the Birmingham Interchange Station and Birmingham International Airport from which other rail services can be accessed.

Health and well-being

The scheme has the potential to affect health and well-being both positively and negatively. The main benefits stem from the reduced crowding on existing rail lines and the implications of this for improving journey ambience on busy commuter lines for rail passengers.

Adverse impacts on mental wellbeing could arise from other environmental impacts, such as noise, where these are either sufficiently extreme to bring about indirect health effects on their own, or where they act in combination. However in very few cases are such impacts considered likely to result in adverse health effects. Residents along and close to the route might experience disturbance from construction activity, but this would not be expected to result in health impacts and moreover best practice techniques would be used to control these impacts.

One location where there is a risk of mental wellbeing issues is around Euston Station due to the large number of demolitions and the general disruption to the local community this would entail. Careful and thorough consideration of potential

health impacts would be necessary in determining how these works should proceed and the particular sensitivities of affected residents, for example in terms of cultural needs, would need to be taken in to account.

Economic prosperity

HS2 would enhance economic competitiveness, support wider economic growth and maintain and enhance employment opportunities. In supporting economic competitiveness, the value of direct economic benefits to businesses of the service improvements HS2 would bring are estimated to be some £17.6 billion over 60 years; further direct economic benefits would be expected from the use of the capacity that is freed on the West Coast Main Line. Both of these will create indirect economic benefits that arise when overall economic competitiveness is enhanced.

The largest economic benefits are for trips that originate in London, with around 36% of these benefits. The next major group of beneficiaries are for trips originating in the North-west (22%) and the West Midlands (18%). Trips originating in the South-east and Scotland comprise 6% and 8% of these economic benefits respectively. Other regions also receive some small benefits.

There is also potential for HS2 to encourage businesses, directly and indirectly, to grow and prosper around locations served by improved rail services. This includes both locations served by HS2 and locations served by the West Coast Main Line.

Businesses in London and Birmingham in particular would also be able to draw on a workforce from a wider area, and due to these workforce effects this wider area would in turn benefit economically as a result.

Economic welfare

HS2 would be expected to also benefit people making commuting, leisure and other personal journeys, and support regeneration at Euston, Old Oak Common and central Birmingham. The direct economic benefits to people making these journeys are estimated as being some £11.1 billion over 60 years. These benefits are expected to increase as options for using released capacity on the West Coast Main Line are refined.

HS2 stations adjacent to areas of deprivation are likely to provide local employment opportunities. Wider benefits would arise if such stations increase the overall appeal of their vicinities for investment and increased development. For example, increased use of Euston is likely to have positive benefits for regeneration in areas near the new station. Opportunities for enhanced commuter services on the West Coast Main Line could support regeneration at Northampton in particular. Better connectivity with London would assist this.

The Fazeley Street Station and approach would have a serious impact on planned residential developments, including at Curzon Street as part of a 130,000m^2 mixed scheme including office, retail and leisure use, and proposed developments for Birmingham City University. In the longer term these developments could be restructured around the new high speed terminal to provide high density city centre commercial and mixed use development.

Perhaps the best regeneration opportunity could come from a station at Old Oak Common. The interchange between HS2 and Crossrail, along with the increased

connectivity such a station could provide for neighbouring areas, may offer significant opportunities for regeneration if supported by appropriate local land use planning.

14. HS2 and sustainable consumption and production

HS2 would affect the land resource both adversely and beneficially. It generally supports planned land use developments, as described above, for example at Old Oak Common and Euston, and it would result in a number of previously developed 'brownfield' sites, totalling some 230 hectares in extent, being brought back to productive use.

Equally, although it would affect none of the most productive Grade 1 farmland, it would cross some 23km of only slightly less productive Grade 2 farmland. The only significant impact to green belt is likely to arise around the Birmingham Interchange Station, where a large section of green belt would be lost to accommodate the station and associated facilities.

In terms of the waste generated by the scheme, particularly during its construction, almost 2 million cubic metres of spoil would arise from tunnel excavation. This would be very costly to dispose of to landfill, and so any opportunity to re-use this material either on other parts of the HS2 such as landscape or noise bunds, or for other uses offsite would be sought.

In terms of the materials and resources to be used in constructing HS2, it is only possible to set out principles at this stage. This is something that would be explored further during ongoing design. In general it is expected that the scheme would seek to commit to using sustainable materials wherever practicable and commercially viable; for example low carbon cement within concrete, recycled steel and aggregates, re-used spoil, and sustainable timber. By the time that HS2 construction commences, the availability of different high sustainability materials in the market could be fundamentally different from now.

