

High Speed Rail: Phase 2b Preferred Route

Sustainability Statement including Post Consultation Update

**Volume 1: Main report of the Appraisal of
Sustainability**

A report by Temple-RSK for HS2 Ltd



TEMPLE

LEADERS IN ENVIRONMENT,
PLANNING & SUSTAINABILITY.

RSK

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High Speed Rail: Phase 2b Preferred Route

Sustainability Statement including Post Consultation Update

Volume 1: Main report of the Appraisal of Sustainability

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A Report for HS2 Ltd

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Executive summary

Phase One of the High Speed Two (HS2) network will run from London to the West Midlands, with a connection to the West Coast Main Line near Lichfield. Phase Two will extend HS2 to the north of England, with trains running to Manchester via Crewe, and to Leeds via the East Midlands and South Yorkshire. Connections to the East Coast and West Coast Main Lines would enable HS2 services to travel onwards on the existing network.

In July 2013 the Secretary of State for Transport published proposals for HS2 Phase Two and initiated a seven-month period of public consultation. Since that time certain refinements and modifications to these proposals have been made, which have been recommended by HS2 Ltd. These have come about in response to the feedback received during consultation; lessons learned from Phase One and strategic considerations such as the Northern Powerhouse project.

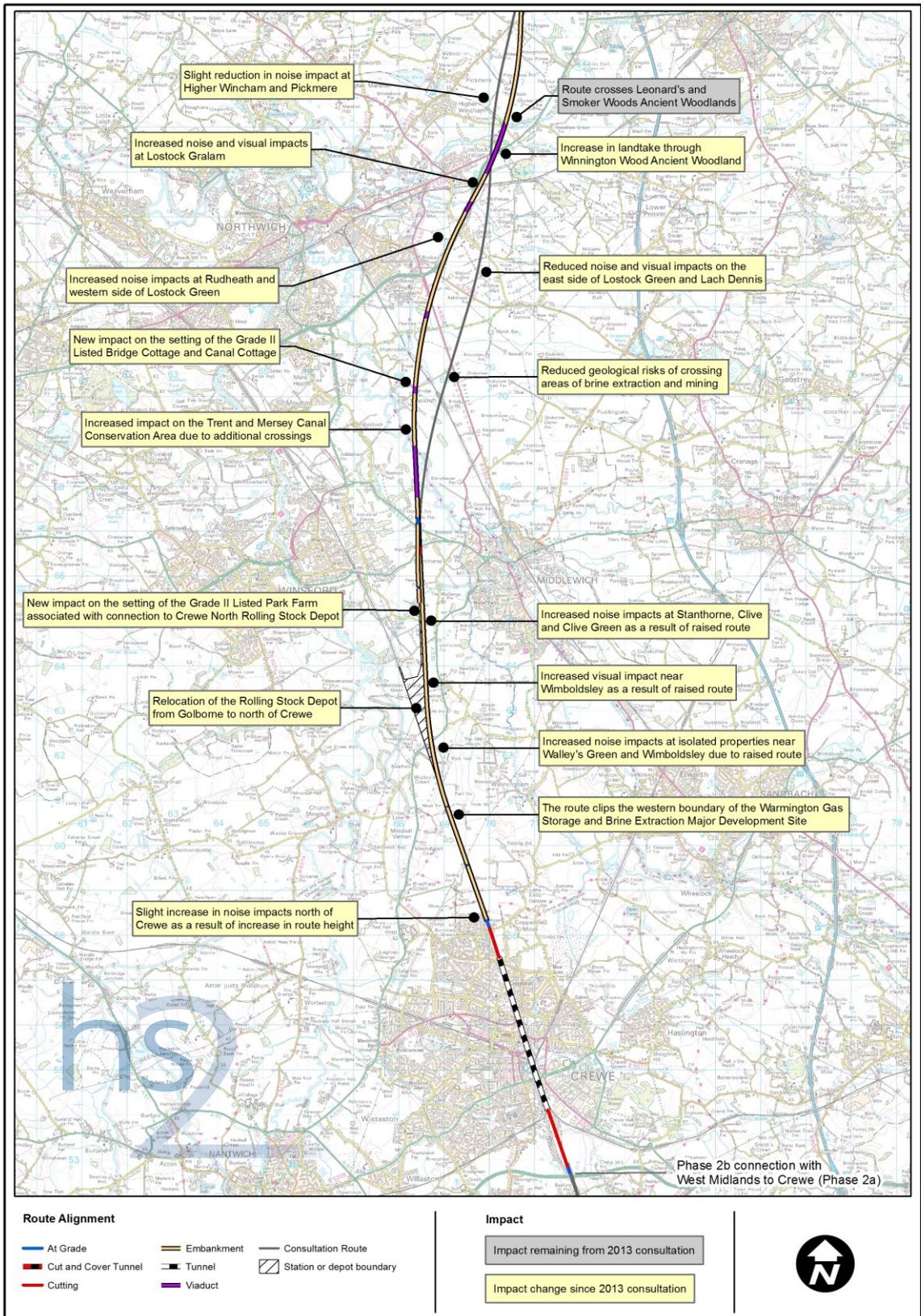
In autumn 2015 the Government announced that delivery of part of the Phase Two route between the West Midlands and Crewe would be brought forward to 2027 in order to realise more of the benefits of HS2 further north, sooner. This project is known as Phase 2a, and is currently progressing through hybrid Bill development and a more detailed environment analysis (in the form of an Environmental Impact Assessment (EIA)). The remainder of the Phase Two scheme is the subject of this report and known as Phase 2b. This report outlines the potential environmental and community impacts of the Phase 2b preferred scheme, and describes how the potential impacts for the route compares with the scheme that was presented at consultation in 2013/14.

Changes to the Phase 2b scheme vary from small changes in alignment to sections of entirely new route. In those locations where there have been more significant changes made since 2013, further consultation will be undertaken, in particular to ensure that those people who would not previously have been consulted have the opportunity to give their feedback.

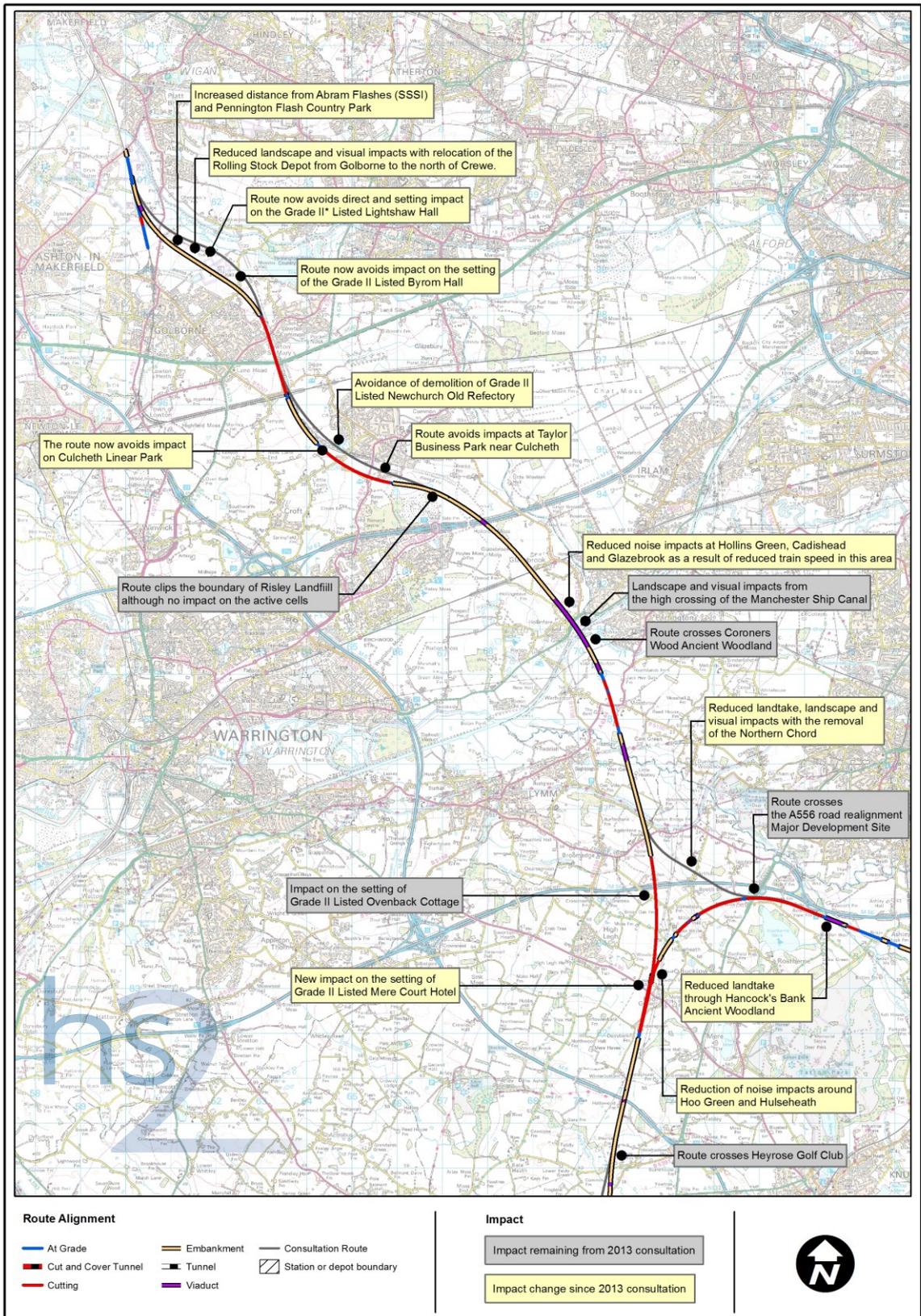
Following the next stage of design, and taking account of this further phase of consultation, an EIA will be undertaken. HS2 Ltd has been working with stakeholders during the appraisal of sustainability (AoS) process and will continue to engage and work closely with stakeholders both during and after the EIA.

The main impacts of this preferred scheme are highlighted on the following maps, with emphasis placed on the changes from the 2013 consultation scheme. Some (not all) of the impacts of this preferred scheme are highlighted on the following maps. In addition, not all topics are covered in this summary, particularly where the change in impact is less distinct.

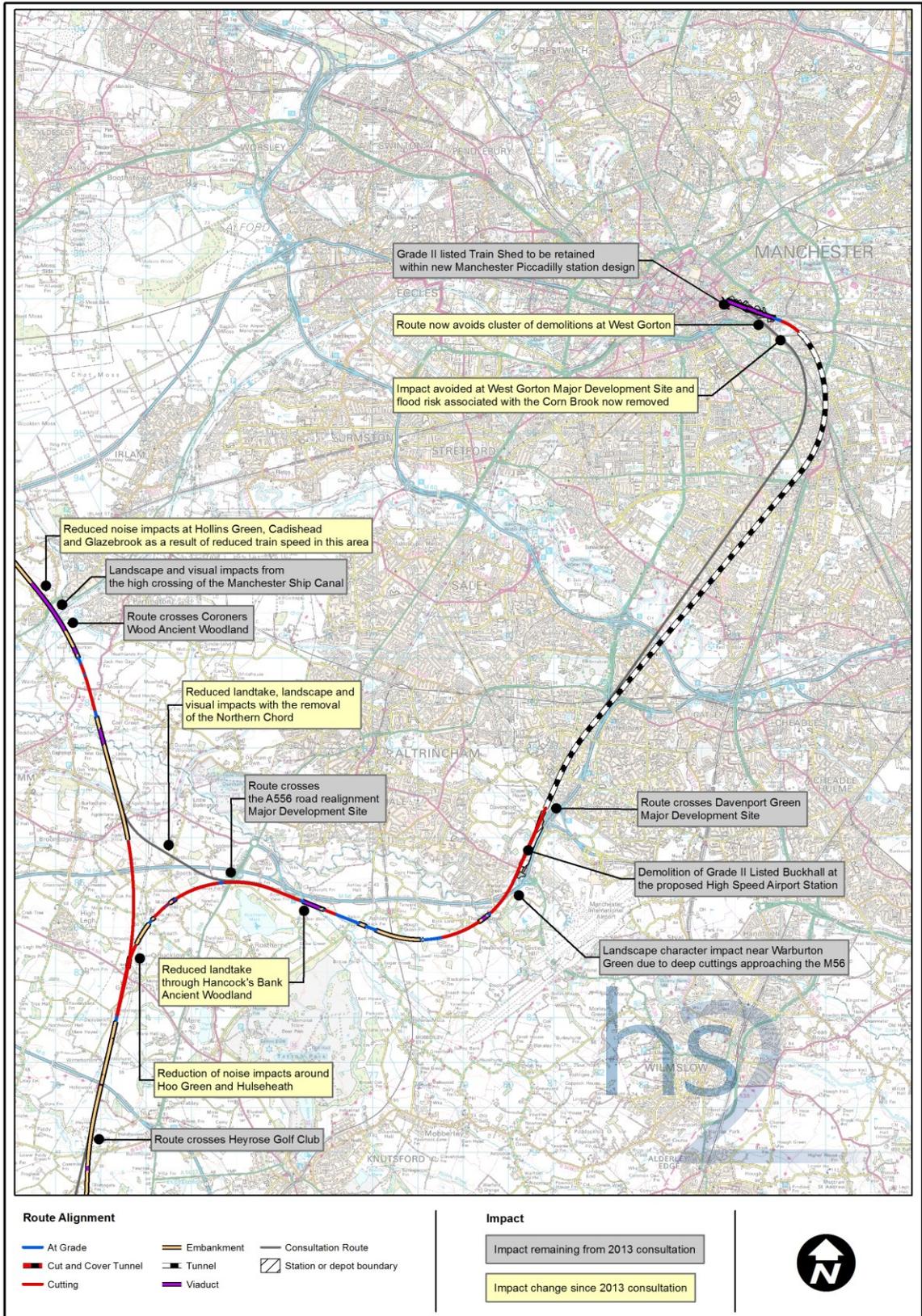
Western Leg Executive Summary Map (1 of 3 Crewe to Winterbottom)



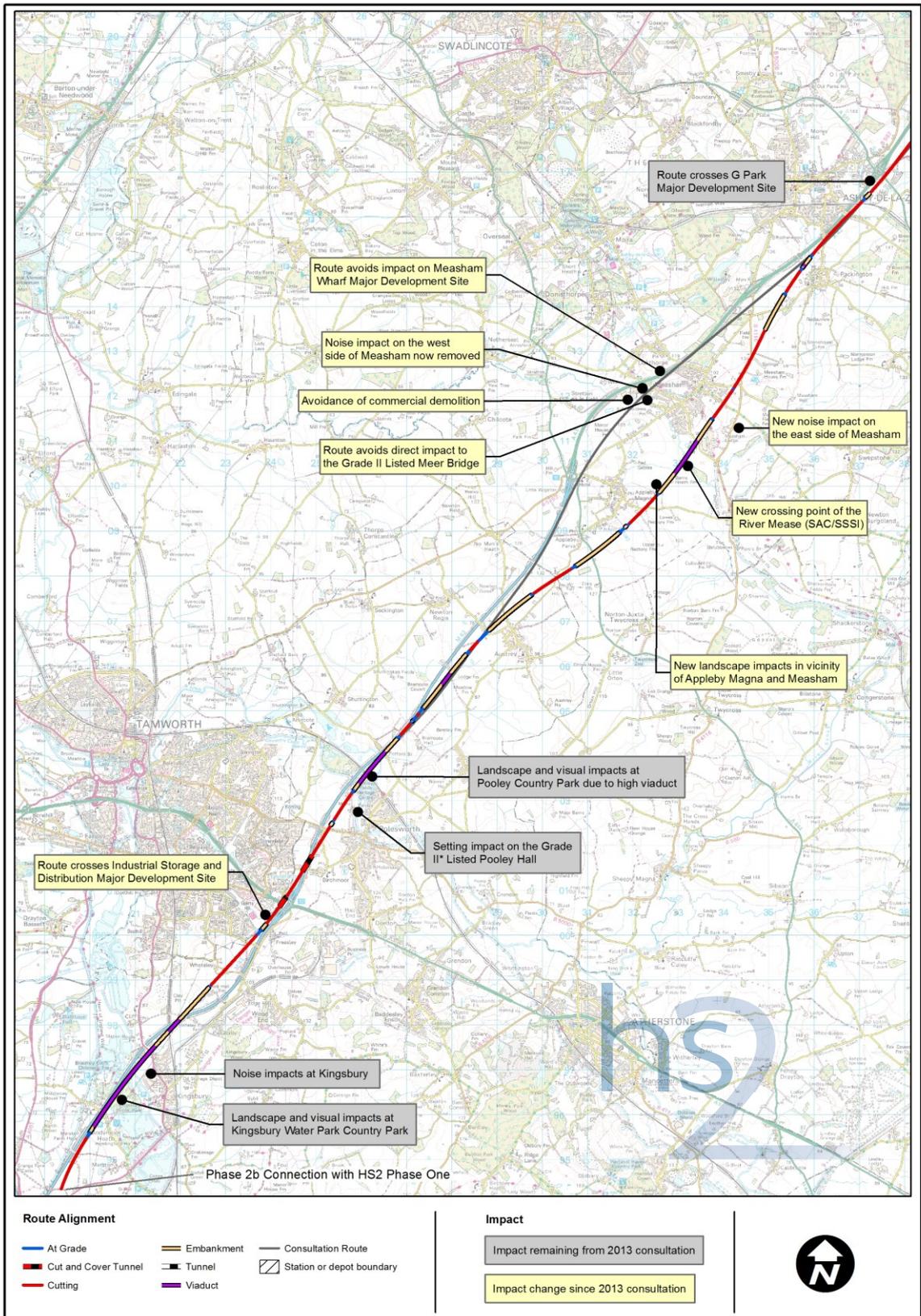
Western Leg Executive Summary Map (2 of 3 Winterbottom to Golborne)



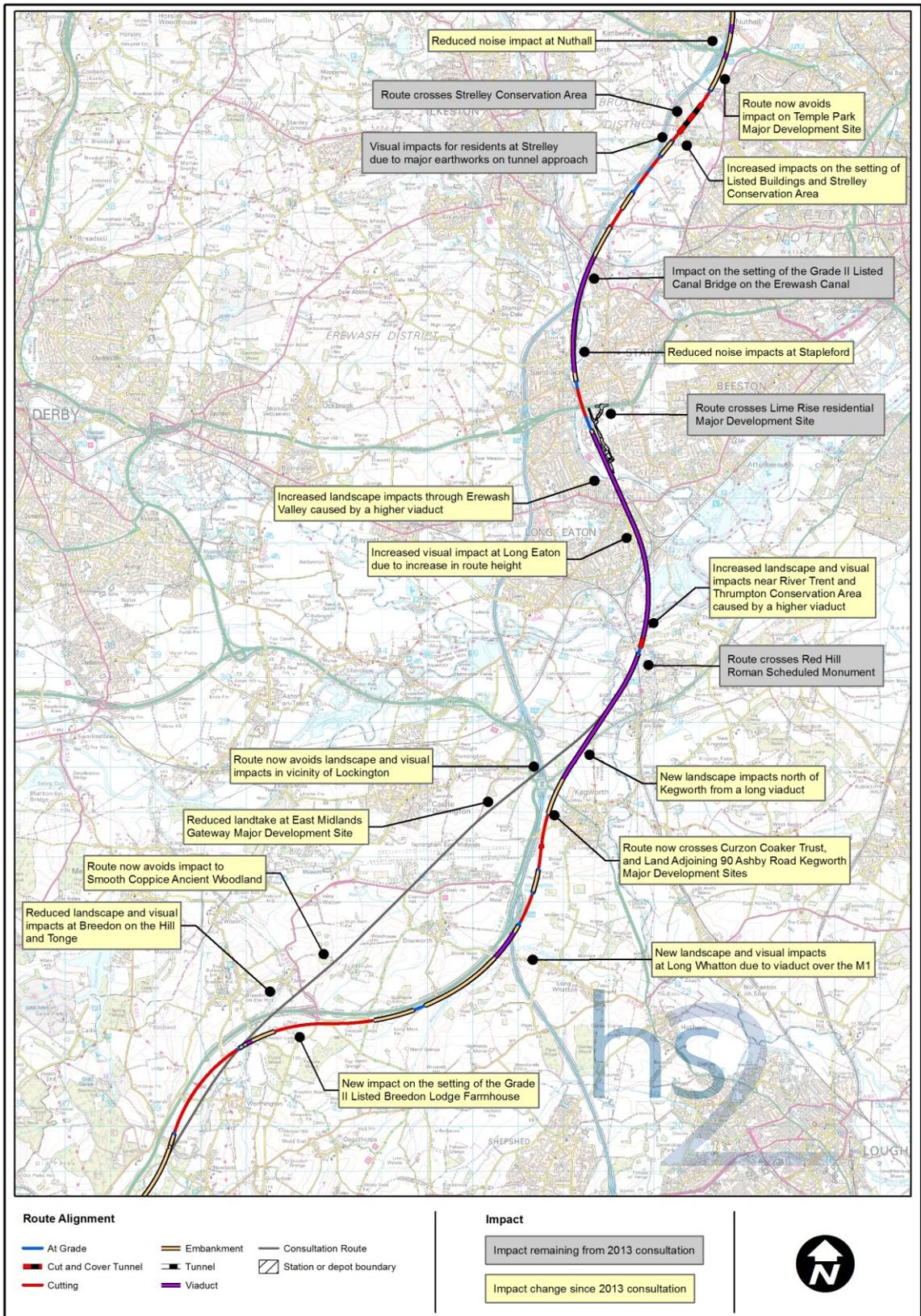
Western Leg Executive Summary Map (3 of 3 Winterbottom to Manchester Piccadilly)



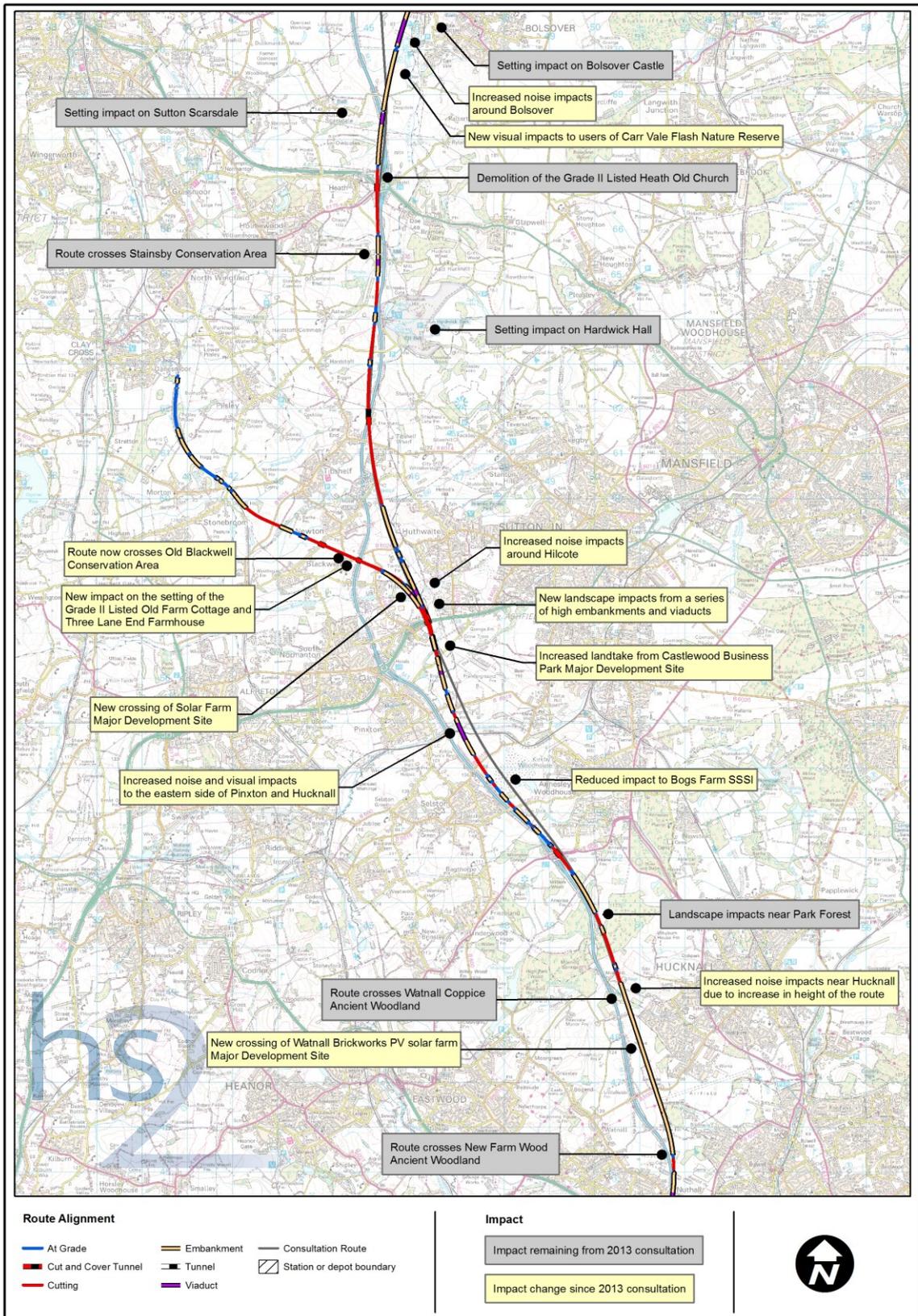
Eastern Leg Executive Summary Map (1 of 6 Marston to Ashby-de-la-Zouch)



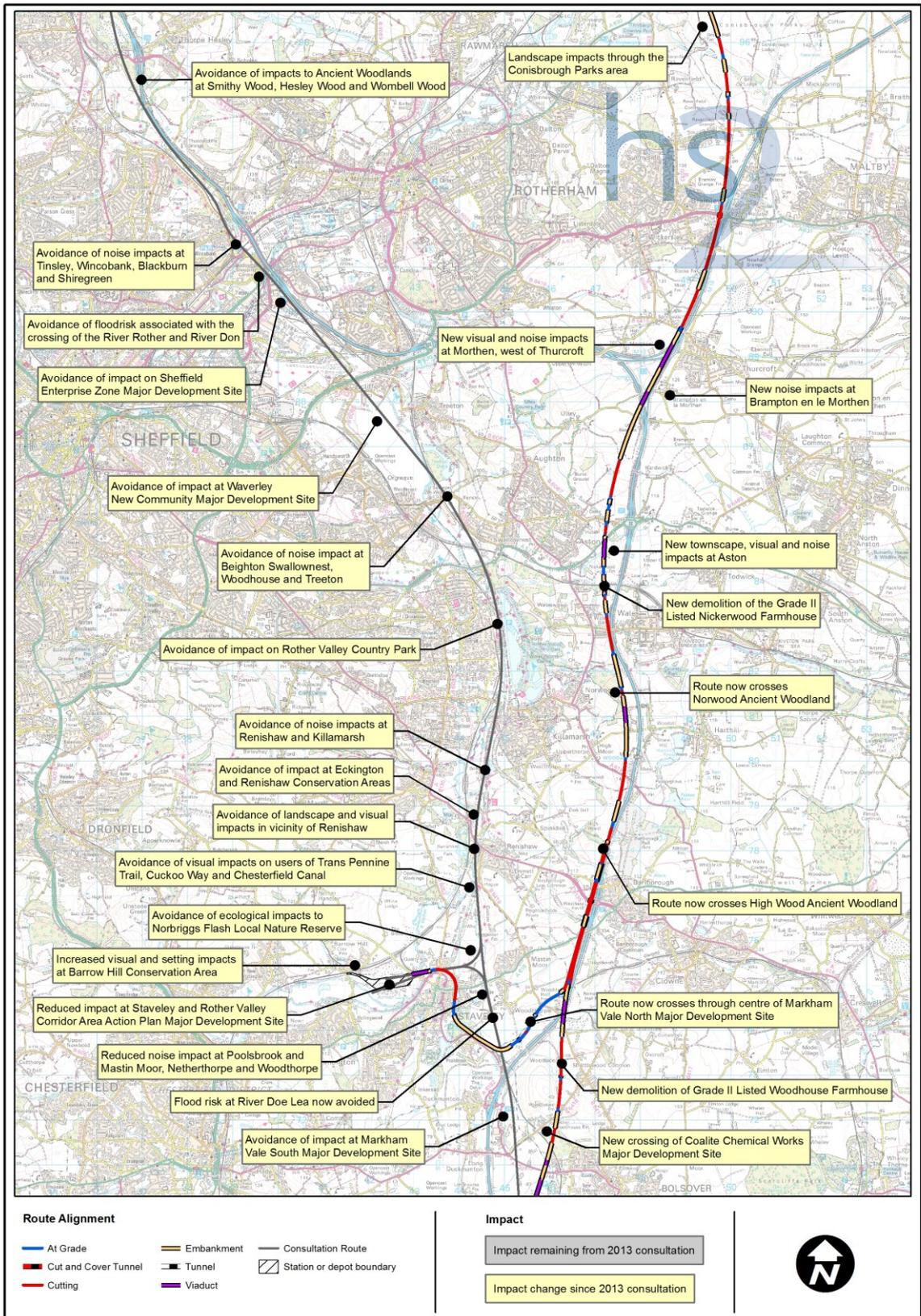
Eastern Leg Executive Summary Map (2 of 6 Ashby-de-la-Zouch to Nuthall)



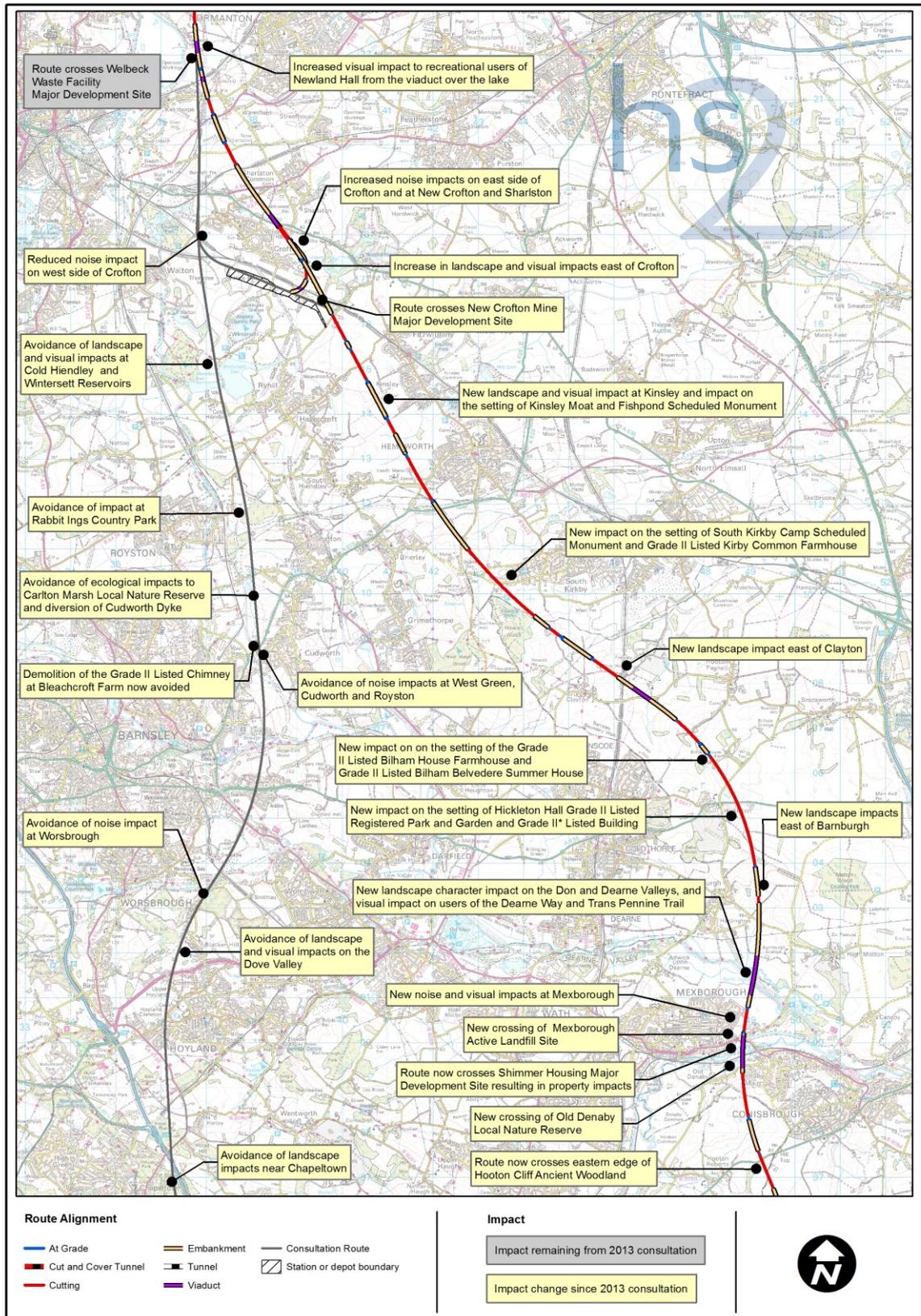
Eastern Leg Executive Summary Map (3 of 6 Nuthall to Bolsover)



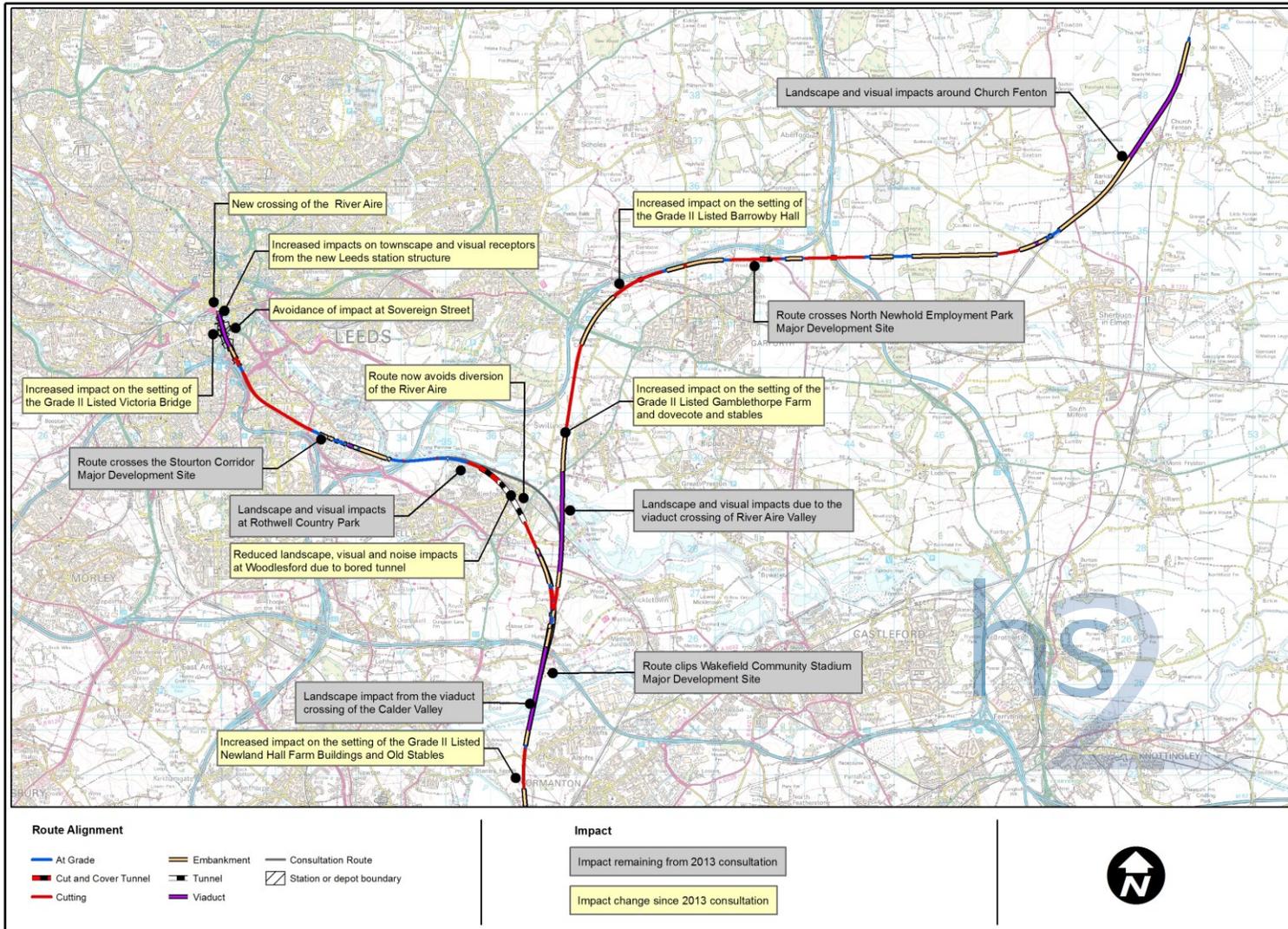
Eastern Leg Executive Summary Map (4 of 6 Bolsover to Conisbrough)



Eastern Leg Executive Summary Map (5 of 6 Conisbrough to Normanton)



Eastern Leg Executive Summary Map (6 of 6 Normanton to Leeds and Church Fenton)



1. Introduction

1.1. Overview

- 1.1.1. This document describes the extent to which the Government's preferred scheme for Phase 2b of High Speed Two (HS2) supports appraisal objectives for sustainable development. It has been prepared independently by Temple-RSK to inform people about the potential sustainability benefits and adverse impacts of the proposals, as well as to explain how sustainability has helped support the scheme selection and design. It also describes how the impacts of the preferred scheme compare with the scheme that was presented at public consultation in 2013/2014¹.
- 1.1.2. There are a number of reports accompanying the announcement of the HS2 Phase 2b preferred route, including a Summary of Route Refinements² that sets out the changes made to the scheme design since the 2013/14 public consultation and the DfT's Command Paper. Parts of the route that have undergone significant changes will be subject to further consultation. The outcome of this further consultation will be fed into the hybrid Bill development, where there will be further opportunities to engage on the development and assessment of the Phase 2b scheme.
- 1.1.3. The Phase 2b proposals will be subject to approval by Parliament in the form of a hybrid Bill to become law (receiving Royal Assent), which will include an Environmental Impact Assessment (EIA) report. The hybrid Bill is expected to be deposited in 2019.
- 1.1.4. At the time of writing, following the EU referendum vote for the UK to leave the EU, it is understood that it is the Government's intention to transpose EU legislation into UK law. Subsequent to the transposition, various elements of the EU sourced legislation may be amended. For the purpose of this document, it has been assumed that EU legislation referred to in this document will be transposed to UK law and will remain relevant.

1.2. HS2 and the Phase 2b Preferred Scheme

- 1.2.1. HS2 is the Government's proposed high speed railway that will provide Britain's rail network with new capacity, better connectivity and quicker journeys. The HS2 project consists of two primary phases. The first phase will link London Euston with a new station at Birmingham Curzon Street, with intermediate stations en-route and a connection onto the existing network; construction is expected to begin in 2017.
- 1.2.2. The second phase of HS2 (Phase Two) will divide into two lines, the western leg to Manchester and the eastern leg to Leeds. The first part of the western leg, between the Phase One connection at Fradley in the West Midlands and Crewe is now being accelerated. The Secretary of State announced in November 2015 that powers for this section would be sought through a separate hybrid Bill to be deposited in 2017, and with a projected opening date of 2027, six years earlier than initially planned. This section is known as Phase 2a and a Sustainability Report³ covering this route accompanied the Secretary of State's announcement in

¹ Temple-ERM. (2013) [High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond. Sustainability Statement.](#)

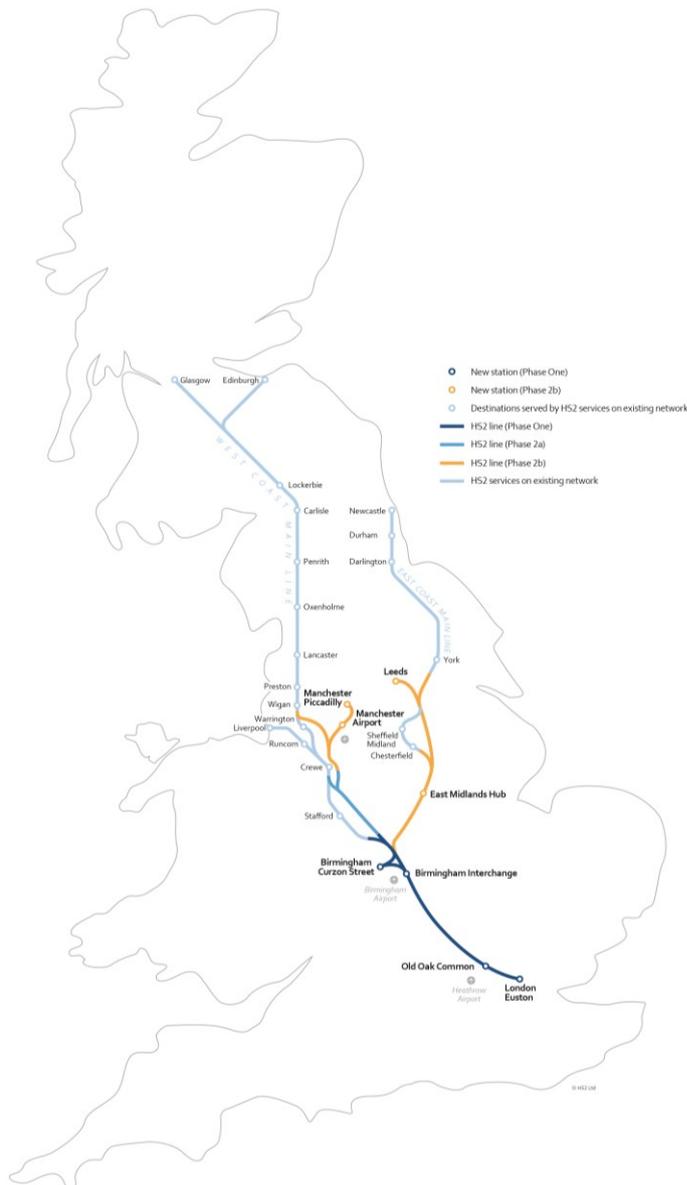
² HS2 Ltd (2016). [HS2 Phase 2b Summary of Route Refinements report.](#)

³ Temple-RSK (2015). [Phase Two Post-Consultation Update: West Midlands to Crewe.](#)

November 2015. The development of the hybrid Bill and an EIA of Phase 2a is now underway.

- 1.2.3. The remainder of Phase Two (Phase 2b) comprises two legs; the western leg which runs from Crewe to Manchester Piccadilly via Manchester Airport and includes a connection to the West Coast Main Line (WCML); and the eastern leg, which runs to Leeds via the East Midlands (including connections to the Midland Main Line and the East Coast Main Line (ECML)). In some locations there have been significant changes to the route presented in 2013. The reasons for those changes are described in the Summary of Route Refinements report and in Section 2 of this report.

Figure 1-1 The HS2 Network, Phase One, Phase 2a and Phase 2b⁴



⁴ Figure 1.1 includes the potential northbound connection that could deliver Transport for the North’s ambition for a frequent 30 minute journey time between the city centres of Leeds and Sheffield. This proposal is presented as part of the consultation. However, as this does not currently form part of the Phase 2b preferred scheme it is not included in the scope of this report.

1.2.4. Further public consultation will be carried out in these areas to ensure that newly affected communities have the opportunity to give their feedback at this stage of the process. There will be further opportunities to engage on the project through the development of the EIA, the hybrid Bill and then through the Parliamentary process.

1.2.5. The following areas are subject to further route refinement consultation:

Western leg:

- new Rolling Stock Depot;
- route between Middlewich and Pickmere; and
- Manchester Piccadilly approach.

Eastern leg:

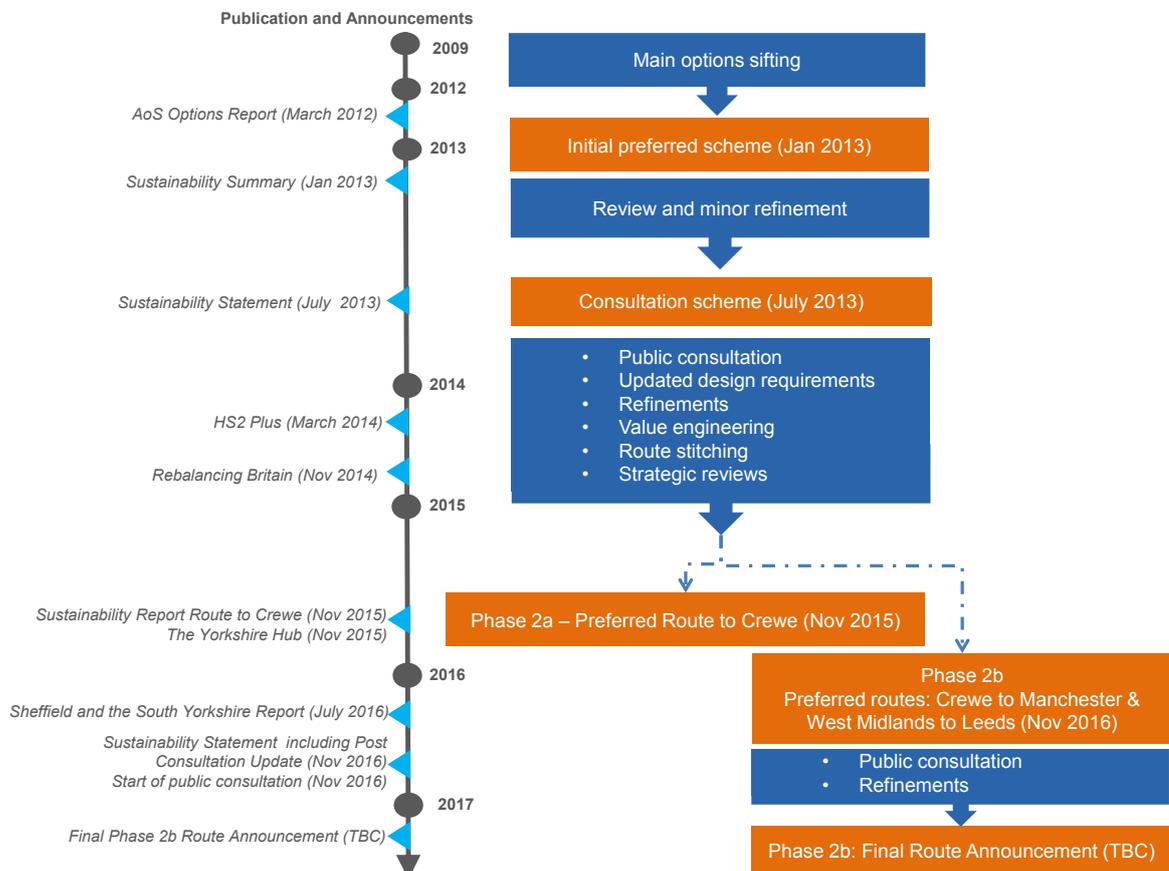
- route around Measham, Leicestershire;
- route along A42 around East Midlands Airport;
- East Midlands Hub approach (Long Eaton); and
- Derbyshire to West Yorkshire (M18/ Eastern route).

2. Development of the Preferred Scheme

2.1. Overview

- 2.1.1. In July 2013 the Secretary of State initiated a seven-month period of public consultation on Phase Two proposals, which also included three months of consultation events.
- 2.1.2. Since the consultation closed in January 2014, the Department for Transport (DfT) and HS2 Ltd have been drawing together information, analysis and opinion from a number of sources, namely:
- response to consultation;
 - strategic considerations, such as the Northern Powerhouse Rail (NPR) project and ongoing strategic review of the Phase 2b proposals, as set out in Sir David Higgins' (HS2 Ltd Chairman) reports; and
 - lessons learned from Phase One and further design development.
- 2.1.3. These have all prompted a number of changes to the scheme, which are described in general terms in this section of the report. Environmental consultants Temple- RSK and the HS2 Ltd Environment Team were fully involved in the appraisal of these changes, including application of the Appraisal of Sustainability (AoS) process (set out in Appendix B) that helped support option development and decision making. Figure 2-1 provides an overview of the AoS process and the key milestones to date.

Figure 2-1 – Evolution of the preferred scheme – AoS



2.2. Responding to consultation

- 2.2.1. The 2013/14 public consultation is described in an independent Ipsos MORI report which summarises the issues that were raised during consultation⁵. An analysis of responses to the AoS was published separately⁶ and updated in 2016⁷.
- 2.2.2. In reviewing consultation feedback, a number of options for refinement and alternatives to the consultation scheme were considered. HS2 Ltd also met separately with local authorities, parish councils, interest groups, local MPs, owners of major assets, and certain key environmental stakeholders.
- 2.2.3. Together, consultation and engagement enabled people and organisations to learn more about the scheme. In turn it allowed HS2 Ltd to better understand local and strategic issues and to glean local knowledge.
- 2.2.4. Options were developed that sought to address the issues raised during consultation and engagement. These were appraised and where they improved the design on balance while maintaining wider scheme requirements, they were adopted into the preferred route following recommendations made by HS2 Ltd. The changes made following consultation are set out in further detail in the HS2 Phase 2b Summary of Route Refinements report.

2.3. Strategic considerations

- 2.3.1. *HS2 Plus*⁸, a report by Sir David Higgins reaffirmed support for the full Phase Two network and stated that *'Phase Two is vital to realising the potential of the North as a whole; but it can only do that if it is done right...'*
- 2.3.2. *Rebalancing Britain*⁹, recommended a review of certain parts of the Phase Two scheme aiming to strengthen the overall case for Phase Two. As well as recommending acceleration of the Phase 2a section of route and the consideration of alternative depot locations serving the western leg of HS2, the report emphasised the need for improved east-west connections across the North of England, including a fundamental review of the best high speed solution for Leeds city centre. These recommendations have each resulted in several scheme changes and are described in the Summary of Route Refinements report.
- 2.3.3. *Rebalancing Britain* also called for the establishment of a new body to manage transport issues at a strategic level across the north of England. The Government subsequently established Transport for the North (TfN) as the body responsible for taking this work forward. TfN has in turn established the Northern Powerhouse Rail (NPR) project to look at new and upgraded rail and road links across the North of England.
- 2.3.4. HS2 Ltd has reviewed the NPR initiative to make sure that HS2 and NPR are co-ordinated and mutually supportive, which has resulted in some Phase 2b scheme changes.

⁵ Ipsos MORI (2014). [High Speed Rail: Investing in Britain's Future. Consultation on the route from the West Midlands to Manchester, Leeds and beyond.](#)

⁶ HS2 Ltd (2015). [Response to HS2 Phase Two Consultation: Appraisal of Sustainability \(Question 7\).](#)

⁷ HS2 Ltd (2016). [Response to HS2 Phase Two Consultation: Appraisal of Sustainability \(Question 7\).](#)

⁸ DfT (March 2014). [HS2 Plus: A report by David Higgins.](#)

⁹ DfT (October 2014). [Rebalancing Britain: From HS2 towards a national transport strategy.](#)

- 2.3.5. *The Yorkshire Hub*¹⁰ recommended a single integrated hub in Leeds to ensure the best outcome for Leeds, Yorkshire, the North and the UK. During consultation, some stakeholders raised concerns over the quality of the linkage between the high speed station at Leeds New Lane proposed during consultation, and the existing Leeds City station. These concerns were further highlighted by the growing strategic focus on transport in the North of England, and particularly the aspiration for better connectivity between urban centres and the need for greater integration of transport at the strategic level.
- 2.3.6. HS2 Ltd also reviewed the approach to serving South Yorkshire. The results of this work are set out in the *HS2: Sheffield and South Yorkshire*¹¹ report. The report recommended an alternative proposal to serve Sheffield and the region with a connection into Sheffield Midland station using a combination of a new spur off the main HS2 route and a connection onto the existing Midland Main Line via the Erewash Valley Line. This proposal removed HS2's Sheffield Meadowhall station and, based on a review of alternative routes, proposed a new HS2 mainline route initially running parallel to the M18, before diverging west and then continuing to join the previous HS2 alignment north of Crofton. This recommendation was made following a review of the needs of Sheffield and the wider region and the sustainability changes are considered further in this report.
- 2.3.7. As part of the refinements to the route presented in 2013, HS2 Ltd has identified a potential northbound connection that could deliver Transport for the North's ambition for a frequent 30 minute journey time between the city centres of Leeds and Sheffield. This proposal is presented as part of the consultation and further information can be found in the Route Refinement 2016 Consultation document¹². However, as this does not currently form part of the Phase 2b preferred scheme it is not included in the scope of this report.

2.4. Lessons learned from Phase One and further design development

- 2.4.1. In support of the Phase One scheme proposals, HS2 Ltd prepared a series of standards that the HS2 design had to meet. The requirements, which reflect industry standards and best practice, aim to ensure 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.
- 2.4.2. Since design of the consultation route these requirements have evolved and, where appropriate, have been applied to Phase 2b, allowing for the more formative state of these proposals. This has resulted in modifications at certain locations, particularly to vertical alignments and gradient profiles.

2.5. Other changes

- 2.5.1. Other minor scheme revisions arose from:
- refreshed data: Geographical Information System data (GIS) and the Digital Terrain Model was updated due to newly available data, which has resulted

¹⁰ DfT (November 2015). [The Yorkshire Hub: An interim report on the redevelopment of Leeds station.](#)

¹¹ DfT (July 2016). [HS2: Sheffield and South Yorkshire Report.](#)

¹² HS2 Ltd (2016). [HS2 Crewe to Manchester, West Midlands to Leeds Route Refinement Consultation 2016, Consultation document.](#)

in some changes along the route;

- route 'stitching': other small changes were necessary where the refined alignments needed to be joined back into the whole scheme; and
- value engineering and updated design: a further series of design updates reflected ongoing initiatives to improve the technical performance of the design (learning from Phase One) or deliver cost efficiencies.

2.6. The AoS and refinement process

- 2.6.1. The AoS process that has been applied since the earliest stages of HS2 continued to be used in appraising the various scheme changes. The AoS covered a range of sustainability topics in a way that enabled appraisal and comparison of a large number of options. The AoS approach was agreed at an early stage with environmental statutory consultees including Natural England, the Environment Agency and Historic England. Further detail on the AoS process is presented in Appendix B.
- 2.6.2. The preferred scheme has emerged through successive stages of sifting and refinement. These have essentially followed three sifting stages, where design and appraisal detail have increased as the number of options has reduced.
- 2.6.3. In general, this three stage process started with consideration of major environmental features (essentially international and national designations) at the initial sift (sift 1), through to more detailed geographical analysis at the intermediate sift (sift 2), and specialist review at the most detailed appraisal during the full sift (sift 3). At this last stage, the options were designed to include earthworks, as well as horizontal and vertical profiles showing approximate rail heights in comparison to ground level. In some cases, where differences between refinement options were minor, a greater level of detail was considered at a comparatively earlier stage in the process to help differentiate between options.
- 2.6.4. Where refinement options were designed to the highest level of detail to support the full sift, a team of environmental specialists were introduced to appraise the options. The findings were consolidated and presented for each option at a series of review workshops to allow relative merits and disadvantages to be discussed and compared.
- 2.6.5. The findings of the AoS work contributed, amongst other considerations, to the progression of options which led to the recommendation of refinements to the route.

3. Scheme description

3.1. Introduction

3.1.1. This section provides a summary description of the preferred scheme. The engineering reports¹³ contain a more detailed description along with plans and profiles, showing both a detailed map of the route as well as an indication of its vertical height or depth along the alignment in comparison to existing topography. This section includes some overview maps; a more detailed view of the route is available in the accompanying Volume 2 maps that show the route in relation to key sustainability features.

3.2. Western leg

Overview

3.2.1. The preferred scheme for the western leg comprises approximately 51 miles (82km) of new railway starting with a connection with Phase 2a at Crewe. This also includes a connection with the WCML near Golborne, and a spur into a new station adjacent to the existing Manchester Piccadilly station. The route comprises the following mix of alignments¹⁴.

Alignment Type	Length km (% of route) ¹⁵
At Grade	3.5 (4%)
Tunnel	16.8 (21%)
Cutting	18.1 (22%)
Embankment	36.2 (44%)
Viaduct	6.9 (8%)

3.2.2. Of this, an estimated 14 miles (22km) (about 34% of the above ground route) is within 150m of an existing major transport route (A-road, motorway or railway). The proposed stations and depot serving the western leg are:

- Manchester Airport station;
- Manchester Piccadilly station; and
- Crewe North Rolling Stock Depot (RSD).

3.2.3. For the purposes of reporting the western leg has been divided into two geographical areas:

- Crewe to Golborne (mainline); and
- the spur to Manchester.

¹³ AECOM (2016). [Crewe to Manchester Route Engineering Report](#).
Mott Macdonald (2016). [West Midlands to Leeds Route Engineering Report](#).

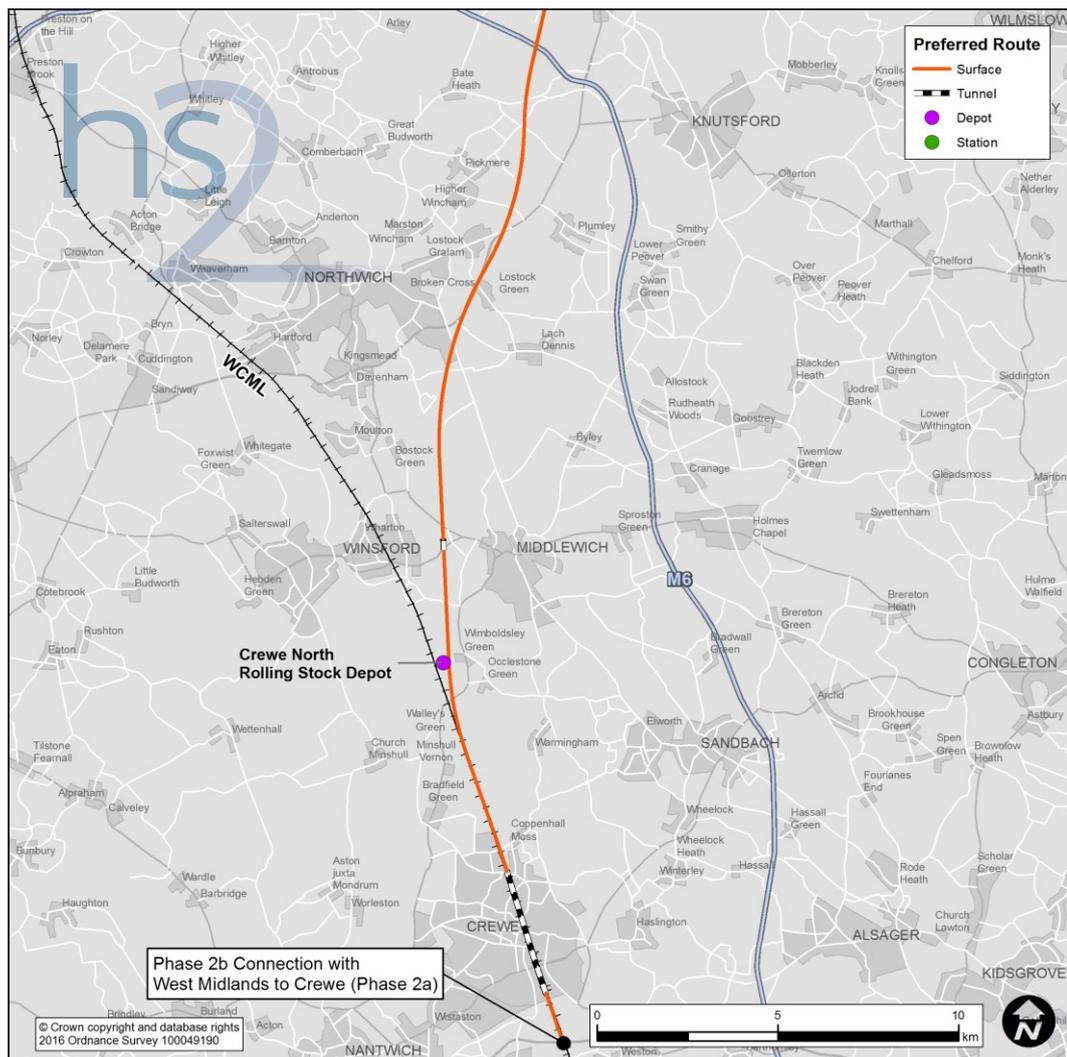
¹⁴ Depot connection length is not included.

¹⁵ Length and percentage of route does not add to 100% due to rounding.

Crewe to Golborne

- 3.2.4. The western mainline route extends between Crewe and Golborne, connecting with Phase 2a south of Crewe before entering a tunnel beneath Crewe for just under 3.6km. A shaft allowing tunnel ventilation, as well as emergency access and evacuation is required. An indicative location is proposed approximately at the mid-point of the tunnel, with access off Middlewich Street.
- 3.2.5. At the time of writing, the Phase 2a scheme is subject to further consultation which includes consideration of how the Phase 2a scheme will join with Phase 2b. As part of this work, the Phase 2a project is considering whether the portal for the tunnel under Crewe should move further south.

Figure 3-1 - Western leg: Crewe to Pickmere (part of the mainline to Golborne)

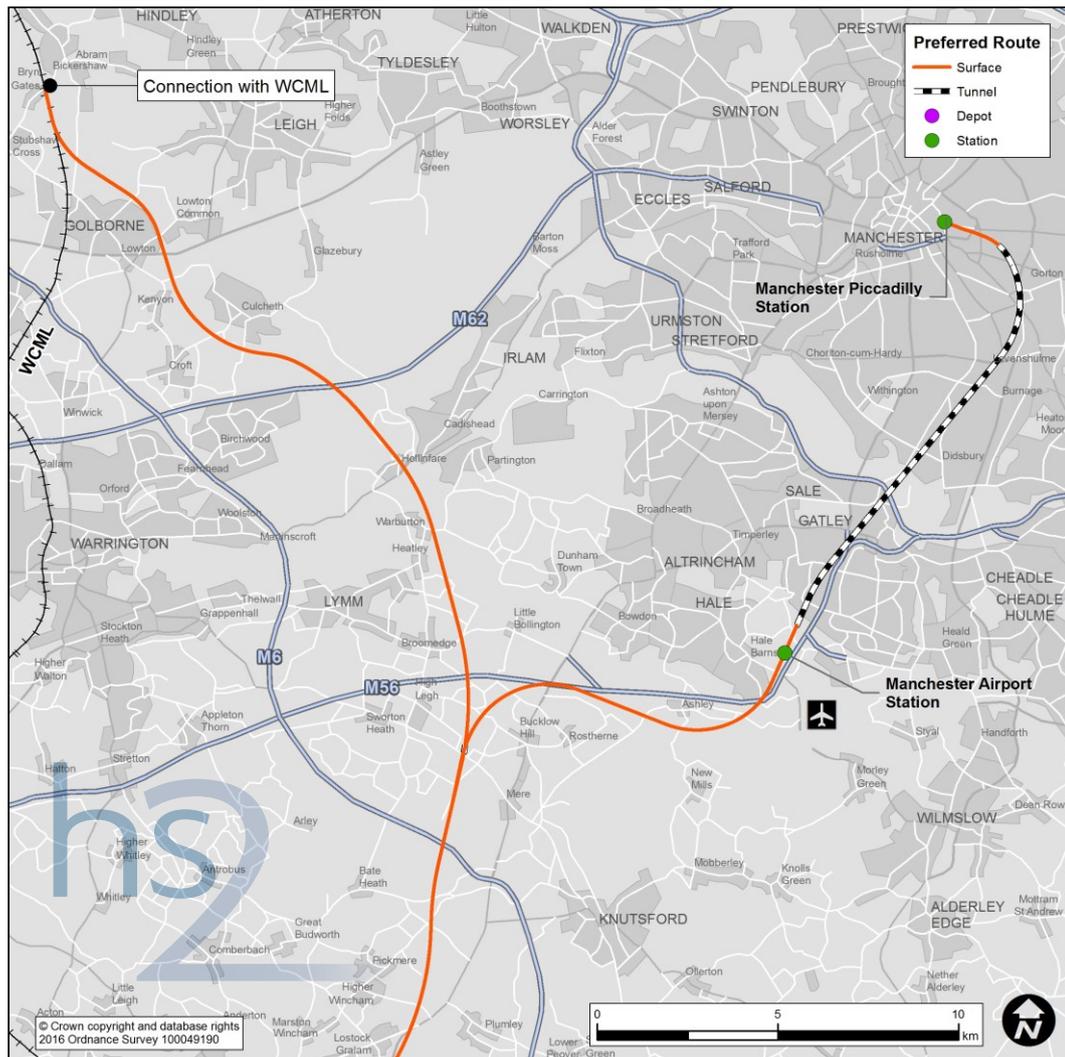


- 3.2.6. The route emerges from tunnel through the town’s northern outskirts, alongside the WCML and maintains this path as far as Walley’s Green where the two railways diverge, with HS2 bearing north across the expansive river-crossed landscape of the Cheshire Plain.

- 3.2.7. Approaching the A530, the Crewe North RSD¹⁶ is proposed at the point at which the WCML and HS2 railways diverge, covering an area of up to 58ha between the two railways. The RSD will be used for stabling, preparing and maintaining the rolling stock.
- 3.2.8. The route passes between Winsford and Middlewich. A junction provides access to the depot from the north. Continuing north past Whatcroft, the mainline requires a series of embankments and bridges or short viaducts to carry it over rivers, canals, railways and roads.
- 3.2.9. The route passes the eastern edge of Northwich and then between Lostock Gralam and Lostock Green, with the A556 proposed to be diverted to the west of the route. The route remains on embankment for several kilometres across the farmland east of Higher Wincham and Pickmere before crossing over the M6 and dividing, with the mainline continuing north and a spur to Manchester bearing east at Hoo Green.
- 3.2.10. The mainline route passes under the M56 and then uses embankments and viaducts as the land dips into the Bollin valley and crosses the farmed former mosslands around the southern edge of Greater Manchester.
- 3.2.11. The mainline route then begins to bear north-west in shallow cutting before rising onto a viaduct over the Manchester Ship Canal. The route continues on embankment for several kilometres across farmland between Warrington and Irlam. It crosses over the M62 and bears west towards Culcheth. Entering cutting it passes on the south side of Culcheth before turning northwards to cross over the Liverpool to Manchester railway. The route descends into cutting and passes beneath the A580, between Lowton St Mary's and Lowton Common east of Golborne. Bearing west it rises onto embankment along the north side of Golborne and then turns northwards as it converges with the WCML at Bamfurlong. The junction allows onward connection with stations further north including Wigan, Preston, Lancaster, Glasgow and Edinburgh.

¹⁶ Further design development is required on depots across Phase 2b, and could be subject to evolving design requirements.

Figure 3-2 – Western leg: Pickmere to Golborne (mainline) and spur to Manchester



Spur to Manchester

- 3.2.12. The spur into Manchester bears east at Hoo Green passing to the north of Rostherne Mere, largely in cutting, parallel and to the south of the M56. It passes between Ashley and Tatton Park before bearing north beneath the M56. A new HS2 station, providing an interchange at Manchester Airport and serving the surrounding area, is proposed west of the airport at Davenport Green.
- 3.2.13. The route continues north in cutting alongside the M56 before entering tunnel for approximately 13km beneath southern Manchester. Four tunnel shafts to provide ventilation and emergency access are likely to be required¹⁷. Indicative locations for these are proposed near the junction of the Altrincham Road (A560) and the M56; the northern edge of Withington golf course off Palatine Road in the Mersey valley; on Wilmslow Road between Ferndene Road and Rathen Road in Didsbury; and off Lytham Road in Rusholme. The route re-surfaces at Ardwick rising onto viaduct into Manchester Piccadilly, where a new HS2 terminus station would be constructed adjacent to and north of the existing station.

¹⁷ These have not been designed or appraised at this stage.

3.3. Eastern leg

Overview

3.3.1. The preferred scheme for the eastern leg would comprise approximately 123 miles (198km) of new railway, including the mainline up to the ECML connection north of Altofts and the spur into Leeds station, as well as the existing rail network south of Sheffield. This would comprise the following mix of alignments¹⁸.

Alignment Type	Length km (% of route) ¹⁹
At Grade	15.8 (9%)
Tunnel	4.9 (3%)
Cutting	71.3 (36%)
Embankment	74.2 (37%)
Viaduct	31.6 (16%)

3.3.2. Of this, an estimated 76 miles (122km) (about 60% of the above ground route) would be within 150m of an existing major transport route (A-road, motorway or railway). The proposed stations and depots serving the eastern leg are:

- East Midlands Hub station;
- Leeds station;
- Staveley Infrastructure Maintenance Depot (IMD); and
- New Crofton Rolling Stock Depot (RSD).

3.3.3. For the purposes of reporting the eastern leg has been divided into four geographical areas:

- Marston to Kegworth;
- Kegworth to Heath;
- Heath to Barnburgh; and
- Barnburgh to Leeds and Church Fenton.

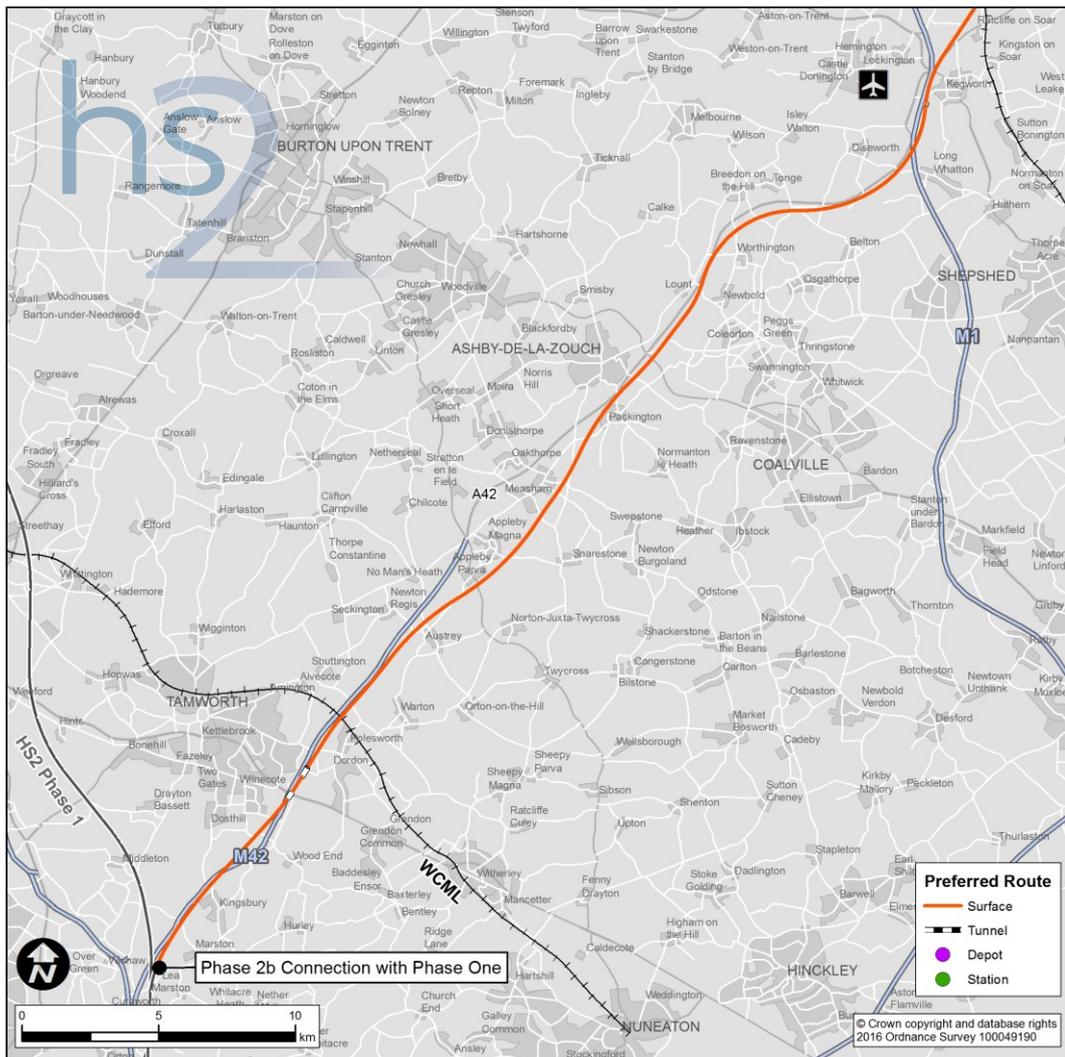
Marston to Kegworth

3.3.4. The route continues north-east from the Phase One alignment near Marston. It passes close by or alongside the M42 and A42 for about the next 45km past Kingsbury, Tamworth, Austrey, Measham, Ashby-de-la-Zouch, Worthington and Kegworth, diverging only briefly past Measham. It may require works affecting these major roads and their junctions at certain locations. Viaducts or bridges carry the route over the valleys of the rivers Tame, Anker and Mease, but much of this section of the route is otherwise within cutting.

¹⁸ Depot connection lengths are not included.

¹⁹ Percentage of route does not add to 100% due to rounding.

Figure 3-3 – Eastern Leg: Marston to Kegworth



Kegworth to Heath

- 3.3.5. South of Kegworth the route is briefly aligned within the corridor of the M1 before diverging eastwards and rising onto viaduct over 3km long, crossing the A6, A453 and Soar floodplain. Emerging north of Red Hill the route passes over the River Trent and associated floodplain on a second longer viaduct which brings the route into the Erewash Valley, which continues on viaduct through Long Eaton and Toton. The East Midlands Hub station, incorporating Network Rail platforms, is proposed at Toton alongside an existing rail freight yard. Indicative locations for maintenance loops are proposed next to the East Midlands Hub Station. Maintenance loops are likely to comprise an additional section of track, each about 0.9 miles (1.4km) long²⁰.

²⁰ An alternative option for a lower alignment through Long Eaton, is being considered by the Secretary of State and is subject to consultation. For the purpose of design development and appraisal, the viaduct described in section 3.3.5 has been incorporated into the scheme at this stage because this option would reduce impacts on the local highways network, as local roads could continue to operate beneath the HS2 viaduct. Please refer to the Route Refinement Consultation Document for further information.

- 3.3.6. The route then passes through the gap between Stapleford and Sandiacre where it bears north-east alongside the M1. The route runs close to the motorway for much of the next 40km as it leaves Toton and passes the settlements of Strelley, Nuthall, Hucknall, Selston, and Pinxton.
- 3.3.7. North of Pinxton, a spur would diverge west from the mainline to enable HS2 services to access Sheffield Midland station using the existing railway through Chesterfield. The spur would pass between the villages of Blackwell and Newton, before connecting to the existing rail corridor near Clay Cross.
- 3.3.8. Heading north from Pinxton, the preferred route would pass to the east of Sutton-in-Ashfield, before going under the M1 in a cut and cover tunnel. It would closely follow the M1 on the motorway's west side, passing Hardwick Hall, Stainsby and Heath. Modification to the M1 and some of its junctions may be required at certain locations.

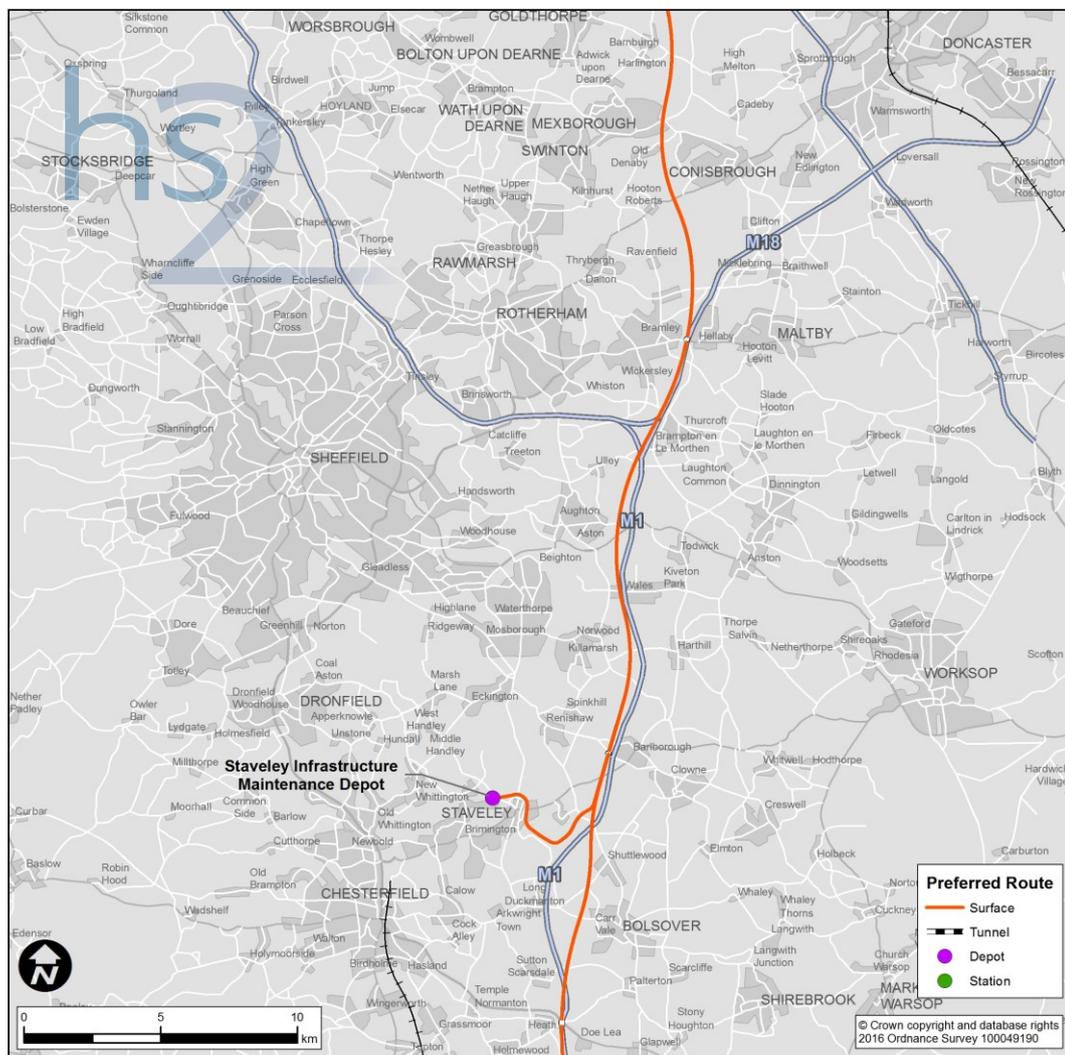
Figure 3-4 – Eastern Leg: Kegworth to Heath



Heath to Barnburgh

- 3.3.9. North of Heath the route continues alongside the M1 before passing over it and bearing east near Bolsover. The M1 and HS2 diverge briefly before converging again, HS2 passing over the motorway once more and then following it on its west side past Barlborough. Just north of the M1 crossing, near Mastin Moor, a grade separated junction links the main HS2 line with Staveley IMD. The IMD will be used for maintaining the railway infrastructure.
- 3.3.10. North of Barlborough, the route follows the west side of the M1, running adjacent to the motorway past the village of Wales, diverging briefly near Woodall and Aston, before crossing the M1/M18 junction on viaduct near Thurcroft. Staying to the western side of the M18, the preferred route would pass between Bramley and Hellaby before diverging north from the M18 through Conisbrough Parks. The route would pass between Mexborough and Conisbrough over the A6023 and to the east of Barnburgh.

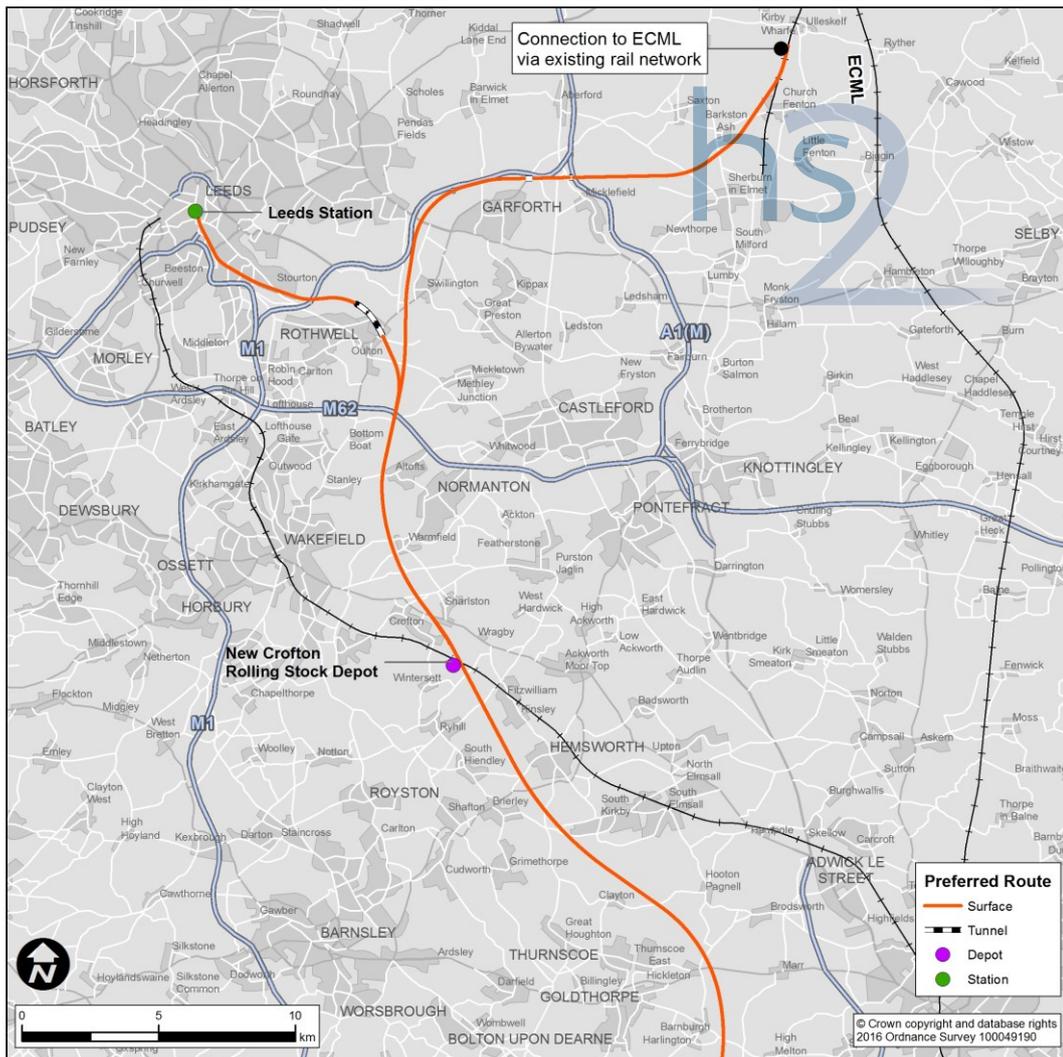
Figure 3-5 – Eastern Leg: Heath to Barnburgh



Barnburgh to Leeds and Church Fenton

- 3.3.11. Passing to the east of Barnburgh and then Hickleton, the route would head west near Clayton, Frickley, South Kirby, Brierley and Hemsworth. The New Crofton RSD is located south of New Crofton. The RSD will be used for stabling, preparing and maintaining the rolling stock.
- 3.3.12. The route enters the edge of the Calder Valley west of Normanton and Altofts, passing on viaduct over the River Calder. It then rises on a long viaduct over the River Aire, the Aire and Calder Navigation and the M62 motorway. The spur into Leeds diverges at this point.
- 3.3.13. The mainline passes Swillington before bearing east to join the corridor of the M1 north of Garforth. It passes beneath the A1(M) just south of its junction with the M1, and then predominantly uses cutting and embankment through undulating and wooded farmland before bearing northwards once again to the north of Sherburn-in-Elmet. It rises onto a long viaduct and connects into the Normanton to York railway between Church Fenton and Ulleskelf, which joins the ECML, allowing onward connection with stations further north including York, Newcastle and Edinburgh.
- 3.3.14. The spur into Leeds diverges from the mainline along the Aire Valley before entering tunnel beneath Woodlesford. Emerging north-west of this settlement it continues along the valley before dropping into cutting and passing beneath the M1. It continues alongside the existing Normanton to Leeds railway through the industrial areas of Stourton and Hunslet, just north of the M621. The spur rises onto viaduct past Pottery Field into an elevated station over the River Aire, which will be integrated with the existing Leeds station.