15. The New Classic Line

One important test for HS2 was to see how the HS2 preferred scheme compared against a new conventional speed line (up to 200kph) in order to determine which costs and benefits were due to the high speed element of the service. A separate alignment for this 'new classic line' was not determined since it was considered that the HS2 alignment could equally serve (in broad terms) new classic services.

In most ways there would be little difference in terms of the sustainability performance of the new classic line in comparison with HS2. The main differences that a new classic line could entail would potentially be:

Climate change

- lower CO_2 emissions due to lower energy demands of slower speed trains.

Natural and cultural environment

- greater flexibility to avoid sensitive features, in more detailed scheme design phases, owing to the smaller curve radius of a slower speed line.

Sustainable communities

- lower noise impacts would result due to the lower operational speeds of the trains (i.e. some 2,350 people estimated to be annoyed, based on WebTAG guidance, compared to some 4,400 for HS2 preferred route), without additional mitigation. Noise impacts could be reduced further with additional mitigation measures;
- greater accessibility since a new classic line could reasonably include more intermediate stations, although the time penalties associated with lower speed lines might reduce overall demand for the service;
- greater potential to coordinate transport planning with regional growth plans (growth areas) by locating new stations specifically to support growth and regeneration; and
- fewer journey time and intercity accessibility benefits of HS2 would arise, but a good part of the released capacity benefits and positive economic benefits would result overall.

Sustainable consumption and production

- lower quantities of waste since new classic services would be able to operate within smaller diameter tunnels (an estimated half a million cubic metres of spoil).

16. Appraisal of Longer Term Strategy

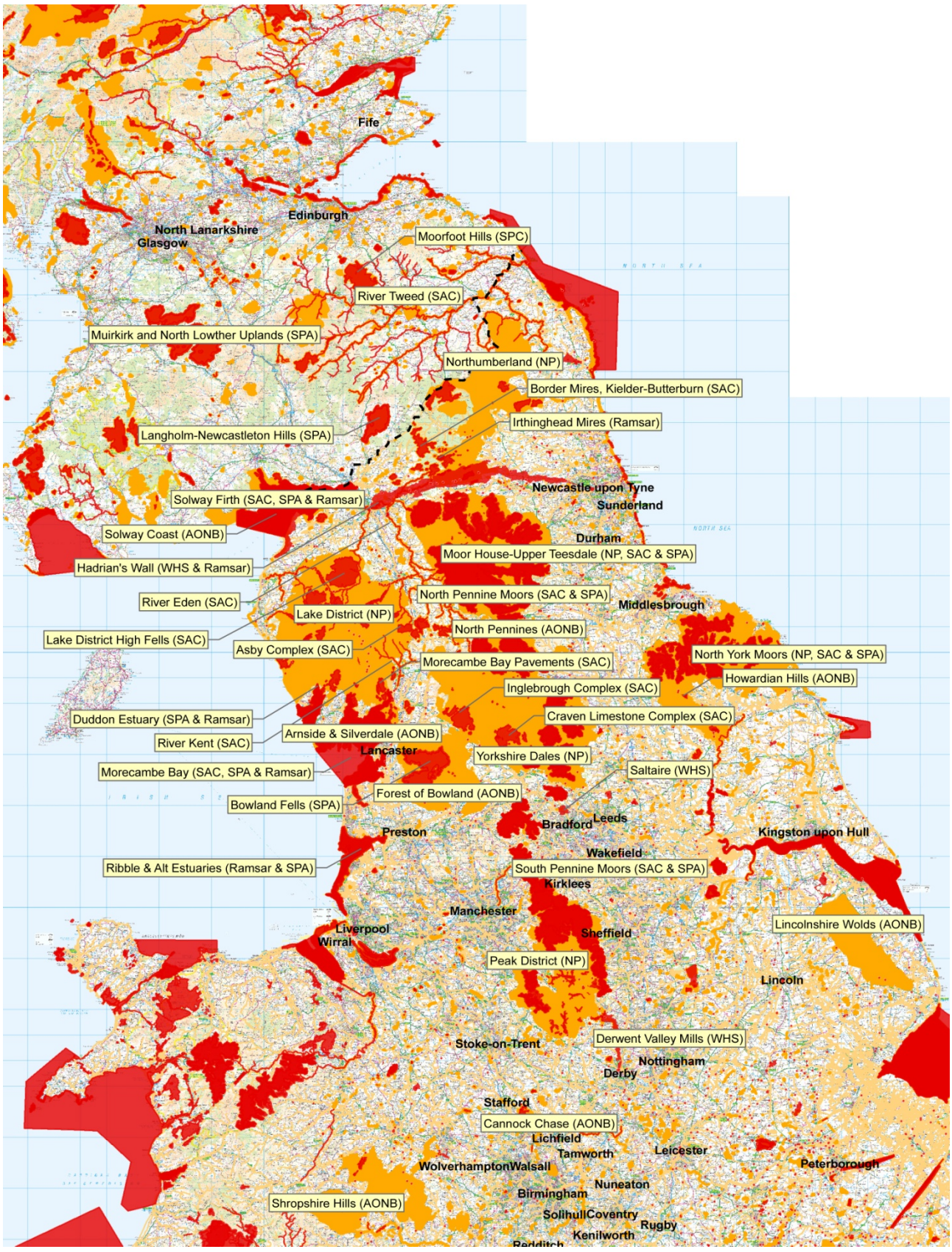
It has become evident from studies of HS2 between London and the West Midlands that some of the greatest benefits would arise only if high speed trains served long distance journeys. Relatively speaking CO_2 emissions would only fall for these longer journeys and many of the economic prosperity and welfare benefits only appear with these longer journeys.