Figure 3-6 – Eastern Leg: Barnburgh to Leeds and Church Fenton



3.4. Trains, services and journeys

3.4.1. Phase 2b services are currently expected to start in 2033. All services on the Phase 2b route would use high speed trains only, operating at a maximum speed of 225mph (360kph) from day one of operation, although the railway alignment has generally been designed to accommodate trains up to 250mph (400kph). The design speed of the route varies for particular sections of the western and eastern leg, which is described further in the engineering reports.

3.4.2. In order to serve both HS2 stations and other destinations, two types of train would be used, namely:

- “HS2 Captive” standard high speed train, running only on the HS2 route.
- “Classic-compatible” high speed train, which would run on the HS2 route, but also serve destinations accessed via connections to the existing rail network²¹.

²¹ HS2 Ltd (2016) [HS2 Operation and Train Types](#).

- 3.4.3. Both types of trains would typically be of units totalling 200m in length, and capable of being doubled to 400m. The trains are expected to have up to 550 seats on the 200m long trains and up to 1,100 seats for the 400m trains, with the railway designed to take up to 18 trains per hour in each direction.
- 3.4.4. It is expected that services would operate from 5am to midnight Monday to Saturday and 8am to midnight on Sunday, with maintenance and engineering activities undertaken at other times.

3.5. Power supply

- 3.5.1. HS2 trains would draw power from overhead lines. These require feeder stations with connections to the National Grid electricity network located approximately every 55km. The locations for these have not been determined at this stage²².
- 3.5.2. In addition to feeder stations, smaller autotransformer stations would be required at approximately 5km intervals. Each would require a small area of land adjacent to the route. Again, the locations for these have not been determined at this stage.

3.6. Construction

- 3.6.1. The way the scheme would be constructed has not been developed at this stage of the process. Construction site locations, access routes, working methods and detailed programmes will be defined in due course and will be considered within the scope of the EIA and during further detailed design stages (see Section 4.3 and Section 10)²³.

²² HS2 (2016) [The HS2 Rail Corridor](#).

²³ HS2 Ltd (2016) [Constructing and maintaining a safe and secure network](#).

4. Describing sustainability impacts

4.1. Introduction

4.1.1. The key potential sustainability impacts of the preferred scheme are described for the western leg in Section 5 with accompanying maps in Section 6 and for the eastern leg in Section 7 with accompanying maps in Section 8, running in a south to north direction. Phase 2b scheme wide impacts are presented in Section 9 and Section 10 presents combined impacts of Phase One, Phase 2a and Phase 2b. This section introduces the sustainability issues covered by the AoS and explains how the appraisal has been undertaken. The order in which the topics are addressed reflects a general grouping of impacts on people, the environment and on land and material resources. These topics are:

- planning and development;
- employment and housing;
- property and community integrity;
- access;
- health, wellbeing and equalities;
- noise;
- air quality;
- landscape and visual;
- cultural heritage;
- biodiversity and wildlife;
- water resources and flood risk;
- land use resources; and
- excavated material and material use.

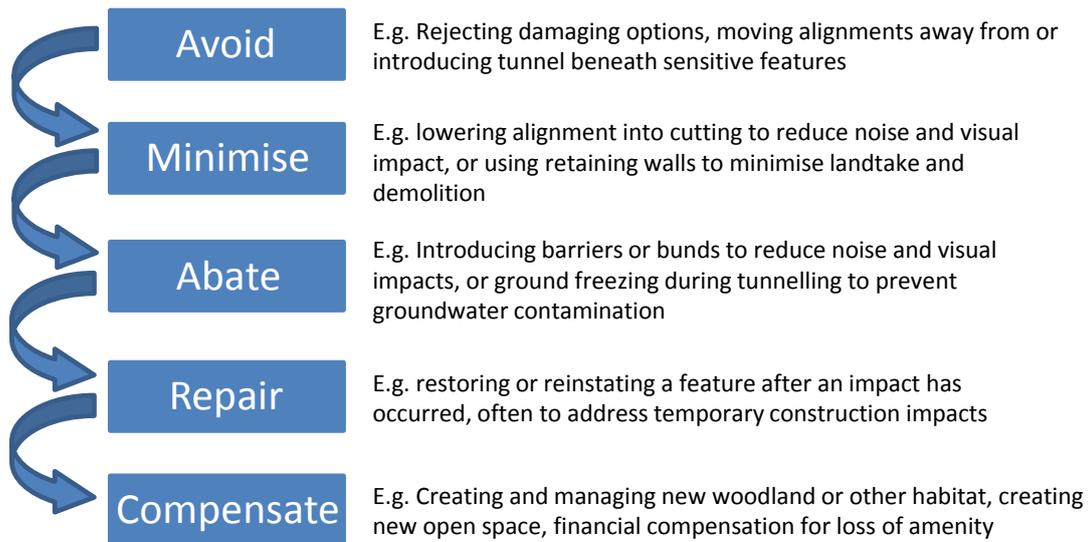
4.1.2. The AoS method (Appendix B) was devised to provide a sound basis for comparing scheme options during the earlier stages of scheme development, to inform decision making and later for reporting and engaging on the principal impacts of the scheme. Only permanent impacts are considered in this report, it does not include temporary construction impacts or impacts on other proposals/projects. A more detailed understanding of environmental effects will be developed in due course through the EIA (see Section 10).

4.2. Mitigation principles

4.2.1. As well as establishing certain design principles and supporting the options development and sifting process, the AoS has enabled a number of potentially adverse effects to be avoided or reduced through design modification.

4.2.2. In the earliest stages, and well before designs are fixed, potentially adverse impacts may be avoided by rejecting the most environmentally damaging options and realigning others, either up or down (vertically) or sideways (horizontally). Impacts may be minimised; for example through reducing the width of the rail corridor within sensitive environments to minimise landtake, or lowering it in cutting to reduce visual impacts.

Figure 4-1 The mitigation hierarchy



4.2.3. As the scheme design develops in detail, the opportunity to change the alignment lessens and alternative mitigation strategies become appropriate. The kinds of mitigation that could be applied at the next stage of design on Phase 2b can be seen through the EIA work on Phase One, as directed by HS2's Sustainability Policy²⁴. These measures are principally of three types, and are set out within Section 6 of Volume 1 of the Phase One Environmental Statement (ES)²⁵:

- mitigation that is provided through the planning and design of the preferred scheme, such as through variation in horizontal and vertical alignment, or use of bridges, tunnels and retained cuttings;
- mitigation that requires physical features, such as noise barriers, landscaped mitigation or balancing ponds; and
- mitigation that comprises further measures or policies, which are set out for different topics.

4.3. Construction impacts and their mitigation

4.3.1. The Phase 2b AoS has concentrated on the potential long term and permanent impacts of the preferred scheme, resulting from landtake and operation of the railway and its infrastructure. Details of construction are yet to be developed; the impacts that are likely to occur over the construction period will be considered in due course by the Phase 2b EIA and during further detailed design.

4.3.2. Construction activities will be a source of concern to many people along the route. As the design of the preferred scheme evolves, construction proposals will be defined including, amongst other things, location of work sites, activities, types of equipment, routes for construction traffic and expected duration of different work elements.

4.3.3. The main potential temporary impacts expected during construction would include:

- temporary landtake for construction sites;

²⁴ HS2 Ltd (2015). [HS2 Sustainability Policy](#)

²⁵ HS2 Ltd (2013). [HS2 Phase One Environmental Statement](#)

- noise and vibration from construction activity;
 - views of construction sites, lighting and equipment;
 - additional road traffic, particularly due to lorries;
 - dust generated at construction sites and along the temporary track alongside the HS2 route; and
 - pollution to surface and groundwater and other changes to flows.
- 4.3.4. HS2 Ltd is committed and legally required to manage potential construction impacts and reduce disruption to communities, businesses and the environment (including land restoration), and follows legislative requirements and reflects best practice used by the construction industry. Local Environmental Management Plans (LEMPs) will be used on Phase One to set out how, at a local level, impacts during construction would be managed; it is expected that Phase 2b will have similar plans. The LEMPs will be informed by a Code of Construction Practice (CoCP), a draft of which defines the principles for mitigating potential impacts such as noise, dust, lighting, traffic, river crossings, disturbance to wildlife or disruption to buried archaeology. The draft CoCP for Phase One and Phase 2a²⁶ will form the basis for the CoCP that would be developed for Phase 2b at the equivalent stage in the process. In this way, HS2 Ltd is confident that many of the impacts that could arise will be effectively controlled.
- 4.3.5. The remainder of this section outlines the approach that has been taken up to this point in appraising and reporting the potential long term and permanent impacts of the scheme.

4.4. Planning and development

- 4.4.1. The AoS has focused on potential changes to the existing environment. However, to consider possible future sites and particularly future developments built along the route between now and the time that construction of Phase 2b will begin, a review of major development proposals known at the time of appraisal has been undertaken along the route, including:
- residential development of 100 or more dwellings or a site area of one hectare or more;
 - other developments with floorspace of 5,000m² or more or a site area of one hectare or more;
 - major infrastructure schemes, including highways schemes; and
 - major minerals and waste management sites (including both new and extended sites).
- 4.4.2. The review considered local planning policy allocations within adopted and emerging development plan documents. It considered masterplan documents, development briefs and consultation documents; it considered live (but as yet undetermined) planning applications registered by the local planning authority or Planning Inspectorate; and it considered extant planning consents, where the consent is granted but development is yet to have commenced or be completed²⁷.

²⁶ HS2 Ltd (2013). HS2 Phase 1: [Draft Code of Construction Practice](#).
HS2 (2016) HS2 Phase 2a: [West Midlands to Crewe Draft Code of Construction Practice](#).

²⁷ Major Development sites that are not announced or have come forward since April 2016 will have not been included but will be considered in the next stage of work.

- 4.4.3. Sections 5.2 and 7.2 identify those major development sites on the western and eastern legs that would be crossed or otherwise impinged by the preferred scheme.
- 4.4.4. Although there are some sections of Phase 2b that are yet to be decided on, the Secretary of State has issued Safeguarding Directions for a corridor of land along the entire Phase 2b route. This is to ensure that HS2 Ltd is notified of, and has the opportunity to comment on and, if necessary, recommend refusal of planning applications for developments that conflict with the scheme proposals.
- 4.4.5. For the known sites potentially affected by Phase 2b, HS2 Ltd would seek to work with the relevant local authority and the affected developers or promoters to determine how potential impacts might best be managed and how potential opportunities could be realised and maximised.
- 4.4.6. Through a co-ordinated approach, HS2 stations could have beneficial effects for some other development sites by making them more accessible. These opportunities will continue to be explored in discussion with the relevant local authorities. The implications for residential and commercial development, in terms of houses and jobs, are considered in Section 4.5.

4.5. Employment and housing

- 4.5.1. Introduction of and investment in HS2 stations could have profound effects on the surrounding areas, as people and businesses take advantage of new opportunities arising from the transformation in connectivity. Using methods for similar appraisal work undertaken for the Crossrail project in London, the AoS estimated the likely number of jobs and houses potentially supported by HS2 in the area immediately around proposed HS2 stations.
- 4.5.2. The appraisal has not attempted to predict the extent to which a high speed rail station could itself effect transformation in an area, where no such major development proposals exist currently. Instead it has focused on the potential for HS2 to “unlock” and bring forward development sites that are already proposed, uplift the capacity of these proposals, and support higher density development, including tall buildings. Those stations served by classic compatible routes, e.g. York, Newcastle, Chesterfield, Sheffield, Liverpool, Crewe do not form part of this strategic appraisal.
- 4.5.3. The amount of development that could be stimulated by HS2 with the introduction of a new station is based on the anticipated net additional floorspace of commercial development and residential development within a catchment²⁸ of the proposed station over the subsequent 25 years, estimated for scenarios both with and without HS2 to determine the difference.
- 4.5.4. Information on the property market and potential future development has drawn on a variety of source material including published policy and guidance; relevant strategic planning documents; local planning information and assumptions; and existing property, retail and employment data and studies.
- 4.5.5. Findings in sections 5.3 and 7.3 are described for each station in terms of HS2's potential support for additional jobs and dwellings (housing units). The numbers reported would represent new jobs and houses occurring within the catchment area of the HS2 stations, some of which might have occurred irrespective of HS2

²⁸ A catchment of 1km was used for central urban areas; a catchment of 2km was used for less built-up areas.

but in other areas, and some of which would be entirely due to HS2: the proportion of each is not possible to quantify with any degree of certainty.

- 4.5.6. In addition, sections 5.3 and 7.3 provide estimates of the likely number of jobs displaced due to potential demolition of commercial and industrial properties around stations and depots. These jobs would potentially be accommodated elsewhere in the region, and as such are expected to be displaced rather than lost. Although it is considered most likely that displaced jobs would be taken up in the local area, the AoS has taken a conservative position by accommodating the jobs displaced within an overall net figure for jobs supported. Where station locations remained similar to those presented in the Sustainability Statement (2013), a gap analysis was undertaken to review any local planning policy changes or proposed new major development sites.
- 4.5.7. Section 9.5 includes HS2 Ltd's latest estimates for the numbers of permanent jobs required to operate trains, stations and depots on the Phase 2b network. The number of operational jobs is based solely on those apportioned to the Phase 2b scheme, accepting that in practice many people, such as drivers and maintenance staff, would work across the full HS2 network. Estimates are also provided for the number of construction jobs required during the peak of construction. Further details on the appraisal of socio-economic issues are available in *Appendix C7 Socio-Economics*.
- 4.5.8. In all probability, there are likely to be wider socio-economic benefits in terms of the additional jobs and commuter trips that would be generated as a result of introducing a high speed station. Some of these themes have been explored further in the wider economic issues (see Section 9.5).

4.6. Property and community integrity

- 4.6.1. The AoS considered the physical impacts of HS2 on property in terms of potential demolitions. Estimates are for impacts during the operation of HS2 only. Property impacts do not include construction, mitigation or road diversion plans; this will be considered during the next stage of design and in the EIA for Phase 2b.
- 4.6.2. Using plans showing the preferred scheme footprint, counts have been made of the number of residential properties, community facilities, industrial properties and commercial properties that would potentially be demolished by the preferred scheme. These counts relied on OS 2014 postal address data, which was updated following consultation to allow consistent comparison of route refinement options. As a result of both updated address information and changes made to the consultation scheme, the numbers differ from those reported in the Sustainability Statement 2013.
- 4.6.3. In addition, the report addresses the potential for the route to cause severance and/or isolation of residential communities. Severance could occur when settlements are divided by the route, leaving some people separated from certain community facilities. Isolation could occur where areas become enclosed between the route and other existing infrastructure (such as motorways or railways) or large linear features, such as main rivers. In most cases, wherever roads would be crossed by the route or its construction, access would be maintained. However, a perception or sense of isolation or severance could still affect residents.
- 4.6.4. All potential occurrences of demolition, isolation or severance based on OS 2014 postal address data are reported in sections 5.4 and 7.4 along with identified isolation or severance impacts on community facilities. Further details on the methodology for the appraisal of property and community integrity are available in *Appendix C6 Property and Community Integrity*.

- 4.6.5. As part of this announcement, the Government is consulting on the introduction of property compensation and assistance schemes for the Phase 2b route. Further information on the HS2 Phase 2b Property Scheme Consultation can be found at www.hs2.org.uk. These schemes will supersede the existing discretionary scheme (the Exceptional Hardship Scheme) that has been available to those who qualify.
- 4.6.6. In addition to appraising direct property impacts, the number of dwellings within 100m of the above ground route is reported as a representation of the number of people at greater risk of construction disturbance, although, the construction details and associated mitigation are yet to be developed.

4.7. Access issues

- 4.7.1. A fundamental purpose of HS2 is to improve access and capacity by getting people to where they need to be more quickly, efficiently, reliably and in larger numbers. To do this most effectively it is important that the preferred scheme provides interchange hubs with other transport systems, including roads, railways, airports, cycleways and footpaths. The AoS included a review of the interchange opportunities at stations. These are reported here in a regional context, looking at the major transport arteries within Greater Manchester, West Yorkshire, South Yorkshire and the East Midlands. The AoS also considers the local context, addressing the availability of conventional train, bus, coach, tram and road services within a 1km catchment of the stations, as well as the provision for pedestrian and cycling links to the nearest residential areas.
- 4.7.2. An assessment of impacts on the road and rail networks, including potential changes in local road traffic (especially during construction) will be addressed in due course and reported in the Phase 2b EIA.
- 4.7.3. The AoS also reviewed the potential crossing of certain public rights of way. Where the scheme or its construction would sever rights of way, new crossings or temporary access would be provided, subject to discussions with local authorities. Not all such potential impacts have been identified. However, any named long distance footpaths potentially affected have been recorded here.
- 4.7.4. Potential impacts from the loss of recreational access were also appraised in terms of National Trust land, open access land and country parks. Impacts are described in sections 5.5 and 7.5. Further details on the appraisal of access issues are available in *Appendix C8 Access*.

4.8. Health, well-being and equality

- 4.8.1. The AoS included separate appraisal of potential impacts on health and well-being, and on equality.
- 4.8.2. Consideration of potential health and well-being impacts involved making a qualitative assessment of the potential health effects and vulnerabilities along the preferred scheme. In the absence of a single agreed method, the approach has followed guidance and methods set out by the National Institute of Clinical Excellence (NICE) and the World Health Organisation as internationally recognised standards.
- 4.8.3. The appraisal has used local authority 2015 health profiles and has drawn on mapped indices of multiple deprivation (IMD) health data along the route. Against this baseline, the health appraisal has taken AoS conclusions on the potential impacts of noise, visual impact, air quality and employment to identify where these could have secondary implications for health. Potential impacts have been validated where possible through review of publicly available data (where available) on the health impacts of other rail projects.

- 4.8.4. Further analysis of the potential direct and indirect health effects (positive and negative) and the significance of those health effects is expected to be undertaken at the EIA stage, so that this can inform the development of the scheme taken forward for consent. A key part of any future appraisal will be stakeholder engagement and taking account of any concerns raised by stakeholders as well as the implications for health identified in this report.
- 4.8.5. A separate equality analysis has examined which groups vulnerable to discrimination and social exclusion may be differentially affected by the preferred scheme (see Appendix A). It identifies the equality groups with protected characteristics to be considered and indicates the potential for both adverse and beneficial effects, either from the scheme as a whole or at specific locations.
- 4.8.6. Equality impacts will tend to result from people (or groups) with protected characteristics having a disproportionately greater sensitivity to impacts such as changes in access, noise, property demolition, isolation and severance, employment and job displacement. The equality analysis has therefore drawn on the wider findings of the AoS in order to determine where equality impacts might occur. This includes impacts relating to changes in access to affordable housing, access to community and healthcare facilities, access to faith-related facilities, access to public transport, play space provision, noise impacts on learning, isolation and marginalisation, unemployment, and shortage of accessible housing.
- 4.8.7. A more detailed analysis of the scheme's compliance with the Equality Act 2010 will be undertaken at the EIA stage.
- 4.8.8. Impacts are described in sections 5.6 and 7.6. Further details on the appraisal of health and well-being are available in *Appendix C9 Health Analysis*.

4.9. Noise and vibration

Overview

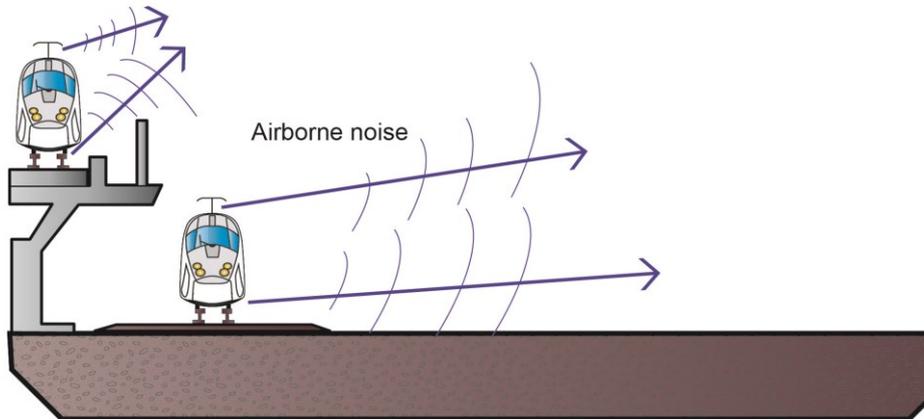
- 4.9.1. The AoS has used a computer-based noise model to predict potential airborne noise impacts on dwellings due to noise from trains on the railway. Construction noise and vibration (including ground-borne noise), and airborne noise at other sensitive locations are described at a commentary level only.
- 4.9.2. A more detailed noise and vibration assessment will take place as part of the EIA. This will draw on a programme of baseline noise surveys to report on the predicted noise changes and absolute noise levels at individual properties. However, the information presented in this Sustainability Statement is commensurate with the level of design information available and will provide a good indication of where noise impacts might be expected, and what those impacts might be. Noise impacts are described in sections 5.7 and 7.7. Further details on the appraisal of noise and vibration are available in *Appendix C5 Noise and Vibration*, and noise maps included within the associated Volume 2 Sustainability Mapping which show modelled noise impacts of the scheme, with and without indicative mitigation.

Types and sources of operational noise

- 4.9.3. Airborne noise from high speed trains comes from a number of sources:
- mechanical noise from motors, fans and ancillary equipment on the train, which tends to be the dominant source at low speeds;
 - rolling noise from wheels passing along the rails, which is predominant at higher speeds; and
 - aerodynamic noise from general air flow around the train body and around

the pantograph and wheel areas, which starts to become prevalent at the highest speeds, over 300kph.

Figure 4-2 - Airborne noise from railways



Approach to appraising operational noise

- 4.9.4. The airborne noise appraisal predicted levels of railway noise on groups of dwellings occurring over 18 hours (between 6am and midnight, when HS2 services would largely operate²⁹). Three different appraisal criteria have been used to indicate the potential noise impact:
- Dwellings potentially exposed to **high HS2 ‘average’³⁰ noise levels**, i.e. greater than or equal to 73dB_{L_{Aeq,18hr}}.
 - Dwellings that could **qualify for noise insulation** based on the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996.
 - Groups of dwellings that could have a **noticeable (although not necessarily significant) increase** in ‘average’ daytime railway noise levels, defined as having a noise level of 50dB L_{Aeq,18hr} or more³¹ and a change in existing rail noise levels of 3dB L_{Aeq,18hr}³² or more.
- 4.9.5. The implication of a noticeable noise increase could be quite different for different people, as human response to noise is variable; whereas some may be disturbed by it, others may barely notice it.
- 4.9.6. The HS2 noise appraisal incorporates noise predictions using methods set out in DfT’s Technical Memorandum for the Calculation of Railway Noise. This uses assumed noise levels of high speed trains, based on the noise levels of currently

²⁹ This 18 hour measurement is a standard period used in noise appraisal. Although HS2 services would likely start at 5am this would not make any material difference to the results.

³⁰ L_{Aeq} is the equivalent continuous A-weighted sound pressure level, in decibels, determined over a time interval. This is the sound level, which, if kept constant over the time interval, would give the same noise energy as is received from a fluctuating sound, for example a railway.

³¹ 50dB(A) is based on a World Health Organisation threshold, below which a few people would be expected to be ‘moderately annoyed’.

³² 3dB is a noticeable change in total noise over an assessment period.

operating high speed trains³³ together with noise level requirements for new trains from European specifications³⁴. It then builds in the:

- number and length of HS2 trains;
- maximum operating speeds, based on speed profiles for different sections of the preferred route;
- existing rail noise levels based on published government noise maps;
- details of the preferred route alignment, including proposed embankments, cuttings, tunnels and viaducts, within the context of the surrounding landscape; and
- screening effects of buildings along the route, based on general screening attenuation.

4.9.7. The approach has predicted potential impacts based on a comparison of HS2 and other existing rail noise only (thereby excluding background noise such as roads).

Mitigating operational noise

4.9.8. The appraisal of the preferred route has involved a phased approach. Initially it considered the inherent noise-reducing effects of the alignment, such as cuttings and tunnels. This identified locations where, despite these alignment characteristics, additional mitigation may be necessary. These 'candidate areas for mitigation' took account of clusters of dwellings affected by noise impacts.

4.9.9. The appraisal used professional judgement of the engineers and acoustic specialists to determine the feasibility and likely effectiveness of potential mitigation measures, including trackside noise barriers, low barriers close to the track on viaducts, or treatment of the track itself, such as rail dampers. The principal assumptions are set out below.

- Improvements will have been made in noise control for the new generation of trains in line with recommendations in current European standards.
- Noise reduction would be equivalent to that achieved by use of 3m high noise-absorbent barriers at all candidate areas for mitigation, or at viaducts by 2m high noise-absorbent barriers. Proposals for the most appropriate and effective mitigation techniques to be deployed at each location (for example, using bunds that give additional landscape mitigation) would be outlined during the EIA based on a detailed appraisal of local conditions and engineering feasibility.

4.9.10. The noise assessment as part of the EIA will identify specific mitigation measures and likely significant residual noise effects that takes this mitigation into account.

Operational ground-borne noise and vibration

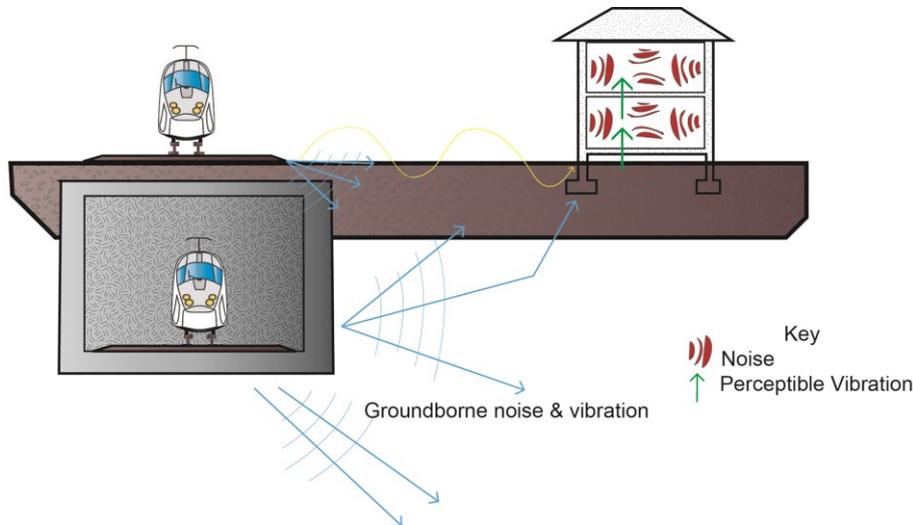
4.9.11. Vibration is generated in the ground by the passage of trains, both at the surface or in tunnels. Vibration can sometimes become heard as low frequency noise within buildings. This ground-borne or structure-borne noise depends on a number

³³ Gautier, P.-E., Létourneaux, F., & Poisson, F. (2007). High Speed Trains External Noise: A Review of Measurements and Source Models for the TGV Case up to 360km/h. SNCF, Innovation and Research Department, France.

³⁴ HS2 Ltd (2008). Commission Decision of 21 February 2008 concerning a technical specification for interoperability relating to the 'rolling stock' sub-system of the trans-European high speed rail system (notified under document number C(2008) 648) (2008/232/CE).

of factors including the speed of the trains, the design of the railway, the distance from the route, the composition of the ground through which the vibration propagates, and the design of the receiving building and its foundations.

Figure 4-3 - Ground-borne noise and vibration from railways



- 4.9.12. Experience from HS1 and international guidance³⁵ suggests that potentially significant effects from ground-borne noise and vibration can be mitigated. With mitigation similar to the resilient track forms developed for HS1 or through equivalent techniques, significant ground-borne noise and vibration effects could be avoided and HS2 Ltd is committed to ensuring that no adverse effects arise.

Additional considerations

- 4.9.13. The AoS has predicted potential impacts based on a consideration of HS2 within the context of existing rail noise. There are other sources of existing noise, such as road, aircraft and industry that have not been considered at this stage, but which would in practice moderate the relative effects of HS2 train noise. Consideration of these other background noise sources could alter the identified potential impacts and in general, impacts are likely to be lower than identified here as any increases in noise attributable to HS2 may be less noticeable.
- 4.9.14. Noise from proposed HS2 stations and depots has not been appraised at this stage. Stations could give rise to additional noise impacts from trains entering and leaving the stations, public address systems, ventilation systems and local road traffic. Noise impacts from depots could arise from trains, as well as from fixed and mobile maintenance equipment and building services. Past experience has shown that the majority of these impacts could be avoided or minimised to a large degree through the use of effective planning and design and other noise mitigation measures.
- 4.9.15. Tunnel ventilation shafts could also give rise to noise impacts. Forced ventilation systems would be required although these would tend to operate only in the event of an emergency or testing. Otherwise, the main potential noise source at the surface would be from the passage of trains due to pressure relief and train pass-by noise. However, experience from HS1 and the Jubilee Line Extension indicates

³⁵ Harris Miller Miller & Hanson Inc., (October 2005). U. S. Department of Transportation Federal Railroad Administration HMMH Report No. 293630-4: High-Speed Ground Transportation Noise and Vibration Impact Assessment

that impacts can be avoided if ventilation shafts are built with appropriate mitigation incorporated within the structure. The approach to HS2 tunnel shaft noise would build on this experience and best practice for noise control.

- 4.9.16. Construction noise has not been appraised at this stage, but measures to control noise from construction would be implemented as part of a wider environmental management system including adherence to measures that will be set out in the draft CoCP.

4.10. Air quality

- 4.10.1. HS2 trains would be electric and would not emit pollutants directly. Generation of electricity to supply the grid from which HS2 would draw its power would give rise to emissions. However, these net emissions are expected to decrease with time as the use of renewables and other low-carbon power-generating technologies increases, with benefits for general air quality as well as climate change.
- 4.10.2. Air quality impacts could also arise as a result of modal shift, with people increasingly using trains in preference to cars. As road vehicles give rise to more emissions of nitrogen dioxide (NO₂), particulate matter (PM₁₀ and PM_{2.5}) and dust compared with electric trains, mode shift to high speed trains would potentially have beneficial impacts on air quality in some locations. However, the air quality impacts of modal shift have not been determined as part of the AoS.
- 4.10.3. HS2 could also affect air quality locally, around stations as a result of increases in road traffic or the generation of traffic on new routes accessing HS2 stations. This report identifies situations where there is a potential for generated road traffic due to HS2 to affect areas with existing air quality problems. These areas, called air quality management areas (AQMAs), have levels of certain pollutants that are expected to exceed stated national objectives. Estimated vehicle trip generation due to HS2 will be considered as part of the EIA, although this report provides a general commentary on potential impacts in sections 5.8 and 7.8 relating to AQMAs around station locations, where traffic movement is likely to be highest.
- 4.10.4. Potential impacts from construction, such as from dust or from construction traffic, emissions are not considered at this stage. Mechanisms to control these potential impacts will be set out in and rigorously applied through the CoCP.

4.11. Safety

- 4.11.1. The AoS has considered implications for safety by taking initial predictions for numbers of people either switching to HS2 from other transport modes or using HS2 where they would not previously have taken long-distance journeys, and considering how this might affect fatality and injury rates knowing the relevant average fatality and injury rates for the different modes of transport. Section 9.4 provides further commentary on safety.

4.12. Landscape and visual impacts

- 4.12.1. The preferred scheme would cross landscapes that differ in terms of their characteristic patterns and scale of landform, vegetation, land use and built development. These characteristics determine the sensitivity of the landscape, as well as its susceptibility to accommodate different forms of built development. The potential landscape impacts of the preferred scheme have been appraised against this background, initially by studies of maps and aerial photographs, and supplemented by site visits at the stations and along the line of route.
- 4.12.2. The AoS also considered the potential visual impacts of the scheme, taking account of who is likely to see it and how these views could affect their 'visual

amenity'. Visual impacts take account of the landscape impacts, but also of more direct changes, either resulting from the obstruction of or intrusion into views by different HS2 structures; or the creation of new views where existing landscape features are removed or altered. Visual impacts are described in terms of these qualitative changes, as well as in terms of the likely sensitivity of people to visual impact and their opportunity to experience it.

- 4.12.3. The sensitivity of people to visual impacts can only be presumed, and is categorised by groups. Residents are generally assumed to be the most sensitive group, as they tend to have a strong interest in what they see and a prolonged exposure to views. Users of recreational open space and footpaths are equally assumed to be a sensitive group.
- 4.12.4. The AoS also took account of statutory landscape designations, although the preferred scheme follows a route that avoids all direct impacts on these areas. The route is also sufficiently distant from them to ensure that impacts on views on the Peak District National Park (which is the only such potentially affected) would be insignificant.
- 4.12.5. Impacts are described in sections 5.9 and 7.9. These are based on a scheme design without additional mitigation included. With continuing design development, proposals for mitigating impacts will be introduced through, for example, minor refinements to the route, use of earthworks to help screen views and proposals for planting. In line with the approach for Phase One and Phase 2a, the landscape proposals would form part of an integrated design approach for the preferred scheme that integrates the engineering requirements of landscape, noise mitigation, ecology, agriculture, cultural heritage and open space³⁶. Further details on the appraisal of landscape and visual impacts are available in *Appendix C1 Landscape*.

4.13. Cultural heritage

- 4.13.1. Cultural heritage comprises three key factors collectively described as heritage assets within the AoS framework. These are:
 - archaeological and palaeo-environmental remains (including geological deposits that may contain evidence of the human past);
 - historic landscapes; and
 - historic buildings and the built environment.
- 4.13.2. A range of designations are used to reflect the relative importance of these different assets.
- 4.13.3. Nationally important assets of archaeological interests can be given legal protection by being placed on a list, or 'schedule' by the Secretary of State for Culture, Media and Sport, with support from Historic England. Significant battlefields are listed by Historic England on a Register of Historic Battlefields, although they are not subject to the same statutory protection as scheduled monuments.
- 4.13.4. Nationally important buildings and structures are listed by virtue of their architectural and historic interest. Listings are further divided into Grade I, Grade II* and Grade II according respectively to a decreasing degree of importance and interest. A separate Register of Historic Parks and Gardens uses a similar

³⁶ Further details of this approach are contained in the [HS2 Phase 2a \(West Midlands to Crewe\) Working Draft Environmental Impact Assessment Report](#)

hierarchy. These include gardens, grounds and other planned open spaces, although these areas are not subject to the same statutory protection as Listed Buildings.

- 4.13.5. Finally, where an area is considered to have special architectural or historic interest, the preservation or enhancement of which is desired, it may be designated a Conservation Area by the local planning authority.
- 4.13.6. The AoS considered designated statutory heritage assets, both in terms of direct physical impacts and potential changes within their settings that could affect their significance. National lists, registers and schedules of such assets held by Historic England were reviewed, and Conservation Area information was obtained from local authority websites. This information was examined against the preferred scheme plans and profiles.
- 4.13.7. Where potential impacts were identified, an inspection of OS maps and aerial photos helped to establish the possible degree of impact, as well as a number of site visits. Recognising the sensitivity of heritage assets between Hardwick Hall and Bolsover, further work has been undertaken in this area, and HS2 Ltd will continue to work with stakeholders such as Historic England, to better understand the assets and particularly their historic context and setting. This information will be used to inform the next stage of design and the EIA will give close consideration to the need and opportunity for mitigation here. Impacts are described in sections 5.10 and 7.10. Further details on the appraisal of cultural heritage impacts, and those on archaeology are available in *Appendix C2 Cultural Heritage*.
- 4.13.8. Non-designated assets were not considered during this stage of the work, although it is recognised that there may be some of potential significance. These include archaeological sites, features and remains including palaeo-environmental deposits, which may be of national importance, but which are not scheduled for a variety of reasons, such as having not been formally assessed.
- 4.13.9. Unlisted buildings (which may be locally listed), and historic landscape features have also not been considered by the AoS although it is recognised that there may be some of potential national importance. The landscape appraisal has considered prevailing historic aspects of land use where these are influential in affecting landscape character.
- 4.13.10. Information on non-designated assets is held on a number of data sources, including local authority Historic Environment Records, historic landscape characterisation and local archives. Research into known non-designated assets will be carried out as part of the EIA, alongside work to identify the potential archaeological interest of affected areas. Work for the EIA will include, where possible, field investigation to inform the impact assessment. Consultation with Historic England and local authority archaeologists and conservation officers will be undertaken as part of that work.

4.14. Biodiversity and wildlife

Statutory designations

- 4.14.1. There is a hierarchy of designations providing protection by law or policy to those sites that are of higher value for biodiversity. The most important sites for biodiversity are collectively referred to as Natura 2000 sites, which effectively include Special Areas of Conservation (SACs - best representing the range and variety of habitats and species listed in Annexes I and II of the European Habitats Directive), Special Protection Areas (SPAs - the most important habitats for rare and migratory birds listed in the Habitats Directive) and Ramsar sites (wetlands

designated under the Convention on Wetlands of International Importance). A number of these sites occur in the vicinity of the route. An extensive screening exercise, with the close involvement and guidance of Natural England and the Environment Agency, was undertaken to determine the likelihood of impacts to influence option choice and to allow for refinement in design. Where required, Habitats Regulations Assessments (HRAs) have been undertaken for some of these sites and updated to reflect scheme changes as necessary.

- 4.14.2. Other key designations considered by the AoS include Sites of Special Scientific Interest (SSSI)³⁷, which represent the best examples of the UK's flora, fauna, geological or physiographical features; National Nature Reserves (NNRs)³⁸, which accommodate the most important natural and semi-natural ecosystems; and Local Nature Reserves (LNR)³⁹ that are declared to provide opportunities for research, education and to allow contact with nature. The AoS appraised the preferred scheme's potential incursion into these sites, as well as considering the risk of other effects through, for example, disturbance or hydrological impacts. The potentially affected sites are listed in this report. In due course, the EIA will be required to look again at these locations to better determine where potential impacts would occur in light of the more detailed designs and baseline information.

Non-statutory sites

- 4.14.3. Information on Wildlife Trusts' Nature Reserves has been included where these are publicly referenced. Information on non-statutory local wildlife sites, which are designated by local authorities as being of local conservation interest, will be provided in the EIA.

Habitat inventories

- 4.14.4. The AoS included areas identified in the Ancient Woodland Inventory. Woodland classed as 'ancient' is essentially irreplaceable as it takes hundreds of years to establish. It is considered important for its wildlife, soils, recreation, cultural value, history and contribution to landscapes. The inventory⁴⁰ includes 'ancient semi-natural woodland' and 'plantations on ancient woodland' sites. During the sifting process the design of the route was assessed and where possible refined to minimise impacts to ancient woodlands.
- 4.14.5. Section 41 of the Natural Environment and Rural Communities Act 2006 required the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The 56 habitats and 943 species are listed⁴¹ to guide decision-making bodies in implementing their duty under the Act to have regard to the conservation of biodiversity in England when carrying out their normal functions.

³⁷ SSSIs were re-notified under the Wildlife and Countryside Act 1981. Improved provisions for the protection and management of SSSIs were introduced by the Countryside and Rights of Way Act 2000 (in England and Wales)

³⁸ NNRs are declared by the statutory country conservation agencies under the National Parks and Access to the Countryside Act 1949 and the Wildlife and Countryside Act 1981.

³⁹ Under the National Parks and Access to the Countryside Act 1949 LNRs may be declared by local authorities after consultation with the relevant statutory nature conservation agency.

⁴⁰ Natural England and Forestry Commission (2014). [Ancient woodland and veteran trees: protecting them from development](#)

⁴¹ Natural England (2015). [Conservation on land and sea](#) (extract from)

- 4.14.6. The AoS included a review of Natural England's Single Habitat Layer (2012) that maps the location of areas containing habitats of principal importance, as well as a review of the former Biodiversity Action Plan Habitat Inventory in order to provide consistency with earlier appraisals. Aerial photography was used to verify the extent of these habitats in order to address limitations in the accuracy of these data. This report describes the main areas of habitat affected by the scheme, based on professional judgment, and takes account of the rarity of the affected habitat, as well as the extent of loss and degree of fragmentation caused by the scheme.

Species

- 4.14.7. There is very limited information relating to specially protected and rare species provided in site designation accounts. Reference to species records held by county biological records and use of detailed survey and assessment of these species will be undertaken at the EIA stage.
- 4.14.8. Impacts are described in sections 5.11 and 7.11. Further details on the appraisal of biodiversity and wildlife are available in *Appendix C3 Biodiversity*.

4.15. Water resources and flood risk

Water Framework Directive

- 4.15.1. The Water Framework Directive (WFD) is European Union legislation brought into UK law in 2003 with a requirement to assess the ecological and chemical status of surface waterbodies and the quantitative and chemical status of groundwater bodies across the UK. Under this legislation, the UK is obliged to prepare River Basin Management Plans to set objectives to achieve good status for all water bodies and to meet these targets for over the course of the next 11 years, with key dates in 2021 and 2027.
- 4.15.2. The WFD has been a key consideration for the updated design requirements. During the next phase of design development, any proposed works which could influence the status of key ecological elements (hydromorphology, biology or physico-chemical quality) or the chemical status of any surface watercourse will require an assessment under the WFD. Assessment will also be required for any below-ground works which could influence aquifer yield or water quality of any groundwater body.
- 4.15.3. WFD assessment will need to demonstrate that the proposed works will not cause any deterioration in current status nor jeopardise the achievement of good status by a set target date and confirm how any adverse impacts will be mitigated. During the detailed design phase (following hybrid Bill), and where reasonably practicable, consideration will be given to enhancing the status of the water body and contribute to delivery of WFD objectives in a positive way.

Watercourse diversions

- 4.15.4. The preferred scheme would cross a network of watercourses of varying size, from small drainage ditches to nationally significant rivers. In some places, the route would run parallel to river valleys and alongside or above river channels. This may necessitate a diversion or modification to the river channel to avoid obstructing both normal (base) flows and flood flows, especially where these could increase flood risk. The engineering teams have worked closely with the AoS water specialists to avoid the need for such diversions. In cases where diversions cannot be avoided, further solutions and refinements will continue to be explored

through discussions with the Environment Agency, Internal Drainage Boards and Lead Local Flood Authorities.

- 4.15.5. At the EIA stage, any potential river diversions that are still likely to be required will be subject to a detailed assessment (which may include hydraulic modelling) to determine the measures needed to meet legal and planning policy standards. Where diversions or in-channel works are proposed, environmental permits will be required and works will be undertaken in consultation with the Environment Agency (for Main Rivers) or Lead Local Flood Authority (for Ordinary Watercourses). Opportunities for environmental enhancement will also be explored during detailed design stage.
- 4.15.6. The rivers potentially affected are described in sections 5.12 and 7.12, categorised as being either major rivers or minor rivers, depending on whether their catchment areas are respectively greater than or less than 50km² at the point of the crossing.

Flood risk

- 4.15.7. The Environment Agency Flood Zone maps highlight areas of flood risk associated with watercourses that have a catchment size of 4km² or more and for smaller catchments with a history of flooding. Viaducts have been assumed for all sections where the route centreline lies within Flood Zone 2 and 3, except tunnels and where the route joins existing rail lines. The preferred scheme could exacerbate flood risk where it crosses these flood zones by changing the flow regime, obstructing flood lows or reducing flood storage capacity, so potentially affecting the severity and frequency of flooding upstream or downstream of the crossing. The design of these crossings and the construction methods used are therefore key design considerations.
- 4.15.8. In some cases, this has resulted in viaducts of significant length where, in practice, there may be alternative solutions that do not increase flood risk. For example, partial lengths of embankment (or embankments with culverts) incorporating appropriate embedded mitigation may be equally effective where a floodplain is already crossed by other embankments for existing roads and railways a short distance upstream or downstream. As well as being cheaper, this may have a number of benefits for reducing potential noise and visual impact and for ecological enhancement, as well as helping manage the cut and fill balances.
- 4.15.9. A more detailed examination of flood risk will be undertaken during the EIA stage. This will include a review of the alignment height relative to flood water levels in order to either guide refinements in alignment or to establish the most appropriate structures to convey watercourses over or under the track. This report identifies all occasions of floodplain crossings over 100m in length. Further flood risk work was undertaken around the preferred Leeds station and East Midlands Hub station, to assist in route refinements, and following consultation responses.
- 4.15.10. The AoS has not addressed in detail risks to HS2 infrastructure from flooding, although the vertical alignment is generally designed to be at least 1m above the expected 1,000-year fluvial water level. Flood risk to HS2 infrastructure will be considered in due course as part of the detailed design and in parallel with the EIA. The more detailed assessment will also look at other flood risk issues including groundwater flooding, failure of reservoirs, flooding from sewers and surface water flooding.

Groundwater

- 4.15.11. Impacts on groundwater have been considered according to the strategic importance of aquifers and how vulnerable they are to pollution. The most

important aquifers are ones that support large abstractions for potable (drinkable) water supply.

- 4.15.12. Source protection zones (SPZs) define the catchment areas for strategic potable water supplies. Three zones (SPZs 1, 2 and 3)⁴² are defined according to the travel time of a potential pollutant from a point in the groundwater catchment to the abstraction point, with the inner zone closest to the abstraction point termed the most sensitive SPZ1 (groundwater travel time of less than 50 days). Potential impacts, where the route would cross these SPZs are reported in sections 5.12 and 7.12.
- 4.15.13. The AoS has also appraised the potential for impacts on the groundwater regime within the SPZs by plotting geological profiles and groundwater levels along the preferred route based on information from British Geological Survey (BGS) borehole data and maps.
- 4.15.14. At the EIA stage, where development is proposed within a SPZ, the impacts will need to be assessed. These will be scoped as part of the EIA in collaboration with the Environment Agency to establish both the baseline conditions and the magnitude of any likely impact. Appropriate mitigation will then be incorporated in the design and construction methodology in order to avoid any permanent impact on the groundwater abstraction. This mitigation might involve one or a combination of different solutions in order to ensure that the quality and quantity of groundwater available at the abstraction point are preserved, and the requirements of the Environment Agency, and ultimately the WFD, are adhered to.
- 4.15.15. Other licensed uses for non-potable groundwater abstraction, which include agricultural and industrial uses, can also be critical to the industries that use them, some of which may be strategic infrastructure. Although generally less critical than potable groundwater, at least from a water quality perspective, works with the potential to impact these abstractions will need to be considered in detail and mitigated appropriately. At this stage, the AoS has considered the key examples of these, which are reported in sections 5.12 and 7.12.
- 4.15.16. The AoS also included a preliminary appraisal of groundwater (as well as surface water) risk of impact to SSSIs in support of the ecological appraisal. Further details on the appraisal of water impacts are available in *Appendix C4 Water*.

4.16. Carbon emissions

- 4.16.1. The AoS includes the carbon footprint for HS2 as a whole, since Phase 2b will not operate in isolation of Phase One and Phase 2a. The assessment described here updates the one undertaken as part of the AoS for the Phase Two 2013 consultation route, and reported in full in the separate carbon report, *HS2 and carbon*⁴³. The 2013 report provides additional details on the context and method supporting the assessment. In this report the term carbon is used as shorthand for the combined greenhouse gas emissions reported in tonnes of carbon dioxide equivalent (tCO₂e). In addition 'Phase Two' means Phase 2a and Phase 2b.
- 4.16.2. Since 2013, a number of changes affecting the carbon footprint have been identified, these include changes to:
- the scheme design (i.e. increase in length to Phase 2b);

⁴² SPZ4 usually represented a surface water catchment which drains into the aquifer feeding the groundwater supply. In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone.

⁴³ Temple-ERM (2013). [HS2 Phase Two Sustainability Statement: Appendix F HS2 and Carbon](#).

- forecast carbon intensity of grid electricity; and
 - forecast modal shift.
- 4.16.3. The assessment involved calculating the potential carbon resulting from HS2's construction and operation, and potential reductions in carbon due to modal shift over the first 120 years of operation of the full scheme, Phase One⁴⁴, Phase 2a⁴⁵ and Phase 2b. The contributions of each were calculated over the full construction period, and thereafter over operational periods of 60 years and 120 years. The 60 year assessment period is in line with that used for the Economic Case for HS2 and in accordance with standard methodology used by the Department for Transport (DfT) to assess transport schemes (the 'WebTAG' carbon assessment assumptions⁴⁶). In practice, the HS2 design life will be twice as long as this, so the assessment has also reflected how this longer 120 year period may affect overall carbon emissions.
- 4.16.4. The assessment of construction emissions takes into account the estimated carbon produced in the manufacture of the materials used to build and operate HS2. For example: from the use of bulk materials within construction, such as steel, concrete and aggregate; from elements of the electrification system, such as copper and aluminium; from the manufacture of rolling stock; from transport of construction materials to construction sites; and from transport of excavated material to disposal destinations.
- 4.16.5. The assessment of operational emissions takes into account the emissions for which HS2 will be directly responsible during operation, namely due to the power consumption by HS2 trains.
- 4.16.6. Modal shift emissions take account of people or freight switching between different types or modes of transport, as they are expected to do with the introduction of HS2. This is partly due to a preference for passengers to use HS2 services, and partly through a switch from road to conventional rail.
- 4.16.7. Emissions from each of these elements of the scheme were calculated using a combination of activity data (i.e. kilometres travelled, passengers displaced or tonnes of materials that go to make up the HS2 scheme) and emissions factors (the relationship between the quantity of greenhouse gases emitted and an emission-generating activity e.g. the number of grams of CO₂ emitted for each kilometre travelled on an electric train).
- 4.16.8. Activity data for the embedded carbon relies mostly on engineering assumptions. For the operational carbon, which is affected by factors such as HS2 annual travel distance and displaced road vehicle distances, quantities were provided from HS2's demand models. These models also generated data for the modal shift assessment.
- 4.16.9. Emissions factors for embedded carbon use values taken from standard literature relating to the manufacture or transportation of materials. For operational carbon and modal shift carbon, the values of key emissions factors (for example electricity generation) were projected forward at five year intervals over the time period to the 2090s, through the use of future carbon scenarios. This is probably the most uncertain factor, as it is difficult to predict how things will change over time. For

⁴⁴ HS2 Ltd (2015). [London to West-Midlands Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement October 2015](#).

⁴⁵ Temple-RSK (2015). [Sustainability Report Phase Two Post-Consultation Update: West Midlands to Crewe Sustainability Report](#).

⁴⁶ Department for Transport. Transport analysis guidance (WebTAG).

example, how much future grid electricity will rely on renewable generation, or how 'clean' future cars and aircraft will be.

- 4.16.10. Two future carbon scenarios were defined, to explore the extent to which carbon changes could be dependent on different views of the future. Each scenario was applied across all elements of the carbon assessment.

Outline of carbon scenarios

Scenario A

Scenario A draws on many of the same assumptions that are used by, and reflected in, the Economic Case for HS2.

The Economic Case for HS2 involves the valuation of carbon emission consequences. These methods require the application of emissions factors to changes in existing rail and road passenger vehicle distances, and also future projections of the mix of vehicle types for these sectors. The factors are set out in DfT documentation, which reflect variations over a timeline up to 2050⁴⁷.

Scenario B

Scenario B uses assumptions contained within advice to Government from the Committee on Climate Change in relation to the Fourth and Fifth Carbon Budget⁴⁸. This tends to be more ambitious in its portrayal of future reductions in carbon with, for example, a greater proportion of power generated from renewables and higher uptake of cleaner road vehicles.

In its supporting evidence for the Fourth and Fifth Carbon Budget submissions, the Committee on Climate Change sets out a series of trajectories for future emissions factors associated with different sectors of the UK economy, such as the electricity generation sector and the road transport sector.

- 4.16.11. The effect of the changes on the carbon footprint is summarised in Section 9.2.

4.17. Climate change resilience

- 4.17.1. The climate is projected to change as a result of the accumulation of carbon dioxide and other greenhouse gases in the atmosphere. The most recent projections for the effect of these changes are contained in the UK Climate Change Projections (UKCP09)⁴⁹. The UKCP09 projections are presented for three different future scenarios representing High, Medium and Low greenhouse gas emissions, and contain information on historically observed climate data as well as climate projections. Although no single definite view of the future is possible, UKCP09 shows a range of possible outcomes and the probability of each outcome, based on how much evidence there is for different levels of future climate change.
- 4.17.2. Analysis completed for Phase One and underway for the Phase 2a EIA adopts a set of assumptions for future levels of greenhouse gas emissions within UKCP09 to define a context for an assessment of HS2's resilience to climate impacts. Future climatic attributes projected under this scenario include: hotter, drier summers; warmer, wetter winters; increases in annual average temperature; more very hot days; more very intense downpours of rain.

⁴⁷ Department for Transport. [Transport analysis guidance \(WebTAG\)](#)

⁴⁸ [Committee on Climate Change](#)

⁴⁹ [UK Climate Projections](#)

- 4.17.3. For HS2 this could mean increased risks from flooding, landslip, ground settlement, storm damage, high summer temperatures, daytime range of temperature and changes in vegetation, all of which could have implications for all phases of HS2. At this stage of the project, the AoS only considers climate resilience through information on flooding (or flood risk) provided in sections 5.12 and 7.12. During the EIA further work will be undertaken to consider HS2 in the context of climate resilience, and some further context is described in Section 9.3.

4.18. Land use resources

- 4.18.1. The intrinsic value of land to farmers or other land managers was considered by the AoS. Potential effects on farmland would occur where agricultural land is lost or becomes inaccessible through severance. Defra's Agricultural Land Classification system classifies agricultural land into five grades based on the physical characteristics of the land and the long-term limits these impose on its agricultural uses. The AoS has considered impacts of the scheme in terms of the areas of the highest quality land (Grades 1 and 2) that may be affected by HS2. A complete set of agricultural land classification maps has been published at a scale suitable for a strategic level of planning for the AoS. The appraisal of agricultural land quality and the restoration of land following the construction of HS2 will focus at a local scale during the EIA.
- 4.18.2. The AoS also appraised environmental impacts related to land designated for waste disposal, including active landfill sites. Impacts related to these represent both an environmental risk in terms of the potential contamination pathways that could be created, and a loss of key municipal services. Impacts related to disused landfill sites are also reported. A preliminary risk profile was determined for each landfill affected, with higher risks identified based on the type and length of crossing, the size of the landfill and its recorded contents. Any crossings of landfill sites would be designed and undertaken to ensure that risks from contaminated materials are fully mitigated.
- 4.18.3. The AoS also considered potential impacts on green belt in terms of lengths crossed by the route and areas of potential landtake at stations and depots. Green belt was introduced throughout England in 1955 as a means of restricting urban growth around major cities and towns. HS2 Ltd could be viewed adversely in relation to green belt if it is considered to conflict with the open and contiguous character for which a green belt is designated, particularly where it forms a new 'edge' that might encourage new infill development.
- 4.18.4. HS2 Ltd will seek to avoid impacts on contaminated land, but where it is unavoidable (for example where excavation through landfill is required) HS2 would implement best practice measures to minimise risks to the environment and avoid disposal off-site. The AoS has identified potentially contaminated areas (and associated generation of hazardous waste) at active and disused landfill sites. There are also other sources of potentially contaminated material, which would be considered as part of an EIA and at later stages prior to the commencement of construction; for example at industrial sites.

4.19. Excavated material and waste

- 4.19.1. Material and waste would arise from demolition, excavation and construction activities as well as the operation of the preferred scheme. Tunnelling would be the principal source of excavated material, but quantities will depend also on the extent and the depth of cuttings used for surface sections (itself a response to the need for environmental mitigation, as well as topographical constraints). HS2 Ltd has estimated quantities of excavated materials, based on preliminary designs in advance of any potential landscaping proposals or noise bunds alongside the line.

This will enable suitable excavated material to be used as a resource within the construction of the preferred scheme with the additional benefit of reducing the quantity of imported fill required.

- 4.19.2. An integrated design approach has been developed for HS2 Phase One, and is underway for Phase 2a, to use excavated material to satisfy the fill material requirements wherever reasonably practicable. A similar approach would be adopted for Phase 2b. Therefore, the general principle for HS2 would be to balance materials taken from cuttings and tunnelling with those required for embankments and filling.
- 4.19.3. Where surplus excavated material arises, HS2 Ltd would explore opportunities to make beneficial use of this on environmental improvement projects and other developments where appropriate before considering landfill, which is an option of last resort.
- 4.19.4. Material and waste will also arise from demolition and construction activities. Potential waste quantities have not yet been determined, but the financial and environmental incentives to avoid these will be a strong driver to minimising them.
- 4.19.5. Since undertaking consultation, further work has been undertaken by HS2 Ltd to better understand the landfills and contaminated sites crossed by the route, which helped to inform the refinement of the design.
- 4.19.6. Operational wastes would comprise maintenance waste, particularly at depots (principally spent ballast, as well as fuels, oils, spent mechanical and electrical components and vegetation) and waste from passengers (principally food packaging, newspapers, magazines etc.). Further details on the appraisal of waste impacts are available in *Appendix C10 Waste*.

4.20. Material resource use

- 4.20.1. This report records estimated tonnages of bulk building materials (steel and concrete) by way of indicating the principal material resource requirements of the project. These have taken into account the steel used for tracks, for tunnel reinforcement and for overhead wires, and the concrete used for permanent way, tunnels, viaducts and stations. The appraisal uses standard conversion factors for steel, but has used more specific conversion factors for concrete that accommodate the different characteristics of the scheme structures. The information was also the basis for embedded carbon figures.

5. Western leg sustainability impacts

5.1. Introduction

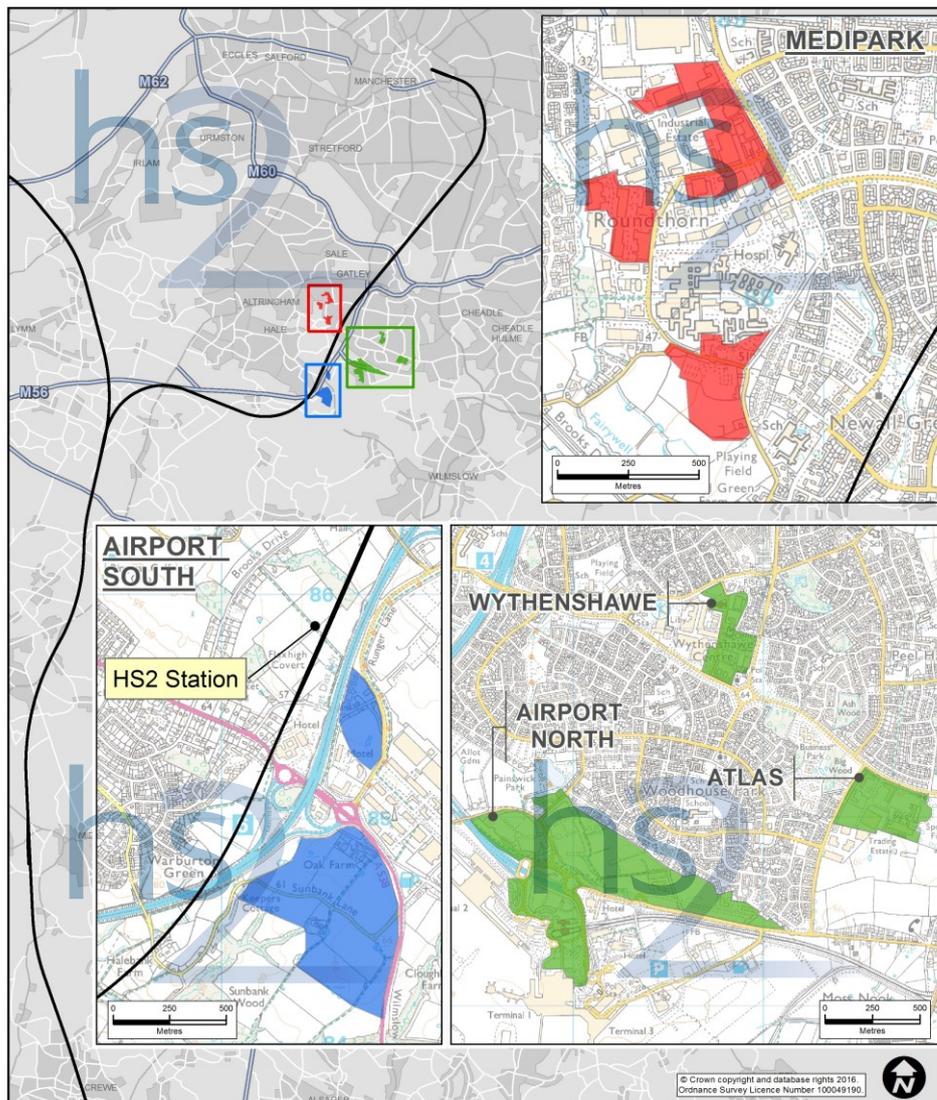
- 5.1.1. This section describes the main potential sustainability impacts, both beneficial and adverse, that would result along the western leg of the Phase 2b scheme; in a south to north direction. The section should be read within the context of Section 4, which provides the AoS scope for each topic and gives an overview of the appraisal method. Plans showing the features and locations referenced as numbered dots are provided in Section 6 and more detailed plans can be found in Volume 2.
- 5.1.2. The potential impacts that are set out here are predicted to result from the preferred route in its current stage of design and on the basis of the current baseline environment. Some of these impacts could change in detail as further refinements are made, and as mitigation is introduced. Only the main impacts are described here. Potentially lesser impacts are not recorded in this document, although they are listed in the technical appendices that are available separately. Text boxes summarise key changes from the 2013 consultation route.
- 5.1.3. Associated works, such as road re-alignments and utilities diversions, which have not been agreed at this stage, may also result in impacts. No construction planning has been undertaken at this stage. In addition, there has been no appraisal of the existing network, and other projects or initiatives. All of these additional works will be assessed by the EIA.

5.2. Planning and development

- 5.2.1. A review of major development proposals along the western leg identified a number of strategic sites that would potentially be affected by the preferred scheme.
- 5.2.2. The route crosses the western boundary of the Warmington gas storage and brine extraction development site ⑥ which lies immediately to the east of the WCML north of Crewe. The proposals for which planning consent has been granted, identify three areas, Parkfield Farm (which is directly impacted), Hole House and Hill Top Farm which are all adjacent to one another and are linked to brine extraction and gas storage proposals by British Salt, Tata Chemicals Europe and EDF. HS2 Ltd will continue to engage and work with the key stakeholders associated with the development proposals.
- 5.2.3. To the east of Northwich, the route clips the western boundary of the King Street Energy underground gas storage development site ⑦. Planning consent has been granted for the site which includes 10 underground gas storage caverns. HS2 Ltd has already engaged with King Street Energy and will continue to do so as part of the route development proposals.
- 5.2.4. The Highways Agency is currently undertaking major improvement works to the A556 trunk road between Junction 19 of the M6 near Knutsford and Junction 7 of the M56 near Bowdon ⑧. The Secretary of State granted the development consent order in August 2014, with works due for completion in autumn 2017. The spur into Manchester crosses this scheme at its northern end, where the route turns east to run alongside the M56. HS2 Ltd will continue to engage and work with Highways England with regards to the development proposals.
- 5.2.5. There are a number of planning policy and development designations around the Manchester Airport station. These include the “World Logistics Hub” and “Airport

City” areas (blue and green zones; see Figure 5-1) that are part of the Manchester Enterprise Zones ④.

Figure 5-1 - Manchester Enterprise Zones



- 5.2.6. The adopted *Manchester Core Strategy Development Plan Document* (July 2012) includes policy support for the growth of Manchester Airport ④, through designation as a strategic site and expanding the airport area through development of adjacent areas for various operational and commercial uses. The green belt boundary in this area has been amended to exclude areas for airport development.
- 5.2.7. On the west side of the M56 there is also an area policy within Trafford Council's Core Strategy that references the future potential development of the Davenport Green site ④; the preferred route would be on the eastern boundary of this area.
- 5.2.8. Manchester Piccadilly station would support local policies in the Core Strategy (adopted in July 2012), including the Mayfield development on the site of the former Mayfield Railway Station. It would also encourage the development of the eastern gateway to the city; and it could increase the density and quality of local development, thereby maximising the opportunities of Manchester Piccadilly station in line with the Strategic Plan for Manchester City Centre (2015-2018). The

implications for jobs and houses as a result of this strategic support are described in Section 5.3.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Key changes include:

- Following consultation and further investigation, route now expected to impact the Warrington gas storage and brine extraction development ⑥ proposals north of Crewe, near to the tunnel portal.
- Route no longer impacts the West Gorton major development site ⑩ (a site with some 565 proposed dwellings) due to the relocation of the tunnel portal and station approach to the north at Ardwick.

5.3. Employment and housing

Manchester Airport station

- 5.3.1. The Manchester Airport station would be located west of Manchester Airport ③7 at a site with a number of development designations (see Section 5.2). Here there are connections to the existing surface transport interchanges at Manchester Airport, including road, rail, bus and coach services and the recently opened Manchester Metrolink extension. HS2 is expected to enhance the development potential of the area, as it could support the delivery of additional warehousing as well as some office floorspace. With quite substantial development anticipated in any case, the relative impact of HS2 could be in the region of an additional 5,000m² - 10,000m². This could be increased through further aspirational policy and changes in green belt policies.
- 5.3.2. The station would result in the demolition of an estimated 3,000m² of existing business space. However, this could be more than offset by an increase in development area, to result in a net increase in commercial floorspace of between 5,000m² and 10,000m², which could support between 300 and 700 jobs. Residential floorspace could decrease by an estimated 2,000m², due to the predicted residential demolitions (see Section 5.4).

Manchester Piccadilly station

- 5.3.3. Piccadilly is a location that would support considerable additional development as a result of HS2, for a number of reasons. Built alongside the existing station at Manchester Piccadilly in the heart of the city, the station terminus would allow better connections with regional rail services (which will increase as a result of the Northern Hub Programme⁵⁰), as well as access to the wider Manchester public transport network. The central location is close to Piccadilly and the commercial core of the city, as well as the Oxford Road Corridor and First Street Regeneration Area, so forming part of a strategic economic growth and investment location. There are few major constraints to development or access for key sites in the immediate vicinity of the proposed station: indeed the introduction of HS2 would provide an opportunity to improve connectivity and address underused development sites in this area. There are numerous strategic sites in the area around the station whose potential would be 'unlocked' and supported by HS2.

⁵⁰ The Northern Hub Programme is a series of targeted upgrades to railways in the north of England.

There is also both a potential and precedent for high density building development within the city centre.

- 5.3.4. Bearing this in mind, it is estimated that HS2 could increase net commercial floorspace by between 605,000m² and 871,000m², which would support between 29,700 and 42,900 jobs. Residential floorspace could increase by at least 184,000m² and potentially up to 246,000m², equating to between 3,100 and 4,100 homes. The additional housing would be a particular local benefit given the above average levels of housing deprivation in the area.
- 5.3.5. Due to the potential demolition of commercial properties, the terminus station could displace businesses currently providing an estimated 1,900 jobs. Although these displaced jobs are accommodated in the net figure for jobs supported, it is anticipated that in practice the majority of these displaced jobs would be accommodated in the city.

No key changes from the 2013 consultation scheme

5.4. Property and community integrity

- 5.4.1. The western leg could result in the demolition of an estimated 111 dwellings. The majority of these would be associated with the spur into Manchester and into Manchester Piccadilly station. An estimated 48 dwellings would be demolished on Chapeltown Street ② as part of the new Manchester Piccadilly high speed station, north of the existing station⁵¹.
- 5.4.2. There are seven clusters of residential demolitions as part of the preferred scheme. A group of five properties would be demolished as part of the introduction of the Crewe North RSD ③. Further north, two groups of properties totalling an estimated 14 dwellings would be demolished to the south and north of Lostock Green ⑥.
- 5.4.3. Three groups of properties, comprising an estimated 15 dwellings in total, would be demolished by the proposed Manchester Airport station and its approach including at Thorns Green ⑩, Halebank ⑫ and Hale Barns ⑬.
- 5.4.4. An estimated five dwellings could be demolished at Lowton St Mary's ④ as the route passes through a narrow corridor between Lowton Common and Golborne. Other demolitions would largely be limited to single properties or small groups (fewer than five) at various locations along the route. The preferred scheme would also require the demolition of two community facilities: the Dominion Chapel Auditorium in the industrial estate on the station approach near Ardwick; and a postal distribution centre at Manchester Piccadilly station. It would require the demolition of an estimated 91 commercial properties, almost all of which would be at Piccadilly ⑨, and south of Lowton Common ⑤. An estimated two industrial properties could be demolished.
- 5.4.5. The route could result in isolation of an estimated total of three residential properties across three locations; at Broken Cross ⑭, Golborne ⑮ and north of Rostherne Mere ⑰.
- 5.4.6. No appraisal of temporary construction impacts has been undertaken at this stage. However, as an indication of the number of people at greater risk from construction impacts (noise, dust and general disturbance), there would be approximately 600

⁵¹ The demolitions included here are for existing buildings affected by the operation of HS2. Impacts associated with approved or partially constructed new developments sites are summarised in Section 7.2.

dwellings within 100m of the surface route and the provisional station and depot construction boundaries.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Overall, there is a reduction in demolitions since 2013. When taking account of planned and new development the property impact is broadly similar across the whole route. However, at this stage of design and appraisal there are 15 fewer demolitions reported compared to the 2013 consultation scheme.

Key changes include:

- Avoidance of the cluster of 22 dwellings at West Gorton due to the relocation of the tunnel portal and station approach further north.
- Avoidance of the cluster of over 20 commercial unit demolitions at Taylor Business Park near Culcheth.
- Reduced area of isolation at Golborne due to the relocation of the RSD and also as a result of route realignment.

New or increased impacts include:

- New demolitions on the route between Crewe and Winterbottom as a result of the horizontal realignment, including two groups of residential properties immediately to the south and north of Lostock Green ②; and the relocation of the RSD to the north of Crewe ③.

5.5. Access

Manchester Airport station

- 5.5.1. The HS2 station would have a direct link with Manchester Airport, the third busiest airport in the UK in 2015, with over 20 million passengers flying annually to around 215 destinations. The airport is expected to grow, with plans to serve around 50 million passengers per year by 2030.
- 5.5.2. Frequent rail services link the airport with various cities including Leeds, Sheffield, Hull, York, Newcastle and Edinburgh, as well as with local stations. The Manchester Metrolink has recently been extended in order to serve the airport.
- 5.5.3. The HS2 station would connect with the existing surface transport interchange, and its network of bus and coach services. The high speed station would have good road access, with links to the M56 and the A538 Wilmslow Road. A car park for approximately 3,000 cars is proposed as part of the new station, although these numbers will be appraised as part of the EIA and discussed with the local authority in light of their policies and assessed as part of on-going appraisal work. Existing car parking at the airport provides some 22,000 spaces, although this is projected to increase to between 40,000 to 50,000 with airport expansion.

Manchester Piccadilly station

- 5.5.4. Manchester Piccadilly occupies a central location that forms a hub for both regional and local transport networks. The existing Piccadilly station offers good rail connections to various key destinations across the city and region including Manchester Airport, Salford, Stockport and Bolton, as well as destinations further afield including South Wales, the south coast of England, Edinburgh and Glasgow.

Passengers would be able to transfer directly between the existing rail and HS2 concourses.

- 5.5.5. A significant programme of improvements at Manchester Piccadilly will take place in connection with the Northern Hub programme of targeted upgrades to the railway in the North of England. This will allow up to 700 more trains to run each day and provide space for 44 million more passengers a year. The programme includes the construction of a link between Manchester Victoria and Manchester Piccadilly, as well as two new platforms at Manchester Piccadilly station that will enable better onward connections to the North. There will be new direct services to Manchester Airport and faster services to a variety of destinations.
- 5.5.6. The HS2 station would also be served by Manchester's Metrolink light rail system, which provides connections to Bury, Altrincham, Eccles, Salford Quays and other destinations. Recent expansions to the Metrolink include services to Oldham, Rochdale and Ashton-under-Lyme town centres as well as to Manchester Airport.
- 5.5.7. Connections to local bus services are provided outside the Fairfield Street entrance of the existing station. The Manchester Central Coach Station, a short walk away on Chorlton Street, provides numerous regional coach services. Opportunities for better pedestrian connections from Piccadilly to the rest of the city would also be provided through the HS2 and Northern Hub station.
- 5.5.8. The Inner Ring Road in Manchester city centre would provide the main route connecting the HS2 station to radial and regional routes, specifically via the A635 and A635(M) (Mancunian Way).
- 5.5.9. A new multi-story car park with a capacity of up to 2,100 vehicles would be built to serve both existing rail and HS2 passengers, although these numbers will be appraised as part of the EIA.

Impacts on rights of way and country parks

- 5.5.10. The western leg of the preferred scheme would cross four long-distance paths: the Crewe and Nantwich Circular Walk ④; the Cheshire Ring Canal Walk ⑩ (four intersections); the North Cheshire Way ③④; and the Trans Pennine Trail ④④.
- 5.5.11. Three national cycle routes would be crossed by the preferred route.
- 5.5.12. It is assumed that permanent access along all public rights of way would be maintained through diversion or re-instatement (subject to agreement with the local authority), although there would be disruption to these routes temporarily during construction. A detailed appraisal of all access crossings will be undertaken as part of the EIA.
- 5.5.13. No country parks would be directly affected on the western leg.

No key changes from the 2013 consultation scheme

5.6. Health, wellbeing and equality

Potential health impacts

- 5.6.1. Initial analysis indicates the potential for both positive and negative health impacts in and around the Manchester, Salford and Wigan areas, where existing levels of health-related deprivation are high. The main potential negative health impacts

relate to displacement of jobs, noise during operation⁵² and demolition of housing and community facilities. Potential positive health impacts relate to improved access to employment, new housing and access to transport, which in turn could increase access to education, services and facilities. People most vulnerable to health impacts (including people living in socio-economically deprived areas, older people and young people) would experience both positive and negative impacts.

No key changes from the 2013 consultation scheme

Potential equality impacts

- 5.6.2. The equality analysis has identified where relevant groups of people with protected characteristics or people (or groups) with protected characteristics (as defined by the Equalities Act 2010) are likely to live in relatively high numbers along the route. The analysis identifies the potential for impacts of the preferred scheme to affect these people (or groups) with protected characteristics groups more than they would affect the local population generally.
- 5.6.3. Beneficial impacts are likely to occur around the Manchester Piccadilly station catchment. This catchment area is home to relatively large proportions of groups with protected characteristics including Black, Asian and minority ethnic groups, faith groups and young people (16-24). These groups are likely to experience a greater benefit from net increases in local jobs and the increased availability of affordable housing that would be supported by the preferred scheme, provided they are able to access them.
- 5.6.4. In the immediate vicinity of this station, adverse impacts on people (or groups) with protected characteristics may occur due to the demolition of housing and commercial, retail and industrial property. The immediate vicinity of the station is home to relatively high populations of people from Black, Asian and minority ethnic groups (many of whom are jobseekers), faith groups and young people (16-24). Access to affordable housing (including for larger families) and access to specialised retail outlets are likely to be some of the key concerns of groups with protected characteristics found in the immediate locality. The demolition of a group of an estimated 48 dwellings on Chapeltown Street ② to facilitate station construction could lead to dispersion of this community and potentially bring adverse health and well-being impacts. HS2 Ltd would be committed to working closely and at an early stage with the local authority and with community groups, residents' associations and affected residents generally to ensure that effective arrangements are in place to meet the housing needs of those affected by the demolition of these dwellings, and to help to address wider impacts on the local community.
- 5.6.5. Access to jobs is also a key concern for Black, Asian and minority ethnic groups, and while some displaced jobs currently held by people in these groups are likely to be replaced by the new employment opportunities, this may not be the case for all. The immediate area around the new station at Manchester Airport is also home to Black, Asian and ethnic minority groups and faith groups who may be subject to similar adverse effects from demolition of homes and businesses in that area.

⁵² As per the methodology for the AoS, appraisal is limited to operational impacts only at this time. Construction impacts will be assessed during the EIA.

Key changes from the 2013 consultation scheme

Route changes and the relative nature of the equality analysis⁵³ mean that there are some small changes in the locations of large populations with protected characteristics (see Appendix A for details of these changes). The main locations where there are large proportions of protected characteristic groups, however, remain the same as those identified in the equality analysis undertaken in 2013.

5.7. Noise

Airborne noise

- 5.7.1. Noise specialists have worked closely with the scheme engineers to determine (at this stage of design) the feasibility of introducing noise barriers at the ‘preliminary candidate areas for mitigation’ (see paragraph 4.9.8). This should substantially reduce the number and extent of noise impacts expected at this early stage. Table 5-1 shows the number of people predicted to experience noise impacts and compares the impacts with and without additional mitigation.

Table 5-1– Estimated numbers of dwellings with noise impacts for the western leg

Preferred Route	High noise levels	Noise insulation regulations	Noticeable noise increase
Without additional mitigation	<15	150	4400
With additional indicative mitigation	<5	<50	1100

- 5.7.2. The use of additional mitigation would reduce noticeable noise by about 75%. It would reduce the number of dwellings potentially qualifying for noise insulation by around two thirds and the number of high noise level impacts by a similar amount⁵⁴.
- 5.7.3. The residential areas which are identified as having a relatively higher risk of residual noise impacts include:
- North of Crewe near the tunnel portal ⑤; and
 - Lostock Green ⑥ and Lostock Gralam ⑦.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Changes in the noise impacts from the 2013 consultation route have arisen due to refinements in both the horizontal and vertical alignment as well as revisions to the operational speeds in some locations.

For the western leg preferred route as a whole, the refinements have resulted in an

⁵³ Thresholds for identifying areas with large proportions of groups with protected characteristics are based on averages for the preferred scheme as a whole and thus have changed with the route refinements.

⁵⁴ Volume 2 Noise Mapping provides further information on indicative locations for mitigation.

increase in the number of dwellings potentially experiencing a noticeable noise increase compared to the consultation route.

Increased or new noise impacts are predicted at the tunnel portal at the north of Crewe ③, Walley's Green ⑦, Wimboldsley ⑨, Stanthorpe ⑭, Clive ⑮, Rudheath ⑳, the west side of Lostock Green ㉔, Lostock Gralam ㉗, Mill Wood ㉚, Wigshaw ㉞ as well as at some isolated properties along the route particularly north of Pickmere.

Noise impacts have been reduced on the east side of Lostock Green, Lach Dennis, Higher Wincham, Pickmere, Hoo Green, Hulseheath, Hollins Green, Cadishead, Glazebrook and Ashley as result of route refinement, including a speed reduction over the Manchester Ship Canal from 360kph to 320kph.

5.8. Air Quality

- 5.8.1. In general, most of the areas along the preferred route are in compliance with national air quality objectives and European limit values. According to Defra's modelled background map data, background levels of NO₂, PM₁₀ and PM_{2.5} are within UK air quality objective levels along the length of the preferred route and are set to decrease in future years.
- 5.8.2. Some areas near the preferred route, predominantly in the vicinity of busy roads, do currently exceed air quality objective levels, particularly for NO₂. AQMAs within 1km of the route (south to north) are:
- Cheshire East;
 - Warrington; and
 - Greater Manchester.
- 5.8.3. Proposed stations at Manchester Airport and Manchester Piccadilly are located within AQMAs. Changes in traffic at these locations, either during construction or operation, might lead to changes in pollution levels. There is the potential for dust effects during construction in built-up areas, particularly at larger sites such as Manchester Airport station and Manchester Piccadilly station. Best practice in the control of highway and dust air quality effects will be through application of measures set out in the CoCP.

No key changes from the 2013 consultation scheme

5.9. Landscape and visual impacts

Crewe to Golborne

- 5.9.1. Landscape impacts would be relatively slight where the route passes in tunnel and cutting through Crewe ① and its outskirts, and equally where HS2 runs alongside the WCML on low embankment for several kilometres north of Crewe. Visual impacts would affect residents locally on the outskirts of Crewe.
- 5.9.2. Diverging from the WCML, the HS2 route would affect historic field patterns between Winsford and Middlewich ⑩ and result in visual impacts at scattered farms, hamlets and dwellings along the route. The crossing over the Shropshire Union Canal ⑫ would cause visual impacts for people using the canal from both the mainline and Crewe North RSD connections. Further north, where the route crosses the A54, the connections to the depot rise on viaduct over the embanked mainline. This would fragment and intrude upon the characteristically flat, open landscape between Winsford and Middlewich ⑩ and cause visual impacts for residents at the hamlets of Clive ⑮ and Stanthorpe ⑭.

- 5.9.3. Crewe North RSD would potentially be highly visible within the farmland west of Wimboldsey ⑨. However, its landscape and visual impacts would be limited as the site has few notable landscape elements apart from some young parkland trees, and views would be partially screened by the low embankments of the WCML and the HS2 line itself. Depending on the massing and height of structures within the depot, visual impacts are expected for recreational users of the Shropshire Union Canal ⑫ and for residents at Wimboldsley ⑨.

Aerial view looking north from Crewe across the Cheshire plain, including the proposed site of the north Crewe Rolling Stock Depot



- 5.9.4. Further north, near Bostock Hall, the route runs onto a high viaduct for over 1km, crossing the River Dane ⑮ and Trent and Mersey Canal ⑰ and causing visual impacts for recreational users. The landscape character of the valley and the immediate setting of Bostock Conservation Area ⑯ approximately 200m away would also be adversely affected despite the partial screening afforded by existing woodland.
- 5.9.5. The route then continues north, crossing a small stream on viaduct and re-crossing the canal on embankment near Whatcroft ⑱, where it would intrude on the character of the floodplain and again have visual impacts.
- 5.9.6. Passing east of the mainly industrial outskirts of Northwich the route runs on embankment and a series of short viaducts. Visual impacts would occur locally at Broken Cross ⑳ and Lostock Green ㉑. Near Lostock Gralam ㉒ the 1.2km long viaduct would cause visual impacts and would intrude on landscape character in part through its impacts on Winnington Wood ㉓ and Leonard's & Smoker Wood ㉔.
- 5.9.7. North of Peover Eye and Smoker Brook the embankment reduces in height, but crossing the Heyrose Golf Course ㉕ it would have visual impacts for users. Local visual impacts would affect residents at Winterbottom ㉖ and further north at the Grade II listed Mere Court Hotel ㉗ and Hoo Green ㉘ where there would be local views into deep cutting. The Manchester spur diverges east from the mainline at this location and is discussed below.

- 5.9.8. Landscape impacts would be generally minor until the route crosses the Bollin Valley. A deep, wide cutting under the M56 ④, embanked sections around Agden Bridge ④ and the viaduct over the River Bollin ④ would affect landscape character, notably where embankment intrudes onto the open floodplain. Visual impacts would affect users of the Bridgewater Canal ②, the Cheshire Ring Canal Walk ① and the Trans Pennine Trail ④. However, from the River Bollin crossing northwards to near Warburton the route is generally in cutting, which would help to limit impacts.
- 5.9.9. The route crosses the Manchester Ship Canal ⑤ on a viaduct 1.3km long, which would result in a major impact on the landscape character of this part of the Mersey Valley. However, the effects would be moderated to some extent: there are already several high road and rail crossings over the Manchester Ship Canal ⑤ between Warrington and Irlam, so the structure would not represent a wholly new landscape element. The new crossing would be reasonably well separated from the closest existing crossing (the historic toll bridge at Warburton, approximately 800m to the south-west) and it is possible that a striking viaduct design and sensitive viaduct design could provide an iconic feature, although the impact of the approaches on this open landscape would remain. Visual impacts from the viaduct and embankments would affect residents at Warburton ④, Partington ④, Hollins Green ①, Cadishead ③ and Glazebrook ③, as well as canal users.

Aerial view looking north east across the Manchester Ship Canal



- 5.9.10. Continuing north-west, the route passes on embankment through an area of restored lakes on the northern edge of Risley landfill ③ which would affect local landscape character. It continues past Culcheth, and towards Lowton on both cutting and embankment: impacts would generally be slight as a result, although visual impacts would affect residents at Wigshaw ③ where the route crosses Glaziers Lane, along with users of the fishery and caravan park.
- 5.9.11. North of Lowton the route is set back from the river and canal corridor so that it lies approximately 700m from Pennington Flash Country Park ② and 500m from Lightshaw Hall thus helping to reduce effects on the country park and setting of the area.

- 5.9.12. Approaching the WCML, the route crosses the A573 on low embankment, then rises onto a long viaduct over the WCML. Landscape impacts would be associated with the embankments and viaduct, but the route is sited away from the attractive, sensitive canal and river corridor which would not be greatly affected. Visual impacts would affect users of the Leeds and Liverpool Canal 66 and residents at Dover 7 on the southern edge of Abram.