Only conceptual routes have so far been prepared, with variations around the cities served and the ways they could be reached. The AoS has a necessarily simpler approach, looking at the most sensitive and highest value resources in particular. This has identified areas where the quantity and quality of sustainability features makes the passage of a high speed railway challenging to accommodate. These areas and features are best illustrated below, which shows the highest priority features based mostly on their national and international protection status.

With respect to greenhouse gases, the expectation is that the extension of HS2, under the Longer Term Strategy, is required before there is sufficient modal shift from air travel to HS2 for the scheme to realise a net reduction in greenhouse gas emissions. This finding is very sensitive to the relative delivery of policy measures relevant to reducing CO_2 emissions. In the absence of more detail on route alignments, it is not possible to determine at this stage, which potential impacts would occur.

The key features of very high (red) and high importance (yellow) for the Longer Term Strategy are shown below.

Key sustainability features for the Longer Term Strategy



17. Next steps

Should the DfT request that work be progressed on the HS2 preferred scheme, the next phase of the project will be initiated. This would involve continued, more detailed appraisal of sustainability issues and identification of ways to avoid and minimise any negative impacts, so helping to ensure that ongoing design continues to reflect the sustainable design aims.

Any formal application for development consent for HS2 would be supported by statutory processes including accompanied environmental impact assessment (supported by appropriate assessment) and equality impact assessment, as well as by non-statutory health impact assessment if deemed necessary. This would propose detailed measures to mitigate any remaining significant negative impacts.

18. Monitoring

The SEA Directive requires monitoring of the significant environmental effects of the implementation of plans in order to identify at an early stage unforeseen adverse effects, and to be able to undertake appropriate remedial action. Unforeseen effects are often interpreted as being underlying assumptions that turn out to have been incorrect or outside the context of the appraisal, for instance population changes or economic growth.

HS2's impacts will be assessed in detail and will be monitored as part of the routine project planning process. This includes its impacts on landscape/townscape, historic and archaeological heritage, biodiversity, water resources, flood risk, air quality, noise and vibration, health, security, land use, waste generation and resource use.

However HS2 could also have some regional or national level impacts; and some of the assumptions on which it is based could affect the development of future rail lines (conventional as well as high speed) in the UK. A proposed monitoring programme has therefore been developed that aims to identify these strategic level impacts and address these where possible.

19. Assumptions and limitations

The AoS is a strategic level appraisal and as such any impacts or effects identified and reported should be viewed as provisional at this stage. Further, more detailed work will be carried out in due course (assuming the Government supports progress of the scheme) and much of this is identified under next steps.

Given the preliminary nature of the design work at this stage only limited information has been used or available in some instances and consequently the approach to the appraisal has been tailored accordingly.

The timescales of the demand modelling output and the nature and extent of these outputs meant that the approach to some topics, in particular the socio-economic, climate change, noise and air quality work, had to be refined throughout the course of the appraisal and as such the full extent of any potential benefits of HS2 may be understated in the AoS.


booz&co.
TEMPLE