Manchester spur

- 5.9.13. Where the Manchester spur diverges from the mainline at Hoo Green 9, a large section of cutting accommodating both the spur and the mainline routes would result in landscape impacts. Although passing under the distinctive winding country lanes north of Hulseheath 1, landtake would still affect the historic field patterns, hedgerows and hedgerow trees. The low embankment past Hulseheath 1 would result in visual impacts in and around the village.
- 5.9.14. The deep and wide cutting past Rostherne Mere 7 would adversely affect the landscape setting of the mere and fragment intact open countryside. Rising then onto low embankment, the route would intrude on landscape character and countryside views and cause visual impacts in Ashley 9 to the north. Views from Tatton Park parkland would be largely screened by the mixed plantings around the edge of Hale Barns.
- 5.9.15. The route enters deep cutting as it turns north past Thorns Green 80 and Halebank 82 and would directly affect landscape character, although the viaduct over the River Bollin would be relatively well concealed in the valley.
- 5.9.16. Approaching the urban fringe of Manchester, the preferred route and Manchester Airport station would be closely associated with the motorway and existing airport structures. Passing in deep and wide cutting beneath the M56 and through Hale Barns, visual impacts would affect residents living on the edges of Hale Barns 86 and Davenport Green 89. North of Hale Barns the route would affect the character of the open countryside east of Davenport Green in the Timperley Brook Valley 88. Landscape effects would be exacerbated by impacts from the proposed airport station and the tunnel portal.
- 5.9.17. Impacts would generally be avoided as the route passes through tunnel under Wythenshawe, Northenden, Withington, Rusholme and Longsight. However, there could be visual impacts from the four proposed ventilation shaft sites.
- 5.9.18. The route resurfaces at Ardwick and approaches the new station on a viaduct. This would increase the influence of rail structures on views and townscape, affecting in particular the character of the public open space to the south and views from the Medlock Valley 91. However, proposals would create new connections through the site, and the inclusion of extra land within the operational site boundary north and south of the station approach could offer opportunities for high quality urban design, landscaping and public realm. The new station would fit well alongside the existing Manchester Piccadilly station.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Key improvements include:

- Reduced countryside fragmentation near Lostock Green as a result of horizontal shift to avoid brine wells and natural gas storage caverns in the Holford Brinefield.

- Avoidance of direct impact on Culcheth linear park, a local community asset, due to route realignment south and west of Culcheth.
- Reduced countryside fragmentation and impact on views in the Pennington Flash and Abram Flash areas at Golborne, where route has been realigned further south. Reduced landscape and visual impact in the Golborne area due to relocation of the depot to the north of Crewe.
- Reduced landscape and visual impacts north of Rostherne Mere with the removal of the northern chord and associated raised structures.

New or increased impacts include:

- Greater visual impact on residents near Wimboldsley ⑨, due to relocation of the depot to this area.
- Greater landscape character impact along much of the route north of Crewe ④ through to Hoo Green ⑰ due to raising of the alignment across the flat generally open 'meres and mosses' landscape.
- Increased visual impact on residents, particularly in the vicinity of Clive ⑬, Stanthorne ⑭, Broken Cross ⑮, Lostock Green ⑯ and Lostock Gralam ⑰ due to route realignment.
- Increased visual impact for recreational users of the Shropshire Union Canal ⑫ and Trent and Mersey Canal ⑰ (the latter having three crossings over a short section).

5.10. Cultural heritage

- 5.10.1. Overall the western leg has been selected, aligned and refined so that it would have few impacts on designated heritage assets. Several changes have been implemented to the consultation scheme, reducing the impacts on heritage assets at a number of locations, particularly around Culcheth and Golborne.
- 5.10.2. The AoS has concluded that the majority of potential impacts would be minor at most. Unless stated otherwise, only those of potentially greater magnitude than this are described below. Based on this provisional stage of design, these are the ones considered likely to adversely affect the significance of the heritage asset.

Crewe to Golborne

- 5.10.3. North of Crewe, the route passes approximately 250m east of the Scheduled moated site at Minshull Vernon ⑤. This medieval double moat comprises a range of shallow earthworks preserved under pasture in a landscape of enclosed fields. The route is in on a low embankment and although alongside the existing WCML, within the generally open farmland, it would change the monument's setting.
- 5.10.4. The Crewe North RSD extends to within about 65m of Park Farmhouse ⑪ which would change the setting of this Grade II listed building.
- 5.10.5. The route crosses the Trent and Mersey Canal ⑰ at three locations east of Bostock Green. The 19th century canal is designated a Conservation Area for its whole length and these three crossings would have a major impact on its character and appearance.
- 5.10.6. Bostock Conservation Area ⑩ incorporates a group of listed buildings including the Grade II* listed Bostock Hall and the Scheduled moated site it sits on. The hall is approximately 730m west of the route and the viaduct runs through part of the parkland associated with the hall. Although tree belts are likely to provide some screening, the setting of the hall would be changed. Changes to the setting of the

Grade II listed Bridge Cottage and Canal Cottage 20 (one listing) to the north of the Trent and Mersey canal including the addition of a viaduct within 25m of the property boundary, would be a major impact.

- 5.10.7. Passing west of Hoo Green, where the spur diverges eastwards, the route passing in cutting through the eastern grounds of the hotel, would affect the setting of the Grade II listed Mere Court Hotel 38. Further north, changes to the setting of the Grade II listed Ovenback Cottage 39 near High Legh would also be changed.
- 5.10.8. Emerging from the Bollin Valley, the main route rises onto viaduct and embankment and passes approximately 200m south-east of the Grade II listed timber frame building at Warburton Park 45, changing the setting of this building, including its relationship with the wider park.

Manchester spur

- 5.10.9. For the Manchester spur approaching the new airport station the change to the setting of the Registered Park and Garden at Tatton Park 70 would be minor although the route may affect some views from its northern edge.
- 5.10.10. Descending into cutting beneath the M56, the route passes 130m north of the Grade II listed Yewtree House 8 and this would change its setting. North of the motorway and approaching the proposed new airport station, the route would require the demolition of the Grade II listed Buckhall 85 at Hale Barns, a mid-18th century brick farmhouse resulting in a major impact.
- 5.10.11. At Manchester Piccadilly, the Grade II listed train shed 95 is located within the footprint of the new station. It is assumed that this structure would be retained, although further assessment is required of the more detailed design before the impact can be determined. Of the numerous other listed buildings in this location (80 within 350m of the new station footprint and three within 50m) changes to their setting are likely. However, the final scheme design will determine whether the changes would result in minor, neutral or beneficial impacts.
- 5.10.12. The terminus could also affect the character of four Conservation Areas. However, only impacts on Whitworth Street Conservation Area 94 would potentially be adverse, and sensitive design of the station could result in neutral or beneficial effects on this and the other Conservation Areas.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Key improvements include:

- No longer demolishes, nor changes the setting of the Grade II listed Newchurch Old Refectory (the Old Rectory) at Culcheth.
- Changes to the setting of the Grade II* listed Lightshaw Hall are avoided.
- Changes to the setting of the Grade II listed Byrom Hall are avoided.

New or increased impacts potentially affecting the significance of the heritage asset comprise:

- Changes to the setting of Grade II listed Park Farmhouse 11.
- Changes to the setting of Grade II listed Bridge Cottage and Canal Cottage 20.
- Changes to the setting of the Grade II* listed Bostock Hall 16.

- Adverse impacts on the character and appearance of the Trent and Mersey Canal Conservation Area ⑩ at Bostock Green.
- Changes to the setting of the Grade II listed Mere Court Hotel ③⑧.
- Changes to the setting of the Grade II listed Yewtree House 8#.

5.11. Biodiversity and wildlife

Statutory designations

- 5.11.1. Much of the ecological interest of the area potentially affected by the western leg is associated with the meres and mosses of the Cheshire and Staffordshire plains. A number of waterbodies have been formed within depressions left by glaciation or from subsidence due to the dissolution of salt deposits, resulting in shallow meres and mosses.
- 5.11.2. One group of meres and mosses within the Cheshire Plain is collectively designated the Midland Meres and Mosses Ramsar site ⑤⑨. The route would pass to the east of the Mere, a component of this designation and a SSSI.
- 5.11.3. Rostherne Mere ⑦④ immediately north of the Mere is separately designated a Ramsar site, as well as a NNR and SSSI. The scheme would pass to the west of this site, and the Manchester spur would pass to the north.
- 5.11.4. Both of these sites would be unaffected by the scheme, given the design measures agreed with the Environment Agency and Natural England to ensure groundwaters feeding them are maintained.
- 5.11.5. The Manchester Mosses SAC consists of three raised bog sites, one of which Holcroft Moss ⑤⑩ is located approximately 65m east of the preferred route. HS2 Ltd will continue to work closely with Natural England and the Environment Agency to ensure the moss would be unaffected by the scheme. This will include agreement over measures such as suitable foundation works, track construction techniques and a design which does not affect the drainage characteristics around the site.
- 5.11.6. No nationally protected sites would be directly affected by landtake along the western leg. Several SSSIs lie within 2km of the scheme, such as Bryn March & Ince Moss ⑦① and Abram Flashes ⑥⑥. There is potential for the preferred scheme to affect surface water flows to these, although impacts are unlikely as the route affects only small proportions of their catchments or is situated downstream of the sites. Any potential impacts would be mitigated through scheme design. There are a number of other SSSIs within 1km of the site. Further information on why indirect impacts on these features are considered unlikely at this stage in the design are listed in *Appendix C3 Biodiversity*.

Non-statutory sites

- 5.11.7. Sean Hawkins Meadow ⑦②, a Wildlife Trust Nature Reserve, may be affected by the preferred route. It is located north east of High Legh and comprises areas of meadow, scrub and woodland and a stream. The location and extent are not currently known and will be explored further at the EIA stage.

Other important habitats

- 5.11.8. There would be a total of four direct impacts on ancient woodland. The western mainline would have direct impacts on three ancient woodlands namely Winnington Wood ②⑨, Leonard's and Smoker Wood ③① (near Lostock Gralam) and

Coroners Wood ④ (near Partington). In addition Hancock's Bank ⑦ on the Manchester spur would also be directly affected.

5.11.9. The western leg would impact on numerous areas of habitat considered to be of principal importance (HPI). The ecological significance of these impacts is not known at this stage and the areas will be surveyed in due course as part of the EIA to assess and evaluate the effects. The total distance of HPI intersected by the centre line of the route is 4.2km. The more notable impacts are expected to affect the following areas:

- lowland deciduous woodland near Lostock Gralam which includes ancient woodland at Leonard's and Smoker Woods ⑩;
- lowland deciduous woodland adjacent to the River Dane ⑮ and Trent and Mersey Canal ⑰ east of Bostock Green;
- lowland deciduous woodland adjacent to the Gad Brook, at Rudheath ⑳;
- lowland raised bog and lowland deciduous woodland west of Holcroft Moss ⑤⑥;
- lowland fen south of Abram ⑥⑤;
- lowland fen north-east of Golborne ⑥⑥; and
- lowland deciduous woodland adjacent to the River Bollin on the Manchester spur ⑩.

5.11.10. Elsewhere along the route smaller areas of isolated lowland deciduous woodland would also be affected.

5.11.11. Impacts on protected species such as bats, great crested newts, otters and badgers will be assessed in the EIA and, as required, appropriate mitigation measures will be identified.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Key improvements include:

- Reduced landtake through Hancock's Bank ancient woodland.
- Impact removed to area of deciduous woodland which is part of Culcheth Linear Park.
- Reduced landtake and habitat fragmentation on areas of lowland meadow and deciduous woodland at Golborne.

New or increased impacts include:

- Increased landtake at Winnington Wood ancient woodland ②⑨.
- Increased fragmentation at Leonard's and Smoker Woods ancient woodland ⑩.
- New impact on deciduous woodland habitat at Billinge Green (east of Northwich) ②.

5.12. Water resources and flood risk

5.12.1. The consultation route considered Environment Agency flood zones along major watercourses. Further work has since been undertaken to understand the clearance at all watercourse crossings along the line of route. The clearance at

each watercourse crossing has been assessed against updated design requirements and where available, updated topographic data.

- 5.12.2. Where clearance over or under the watercourse was insufficient compared with the design requirements, the alignment has been adjusted where practical. This has resulted in the heights of viaducts and embankments increasing in a number of locations in order to achieve sufficient clearance over the watercourse and/or flood water levels.

Watercourse diversions

- 5.12.3. Close working between the scheme engineers and AoS water specialists has been successful in avoiding the need for many permanent diversions of watercourses along most of the route.
- 5.12.4. On the mainline route the need for permanent diversions is envisaged for two major rivers and five minor rivers. Major rivers that would require diversions are the River Dane 15 and Red Brook 49. There are five minor rivers that would require diversions, three of which (Waterless Brook 22, Holcroft Lane Brook 7 and Coffin Lane Brook 48) are also Environment Agency designated Main Rivers.
- 5.12.5. On the Manchester spur, major river diversions would affect only the River Medlock 11 in Manchester, where the approach to Piccadilly station lies above the canalised River Medlock. Minor river diversions would affect four watercourses, one of which (Timperley Brook 38, crossed at the airport station) is also an Environment Agency designated Main River.

Flood risk

- 5.12.6. The route would cross floodplains at numerous locations. Generally, these crossings would be on viaduct or a clear-span bridge to reduce the potential loss of flood storage and obstruction to flood flows. Viaducts are currently proposed for six floodplains crossed for more than 100m.

Table 5-2 – Floodplain crossings

Watercourse name	Viaduct name	Viaduct length (m)	Floodplain crossing (m)
River Dane and Trent & Mersey Canal 15	River Dane and Trent & Mersey Canal Viaduct	1,160	880
Puddinglake Brook 21	Puddinglake Brook Floodplain Viaduct	160	150
Peover Eye and Smoker 31	A556, A559, Linnards Lane, Peover Eye and Smoker Brook Floodplain Viaduct	1,170	110
River Bollin 13	River Bollin Flood Plain Viaduct (mainline)	350	340
Manchester Ship Canal 50	Manchester Ship Canal, Manchester Road and A57 Viaduct	1,320	310
Holcroft Lane Brook 7	At Grade	n/a	415
Blackburn's Brook and Birkin Brook 76	Blackburn's Brook and Birkin Brook Floodplain Viaduct	390	210

- 5.12.7. In total, the route would cross major rivers at 11 locations, including the River Dane at three locations, and would involve 59 crossings of minor rivers and five of

navigable waterways. Each of these will require more detailed study in due course where, for example, no flood mapping currently exists.

Groundwater

- 5.12.8. At Lowton, east of Golborne, the route passes in cutting through an area of more sensitive groundwater (designated as SPZ2 ①). This potentially affects abstraction from a nearby borehole that abstracts from a principal sandstone bedrock aquifer. This bedrock aquifer is overlain by drift deposits of clay between 2m and 15m thick. It is anticipated that the route will be within the superficial clay deposits or top few metres of the sandstone aquifer, and therefore likely that the cutting will be above the water table. Consequently, permanent impacts are unlikely.
- 5.12.9. There are two public water supply boreholes close to Little Town, Culcheth. The route is in shallow cutting through SPZ3. The cutting would be within clay deposits and above the water table. Adverse effects are therefore unlikely.
- 5.12.10. In addition, the route passes through an extensive area of linked catchment SPZ associated with this and several other water supply locations in the Golborne area, including two potable water supply boreholes. However, passing on embankment between these two boreholes, which are overlain by thick clay, means that adverse impacts are unlikely.
- 5.12.11. In addition to potable groundwater supplies, other notable large groundwater abstractions, include one at Origin Developments, Manchester. This is located close to the end of the route where all platforms are on viaduct coming into Manchester Piccadilly station. Impacts on this are unlikely.
- 5.12.12. The EIA stage will assess water resources and flooding (including WFD compliance) in further detail. Nevertheless, this will be assessed in consultation with the Environment Agency and will be accompanied by a detailed ground investigations and an appropriate Groundwater Risk Assessment during the next phase of design.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Vertical alignment changes between the 2013 consultation scheme and the current preferred scheme have been driven in part by the need to cross watercourses with sufficient clearance. This has provided improved clearance for a number of viaducts and culverts. Key improvements include:

- Reduction in length of floodplain crossings at Gad Brook, Wade Brook, Peover Eye and Wincham Brook to below 100m.
- The crossing of the Higher Wincham Brook near Northwich has now been avoided, removing the potentially adverse impact on the watercourse and the risk of flooding.
- At West Gorton the above-ground route no longer passes through Flood Zone 3 of the Corn Brook, removing the potential flood risk.
- There is a reduction in the number of minor river diversions required; of specific note is the removal of the diversions of Upper Wincham Brook and Coffin Lane Brook.
- The preferred route now passes on embankment between two boreholes near Golborne, reducing the risk to these abstractions.

New or increased impacts include:

- New major river diversions are required at the River Dane ⑮ and the Red Brook⁵⁵ ④9.
- New impact on Holcroft Lane Brook ⑦, which would require diversion of the watercourse, including floodplain realignment, and potentially present a risk of flooding to the preferred scheme.

Realigned south-west of Culcheth, the route cuts closer to two public water supply boreholes, which were previously outside of the buffer zone. Shallow cutting within clay deposits above the water table limits the risk of impact.

5.13. Land use resources

Agricultural land take

- 5.13.1. The AoS process has sought to limit the loss of the highest quality agricultural land. High level agricultural land classification maps show that Grade 1 classified agricultural land is limited to the drained peat of Chat Moss ⑤ between Manchester and Liverpool. Approximately 900m of land shown as Grade 1 would be crossed by the mainline in the vicinity of Holcroft Moss. In addition, an estimated 19.8km of the route would be through land classified as Grade 2, notably in the Mersey Valley around Lymm and Warrington.

Green Belt land

- 5.13.2. The main areas of green belt crossed by the route occur north of Lostock Gralam ②7, with a total of 30km on the mainline to Golborne ③ and 8km along the spur into Manchester. The Manchester Airport station would occupy approximately 15ha of green belt.

Landfill sites

- 5.13.3. The AoS identified two active (operational) landfill sites and seven disused (non-operational) landfill sites within 250m of the preferred route. Higher risks were identified for both of the active sites and three of the disused sites, based on the type and length of crossing, the size of the landfill and its recorded contents.
- 5.13.4. The active sites are both permitted for hazardous/industrial waste. The Bostock landfill ⑩ north-east of Winsford would be crossed on embankment and viaduct for about 395m, although associated environmental impacts are unlikely as the site is deep underground. The Risley IV landfill ⑤9 south of Culcheth would be crossed at grade and on embankment for about 140m, although the crossing would impact the surface water run-off ponds and not the landfill cells. Risley landfill has now ceased accepting domestic waste and is in the process of undergoing site restoration and landscaping.
- 5.13.5. The three disused landfills, each designated for non-hazardous waste, comprise:
- Hollins Green tip east of Warrington ②, crossed by viaduct for about 215m;
 - Lowton Sidings east of Golborne ①, crossed by cutting and embankment for about 320m; and

⁵⁵ This has been reclassified as a major diversion since the 2013 scheme due to newer information about the size of the catchment for this river.

- Former British Railways tip at Tommy's Lane, Crewe ②, crossed by bored tunnel for about 120m.

No key changes from the 2013 consultation scheme

5.14. Excavated materials and material resource

- 5.14.1. The estimate for excavated material arising on the preferred route is 2.4 million cubic metres, of which about 2.0 million cubic metres would be from tunnel excavation. However, these estimates do not take account of the materials likely to be incorporated within the scheme for the creation of landscaping and bunding as part of any mitigation proposals.
- 5.14.2. The estimated quantities of bulk building material required for construction of the preferred route would comprise 187,000 tonnes of steel and 2,046,100 tonnes of concrete.

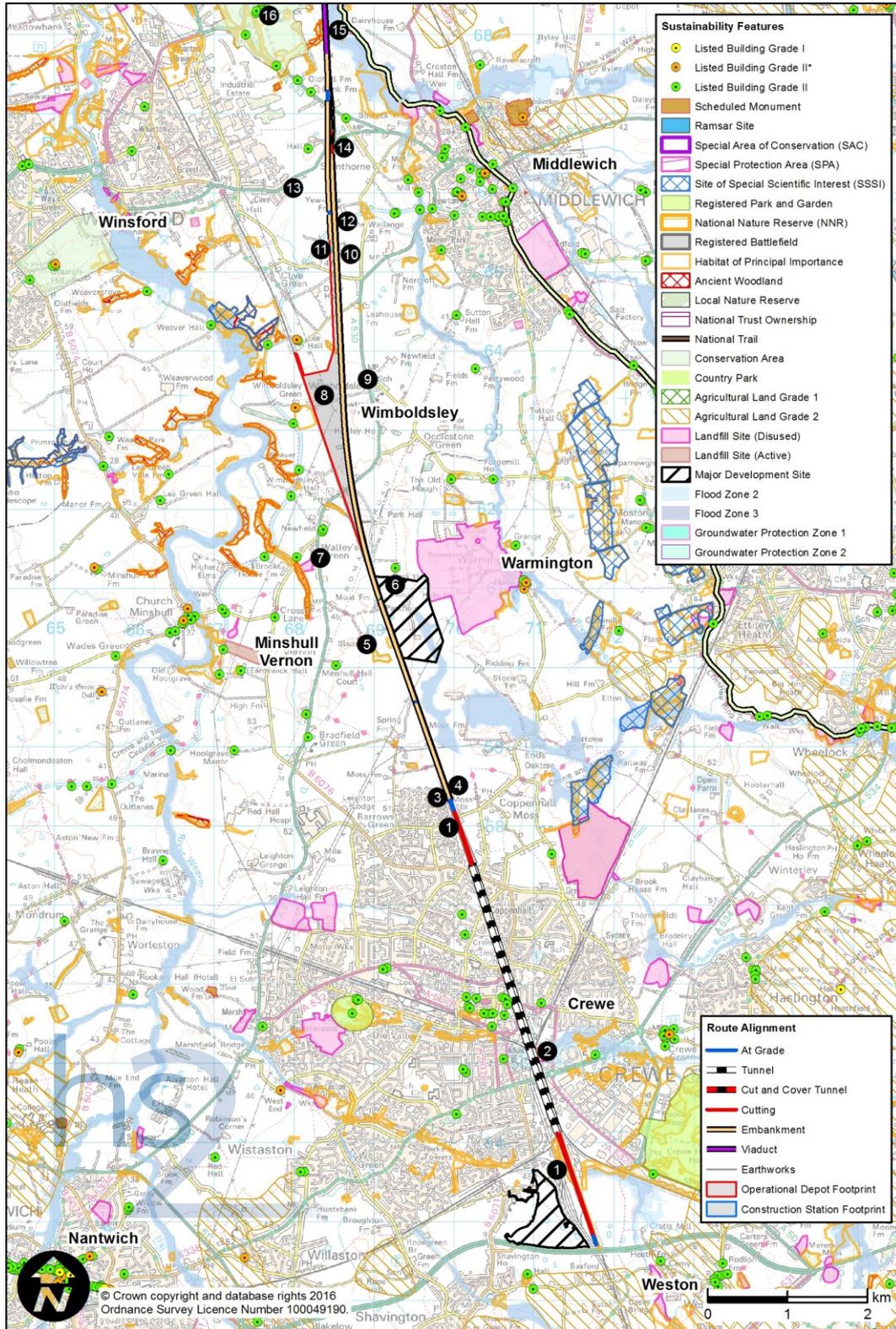
Key changes from the 2013 consultation scheme

As a result of refinements to the route, including a raising of the section of alignment north of Crewe, the preferred route now has:

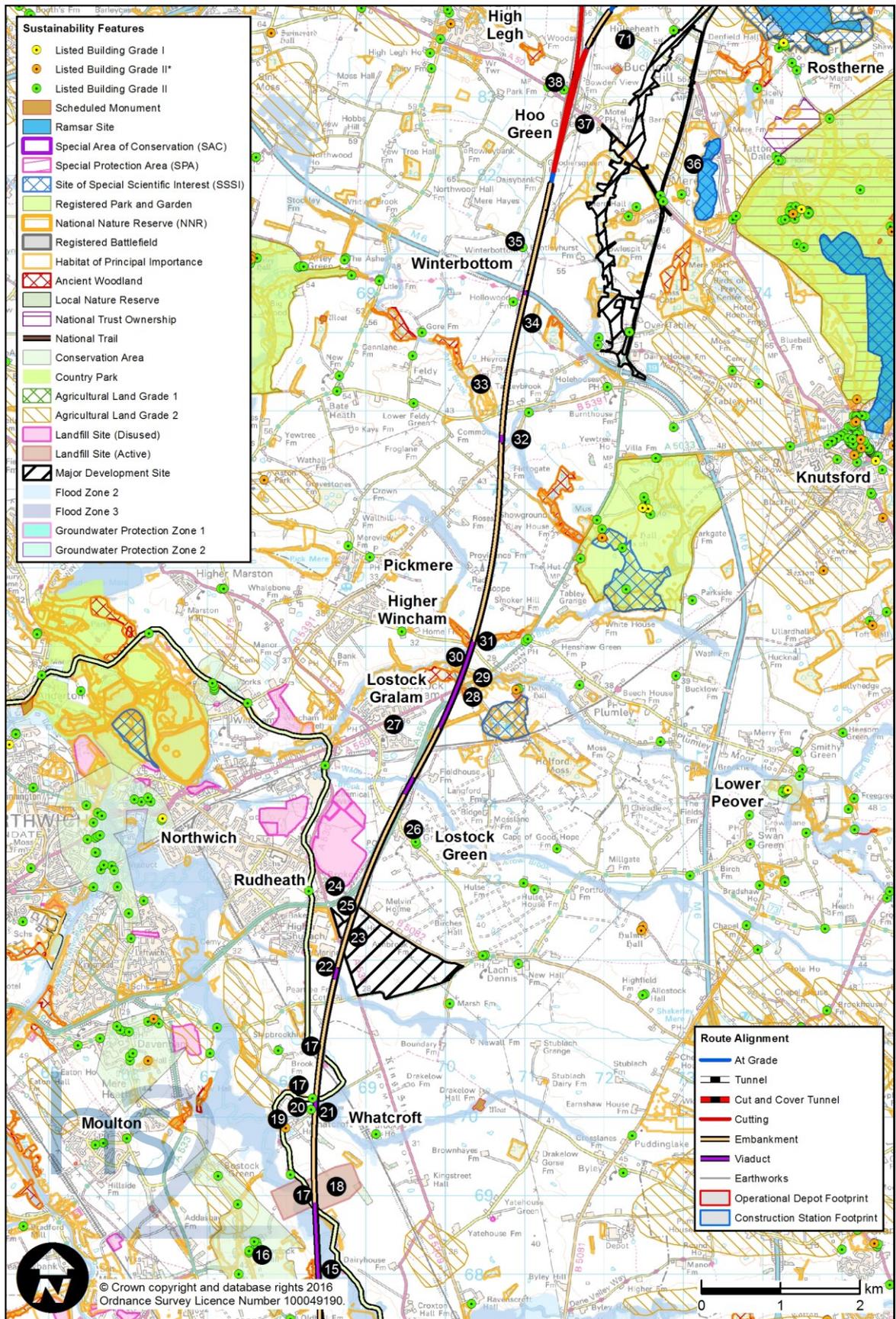
- An estimated 5.6 million cubic metres less excavated material.
- An estimated 238,300 tonnes more concrete required.

6. Western Leg Sustainability Maps

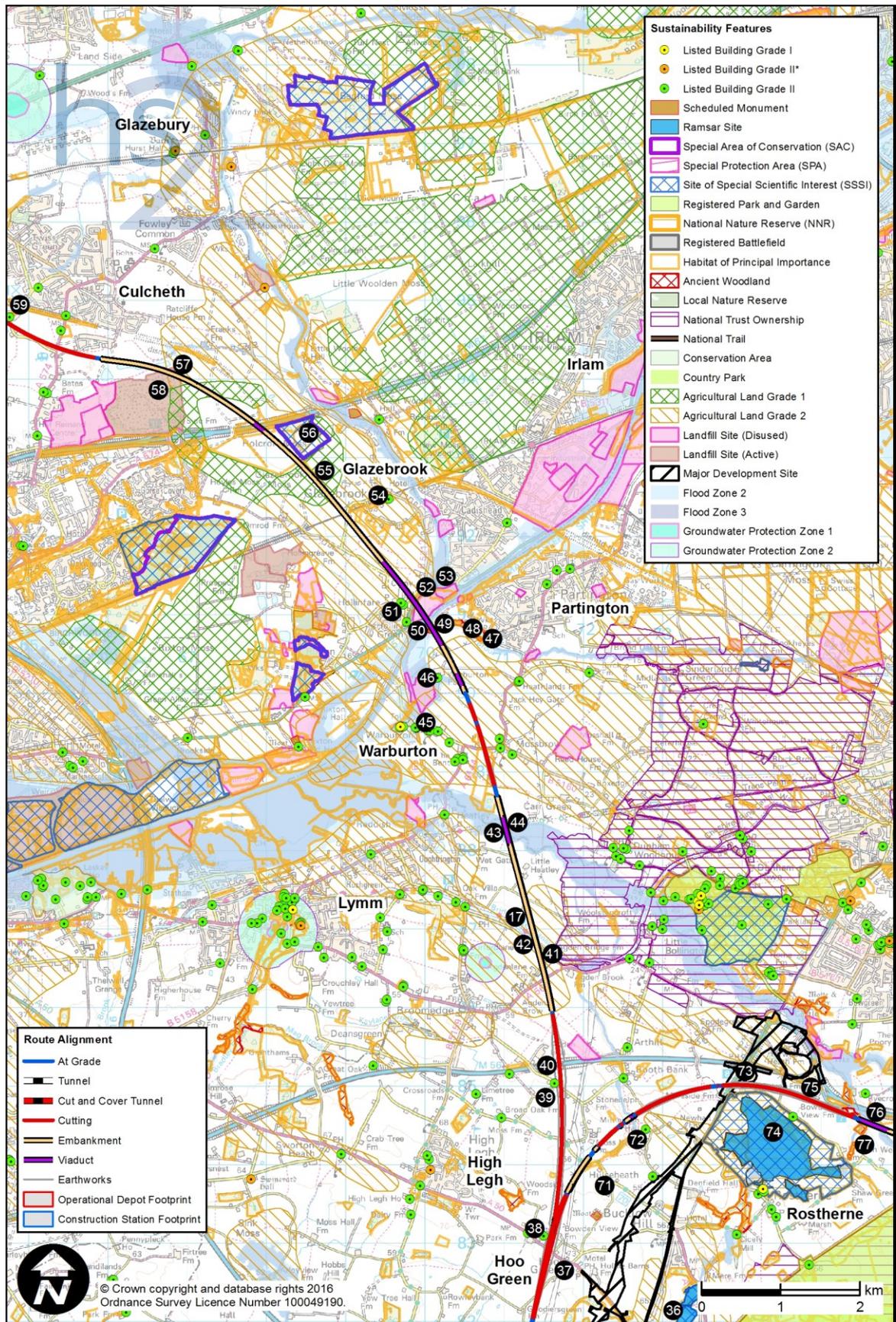
Western Leg Sustainability Mapping (1 of 6 – Crewe to Bostock)



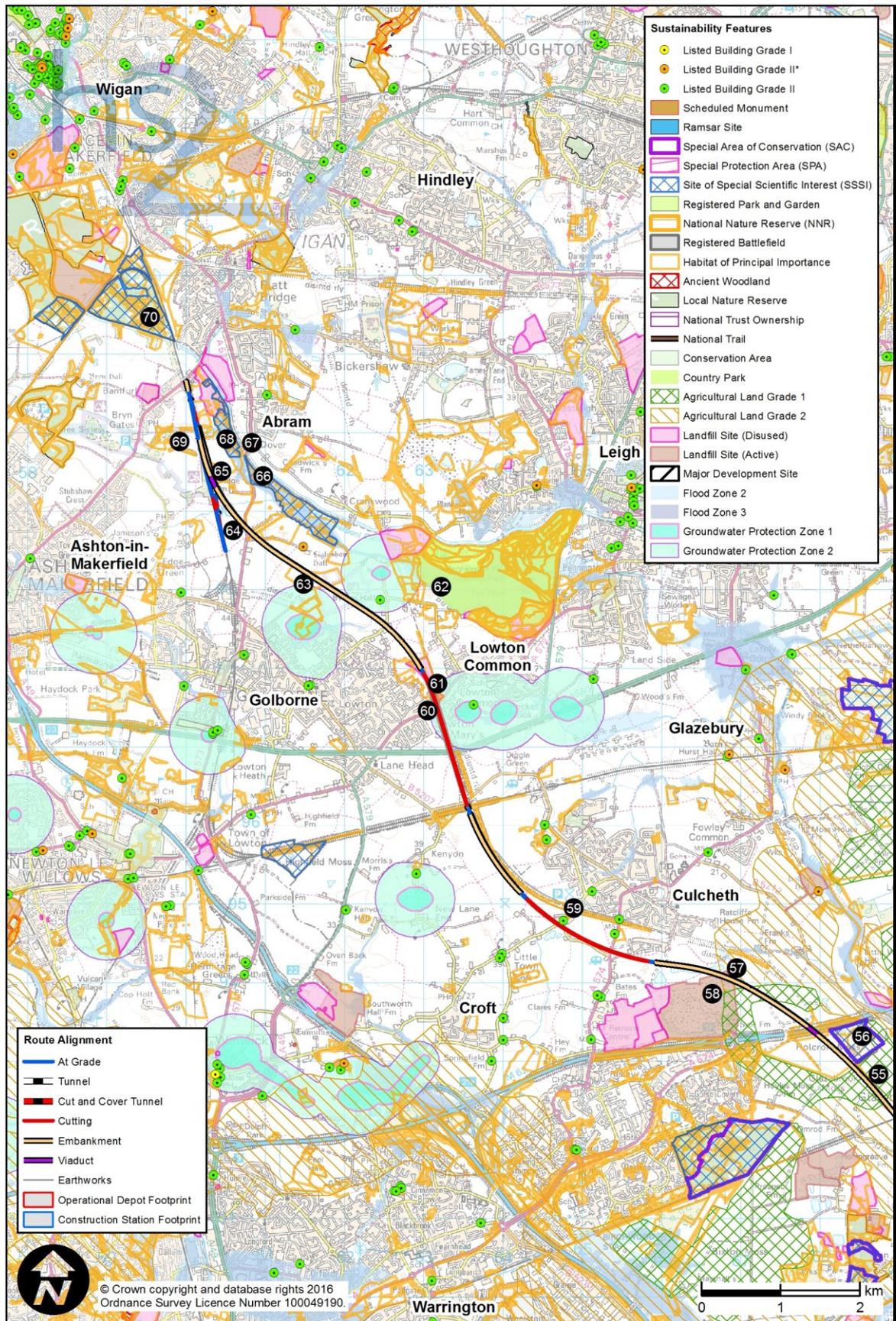
Western Leg Sustainability Map (2 of 6 – Bostock to Hoo Green)



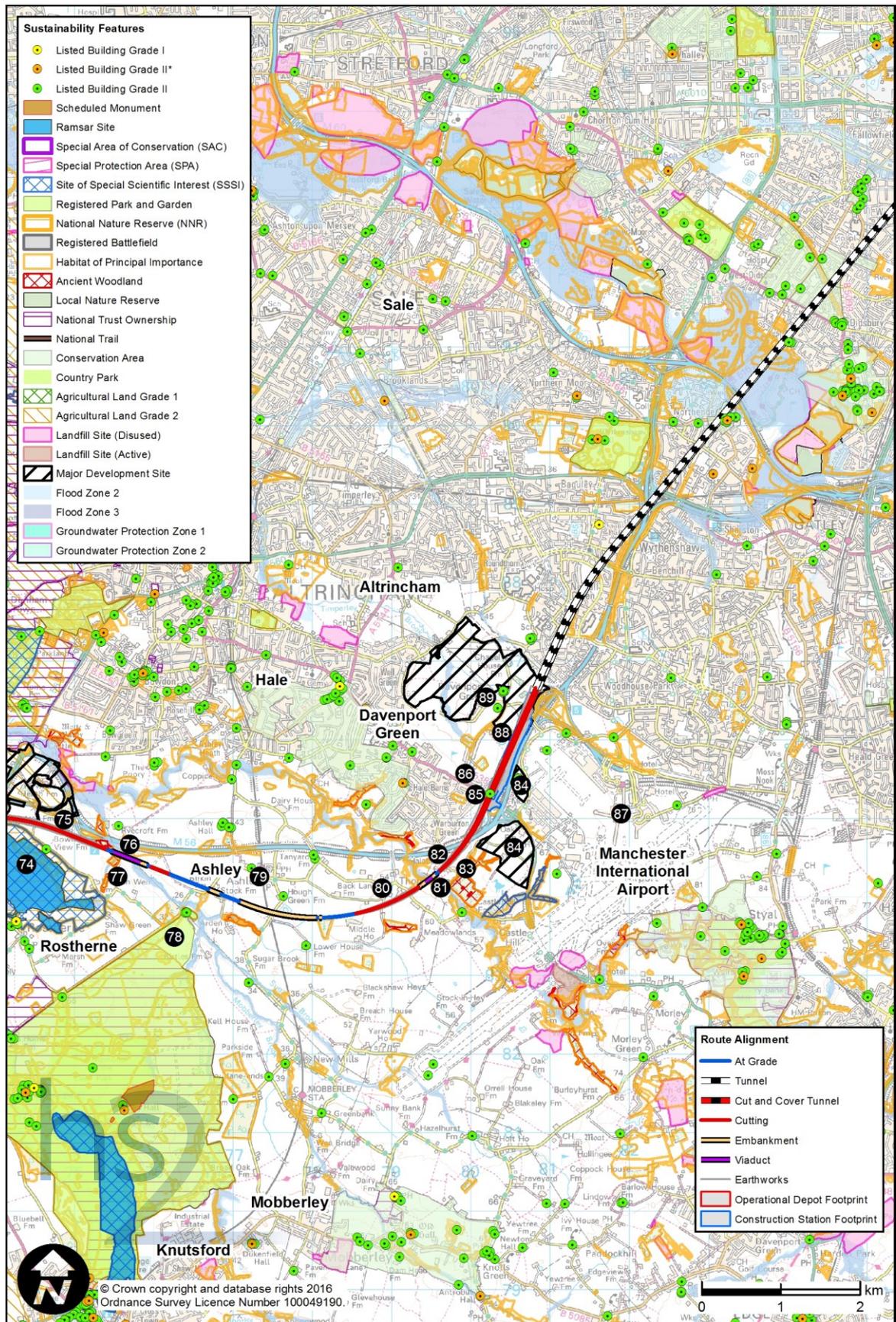
Western Leg Sustainability Map (3 of 6 – Hoo Green to Culcheth)



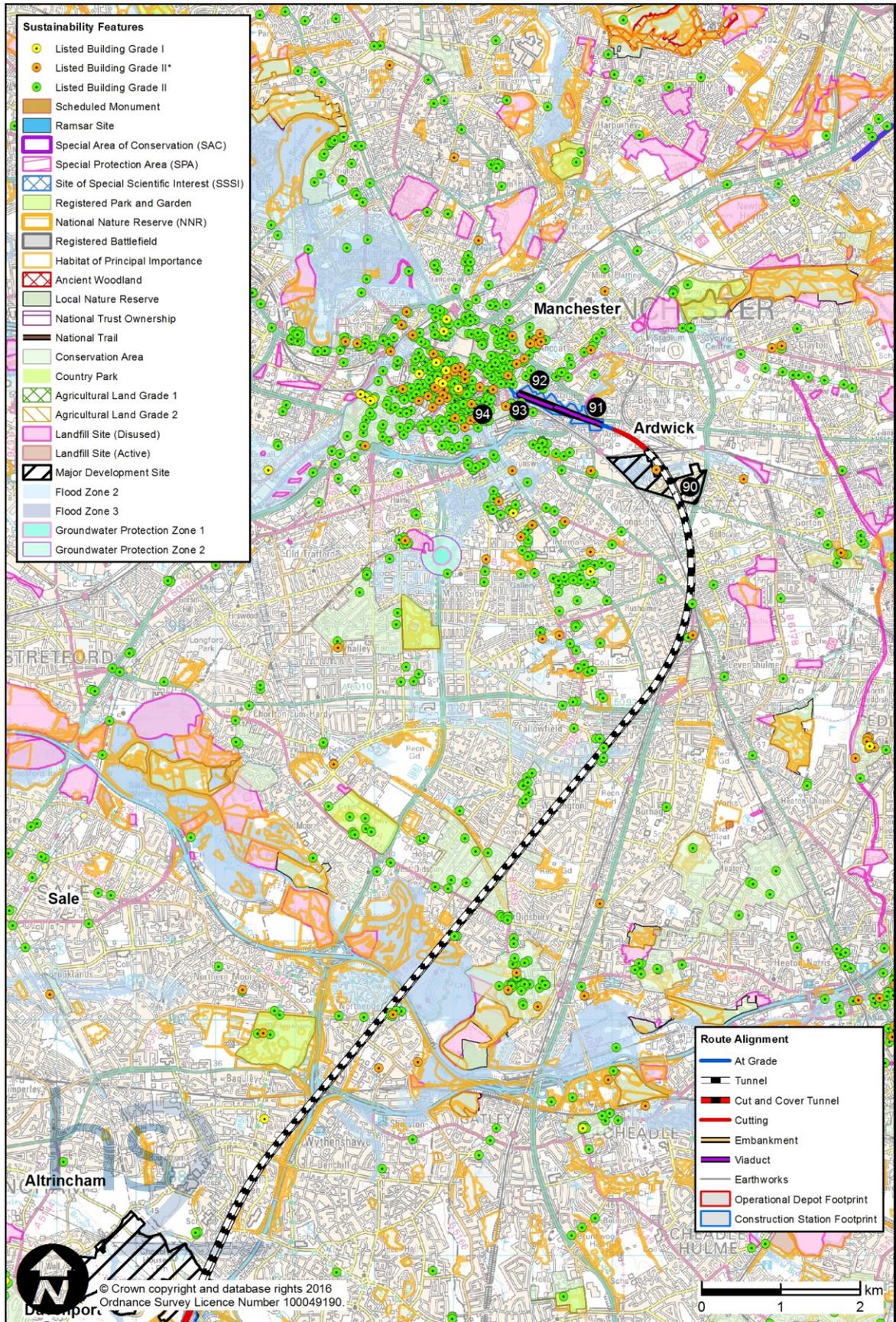
Western Leg Sustainability Map (4 of 6 – Culcheth to Golborne)



Western Leg Sustainability Map (5 of 6 – Rostherne to Withington)



Western Leg Sustainability Map (6 of 6 Withington to Manchester)



7. Eastern leg sustainability impacts

7.1. Introduction

- 7.1.1. This section describes the main potential sustainability impacts, both beneficial and adverse, that would result along the eastern leg of the Phase 2b scheme; in a south to north direction. The section should be read within the context of Section 4, which provides the AoS scope for each topic and gives an overview of the appraisal method. Plans showing the features and locations referenced as numbered dots are provided in Section 8 and more detailed plans can be found in Volume 2.
- 7.1.2. The potential impacts that are set out here are predicted to result from the preferred route in its current stage of design and on the basis of the current baseline environment as determined through desktop research and limited site visits. Some of these impacts could change in detail as further refinements are made, and as mitigation is introduced as a result of the EIA. Only the main impacts⁵⁶ are described here. Potentially lesser impacts are not recorded in this document, although they are listed in the technical appendices that are available separately. Text boxes summarise key changes from the 2013 consultation route.
- 7.1.3. Associated works, such as road re-alignments and utilities diversions, which have not been agreed at this stage, may also result in impacts. No construction planning has been undertaken at this stage. In addition, there has been no appraisal of the existing network, and other projects/initiatives. All of these additional works will be assessed by the EIA.

7.2. Planning and development

- 7.2.1. A review of major development proposals along the eastern leg identified a number of strategic sites that would potentially be affected by the preferred scheme.
- 7.2.2. Near Dordon, the route would pass through the centre of an industrial storage and distribution facility ① that has planning consent on an 8.5 ha site to the east of the M42.
- 7.2.3. To the east of Ashby-de-la-Zouch, the route would pass through G Park ②, a 35 ha site that has planning consent for sustainable industrial and distribution units. The preferred route would intersect an area of the site that is proposed for warehousing and HGV parking.
- 7.2.4. The consultation scheme has been modified to avoid all but the access road of the East Midlands Gateway ③, a strategic rail freight interchange adjacent to East Midlands Airport that has planning consent.
- 7.2.5. A 163 dwelling residential development ④ is proposed on land south of the A6, adjacent to Ashby Road near Kegworth. The route would intersect the centre of the site as it heads north along the east side of the A42. To the north and adjacent to this site a 150 dwelling residential development is also proposed.
- 7.2.6. Immediately east of the East Midlands Hub station is the Lime Rise development site ⑤, consisting of up to 500 dwellings and other mixed uses, which has planning consent. The access road to the station would cross the development site

⁵⁶ Main impacts are similar to the 'significant' effects that would be described within an EIA, in line with the EIA Regulations. The AoS has generally avoided defining 'significance', given the preliminary nature of the appraisal and the information upon which it relies.

although this has already been incorporated within the development plans. The site is currently designated green belt but is in an area identified by the council as a strategic location for growth.

- 7.2.7. North of Sandiacre, is an area designated for regeneration, the former Stanton Iron Works site ⁶⁴. The masterplan for this 185 ha site would include 1,950 dwellings as well as commercial and industrial uses. The route is within 150m of the eastern boundary on viaduct although it doesn't directly intersect the site.
- 7.2.8. Heading north past Pinxton and towards the A38, the route would pass through the centre of a large site named Castlewood Business Park ⁶⁵ which has planning consent on its 110ha site for the development of employment uses. Near to this, a 10 ha site to the east of the village of Hilcote is proposed for a photovoltaic solar farm ⁶⁶. The spur into Sheffield city would pass through the centre of the site.
- 7.2.9. A development at the former coalite chemical works site ¹⁰⁶ lies to the north-west of Bolsover. The mixed use development would include 795 dwellings and it would be crossed by the route on the eastern side of the site that is proposed for residential and commercial use.
- 7.2.10. The mainline would pass near a number of planned growth sites that form part of the Markham Vale Enterprise Zone ¹⁰⁹. HS2 Ltd explored alternative options to reduce impacts on the Enterprise Zone and through route refinement the mainline now avoids the Markham Vale South and North sites. However, the Staveley IMD approach is proposed to run on an existing disused rail corridor through the Markham Vale North site.
- 7.2.11. The site of the proposed Staveley IMD ¹¹⁸ is designated for industrial and business use; Chesterfield Borough Council is preparing the Staveley and Rother Valley Corridor Area Action Plan, which included the 2013 consultation depot site. Following discussions with the local council, the location of the depot has been moved to better align with the Action Plan.
- 7.2.12. The Shimmer housing development ¹³⁹ has planning consent for 212 dwellings on a site in Mexborough and is partially constructed and occupied. The route would intersect the development as it crosses over the River Don and River Dearne on a viaduct requiring a number of properties to be demolished.
- 7.2.13. To the south of New Crofton, lies a site that has planning consent for the development of an underground coal drift mine ¹⁵¹. The New Crofton RSD is proposed at the northern edge of the site where the surface workings and site entrance are located. The depot amounts to approximately 15-20 ha of the 174 ha site.
- 7.2.14. The Welbeck landfill ¹⁶¹ west of Normanton, which is currently the largest landfill facility within Wakefield District, would be crossed by the route. This site is currently identified under the waste development plan document for additional landfill capacity and for the development of new commercial and industrial waste recovery facilities and modernised household waste recycling facilities. In February 2013, planning consent was approved to allow waste disposal operations to continue for a period of three years.
- 7.2.15. Just north of this, the route would pass through the eastern edge of a mixed used development site ¹⁶⁵ with planning consent, which includes Wakefield Trinity Wildcats Stadium and business units.
- 7.2.16. The route to the ECML connection would pass through North Newhold ¹⁷⁷, a proposed employment park north of Garforth. The site has planning consent for the development of approximately 77,000m² of commercial and industrial floorspace.

- 7.2.17. The approach to the HS2 Leeds station would pass through Character Area 8 of the Aire Valley Action Plan known as the Stourton Corridor 186. The preferred scheme would follow an existing rail corridor but would require widening through an area with a number of policy allocations, including mixed employment, general industry and warehousing.
- 7.2.18. The HS2 Leeds station adjoins the existing Leeds station near Holbeck Urban Village, Sovereign Street, and Leeds South Bank area 188. The station would be on viaduct over the River Aire and adjacent to the City House New Street development. The central location of the station has potential to aid regeneration and the delivery of jobs and housing. HS2 Ltd continues to work with the local authority and other stakeholders to support the realisation of development opportunities in this area.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Key improvements include:

- The route would no longer cross the Measham Wharf Development (a site with some 450 proposed dwellings).
- At East Midlands Gateway, the route now avoids the main site aside from the access road.
- Temple Park, a proposed residential development at junction 26 of the M1, was refused planning permission, as such the site cannot be affected by the route.
- Route refinements avoid mainline impacts through Markham Vale South Enterprise Zone.
- At Staveley, the proposed IMD site has been moved to better align with the Area Action Plan. The depot approach now aligns with the existing rail network.
- The route would no longer intersect the Waverley New Community, (a site with some 4,000 proposed dwellings and mixed use development) and the Waverley Advanced Manufacturing site.
- The route would no longer intersect most of the Sheffield Enterprise Zone, an area that is subject to a number of policy allocations and planning consents.
- The Leeds HS2 station has been shifted north, over the River Aire. The station location strategically avoids development at Sovereign Street and maintains regeneration opportunities in the wider city centre area.

New or increased impacts include:

- New industrial and storage site near Dordon 14 has outline permission and the route would cross the centre of the site.
- An industrial and distribution site 31 near Ashby-de-la-Zouch would be intersected on its western edge by the route.
- The route would intersect the centre of two residential developments near Kegworth 31.
- The Stanton Iron Works site 64 is a regeneration area, the route would pass to the eastern edge of this site.

- The spur to Sheffield Midland Station would cross through the centre of a solar farm site near Hilcote 88.
- The former coalite chemical works site 106 has been proposed for redevelopment and would be intersected by the route on its eastern edge.
- The Staveley IMD approach would cross through the centre of the Markham Vale North Enterprise Zone 109.
- The route would bisect the western extent of the approved, partly constructed and occupied Shimmer Housing Development 133 between Mexborough and Conisbrough. This would result in a number property demolitions.
- The New Crofton RSD would be located at the site of an approved underground coal mine 151.

7.3. Employment and housing

East Midlands Hub

- 7.3.1. At the East Midlands Hub station, HS2 could increase net commercial floorspace by between 132,000 to 151,000m², which could support between 8,800 and 9,900 jobs. Residential floorspace is estimated to increase by at least 14,000m², and potentially up to 35,000m², equating to between 140 and 350 homes.
- 7.3.2. Potential demolitions of industrial and commercial properties could displace businesses currently providing an estimated 50 jobs⁵⁷. Although these displaced jobs are accommodated in the net figure for jobs supported, it is considered likely that they would be taken up in the local area.
- 7.3.3. The jobs and houses that would be supported by HS2 at the East Midlands Hub station would be more limited initially than at the other more centrally located HS2 urban stations on the Phase 2b network. Local public transport connections are currently relatively few, though have improved with the expanded Nottingham Express Transit (NET) (see Section 7.5). It would be greatly enhanced in the future, both by the integration of existing services at the new station and its connection with an extended NET.
- 7.3.4. Available development sites are limited within the generally residential area. The principal development site within a 2km catchment is between Toton and Stapleford, located in the green belt between East Midlands Hub station and the tram station 9, which has planning consent (Section 7.2).

Leeds station

- 7.3.5. The overall net additional commercial floorspace brought about by HS2 is estimated to be between 197,000m² and 334,000 m², which could support between 12,400 and 19,800 jobs. Residential floorspace is likely to increase by at least 183,000m² and potentially up to 274,000m², equating to between 3,000 and 4,600 homes.
- 7.3.6. The estimated employment figure takes account of the potential local job losses from the demolition of commercial properties, which could displace businesses

⁵⁷ Jobs were calculated using strategic level land classification suitable for this level of appraisal. This figure may be over-estimated at this location.

currently providing an estimated 3,100 jobs. However, it is likely that the majority of these jobs would be accommodated in the region.

- 7.3.7. Leeds city centre is likely to support a large amount of additional development as a result of HS2. It has excellent local transport links including good rail connections throughout the region. There are also numerous sites of vacant and underused brownfield land within the station's catchment area that are available for development; for example, areas to the south of the river (the South Bank), to the east of Marsh Lane and along the Wellington Street and Whitehall Road corridors to the west. There is also large development potential in Holbeck, to the west of the station. Local planning policy seeks to promote such areas for comprehensive redevelopment and re-use as major retail, leisure, hotel, culture and office developments. The current mix of land use reflects the kind of development likely to be supported by HS2, with high rise buildings a key element.
- 7.3.8. The station would serve the majority of Leeds city centre, which is characterised by a high level of deprivation, but also high levels of qualification and professional occupations. Many workers in the city come from the local area, so the employment supported by HS2 would offer substantial benefits for the local population. Leeds City Council is developing a masterplan that proposes to improve the connectivity and development potential between the north and south areas of the city. It is also looking to ensure benefits from HS2 are optimised within the wider regeneration potential of the area.

Key changes from the 2013 consultation scheme

Revisions to predicted employment and housing impacts result from both refinements to the route, and updates to the baseline on which the appraisal was undertaken in terms of changes in policy and land use.

The number of jobs that could be supported at the East Midlands Hub station has increased (from 1,500-1,600 jobs to 8,800-9,900 jobs) since the present station proposals do not require any commercial demolitions and further potential development sites have been identified since the previous analysis. The housing number supported has also changed (from 150-800 additional homes to a narrower range of 140-350 homes) owing to changes in residential density assumptions and the areas identified for potential development.

Key changes include the removal of employment and housing opportunities (additional 4,000-5,400 jobs and 250-300 homes) that were associated with Sheffield Meadowhall station due to this station no longer forming part of the preferred scheme. Opportunities around Sheffield Midland station have not been considered as part of this assessment, although these would offset to some extent the additional growth at Meadowhall which will not now be realised.

At Leeds station there has been an increase in the number of homes that could be supported (from 1,700-2,400 to 3,000-4,600 homes), since the viability of residential development has increased relative to office development.

7.4. Property and community integrity

- 7.4.1. The eastern leg could result in the demolition of an estimated 144 dwellings. The majority of these are either at or approaching East Midlands Hub station where there are a total of 76 residential demolitions in two clusters, north of Station Street

(59) ⁵⁴ and south of Station Street (17)⁵⁸ ⁵² in Long Eaton. These figures do not include estimated demolitions at the Shimmer housing development ¹³³ in Mexborough as this development was still under construction at the time of appraisal (see Section 7.2 'Planning & Development'). However, based on site plans provided by the Developer and on the operational footprint of the railway at this stage of design, it is estimated that the route could result in the demolition of approximately 16 dwellings. Further information on the methodology for demolitions can be found in Appendix E6 Property and Community Integrity.

- 7.4.2. Elsewhere along the route the demolitions would be largely limited to single properties or small groups (less than five). Locations where groups of five or more residential demolitions are anticipated include Whateley (six demolitions) ¹², Nuthall (five demolitions) ¹³ and Newton (five demolitions) ⁹¹.
- 7.4.3. The route would also require the demolition of two community facilities including a bingo hall in Leeds. It would require the demolition of an estimated 108 commercial properties, largely at the station locations including the approach to East Midlands Hub station and Leeds station. Other locations where groups of five or more commercial demolitions are anticipated include Barns Heath Farm south of Measham (11 demolitions) ²⁴, Nottingham Business Park north of Strelley (12 demolitions) ⁷¹ and Sawpit Lane near Tibshelf (seven demolitions) ⁹². An estimated eight industrial properties would be demolished.
- 7.4.4. The route could result in isolation of an estimated 209 residential properties at a number of locations, most notably: Whateley (also affected by severance) ¹⁰, Worthington ⁶⁵, Long Eaton ⁵⁰, Netherthorpe ¹²⁵, Crofton ¹⁵⁷, Methley Lanes ¹⁶⁶ and Church Fenton ¹⁸¹.
- 7.4.5. No appraisal of temporary construction impacts has been undertaken at this stage. However, as an indication of the number of people at greater risk from construction impacts, there would be approximately 1,900 dwellings within 100m of the surface route and the provisional station and depot construction boundaries.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. When taking account of planned and new development the property impact is broadly similar across the whole route. However, at this stage of design and appraisal there are 17 fewer demolitions reported compared to the 2013 consultation scheme. The main changes have occurred in South Yorkshire where there has been a reduction in property impact from the change in alignment through this area including the removal of the station at Sheffield Meadowhall. However, this is offset by a significant increase in property impact in Long Eaton due to the change approaching the East Midlands Hub station.

Key changes include:

- Avoidance of clusters of residential demolitions at Langton Hall (seven demolitions), Renishaw (nine demolitions), South Tinsley (49 demolitions) and Wincobank (11 demolitions).
- Avoidance of commercial demolitions at Measham, Wincobank and South Tinsley.

⁵⁸ The demolitions included here are for existing buildings affected by the operation of HS2. Impacts associated with approved or partially constructed new developments sites are summarised in Section 7.2.

New or increased impacts include:

- New cluster of commercial demolitions south-east of Measham ⑭.
- An increase in both residential and commercial demolitions approaching the East Midlands Hub station, particularly to the north ⑮ and south ⑯ of Station Street.
- New cluster of five residential demolitions at Newton ⑰.

7.5. Access

East Midlands Hub

- 7.5.1. There are currently no rail stations in the immediate vicinity of the East Midlands Hub, but the new HS2 station would integrate platforms for existing services allowing direct connections with the existing rail network and potentially allowing direct shuttle services from Nottingham and Derby (with journey times of 12 minutes and 15 minutes respectively) and wider connections with Leicester and other stations in the East Midlands.
- 7.5.2. The Nottingham Express Transit (NET) tram network has been extended with a new tram stop at Toton Lane ⑱, less than 1km from the proposed HS2 station. With the introduction of the East Midlands Hub, there could be a further extension of the NET Line 3 across Toton Lane to the HS2 station, so linking it with Nottingham city centre, Beeston, Chilwell, the University of Nottingham and the Queens Medical Centre.
- 7.5.3. The area is currently well served by an extensive network of regular bus services, and road access is generally good with the A52 running east and west between Derby and Nottingham, and the M1 via Junction 25. Up to 1,700 car parking spaces (including both long and short stay parking) are currently proposed at the HS2 station, although these numbers will be appraised as part of the EIA and discussed with the local authority in light of their policies and assessed as part of on-going appraisal work.
- 7.5.4. In terms of airport access, East Midlands Airport is about 20 minutes' drive south along the M1.

Leeds station

- 7.5.5. The proposed HS2 station in central Leeds would be adjacent to the existing station, spanning the River Aire. The existing Leeds station currently provides connections with a number of regional rail destinations including Bradford, Halifax and Castleford, as well as destinations further away; for example Newcastle upon Tyne and Edinburgh.
- 7.5.6. Two concourses are proposed at the station, one to the north of the River Aire along Neville Street and the other along Victoria Road, to the south of the river. Pedestrian access would be via both of these concourses, with additional pedestrian connectivity provided within the station between HS2 and services on the existing rail network. Neville Road is proposed to be remodelled for pedestrians and public transport use only. Taxi ranks would be located along the west side of the station's southern concourse and fed from the junction of Victoria Road and Meadow Lane.
- 7.5.7. The existing Leeds station has a bus interchange providing connections to the city's extensive bus network. In addition, a new bus drop off will be located to the

west of the southern concourse, near to the taxi ranks. The existing station also includes facilities for cyclists.

- 7.5.8. Highway access to the Leeds station would be from the M621 (Junction 3), which connects to the Inner Ring Road and also to regional motorways. Car parking for the HS2 station is currently proposed at the southern entrance and would provide up to 1,500 spaces (including both long and short stay parking), although these numbers will be discussed with the local authority in light of their policies, and assessed as part of on-going scheme development.
- 7.5.9. Leeds-Bradford International Airport is located to the north-west of the city, some 30 minutes drive away. There are also direct bus services (half-hourly in daytime) to the airport from Leeds and Bradford city centres.

Aerial view looking north from the M621 towards the existing Leeds station (centre) and proposed Leeds station site



Impacts on rights of way and country parks

- 7.5.10. The eastern leg of the preferred scheme would cross 11 named long distance paths, including the Trans Pennine Trail, which would be intersected in five locations 113. The other crossings would affect the Heart of England Way 9; Ivanhoe Way (two intersections) 27; Derwent Valley Heritage Way 43; Midshires Way 43; Trent Valley Way 49; Nutbrook Trail (two intersections) 61; Robin Hood Way (two intersections) 77; Cuckoo Way 121; Dearne Way (two intersections) 134; and Leeds Country Way (five intersections) 164.
- 7.5.11. Six national cycle routes would be crossed by the preferred route.
- 7.5.12. It is assumed that permanent access along all public rights of way would be maintained through diversion or re-instatement (subject to agreement with the local authority), although there would be disruption to these routes temporarily during construction. A detailed appraisal of all access crossings will be undertaken as part of the EIA.
- 7.5.13. Three country parks would be crossed on the eastern leg, namely Kingsbury Water Park (for an estimated 1,930m) 1; Pooley Country Park (for an estimated 570m)

16; and Rothwell Country Park (for an estimated 30m) 185. At Rothwell Country Park 185 the route would pass alongside the northern boundary in existing rail corridor. Section 7.9 addresses any landscape and visual impacts on these designated areas.

Key changes from the 2013 consultation scheme

There are a number of changes to the route which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Key improvements include:

- North of Staveley, the number of crossings of the Trans Pennine Trail and the Cuckoo Way would be reduced.
- The preferred route would no longer cross the Sheffield Country Walk, Barnsley Boundary Walk and Dove Trail.
- The route now avoids a number of crossings of the Leeds Country Way.
- The Rother Valley Country Park and Rabbit Ings Country Park would no longer be intersected.
- Leeds station would be adjacent to the existing station and serviced by two concourses on either side of the River Aire.

New or increased impacts include:

- The Rothwell Country Park 185 would be intersected for a short distance.

7.6. Health, Wellbeing and Equality

Potential health impacts

- 7.6.1. Initial analysis indicates the potential for both positive and negative health impacts at certain locations where existing levels of health-related deprivation are high, namely Rotherham, Doncaster, Barnsley, Wakefield and Leeds. The main adverse health impacts relate to displacement of jobs, noise during operation⁵⁹ and demolition of housing and community facilities. Beneficial health impacts relate to improved access to employment, new housing and access to transport, which in turn could increase access to education, services and facilities. People most vulnerable to health impacts (including people living in socio-economically deprived areas, older people and young people) will experience both positive and negative impacts.

Key changes from the 2013 consultation scheme

Changes to the location of the route now mean that:

- Rotherham and Doncaster, both areas where there are high levels of health-related deprivation, are potentially adversely affected.
- Sheffield Meadowhall, an area where levels of health-related deprivation are also high, is no longer affected.

⁵⁹ As per the methodology for the AoS, appraisal is limited to operational impacts only at this time. Construction impacts will be assessed during the EIA.

Potential equality impacts

- 7.6.2. The equality analysis has identified where groups vulnerable to discrimination and social exclusion (referred to as people (or groups) with protected characteristics) are likely to live in relatively high numbers along the route. The analysis also identifies the potential for impacts of the preferred scheme to affect them more than they would affect the local population generally.
- 7.6.3. The East Midlands Hub is not likely to give rise to many equality impacts, since protected characteristic groups are not found in particularly high numbers in the immediate vicinity or catchment area of this new station, excepting in Long Eaton. In this area there are relatively large proportions of Black, Asian and minority ethnic people and some faith groups.
- 7.6.4. There may be adverse effects on protected characteristic groups at Broxtowe. This area is home to relatively large proportions of Black, Asian and minority ethnic people as well as high numbers of faith groups. In particular, job loss as a result of demolition of commercial property at Nottingham Business Park ⑩, north of Strelley, could have a disproportionate effect on all these groups.
- 7.6.5. The catchment around Leeds station is home to relatively high proportions of young people (16-24), Black, Asian and ethnic minority groups, and faith groups. These groups are likely to experience a greater benefit arising from net increases in local jobs and the increased availability of affordable housing that could be supported by HS2, provided they are able to access them.
- 7.6.6. Adverse impacts on people (or groups) with protected characteristics may occur due to the demolition of housing and commercial, retail and industrial property. Access to affordable housing (including for larger families) and access to specialised retail outlets are some of the key concerns amongst Black, Asian and minority ethnic groups. Access to jobs is a key concern for Black, Asian and minority ethnic groups and while displacement of some jobs in the area of these stations are likely to be replaced by the new employment opportunities, this may not be the case for all.

Key changes from the 2013 consultation scheme

Route changes mean that some areas with large proportions of people (or groups) with protected characteristics are now potentially affected, whereas other previously affected areas are now avoided and some areas previously identified are not likely to be affected:

- Long Eaton and Broxtowe, which both have large proportions of Black, Asian and minority ethnic people as well as high numbers of faith groups, are now potentially adversely affected.
- A high proportion of lone parent families in the vicinity of Leeds station are no longer evident within the revised data, and therefore no longer affected.

7.7. Noise

Airborne noise

- 7.7.1. The airborne noise appraisal predicted levels of railway noise on groups of dwellings. The approach is described in more detail in Section 4, but in summary, three categories of impact have been used:

- dwellings potentially exposed to 'high' HS2 noise levels, i.e. greater than or equal to 73 dB $L_{Aeq,18hr}$;
- locations where dwellings could qualify for noise insulation; and
- groups of dwellings that could have a noticeable (although not necessarily significant) increase in railway noise levels, a noise level of 50 dB $L_{Aeq,18hr}$ or more, and a change in existing rail noise levels of 3 dB $L_{Aeq,18hr}$ or more.

7.7.2. Noise specialists have worked closely with the scheme engineers to determine (at this stage of design) the feasibility of introducing noise barriers at the 'preliminary candidate areas for mitigation' (see paragraph 4.9.8). This should substantially reduce the number and extent of noise impacts expected at this early stage. Table 7-1 shows the number of people predicted to experience noise impacts and compares the impacts with and without additional mitigation.

Table 7-1– Estimated numbers of dwellings with noise impacts for the Eastern Leg

Preferred route	High noise levels	Noise insulation regulations	Noticeable noise increase
Without additional mitigation	<30	200	26,800
With additional indicative mitigation	<5	<30	4,500

7.7.3. The use of additional mitigation would reduce the number of properties potentially experiencing a noticeable noise increase by about 80%. It would reduce the number of dwellings potentially qualifying for noise insulation by approximately 90% and the number of high noise level impacts by a similar amount.

7.7.4. With additional indicative mitigation, the main residential areas where residual noise impacts are currently predicted include:

- Kingsbury 5 in North Warwickshire;
- Measham 28 in North West Leicestershire;
- Hucknall 77 in Ashfield;
- Pinxton 88, Hilcote 89 and Bolsover 104 in Bolsover;
- Aston 124, Brampton-en-le-Morthen and Thurcroft 126 in Rotherham;
- Mexborough 136 in Doncaster; and
- Crofton 157, New Crofton 155 and Sharlston 159 in Wakefield.

Key changes from the 2013 consultation scheme

For the eastern leg preferred route as a whole, the refinements have reduced the number of dwellings with a potentially noticeable noise increase. There are a number of changes which deliver improvements in some areas, whilst introducing new/increased impacts in other areas. Changes in the noise impacts from the consultation route have come about due to refinements in both the horizontal and vertical alignment as well as revisions to the operational speeds in some locations. Some places would have increased noise impacts and others reduced noise impacts.

Increased or new noise impacts are predicted at the east of Measham 28, Hucknall 77, Pinxton 88, Hilcote 89, Bolsover 104, Aston 124, Brampton-en-le Morthen,

Thurcroft 126, Mexborough 136, the east of Crofton 157, New Crofton 155 and Sharlston 159.

Noise impacts are reduced at the west of Measham, Long Eaton, Sandiacre and Stapleford, Nuthall, Poolsbrook, Netherthorpe, Woodthorpe, Mastin Moor, Renishaw, Killamarsh, Beighton, Swallownest, Woodhouse, Treeton, Tinsley, Wincobank, Blackburn, Shiregreen, Worsbrough, West Green, Cudworth, Royston, the west of Crofton and Woodlesford.

7.8. Air Quality

- 7.8.1. In general, most of the areas along the preferred route are in compliance with national air quality objectives and European limit values. According to Defra's modelled background map data, background levels of NO₂, PM₁₀ and PM_{2.5} are within UK air quality objective levels along the length of the preferred route and are set to decrease in future years.
- 7.8.2. Some areas near the preferred route, predominantly in the vicinity of busy roads, do currently exceed air quality objective levels, particularly for NO₂. AQMAs within 1km of the route (south to north) are:
- a site parallel to the M1 in the vicinity of East Midlands Airport, North West Leicestershire;
 - a site in Kegworth, close to the M1;
 - three sites close to the M1 in Trowell;
 - a site next to the M1 and B600 junction in Nuthall;
 - areas along the A655, A638 and M62 near Wakefield; and
 - areas within Leeds.
- 7.8.3. Changes in traffic at these locations, either during construction or operation, might lead to changes in pollution levels. There is the potential for dust effects during construction in built-up areas, particularly at the East Midlands Hub station. Best practice in the control of highway and dust air quality effects will be through application of measures set out in the CoCP. Construction vehicle emission standards will be set in the Air Quality Strategy.
- 7.8.4. There is also the potential for dust effects from construction and construction traffic at a number of SSSIs. These effects at SSSIs are likely to be negligible in most cases based on past experience of assessing construction dust effects at SSSIs.
- 7.8.5. Leeds station, Staveley IMD and New Crofton RSD are not within AQMAs and do not have high densities of residential properties nearby, so are unlikely to generate traffic or dust air quality effects nearby.

Key changes from the 2013 consultation scheme

- East Midlands Hub station is no longer within 1km of the AQMA in Trowell due to reconfiguration of the station footprint.
- Sheffield Meadowhall station is no part of the Phase 2b preferred route, therefore the route would have no impact on the Sheffield AQMA.

7.9. Landscape and visual impacts

Marston to Kegworth

- 7.9.1. The preferred route's initial close alignment with the M42, largely in cutting, would limit potential landscape and visual impacts between Marston and Tonge. Loss of woodland would give rise to local landscape impacts and visual impacts for visitors to Alder and Sandy Pool areas ② on the northern edge of Kingsbury Water Park. Immediately north of the park, prominent viaducts and embankments would affect parts of the farmed landscape ⑥. The low embankment past Holt Hall Farm, then cutting past Whateley village ⑩ would directly impact the village, resulting in demolitions and affecting its landscape setting. Embankments would be visually intrusive for some residents of Kingsbury ⑤ and Holt Hall Farm ⑩. The route would be generally screened from view past Tamworth but localised visual impact would affect recreational users at Kettle Brook ③ near Hockley.
- 7.9.2. The route passes through undulating land alongside or close to the M42/A42 for some distance before diverging from the motorway across the southern part of Pooley Country Park ⑬ and over the Coventry Canal ⑮ and River Anker ⑰ on viaduct, with resultant landscape impacts and visual intrusion. Near Austrey ⑲ the route diverges again from the M42 on embankments that would cause localised visual impacts, although views would be in the context of the embanked motorway. The route then passes east of Appleby Parva ⑳ and Appleby Magna ㉓ in cutting or on low embankment, fragmenting the open countryside and causing some visual impact at Appleby Parva.
- 7.9.3. Passing east of Measham ㉞ on viaduct and embankment, landscape and visual impacts would be slight as the route crosses an active mineral/brick working area and industrial land some distance from residential areas. It then continues north across open countryside in a mixture of cutting and embankment, causing landscape fragmentation. Near Packington ㉟ the route re-joins the A42 corridor and runs mainly in cutting past the village with a short low viaduct north of the village. Further north, close alignment with the A42 and associated tree screening would tend to limit landscape and visual impacts. The short section of embankment and viaduct near Stocking Lane ㉫, north of Worthington, would affect local landscape character.
- 7.9.4. The route continues alongside and south of the A42 as it passes through The National Forest ㉭ mainly in cutting or near ground level, with limited landscape impact other than some woodland loss. However, the long viaduct over the M1 near its junction with the A42 and subsequent cutting north to Kegworth would affect landscape character and cause visual impacts for residents on the western outskirts of Long Whatton ㉯.

Kegworth to Heath

- 7.9.5. North-west of Kegworth the route rises onto a long viaduct, crossing the A453 and River Soar floodplain. It would have an adverse impact on landscape character. Visual impacts for residents on the outskirts of Kegworth would be limited ㉰ although recreational users of the Midshires Way path ㉳ and River Soar ㉵ would be affected.
- 7.9.6. Emerging north of Red Hill the route passes across the wooded valley sides and a second longer viaduct over the River Trent ㉷ brings the route into Long Eaton. This would greatly affect the landscape character of the valley and the local landscape around Thrumpton (including part of the Conservation Area ㉸), and cause visual intrusion for recreational users of the Trent Valley and for residents in the Trent Lane area ㉹ south of Long Eaton.

- 7.9.7. The viaduct extends past Trent Lane 51 and rises through Long Eaton town centre along the line of an existing railway. The elevated railway would cause visual impact for residents and greatly affect the townscape of Long Eaton 55.
- 7.9.8. In the vicinity of the East Midlands Hub station, impacts on landscape and townscape character would be generally low given the existing context of railway and brownfield land, although the new station access and car park would remove a large area of young woodland adjacent to Banks Road Open Space 57. The viaduct through Toton would affect the landscape of the Erewash Valley 55. Visual impacts from the approaching viaduct and the station would affect residents in Toton 55, particularly on its western edge.
- 7.9.9. To the north, the proposed viaduct near Sandiacre 60 would intrude into the characteristically flat and open floodplain causing impacts on local landscape and townscape character, as well as visual impacts for users of the Erewash Canal 62 and local footpaths. Residential views from the north-east edge of Sandiacre 60 would also be affected. A small number of residents of Stanton Gate 65 and on the northern edge of Stapleford 65 would experience visual impacts, although this would be in the context of the embanked M1.
- 7.9.10. At Strelley 68, the approach to the cut and cover tunnel requires large scale earthworks immediately south of Main Street, which would result in visual impacts for residents and recreational users of Monks Way. Construction of the cut and cover tunnel would directly affect the parkland and mature trees within the Conservation Area.
- 7.9.11. A long section of embankment on the north-west edge of Nottingham near Broxtowe 72 would affect the undulating landscape, although residential views from the east are generally well screened. Further north, visual impacts would affect residents at Nuthall 73 where the route crosses over the B600.
- 7.9.12. The undulating landform west of Hucknall requires sections of embankment and a deep cutting through Park Forest 79, which would result in landscape impacts. Visual impact would result from the substantial viaduct 82 near Pinxton. North of Pinxton, the route diverges from the M1, where a series of high embankments and viaducts would fragment the open and undulating countryside in the area between Pinxton and Huthwaite 84. South of Tibshelf, the Sheffield Spur would disrupt the historic farmed landscape around Old Blackwell 90 and Newton 91 and have some visual impact on recreational users of the Silverhill Trail.
- 7.9.13. At Tibshelf 93, the deep cutting and structures beneath the motorway would have local landscape impacts. In the vicinity of Hardwick 94, Stainsby 97 and Heath 98, prominent earthworks and deep cuttings within the undulating landform would affect landscape character and visual impacts would be expected for residents at Stainsby 97.

Heath to Barnburgh

- 7.9.14. South-east of Sutton Scarsdale 100 the long, high embankment and viaduct over the motorway would be widely visible across the landscape. Visual impacts would be expected for residents at Bolsover 104, affecting residents on the A632 west of the route and visitors to Carr Vale Flash nature reserve 101 and Bolsover Castle 105. North of Bolsover the route cuts through an area near a spoil heap before rising onto a long, high and locally prominent viaduct over the M1 108. However, the mainline route's continued close alignment with the motorway would limit further impacts northwards until reaching Woodall.
- 7.9.15. The approach to the proposed Staveley IMD, largely along an existing railway corridor, would have limited landscape and visual impacts. The depot itself would

lie amidst brownfield and industrial land, although the prominence of structures would affect the character of the Rother Valley **114** and setting of Staveley Conservation Area **112**. Direct visual and setting impacts would affect a small area on the southern edge of Barrow Hill Conservation Area **117**, adjacent to the depot; and there would be visual impacts on recreational users of Canal Marina, Chesterfield Canal **115** and the Trans Pennine Trail **113**.

- 7.9.16. West of Woodall, near Norwood **120**, the route diverges from the M1 and then again near Aston **124**, in both cases fragmenting attractive rolling countryside, with three high viaducts in particular cutting across the topography and causing loss of distinctive valley side woodland. The landscape character and designed landscape features around Aston would be affected as would the views of some of its residents.
- 7.9.17. The route passes over the M1/M18 junction on a series of long, high embankments and viaducts. Residents on the western edge of Thurcroft **126** would experience visual impacts where the viaduct intrudes into currently open views beyond the motorway.

Aerial view looking west from the M1 towards Staveley (centre) including the proposed site of the Staveley Infrastructure Maintenance Depot



- 7.9.18. Passing east of Rotherham the route's close alignment with the M18 would limit impacts. North of Bramley the route diverges from M18, cutting across attractive countryside as it passes through Conisbrough Parks **127** and Hill Top **128** bringing adverse landscape impacts and some visual impacts on nearby residents at Conisbrough **129**.
- 7.9.19. The route would cross the Rivers Don and Dearne between Mexborough and Conisbrough **129**. Two viaducts would remove valley woodland and affect the character of the Don and Dearne valleys **132** and the visual amenity of recreational users including users of the Dearne Way **134** and Trans Pennine Trail **113**. Visual impacts either side of the Dearne would also affect residents at Mexborough **135** and Barnburgh **133**. The landscape setting and character of the area to the east of

Barnburgh 138 would be greatly affected by high embankments and a deep cutting through Barnburgh Cliff.

Barnburgh to Leeds and Church Fenton

- 7.9.20. Deep cutting east of Hickleton 139 would greatly affect the landscape setting of the village and parkland, and there would be direct impacts on distinctive landform features to the north at Bilham Belvedere and Watchley Crag, also affecting the views of recreational users in this area. The high viaduct at Frickley 142 would intrude on the surrounding landscape.
- 7.9.21. Between Clayton 143 and Crofton 157 the route would fragment the countryside, with embankments in particular affecting the landscape settings of a number of historic sites. Views for walkers near Clayton 143 and residents at Kinsley 149 would be affected.
- 7.9.22. The mainline viaduct and embankment passing between New Crofton 155 and Nostell Priory 153 would affect landscape character locally, although the grounds of the priory are fairly well screened. Visual impacts would affect residents near Windmill Hill 158 and Foulby 159 east of Crofton.
- 7.9.23. The approach to New Crofton RSD descends to cross under the mainline, then rises to cross the existing railway with some landscape impact. The New Crofton RSD is situated on reclaimed land, but on relatively prominent high ground, and may intrude on landscape character when viewed from the south. Glimpsed views of the depot would also result in visual impacts for residents on the southern edges of Crofton 157 and New Crofton 155, and users of Anglers Country Park 152 to the south would be similarly affected.
- 7.9.24. Further north, the viaduct and embankments between Sharlston Common 159 and Kirkthorpe 161 would interrupt the landform. At Newland Hall 162 the viaduct over the lake would have an impact on the newly restored landscape and cause visual impacts for recreational users.
- 7.9.25. The embankment and viaduct across the Calder Valley 163 and the grade-separated junction with the Leeds spur on the northern edge of the valley would cause some woodland loss and intrude on the open floodplain landscape. North of the M62 the embankment and cutting through part of Methley Park estate 167, in combination with the Leeds spur, would cause some further woodland loss and landscape impact.
- 7.9.26. The crossing of the Aire Valley 171 would directly impact several areas of riverside woodland and lakes affecting the valley's character, although the impact would be partly contained by tree cover. Some residents on the eastern outskirts of Woodlesford would have views of the viaduct.
- 7.9.27. In a number of locations, the crossings of the Calder 163 and the Aire valleys 171 would have visual impacts on recreational users, particularly users of the Aire and Calder Navigation 170, the Trans Pennine Trail 113 and the Leeds Country Way 164.
- 7.9.28. Further north, the embankment west of Swillington 172 would affect the landscape of a small river valley. West of Garforth, the landscape character of the area around Barrowby Hall 175 would be affected and residents at Swillington Common 174 would have visual impacts. Impacts would then be generally limited across the wooded farmland further east.
- 7.9.29. The route passes south-east of Barkston Ash on embankment before diverging across Barkston Moor 179, resulting in some landscape and visual impacts although the embankment would be seen in the context of an existing railway. The new viaduct structure and the embankment east of Church Fenton 181 would alter the

character of the landscape and cause visual impacts for residents on the north-western edge of the village.

- 7.9.30. For the Leeds spur, localised views of the tunnel portal east of Woodlesford ¹⁸⁴ would affect footpath users but there should be little visual impact on residents. On the north side of Woodlesford the spur could intrude into close views from the Aire and Calder Navigation ¹⁷⁰ and Trans Pennine Trail ¹¹³, depending on the extent of tree loss. Otherwise, impacts would be limited due to the tunnel under Woodlesford ¹⁸⁴ and the route's passage through the largely industrial fringe of Leeds.
- 7.9.31. Approaching the station, the viaduct and elevated platforms would bring some disruption to existing street patterns and cause some visual intrusion. The new station would be of a substantial scale, spanning the River Aire ¹⁸⁹, with extensive redevelopment on both sides of the river. The historic townscape and the character of the riverside would change greatly. The long station structure would cause east-west visual severance in the Neville Street area ¹⁹⁰ and would also intrude on many views along the river in both directions.

Key changes from the 2013 consultation scheme

There are a number of changes which deliver improvements in some areas, whilst introducing new/increased impacts in other areas. Key improvements include:

- Realignment to follow the southern edge of the A42 east of Tonge, avoiding landscape and visual impacts in the vicinity of Tonge and Lockington.
- In the Pinxton area, lowering of the viaduct over the River Erewash and realignment closer to the M1, reducing its landscape and visual impact.
- Realignment east of Staveley and Renishaw, reducing visual impacts to users of the Trans Pennine Trail, Cuckoo Way and the proposed restoration of the Chesterfield Canal.
- Realignment east of Sheffield, so that the route no longer affects Eckington and Renishaw Park Conservation Area, visitors to Rother Valley Country Park, the landscape of the Rother Valley, townscape and visual amenity in the Meadowhall area, or woodland near Chapelton.
- Avoidance of landscape and visual impacts on the Dove valley south of Worsbrough, due to eastward route realignment.
- Avoidance of direct impacts on Rabbit Ings Country Park and Cold Hiendley and Winterset Reservoirs, due to eastward route realignment.
- Tunnelling at Woodlesford, greatly reducing landscape impacts on the Aire valley as well as visual impacts on residents and recreational users.

New or increased impacts include:

- Fragmentation of open countryside and some additional visual impacts in the Measham area ²³, where the route now diverges from the M42.
- At Long Whatton ³⁹, new landscape and visual impacts due to the embankments and cuttings as the route passes to the west of the village.
- A longer and higher viaduct crossing of the River Trent floodplain and towards Long Eaton ⁴⁶, tending to increase the visual impact on nearby residents and recreational users of the river corridor.
- An elevated route through the centre of Long Eaton ³⁵, bringing greater

townscape and visual impacts.

- A slightly higher route alignment west of Toton, causing some increase in landscape and visual impact on this section of the Erewash Valley 55.
- Impacts associated with the new Sheffield Spur, affecting landscape character and the views of recreational users around Old Blackwell 90 and Newton 91.
- Some additional landscape and visual impacts at Barrow Hill 117 associated with a change in the footprint of Staveley IMD.
- Visual impacts from realignment closer to Bolsover 104, affecting residents on the A632 west of the route and visitors to Carr Vale Flash nature reserve 101 and Bolsover Castle 105.
- Major impacts on woodland and designed landscape features near Norwood and Aston 124, where high viaducts would also give rise to visual intrusion.
- Visual impacts on some residents of Thurcroft 126, where the viaduct would intrude into the currently open westward views.
- New landscape impacts where the route would cut through Conisbrough Parks 127 and Hill Top 128.
- Landscape and visual impacts associated with the new viaduct crossings of the Don and Dearne 134 between Mexborough and Conisbrough.
- Major impacts on the landscape east of Barnburgh 138 which would be affected by high embankments and a deep cutting through Barnburgh Cliff.
- Further major impacts east and north of Hickleton 139, where important and distinctive landform features and recreational views would be adversely affected.
- Landscape and visual impacts from large new structures in the Frickley 142 and Clayton 143 areas.
- Increased landscape and visual impacts at the crossing of the River Calder 163, where the viaduct would be higher, with a grade-separated junction connecting to the Leeds spur at its northern end.
- Much greater impacts on townscape and visual receptors in central Leeds where the new station structure is now proposed to span the Aire riverside 189.

7.10. Cultural heritage

- 7.10.1. The eastern leg has been selected and aligned so that it would have few impacts on designated heritage assets. One Scheduled Monument (the Roman site at Ratcliffe on Soar 45) would be directly impacted, and the settings of three others would be affected. Four Grade II listed structures may be demolished. The route passes through four Conservation Areas but avoids all direct impacts to Registered Parks and Gardens.
- 7.10.2. The AoS has concluded that the majority of potential impacts would be minor at most. Unless stated otherwise, only those of potentially greater magnitude than this are described below. Based on this provisional stage of design, these are the ones considered likely to adversely affect the significance of the heritage asset in question.

Marston to Kegworth

- 7.10.3. West of Polesworth, the cutting earthworks are located approximately 245m from Pooley Hall 15 which would change the setting of this Grade II* listed building and segregate it from the historic site of Pooley Hall colliery to the north.
- 7.10.4. At Rough Park 32, west of Coleorton, the embanked route passes between 135m and 200m west of three coal mining sites that are Scheduled Monuments. The designated areas include above and below ground remnants of medieval and later coal mining preserved in woodland. The preferred route would change the setting of the remains, particularly on the Birch Coppice area 33; although potential impacts would be reduced by the screening afforded by woodland and topography.
- 7.10.5. Cutting earthworks are located approximately 70m west of Breedon Lodge Farmhouse and Cottage 37, which would result in a major impact on this Grade II listed building, severing its relationship with the moat to the north.

Kegworth to Heath

- 7.10.6. Having crossed the Soar Valley, the route passes through Red Hill and would directly impact on a Scheduled Roman site just north-west of Ratcliffe on Soar 45. The site is thought to have originated as an early Iron Age settlement that grew into an important Roman trade centre and river crossing. Recorded fieldwork associated with other development proposals in the immediate area suggests that archaeological remains of potentially national importance extend beyond the designated area. With the preferred route on viaduct at this point, construction could have a major adverse impact on below ground remains. The southern and northern portals of the existing Red Hill railway tunnel are both Grade II listed and the new viaduct would sever their relationship with Thrumpton Hall 46.
- 7.10.7. On the north side of Red Hill is the historic village of Thrumpton with its collection of over 20 listed buildings. The route crosses the western end of the Thrumpton Conservation Area 48 having a major impact on the character and appearance of the open land about 1km west of the main village.
- 7.10.8. Although passing very close to the edge of Town Centre and Lace Factories Conservation Areas 53 in Long Eaton, the historic setting of this Conservation Area has been diminished by more recent additions. The route is located beyond an existing railway therefore impacts on the significance of the Conservation Areas would be minimal.
- 7.10.9. Further north, the route passes through Strelley. This historic village has several listed buildings 68 (including the Grade I listed Church of All Saints and four Grade II buildings associated with Strelley Hall 70), as well as a Scheduled medieval moat and fishpond 69 at Strelley Church, which survive as earthworks. Impacts on most of these assets would be reduced by incorporating a cut and cover tunnel through this area. However, the cutting leading into the tunnel passes through Strelley Conservation Area 66 and would have a major impact on its character as well as changing the setting of the Scheduled moat. Links between the moat 69, Strelley Hall 70 and the church would be maintained. The setting of the complex of listed buildings at Strelley Hall 70 (with three located 60m to 120m from the southern cut and cover tunnel portal) including the historic layout of trees and open park would be changed.
- 7.10.10. The village of Old Blackwell is a Conservation Area 90 and the route passes through its northern edge severing the Grade II listed Old Farm Cottage from the remainder of the village; it would also change the setting of the Grade II listed Three Lane End Farmhouse resulting in a major impact.

Heath to Barnburgh

- 7.10.11. The route passes to the west of the Registered Park and Garden of Hardwick Hall 92 which includes the Scheduled and Grade I listed Old Hall, Grade I listed New Hall and several other associated listed buildings. The route lies beyond the existing M1 motorway corridor in an area of landscape much changed in the 20th century. The AoS has concluded that, given this context, the impact on the significance of these assets would be minor. However, the sensitivity of views and concerns of relevant stakeholders are recognised. As the design develops, the EIA will continue to explore this issue, including the development of mitigation options where appropriate.
- 7.10.12. The route passes through the Conservation Area at Stainsby 93 having a major impact on its character and appearance. The village also includes the Scheduled remains of the former manor (surviving as earthworks) which would, to a more limited extent, be subject to changes to its setting.
- 7.10.13. At Heath the route passes to the east of the Conservation Area 96, beyond the existing M1 motorway corridor. However, it would result in the demolition of the ruined remains of the Grade II listed Heath Old Church 99 and its burial ground resulting in a major impact.
- 7.10.14. Further north the route passes between the Conservation Areas, Scheduled Monuments and listed buildings of Sutton Scarsdale Hall 100 and Bolsover Castle 105. The landscape lying between these assets is of a 20th century character and contributes little to their heritage significance. As with Hardwick Hall, the AoS has concluded that this much changed context would limit the extent of impact on the significance of these assets as a result of HS2. However, the sensitivity of views and concerns of relevant stakeholders are recognised. The EIA will continue to explore the potential effects and to develop mitigation options where appropriate.
- 7.10.15. North of Bolsover the route would demolish the early 19th century Grade II listed Woodhouse Farmhouse 107 resulting in a major impact.
- 7.10.16. South of Aston, the route would demolish the Grade II listed Nickerwood Farmhouse 123, as well as other farm buildings within the listed curtilage resulting in a major impact. A separate Grade II listed farm building 40m to its north-east would not be demolished but its setting would be changed.
- 7.10.17. East of Barnburgh the route passes approximately 320m west of the Scheduled site of St Helen's chapel 137, where low stone remains survive within a wooded copse. The high embankment past this monument would affect a rural landscape that may retain some aspects of the chapel's original setting resulting in a major impact.

Barnburgh to Leeds and Church Fenton

- 7.10.18. Following the northern slopes of the Dearne Valley, the route passes very close (within 10m) to the Grade II Registered Park and Garden of Hickleton Hall 140, which include grandly designed gardens surrounding the 18th century country house, as well as a wider parkland landscape. The route would pass the end of a mature double avenue of trees, potentially affecting the uninterrupted views from the Grade II* listed house. The route would also pass in cutting approximately 300m east of the Scheduled remains of a medieval standing cross and early 20th century memorial cross at Hickleton, separating them from the church and village with which they are associated.
- 7.10.19. Further north, the route passes in cutting between the Grade II listed buildings of Bilham Belvedere Summerhouse and Bilham House 141 severing the relationship between them. This major impact is associated with further impacts on the

settings of three Grade II listed buildings (farmhouse, barn and cart shed) within Bilham House Farm, lying approximately 270m from route earthworks.

- 7.10.20. Passing west of South Kirkby, the route passes in cutting approximately 50m west of South Kirkby Camp ¹⁴⁵. The Scheduled site includes a prehistoric enclosed settlement at the east end of a low ridge that contributes to a setting that would be affected by HS2. It is also possible that there are other non-designated associated features in the immediate area that could be impacted.
- 7.10.21. The settings of the Grade II listed Kirkby Common Grade farmhouse ¹⁴⁴, and slightly further north the Grade II listed Vissitt Manor ¹⁴⁸ west of Hemsworth, would be impacted by HS2.
- 7.10.22. At Kinsley, the route passes on embankment about 50m west of Kinsley Moat and Fishpond ¹⁵⁰. This change to the setting of the Scheduled Monument would impact on its significance.
- 7.10.23. The Grade II* Registered Park and Garden of Nostell Priory lies within 400m of the route on embankment near New Crofton. Potential impacts on its setting are expected to be only minor, although the EIA will continue to assess this issue.
- 7.10.24. Entering the Calder Valley, the route passes to the west of Newland Hall ¹⁶², and Normanton, on embankment and a short stretch of viaduct approximately 150m away. The farm buildings and old stables of the former hall are both Grade II listed and the route passes through the remains of the (non-designated) Newland Park.
- 7.10.25. West of Swillington, the route passes close to Gamblethorpe Farm, the dovecote and stables which are Grade II listed ¹⁷². Embankment earthworks approximately 150m away would sever links between these farm buildings and Swillington Park.
- 7.10.26. North-west of Garforth, earthworks near the Grade II listed Barrowby Hall ¹⁷⁵ would sever the connection between the hall and Barrowby Carr Cottage.
- 7.10.27. A Grade II listed milepost on Aberford Road lies within the proposed footprint of the route. However, it is likely that through detailed design and mitigation, the milepost can be stored during construction and sensitively relocated without any permanent impacts occurring.
- 7.10.28. Route development has sought to avoid or minimise impact on Towton Registered Battlefield ¹⁸⁰. The route passes 1.7km to its south-east, although proposals to extend the designated area of the battlefield would reduce this to approximately 800m. However, the impact would remain minor.
- 7.10.29. The Leeds spur passes Clumpcliffe Farm ¹⁶⁸ south of Oulton. The farm includes a Grade II* listed gazebo and three other Grade II listed buildings. Earthworks approximately 300m away would cut through the historic estate separating the listed elements from others on the estate.
- 7.10.30. There are two Grade II* and seven Grade II listed structures located in the Leeds Canal Wharf Conservation Area ¹⁹⁰ that lie within 350m of the new Leeds station. The impacts of the station on these and on the character of the historic core of Leeds will depend very much on final designs. The Grade II listed Victoria Bridge would be retained and used as a footbridge, but the presence of the new river crossing would affect its setting.

Key changes from the 2013 consultation scheme

There are a number of changes which deliver improvements in some areas, whilst introducing new/increased impacts in other areas. Key improvements include:

- Impacts have decreased at two Conservation Areas, Leeds Canal Wharf and the Eckington and Renishaw Conservation Areas.

- Avoidance of direct impacts (demolition) to the Grade II listed Bleachcroft Chimney, Grade II listed Swillington Bridge and Grade II listed Meer Bridge.

New or increased impacts potentially affecting the significance of the heritage asset comprise:

- New impacts to 14 listed buildings, which include: Grade II listed Nickerwood (demolished), Grade II listed Kirkby Common Farmhouse, Grade II listed Bilham Belvedere Summerhouse and three associated buildings, Grade II Breedon Lodge Farmhouse ⑦, Grade II Woodhouse Farmhouse (demolished) ⑩, Grade II Gamblethorpe Farm dovecote ⑩ and Grade II* Clumpcliffe Farm and four associated buildings ⑩.
- New impacts to Old Blackwell Conservation Area ⑩ and the Grade II listed buildings of Old Farm Cottage and Three Lane End Farmhouse.
- New impact to Hickleton Hall Grade II Registered Park and Garden and Grade II* listed building ⑩.
- Increased impacts in five locations, which include: Grade II* Pooley Hall ⑩, Grade II Red Hill railway tunnels ⑩, cluster of listed buildings at Strelley (including Grade I and Grade II) ⑩, Grade II Newland Hall ⑩ and Grade II Barrowby Hall ⑩.
- Increased impacts on Thrumpton ⑩ Strelley ⑩ and Stainsby ⑩ Conservation Areas.

7.11. Biodiversity and wildlife

Statutory designations

- 7.11.1. South of Measham, the route bridges the River Mease ⑩, which is designated a SAC. This is principally due to its aquatic plant communities and the presence of otter, white-clawed crayfish and two species of fish, spined loach and European bullhead. A HRA screening report was completed based on the 2013 consultation route. This identified potential significant effects on aquatic plant communities within the SAC, therefore a draft Appropriate Assessment was prepared. On the basis of design details available at the time it concluded that there would be no adverse effect on the SAC and this preliminary conclusion was agreed with Natural England and the Environment Agency.
- 7.11.2. Since the 2013 consultation route, the route has been realigned further to the east of Measham ⑩ and entails a slightly lower, longer viaduct. The crossing is in close proximity to a section of the river that bends north-east adjacent to the viaduct. The screening report and Appropriate Assessment undertaken in 2013 have been reviewed and updated. These reports will be finalised prior to submission of the hybrid Bill and the design will be developed in discussion with Natural England and the Environment Agency to ensure that there is no adverse effect on the SAC.
- 7.11.3. The preferred route will pass through the south-western extremity of Park Forest ⑩ which is part of Sherwood Forest in Nottinghamshire. Park Forest has been identified by Natural England as one of a number of core areas within Sherwood Forest that could support nightjar and woodlark, and could therefore meet the Stage 1 SPA selection criteria as it may contain more than 1% of the UK population of both nightjar and woodlark. However, no such formal designation has been proposed by the Joint Nature Conservation Committee (JNCC) at this stage. In accordance with the precautionary approach recommended in Natural England's Advice Note (March 2014), a draft Shadow HRA Screening Report (that follows the Habitats Regulations Assessment procedure) has been prepared. The

strategic conclusions have been discussed with Natural England. This work will need to be reviewed as the design detail progresses and the EIA is carried out following a route announcement. This will require ongoing liaison with Natural England. The assessment will be finalised prior to submission of the hybrid Bill and the design will be developed to ensure there would be no adverse effect on any future potential SPA.

- 7.11.4. The River Mease SSSI 25 is designated for similar reasons to the River Mease SAC 25 with additional interest provided by populations of white-clawed crayfish and otter. As discussed above, assessment of the River Mease has already been undertaken due to the rivers European protection and HS2 Ltd will continue to work closely with Natural England and the Environment Agency to ensure there are no adverse impacts on the SAC and the SSSI designations.
- 7.11.5. The preferred route largely avoids nationally designated nature conservation sites, but crosses the River Mease SSSI 25 on viaduct and the western-most point of Bogs Farm Quarry SSSI 30 on an embankment for approximately 20m. Effects will be discussed in detail with Natural England and the Environment Agency to ensure that appropriate mitigation measures are developed as part of the EIA.
- 7.11.6. The preferred route also passes near to a number of other SSSIs. Through consideration of the respective sensitivities of each site, as well as the possible impact pathway from the preferred route, the AoS has identified a risk of ecological impacts to seven of these SSSIs, generally due to potential impacts on surface and groundwaters associated with the sites. These SSSIs comprise:
- Alvecote Pools 18, east of Tamworth and 180m from the route;
 - Lount Meadows 34, north of Ashby-de-la-Zouch and 90m from the route;
 - Robbinetts, west of Strelley 69 and 850m from the route;
 - Sellers Wood 74, north of Nuthall and 120m from the route;
 - Bulwell Wood 76, also north of Nuthall and 35m from the route;
 - Annesley Woodhouse Quarries SSSI 81, south of Kirkby in Ashfield and 345m from the route; and
 - Kirkby Wharfe SSSI, west of Ulleskelf 132 and 760m from the route.
- 7.11.7. In all cases, it is most likely that the application of measures set out in the Phase 2b CoCP would effectively mitigate potential construction impacts. Equally, any risks of hydrological impacts would be addressed through careful design to ensure that surface or groundwater flows were maintained. Risks of other impacts will need to be addressed through detailed design and mitigation. There are a number of other SSSIs within 1km of the site. Further information on why indirect impacts on these features are considered unlikely at this stage in the design are listed in *Appendix C3 Biodiversity*.
- 7.11.8. Several Local Nature Reserves (LNR) are situated near the route, although risks to most would be addressed by careful design and implementation of good construction practise. However, Nottingham Canal LNR 65 designated for its open water, hedgerows, semi-improved grassland and reedbed habitats, would be crossed by embankment to the north of Trowell. This will necessitate shading of part of the canal, habitat removal and will fragment a small section between the route and motorway. Old Denaby Wetland LNR 130 in the Don Valley, designated for its wetland habitats and grassland would also be bisected on viaduct, resulting in habitat loss and potentially also affecting surface and groundwater flows.

Non-statutory sites

- 7.11.9. Based on publicly available data, one Wildlife Trust reserve, Carr Vale Flash ¹⁰¹ near New Bolsover is close to the route. It comprises a mixture of open water, marsh, wet and dry grassland and scrub, attracting a variety of birds throughout the year. The extent of the reserve is currently not known and the effects of the scheme will be assessed in the EIA.

Other important habitats

- 7.11.10. The eastern leg would result in direct effects at six discrete parcels of ancient woodland. These are New Farm Wood ⁷⁵ to the east of Bulwell; Watnall Coppice ⁷⁸ to the west of Hucknall; High Wood ¹¹⁹, north of Barlborough; Nor Wood ¹²⁰, east of Killamarsh; Nicker Wood ¹²⁴, south of Aston and Hooton Cliff ¹²⁸, east of Hooton Roberts.
- 7.11.11. The eastern leg would have direct impacts on numerous areas of HPI. The ecological significance of these impacts is not known at this stage and the areas will be surveyed in due course as part of the EIA to assess and evaluate the effects. The total distance of HPI intersected by the centre line of the route is 18.5km. The more notable impacts are expected to affect the following areas:
- coastal and floodplain grazing marsh, lowland fen, reedbed, good quality semi-improved grassland, lowland meadow, wood pasture and parkland and deciduous woodland located along the River Tame ⁴, Anker ¹⁷, Doe Lea ¹⁰³, Dearne ¹³², Don ¹³¹, Calder ¹³³ and Aire ¹³⁷;
 - lowland meadow at Packington ³⁰;
 - wood pasture and parkland and lowland meadow at Strelley Hall ⁷⁰, south of Nuthall;
 - deciduous woodland west of Thrumpton, Park Forest (west of Hucknall) ⁷⁹, east of Wales Bar; east of Killamarsh, east of Old Denaby ¹³⁰ and west of Methley ¹⁶⁷; and
 - wood pasture and parkland at Brookhill Hall and lowland meadow east of Pinxton ⁹².
- 7.11.12. Smaller areas of lowland deciduous woodland located along the route are also intersected with habitat loss. This includes discrete woodlands east of Measham ²⁸, east of Tonge ³⁸, south of New Crofton ¹⁵⁴; east of Barnburgh ¹³⁸, north of Hickleton ¹⁴¹ and around Garforth ¹⁷⁶.
- 7.11.13. Impacts on protected species such as bats, great crested news, otters and badgers will be assessed in the EIA and as required appropriate mitigation measures will be identified.

Key changes from the 2013 consultation scheme

There are a number of changes which deliver improvements in some areas, whilst introducing new/increased impacts in other areas. Key improvements include:

- Reduced impact (approximately 75m less intersection) on Bog's Farm SSSI, lowland meadow and good quality semi-improved grassland with the route aligned further to the west.
- Impact removed from Norbriggs Flash LNR and Carlton Marsh LNR.
- Impact removed from ancient woodland at Smooth Coppice and an unnamed site east of Lundwood, as well as near Chapelton and Worsborough to the north-east of Sheffield (including Smithy Wood, Hesley

Wood, Barley Hole Springs and Wombwell Wood).

- Impact removed from the River Rother habitat corridor, River Don and deciduous woodland at Renishaw.
- Impact removed from lowland fenland at Cold Hiendley.
- Reduced impact on River Aire habitat corridor, near Woodlesford.

New or increased impacts include:

- Impact on woodland contiguous with the River Mease SSSI 25.
- Passing within 5m from Stanton Gate LNR, north of Sandiacre 3.
- New impact of Old Denaby Wetland LNR 130.
- New impact on ancient woodland at High Wood 119, Nor Wood 120, Nicker Wood 124 and Hooton Cliff 128.
- New impact on one Wildlife Trust Reserve: Carr Vale Flash 101 (near New Bolsover) supporting lowland fen, reed bed, lowland meadow and deciduous woodland.
- New impact of deciduous woodland east of Wales Bar, east of Killamarsh and at Old Denaby 130.
- New impact on Brookhill Hall wood pasture and parkland, east of Pinxton 82.
- New impact on the River Dearne 132 and River Don 131 habitat corridors near Mexborough.

7.12. Water resources and flood risk

Overview

- 7.12.1. The consultation route considered Environment Agency flood zones along major watercourses. Further work has since been undertaken to understand the clearance at all watercourse crossings along the line of route and in order to comply with the guidance set within the WFD. The clearance at each watercourse crossing has been assessed against updated design requirements (refer to Section 4.15).
- 7.12.2. Where clearance over or under the watercourse was insufficient compared with the design requirements, the alignment has been adjusted where practical. This has resulted in the heights of viaducts and embankments increasing in a number of locations in order to achieve sufficient clearance over the watercourse. This would reduce flood risk, other hydrological and ecological impacts as well as providing operational benefits to the railway in terms of maintenance requirements.

Watercourse diversions

- 7.12.3. Close working between the scheme engineers and AoS water specialists has been successful in avoiding the need for many potential permanent watercourse diversions along the eastern leg. However, the need for permanent diversions or realignments to three major watercourses at one location and 35 minor watercourses is still envisaged at this stage.
- 7.12.4. Between Marston and Kegworth there would be no major river diversions. Nine minor watercourse diversions would be required, including one designated by the Environment Agency as a Main River, namely Bramcote Brook 20 near Warton.

- 7.12.5. Between Kegworth and Heath there would be one major river diversion, namely the River Erewash 55 at Toton. Seven minor watercourse diversions would be required, including realignment of the Erewash Canal 62 in the Toton area.
- 7.12.6. From Heath to Barnburgh there would be no major river diversions. Nine minor watercourse diversions would be required.
- 7.12.7. From Barnburgh to Leeds and on the connection to the ECML there would be no major river diversions and 10 minor watercourse diversions.

Flood risk

- 7.12.8. The route would cross floodplains at numerous locations. Generally, these crossings would be on viaduct or a clear-span bridge to minimise the potential loss of flood storage and obstruction to flood flows. Viaducts are currently proposed for 27 floodplains crossed for more than 100m.

Table 7-2 – Floodplain crossings

Watercourse name	Viaduct name	Viaduct length (m)	Floodplain crossing (m)
River Tame* 4 and Thistlewood Brook	Kingsbury Viaduct	2,240	1,020
River Anker* 17 and Bramcote Brook* 20	Polesworth Viaduct	900	420
Bramcote Brook* 20	Austrey Viaduct	310	290
River Mease* 25	River Mease Floodplain Viaduct	880	510
Westmeadow Brook 38	Embankment	n/a	350
River Soar* 44	Ratcliffe on Soar Viaduct	3,240	3,060
River Trent* 46 and River Erewash* 55	Long Eaton Viaduct	4,640	4,470
River Erewash* 55	East Midlands Hub station	n/a	1,800
River Erewash* 55	Sandiacre Viaduct	2,660	1,360
River Erewash* 55	Stanton Gate Viaduct	1,410	770
Normanton Brook 87	Normanton Brook Viaduct	140	120
The Goit 102	The Goit Floodplain Viaduct	540	460
River Doe Lea* 103	Bolsover (including embankment)	130	160
River Don* 131	River Don Floodplain Viaduct	740	630
River Dearne* 132	River Dearne Floodplain Viaduct	880	800
Frickley Brook 142	Frickley Beck Viaduct	490	100
River Calder* and tributary 153	Aire and Calder Navigation and River	1,900	940

Watercourse name	Viaduct name	Viaduct length (m)	Floodplain crossing (m)
	Aire Viaduct		
Oulton Beck* ¹⁸³ (Church Fenton)	Oulton Beck Viaduct	470	220
River Aire ¹⁷¹ (Church Fenton connection)	Aire and Calder Navigation and River Aire Viaduct	2,230	910
River Wharfe* ¹⁸² South Floodplain – various dikes	Including solid construction on approach to ECML	2,170	2,610
River Aire* Floodplain ¹⁸⁷	Hunslet, cutting	n/a	300
River Aire* Floodplain ¹⁸⁷	Leeds station Approaches (at grade)	n/a	130
River Aire* ¹⁸⁷	Leeds station	n/a	760
Hawke Brook ¹¹⁰	Embankment – Staveley IMD loop	n/a	200
River Doe Lea* ¹⁰³	Embankment – Staveley IMD loop	n/a	610
Pools Brook* ¹¹¹	Embankment – Staveley IMD loop	n/a	170
River Rother* ¹¹⁴	Staveley IMD approach viaduct	370	310

*Classified by the Environment Agency as a Main River

- 7.12.9. Issues of flood risk would arise at both stations. The approach to the East Midlands Hub station would lie partly within Flood Zone 3, and the route is on viaduct in this location. Leeds station spans Flood Zone 3 of the River Aire, with construction crossing the entire width of the floodplain.
- 7.12.10. In total, the eastern leg would cross major rivers at 19 locations, including multiple crossings of the River Erewash ⁵, and River Calder ¹³. The eastern leg would also involve 253 crossings of minor rivers and 11 navigable waterways.

Groundwater

- 7.12.11. None of the eastern leg would pass in cutting through the most sensitive areas for potable groundwater, SPZ 1 or 2, and no public water supplies would be directly affected. In addition to potable groundwater supplies and associated SPZs there are four other notably large groundwater abstractions on the eastern leg, namely: Acton Road Works (Long Eaton), Grange Farm (Micklefield), Stourton Dairy (Pontefract Road) and The Brewery (Hunslet Road).
- 7.12.12. The AoS indicates that all four non-potable abstractions appear unlikely to be significantly affected as a result of the preferred route. This is based on the fact that the route passes above ground adjacent to three boreholes and would not affect these abstractions. The route passes in shallow cutting adjacent to the fourth borehole, however this abstraction pumps from Principal Bedrock aquifer which is likely to be substantial in thickness. It is anticipated that there would be minimal impact on flows to the abstraction as a result of the preferred route. In addition, best-practice construction techniques would be employed to protect the groundwater resources from pollution.

7.12.13. The EIA stage will assess water resources and flooding (including WFD requirements) in further detail.

Key changes from the 2013 consultation scheme

There are a number of changes which deliver improvements in some areas, whilst introducing new/increased impacts in other areas.

Changes in the horizontal and vertical alignment, as well as refinements to construction type, have resulted in changes to the sustainability of the route in terms of diversions and the impact of the route on the risk of flooding. Overall there is a reduction by four in the number of major river diversions; however there is an increase in the number of minor river diversions. Key improvements include:

- Removed minor watercourse diversions and reduced impact at Kingsbury Water Park due to removal of embankments.
- Removed requirement for tunnelling underneath East Midlands Airport within aquifer of good yield and good quality.
- Reduced impact on the Gilwiskaw Brook, near Packington, which no longer requires diversion.
- Reduced risk of flooding to the route at the Long Eaton viaduct.
- Substantial reduction to the impact on the River Doe Lea and associated floodplain near Bolsover as a result of route refinement.
- Removed impacts near Sheffield on the River Rother, River Don and their associated floodplains due to the route no longer going through Meadowhall.
- Diversion of the Cudworth Dyke is no longer required and impact on the Cudworth Dyke floodplain is removed.
- Reduced impact on the River Aire and the Aire and Calder Navigation around Woodlesford.
- The impact on the River Aire, Aire and Calver navigation are reduced as a result of route refinements near Woodlesford
- The impact on Farnley Wood Beck near Stourton is reduced as a result of route refinement in this area.

New or increased impacts include:

- New impact on River Dearne **182** and River Don **181** as route crosses near Mexborough, though clear-span viaducts minimise this impact.
- Leeds station now crosses the floodplain of the River Aire **189**, increasing the impact of the station on the risk of flooding in the vicinity and introduces an impact to the River Aire.

7.13. Land use resources

Agricultural land take

7.13.1. The AoS process has sought to limit the loss of the highest quality agricultural land. High level agricultural land classification maps show that no Grade 1 classified agricultural land would be directly affected by the eastern leg. An estimated 28km of the route would be through Grade 2 classified agricultural land, notably in the Tame Valley **7**, in the low hills between the Anker and the Mease

valleys ⑩, in the hills between Strelley and Greasley ⑳, and in the undulating plateau between Garforth and Church Fenton ⑰.

Green Belt land

- 7.13.2. Green belt surrounds Nottingham and all of the main conurbations between Sheffield and Leeds, so the route would pass through it for much of its length. The East Midlands Hub station would occupy an estimated 19ha of green belt. The New Crofton RSD would occupy an estimated 40ha of green belt.

Landfill sites

- 7.13.3. The AoS identified seven active (operational) landfill sites and 46 disused (non-operational) landfill sites within 250m of the preferred route. Higher risks were identified for four of the active sites and 15 of the disused sites, based on the type and length of crossing, the size of the landfill and its recorded contents. Additional work was undertaken by the engineers to better understand the risks associated with landfills, which helped inform route refinements.

- 7.13.4. Of the active landfills:

- Kingsbury Landfill ⑨ west of Wood End and designated for inert and non-hazardous waste would be crossed by embankment for approximately 190m;
- Measham landfill ⑳ (an active mineral/brick working area) south of Measham and designated for industrial waste would be crossed by viaduct for approximately 550m;
- Mexborough Landfill ⑬ to the east of Mexborough and designated for household, commercial and industrial waste would be crossed predominantly in cutting for approximately 220m; and
- Welbeck Landfill ⑯ east of Wakefield and designated for hazardous/industrial waste, would be crossed by embankment for approximately 25m.

- 7.13.5. Of the 15 disused landfills identified, five are designated for hazardous/industrial waste, namely:

- Measham Red bank Brickworks ⑳ at Measham, which is within 25m of the preferred route;
- Cragg Lane ⑳ at Blackwell, crossed by cutting for approximately 280m;
- Railway Cutting ⑫ at Wales, crossed by embankment for approximately 40m;
- Brickworks Quarry ⑬ at Mexborough, crossed by viaduct, embankment, at grade and in cutting for approximately 215m; and
- Smoile Wood ⑳ west of Newbold, which is within 25m of the preferred route.

- 7.13.6. The recorded waste for the other disused landfills is non-hazardous waste. These sites comprise:

- Land west of railway ⑧, north of Kingsbury, crossed on viaduct for about 75m;
- Blackwell Tip ⑳ at Hilcote crossed by embankment and viaduct for approximately 275m;
- Hall Lane Tip ⑰ at Staveley, which is within 25m of the preferred route;

- Denaby Lane 130, at Denaby Main, crossed by viaduct for approximately 80m;
- Land off Southmoor Road 146 east of Brierley, crossed by embankment for approximately 20m;
- Land at Bellholme 147 north of east of Brierley crossed by embankment for approximately 15m;
- Abbots Tip 158, at Crofton crossed by cutting and embankment for approximately 115m;
- Armitages Quarry 184, at Oulton crossed by cutting and tunnel for approximately 170m;
- Lemonroyd 169 at Oulton, crossed on embankment and viaduct for approximately 560m; and
- Hunslet Grange 187, former housing site at Hunslet, which is within 25m of the preferred route.

Key changes from the 2013 consultation scheme

There are a number of changes which deliver improvements in some areas, whilst introducing new or increased impacts in other areas. Landfills now avoided comprise:

- Erin Landfill, an active landfill near Staveley.
- Staveley Landfill, northwest of Staveley.
- Old Chesterfield Canal at Killamarsh.
- Woodhouse Mill Tip at Treeton Dyke, Orgreave.
- Orgreave Road at Catcliffe.
- British Steel Corporation sites at Sheffield.
- Swaithe Tip at Swaithe, Worsbrough.
- C E Medlam also at Swaithe, Worsbrough.
- Stairfoot Landfill, southeast of Barnsley.
- Cudworth North Junction at Royston.

Landfills now affected are listed above, but in summary comprise 17 sites namely:

- Kingsbury active landfill 9.
- Land west of railway (non-operational) 8.
- Measham active landfill 26.
- Measham Red bank (non-operational) 26.
- Smoile Wood (non-operational) 34.
- Blackwell Tip (non-operational) 86.
- Cragg Lane (non-operational) 86.
- Hall Lane Tip (non-operational) 116.
- Railway Cutting at Wales (non-operational) 122.
- Denaby Lane (non-operational) 130.

- Mexborough active landfill ¹³⁵.
- Brickworks Quarry (non-operational) ¹³⁵.
- Land off Southmoor Road (non-operational) ¹⁴⁶.
- Land at Bellholme (non-operational) ¹⁴⁷.
- Abbots Tip (non-operational) ¹⁵³.
- Armitages Quarry (non-operational) ¹⁸⁴.
- Hunslet Grange (non-operational) ¹⁸⁷.

7.14. Excavated materials and material resource

- 7.14.1. The estimate for excavated material arising on the preferred scheme is 13.6 million cubic metres, of which only a very small proportion (0.1 million cubic metres) would be from tunnel excavation. However, these estimates do not take account of the materials likely to be incorporated within the scheme for the creation of landscaping and bunding as part of any mitigation proposals.
- 7.14.2. The estimated quantities of bulk building material required for construction of the preferred scheme would comprise 326,700 tonnes of steel and 2,601,400 tonnes of concrete.

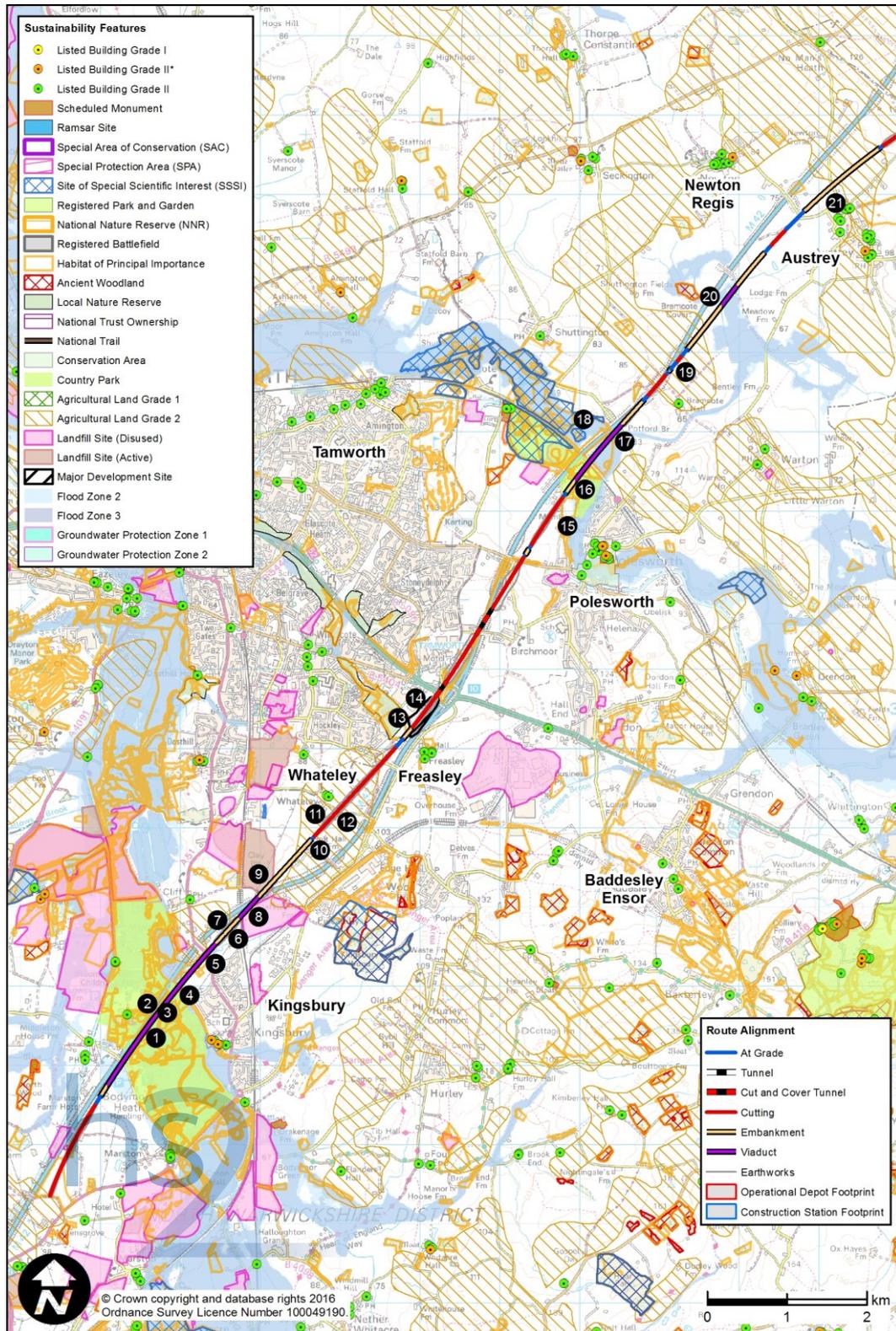
Key changes from the 2013 consultation scheme

As a result of refinements to the route, including a longer spur between HS2 and the Erewash Valley and an increase in sections of cutting, and with an overall reduction in the amount of bored tunnel, the preferred route now has:

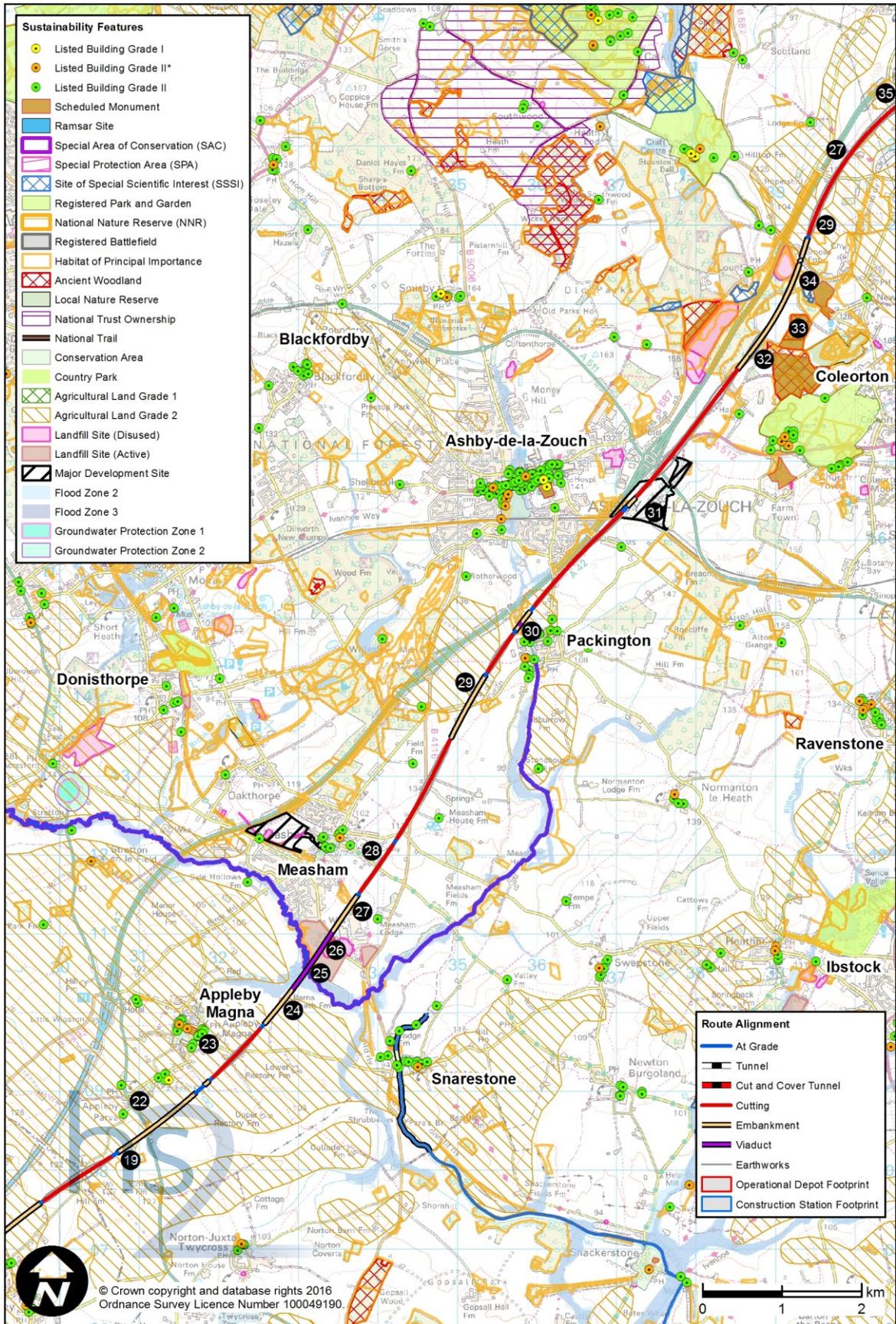
- An estimated 1.2 million cubic metres more excavated material.
- An estimated 1,060,200 tonnes less concrete required.

8. Eastern Leg Sustainability Maps

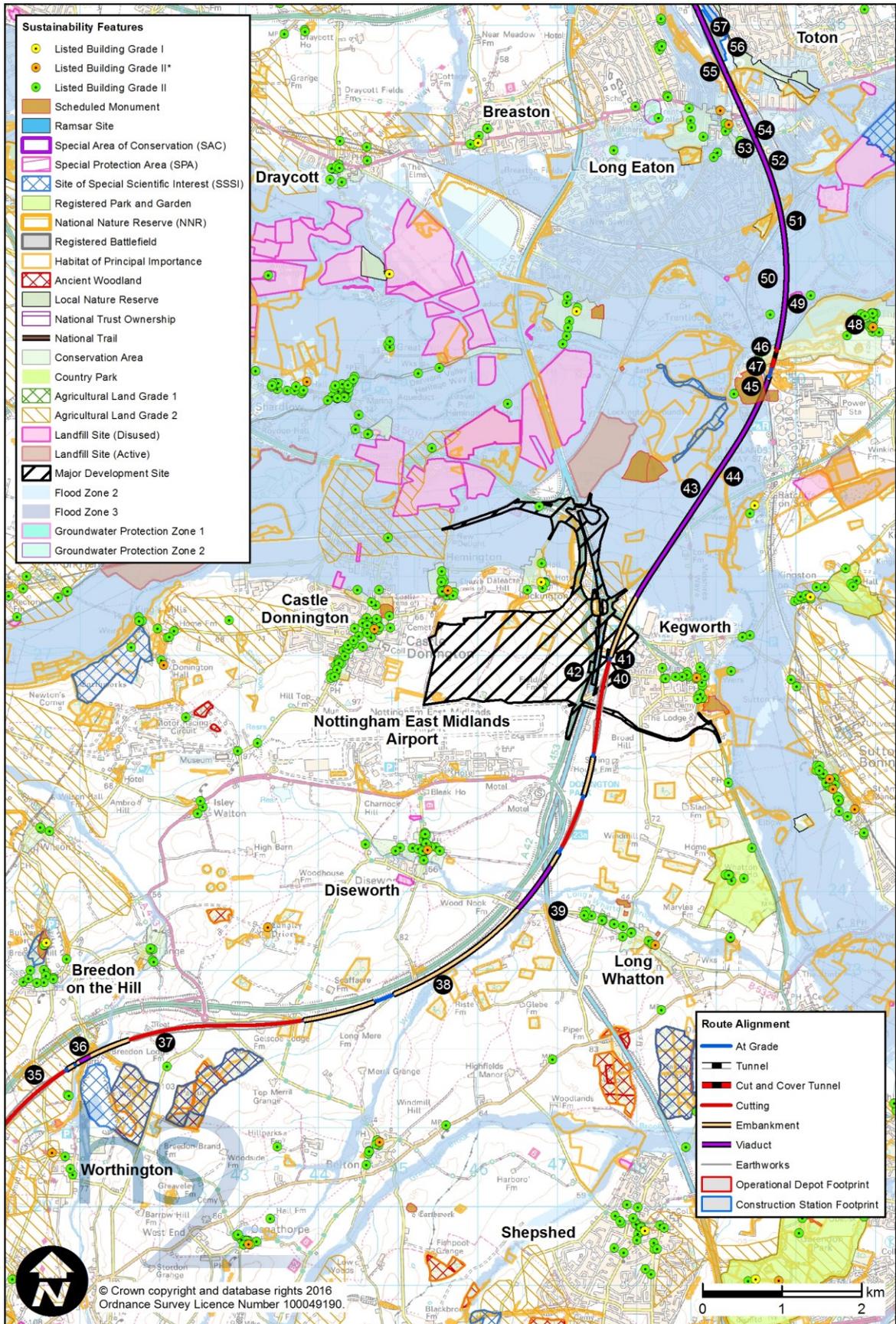
Eastern Leg Sustainability Map (1 of 11 – Marston to Austrey)



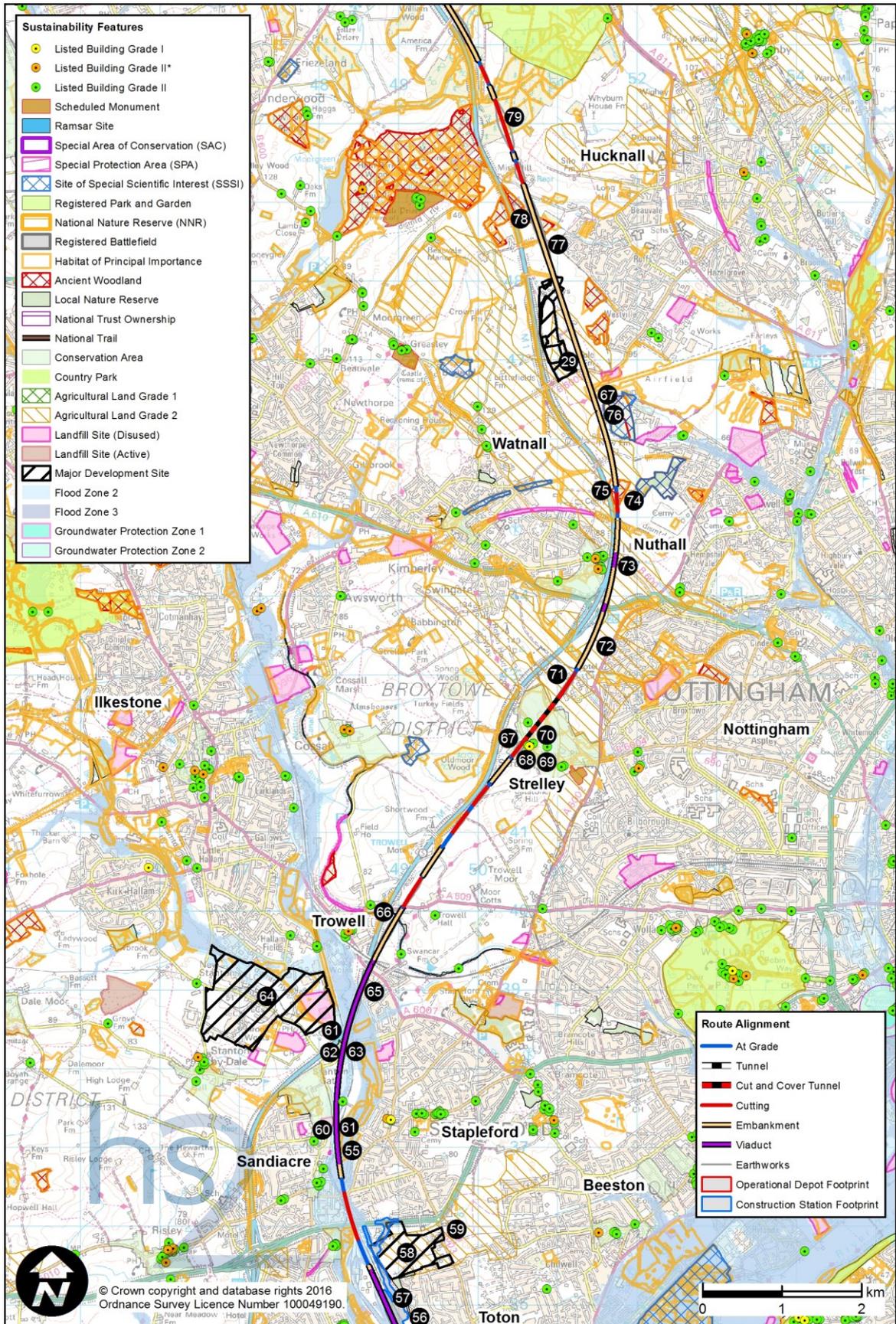
Eastern Leg Sustainability Map (2 of 11 – Austrey to Worthington)



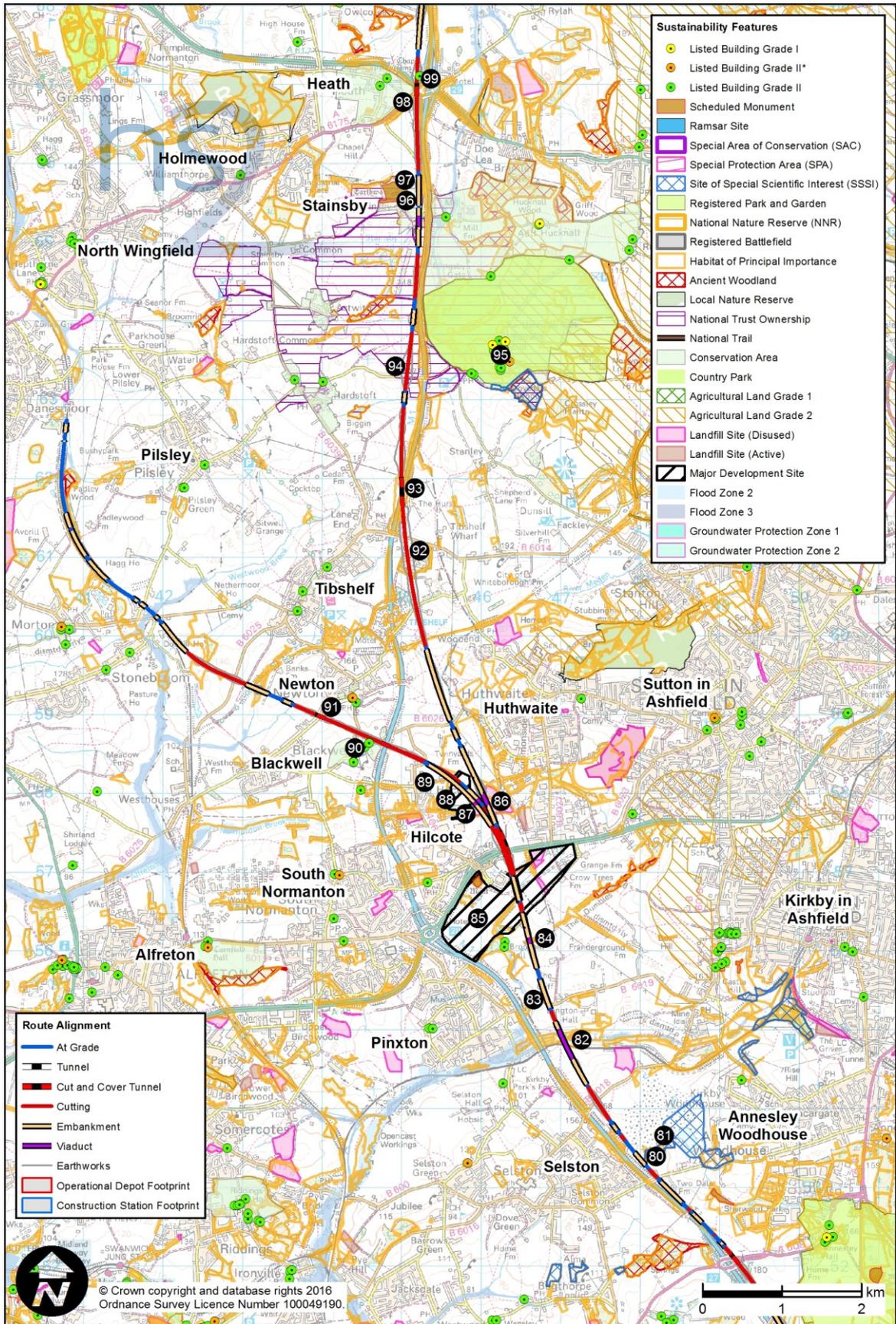
Eastern Leg Sustainability Map (3 of 11 – Worthington to Long Eaton)



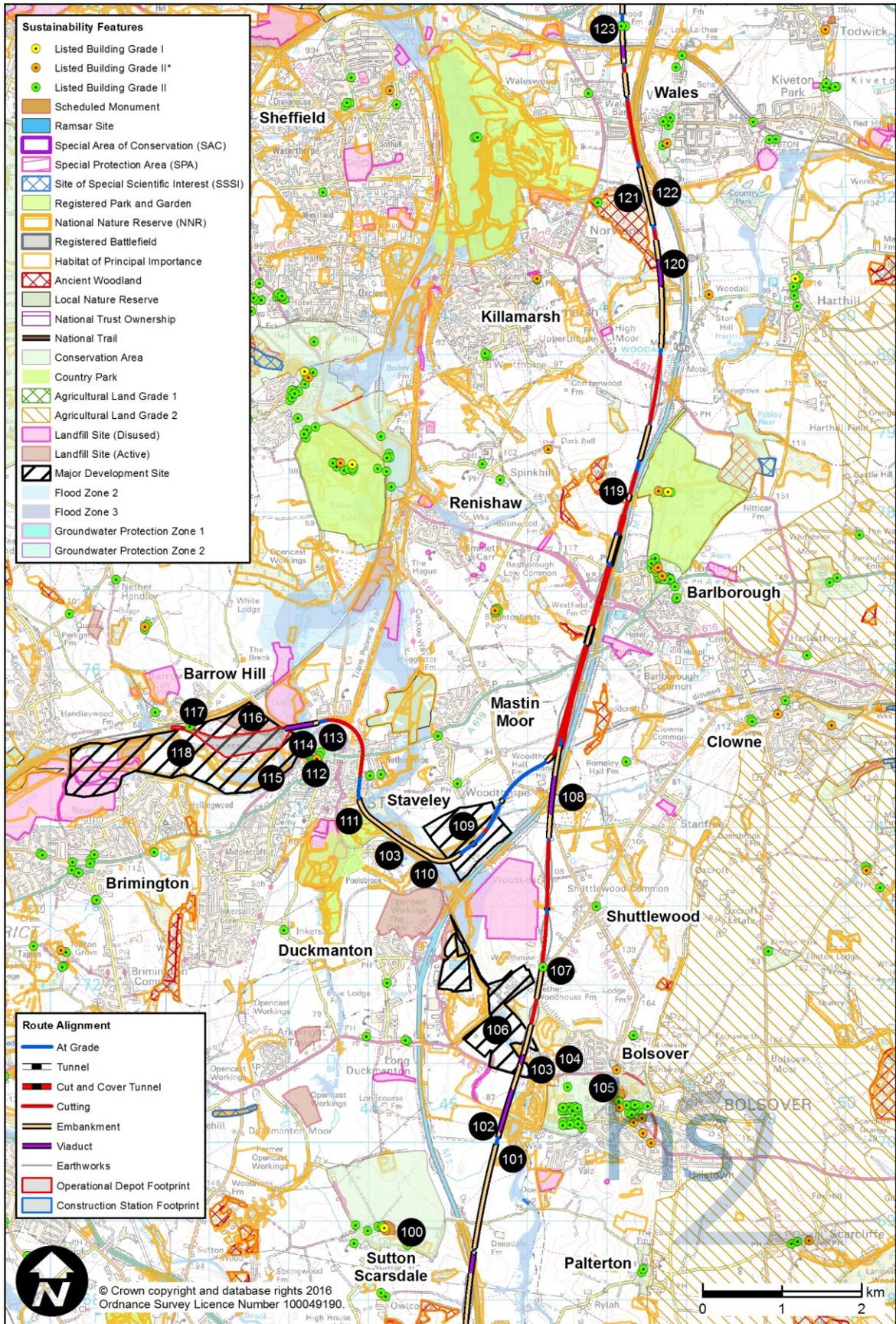
Eastern Leg Sustainability Map (4 of 11 – Long Eaton to Annesley Woodhouse)



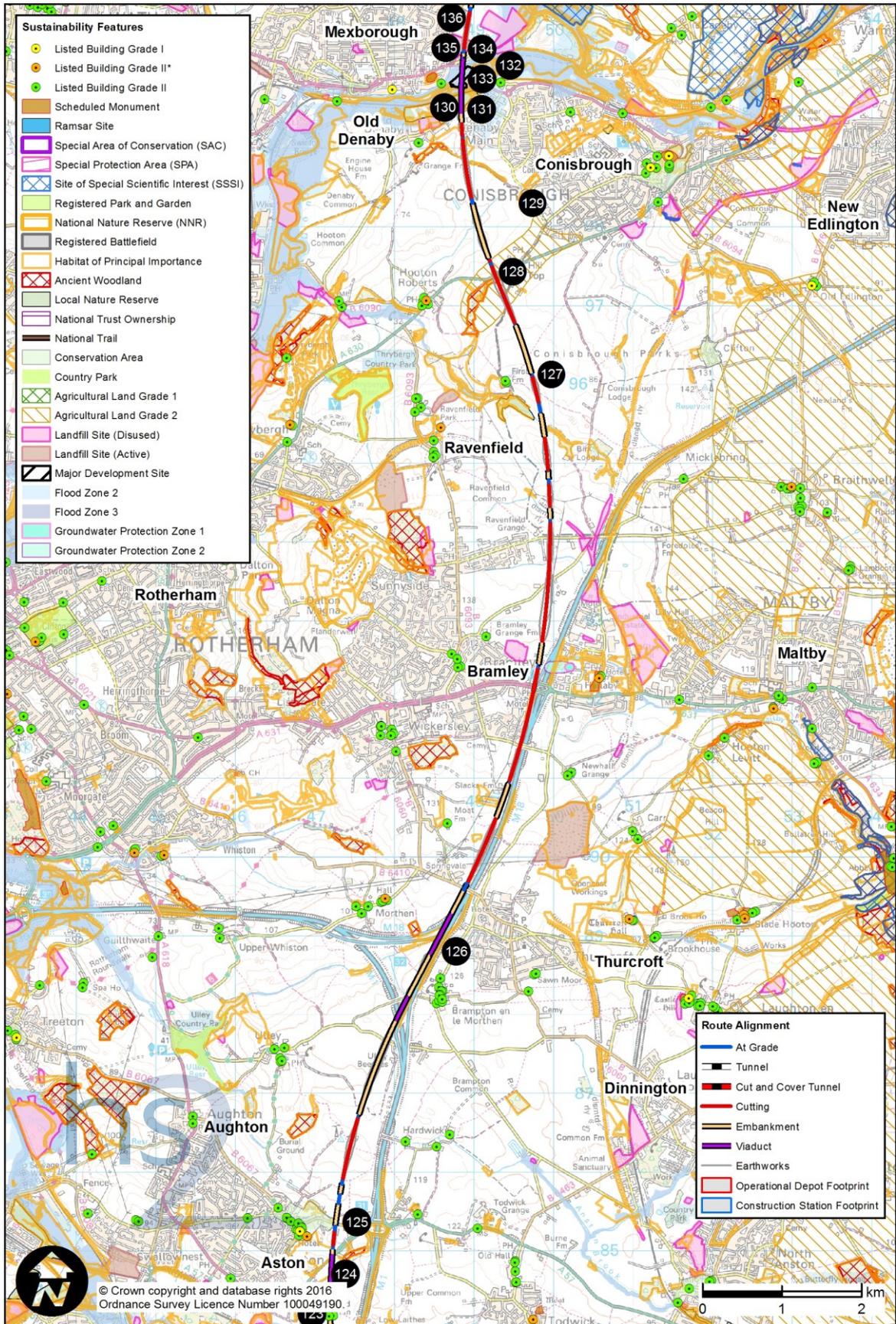
Eastern Leg Sustainability Map (5 of 11 – Annesley Woodhouse to Heath)



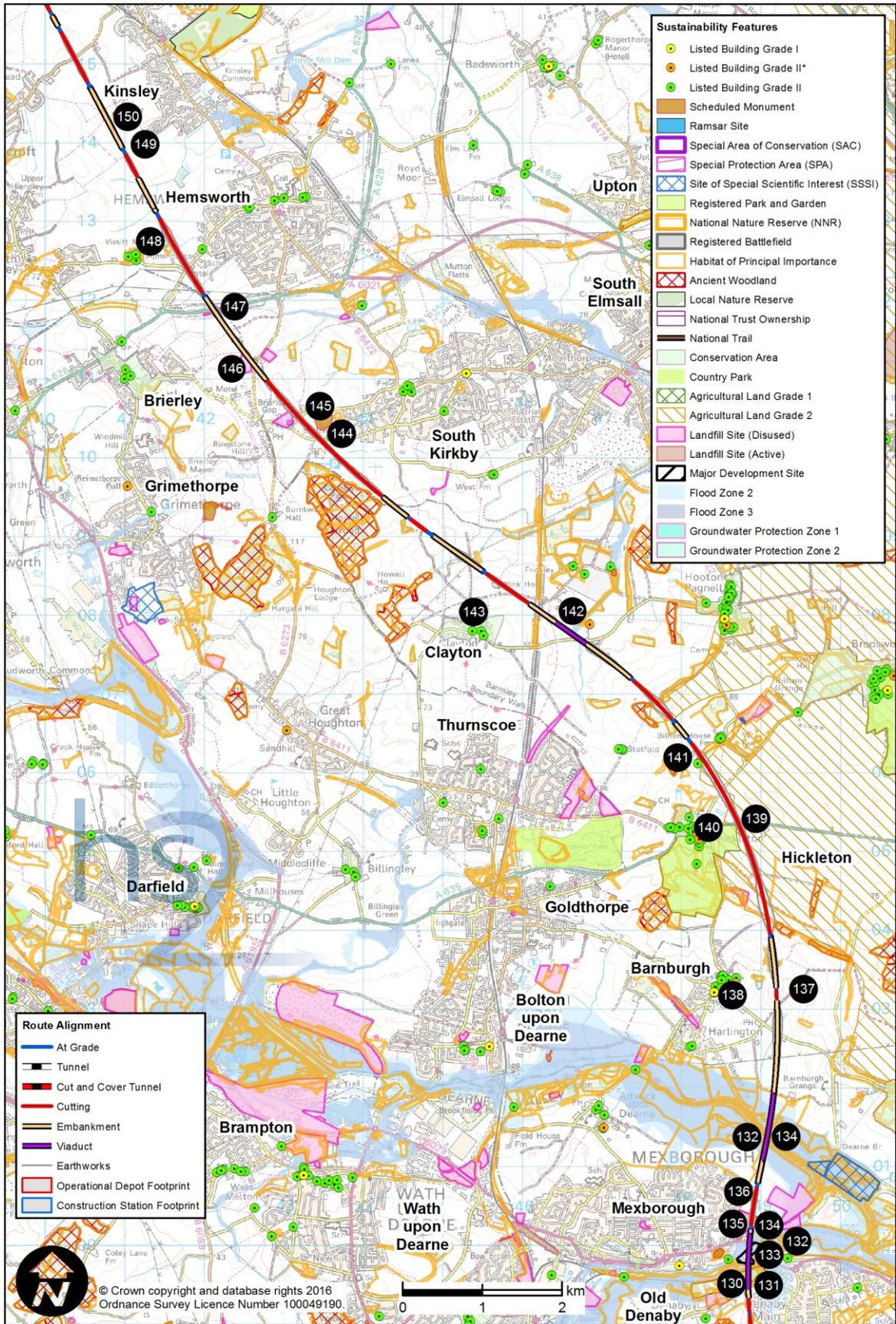
Eastern Leg Sustainability Map (6 of 11 – Heath to Wales)



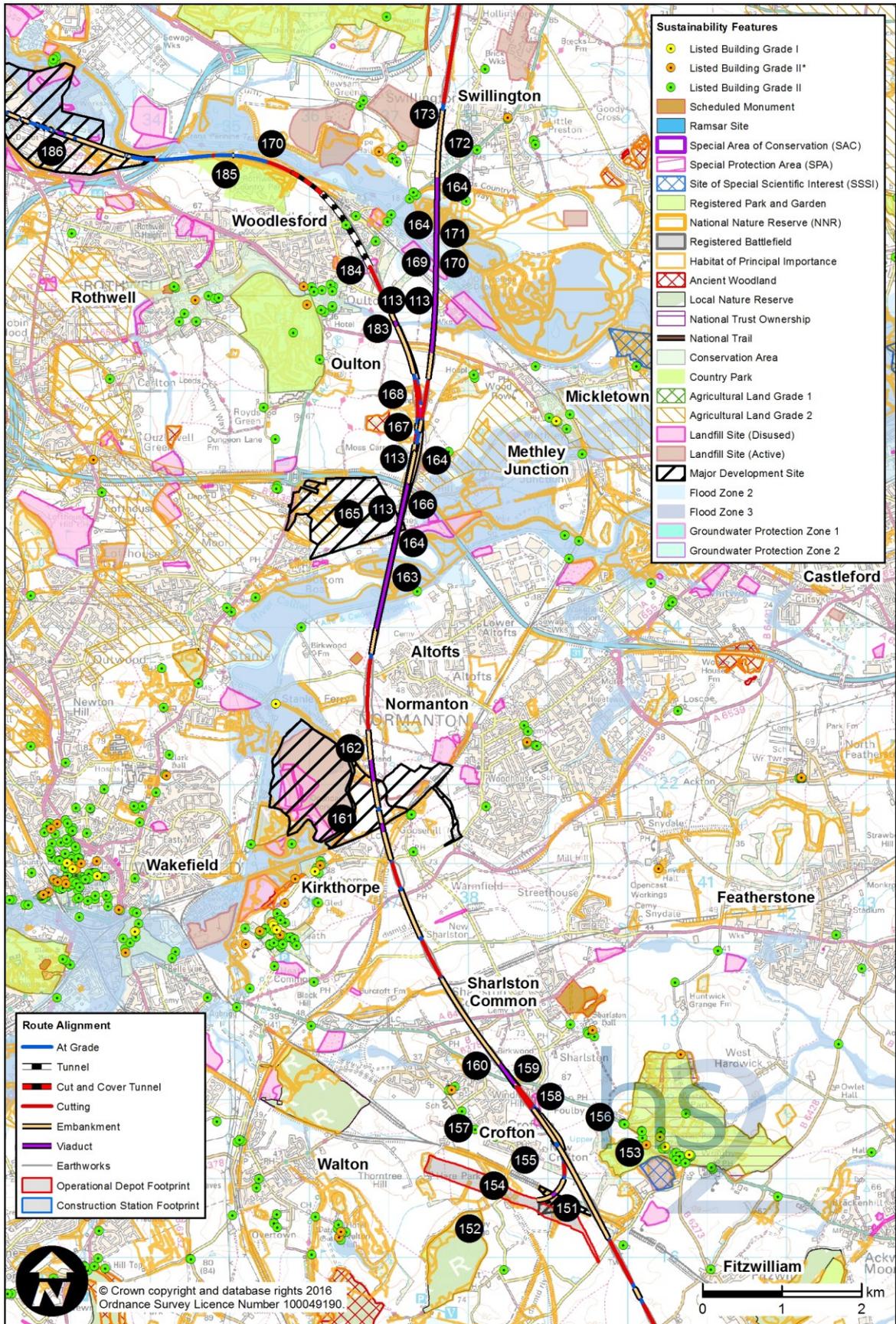
Eastern Leg Sustainability Map (7 of 11 – Wales to Mexborough)



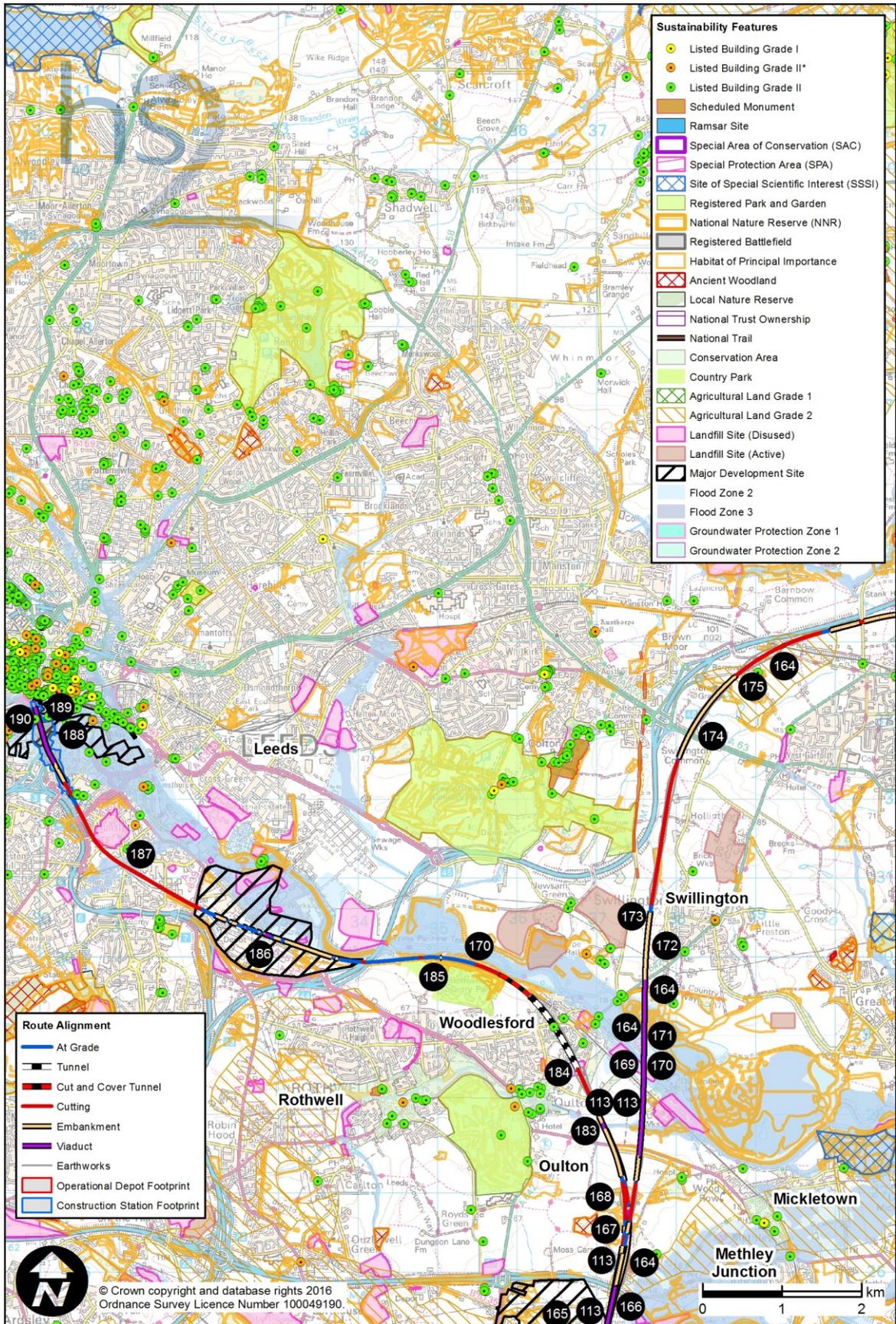
Eastern Leg Sustainability Map (8 of 11 – Mexborough to Kinsley)



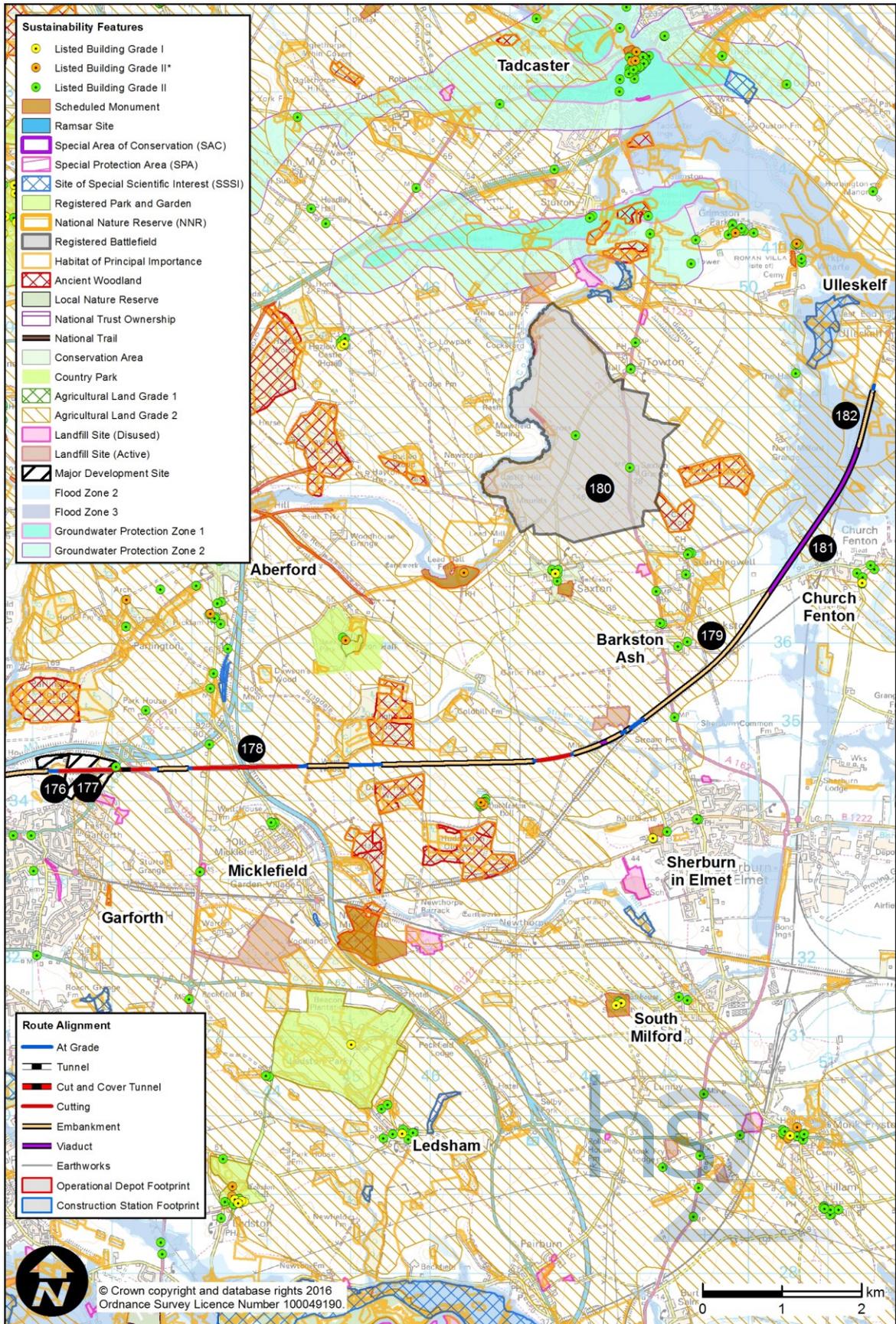
Eastern Leg Sustainability Map (9 of 11 – Kinsley to Woodlesford)



Eastern Leg Sustainability Map (10 of 11 – Woodlesford to Leeds and Garforth)



Eastern Leg Sustainability Map (11 of 11 – Garforth to Church Fenton)



9. Scheme wide issues and combined impacts

9.1. Introduction

9.1.1. Although the main focus of this Sustainability Statement has been on highlighting the key sustainability issues that would occur along the route, some of the impacts of Phase 2b can only be realised if Phase 2b proposals are considered as a whole, or as part of a larger scheme – combined with Phase One and Phase 2a. Carbon emissions, wider economic issues and implications for the safety of passengers are all examples of scheme wide issues which are considered in this report.

9.2. Carbon Emissions

Overall carbon emissions

9.2.1. Table 9-1 and Figure 9-1 summarise emissions for the HS2 scheme over its construction period and an assumed operational lifetime of 60 years under both of the UK future carbon scenarios.

Table 9-1 Carbon emissions for HS2 over the 60 operational assessment period

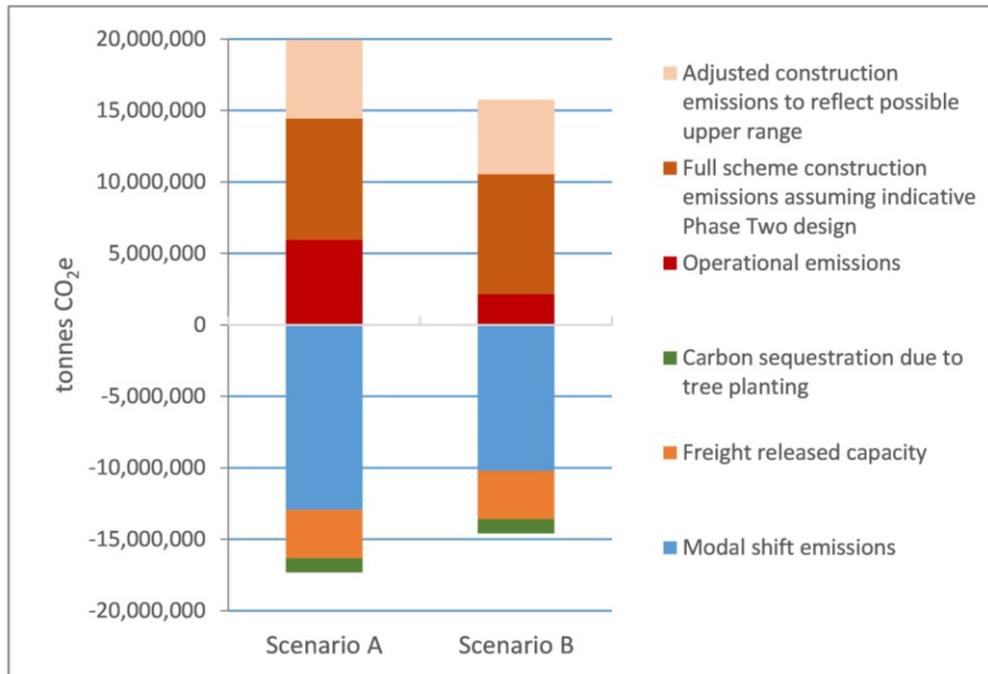
Emission Source	Scenario A (MtCO _{2e})	Scenario B (MtCO _{2e})
Operational emissions	+5.96	+2.15
Modal shift emissions	-12.90	-10.21
Freight uptake of released capacity	-3.39	-3.39
Carbon sequestration from tree planting	-1.00	-1.00

9.2.2. Table 9-1 shows that over the first 60 years of operation, HS2 would result in an overall decrease of about 11.3MtCO_{2e} under Scenario A and about 12.5 MtCO_{2e} under Scenario B. However, these potential carbon reductions during operation need to be seen in the context of potential carbon increases during the construction phase (from paragraph 9.2.6), which are estimated to be between 8.4 MtCO_{2e} and 14.0 MtCO_{2e}. The smaller figure uses construction data for Phase Two⁶⁰ that is based on the indicative design available at the current time. In practice, the Phase Two construction emissions are expected to be greater than this; the larger figure for construction emissions therefore accommodates an adjustment to account for a more developed Phase Two design based on the current, more detailed Phase One assessment of construction emissions.

9.2.3. Taking both the construction and operational phases together, and assuming the value of construction emissions based on the Phase Two indicative design, there would be an estimated net decrease of about 2.9MtCO_{2e} under Scenario A and about 4.0MtCO_{2e} under Scenario B. However, accepting that the construction emissions for Phase Two may be larger in practice, a net increase in emissions is also possible, with estimated increases of 2.7MtCO_{2e} and 1.2MtCO_{2e}, for scenarios A and B respectively.

⁶⁰ Phase 2a and Phase 2b combined.

Figure 9-1 Carbon emissions for HS2 over the 60 year assessment period



- 9.2.4. An important qualification for these results is that they reflect only the first 60 years of operation. Over its full 120 year design life, HS2 would continue to give rise to ongoing carbon reductions due to the net effect of its operations, as well as to carbon increases due to the natural cycle of maintenance, repair and replacement of the infrastructure. Assuming that these reductions and increases continue in line with trends for years 0-60, then over years 61-120, net reductions of around 8.2MtCO₂e could result⁶¹, ensuring that HS2 over its design life would be carbon beneficial.
- 9.2.5. These results demonstrate the strong influence of the UK future carbon scenarios on the carbon emissions of the HS2 scheme. Further analysis is illustrated in subsequent sections.

Construction carbon

- 9.2.6. Construction carbon is largely due to the use of high energy bulk materials such as steel and concrete, and highly energy-intensive construction processes such as tunnel boring. Estimates of embedded carbon associated with concrete and steel have been calculated using projected future emissions factors for these materials, pertaining at the time of construction. Table 9-2 provides the findings for construction carbon emissions.

⁶¹ This indicative estimate for Scenario A was derived assuming that net benefits from HS2 operation, mode shift, released capacity and carbon sequestration would remain the same in years 61-120 as during years 1-60, and that additional construction carbon would be incurred during years 61-120 for replacement of track and rolling stock.

Table 9-2 Carbon emissions for HS2 over the construction period

Emission Source	Scenario A (MtCO_{2e})	Scenario B (MtCO_{2e})
Construction emissions (un-adjusted)	+8.46	+8.38
Construction emissions (adjusted)	+13.99	+13.62

9.2.7. Based on the assessment methods used, the Phase One construction carbon was found to be relatively larger than the equivalent measure for Phase Two, despite having a shorter track length. There are certain design factors which would result in larger construction carbon emissions on Phase One, notably the greater extent of tunnel. However, this discrepancy has highlighted some limitations in the construction carbon assessment method for Phase Two due to its less refined and detailed design proposals and associated construction information. In particular, the Phase One assessment has been able to include:

- A more comprehensive range of materials, including glass, plastics, and other non-bulk materials;
- specified construction activities, for which required plant are defined;
- additional factors based on the defined scheme footprint, including changes in land use; and
- a refined estimation of bulk material requirements which includes better defined infrastructure requirements.

9.2.8. As a result, the estimated construction carbon emissions have been adjusted for Phase Two using representative factors such as tunnel distances and track lengths to give the adjusted construction carbon figure presented in Table 9-2. Taken together these construction carbon emissions for the scheme are estimated to be about 14MtCO_{2e}.

9.2.9. An understanding of the relative contribution to the construction carbon of the different scheme elements for Phase One, and the different materials for Phase Two will help HS2 Ltd to focus attention on where emphasis should be placed in seeking carbon efficiencies as the scheme progresses. The large proportion of construction emissions embedded through the use of steel and concrete, and the logistics involved in the transportation of bulk construction material and excavation material suggest that there remain opportunities for reducing carbon emissions during the construction process. Some examples of these opportunities are shown below.

Carbon efficiency opportunities in HS2 construction

- Increased use of recycled materials (particularly steel).
- Use of less carbon-intensive concrete blends.
- Improved design and construction of rolling stock to reduce weight where possible.
- Maximum management and re-use of excavated material in the construction process, for landscaping and other mitigation measures.
- Adoption of efficient logistics management for transport of construction materials and excavated material.
- Adoption of construction workers travel plans to encourage use of sustainable

modes of transport to construction sites.

- Maximisation of materials transported via rail rather than road.
- Energy efficiency in site management and transport.
- Adoption of resource efficiency measures to tackle inefficiencies across supply chains, overuse of resources (eg materials, energy and water) and waste generation.

9.2.10. It is clear that the construction carbon within HS2 is a key factor in the scheme's overall performance. However, the carbon figures reported are set against a background of nil construction carbon in the absence of HS2. In practice, if HS2 did not proceed, other strategic transport alternatives would be required to seek to address the current and emerging transport challenges, each with their own carbon impacts. These alternatives have not been considered as part of this study. However, in comparison with most other transport modes, high speed rail offers some of the lowest carbon emissions per passenger-kilometre, and significantly less than cars and planes.

Operational carbon

9.2.11. The operation of HS2 trains would result in carbon emissions through demand for electricity. The scale of these emissions varies greatly according to the UK future carbon scenario assumed, as shown in Table 9-1 and Figure 9-1.

9.2.12. There is likely to be scope for innovation in design and energy management in the operation of HS2 trains, stations and infrastructure leading to reductions in operational carbon emissions, as shown below.

Carbon efficiency opportunities in HS2 operation

- Improved aerodynamic design of HS2 rolling stock.
- Reduction of rolling stock weight.
- Drive style management and/or automatic operation (consistent, optimal use of energy throughout journey).
- Better management and control of infrastructure and rolling stock auxiliary (non-traction) power usage.
- Changes to speed profiling / improved fleet operation control and timetabling.
- Local renewable energy generation at stations and associated HS2 infrastructure sites.

Modal shift carbon

9.2.13. The operation of HS2 would lead to modal shift changes in carbon emissions associated with the displacement of journeys on alternative transport modes. The results of these assessments under each of the UK future carbon scenarios are shown in Table 9-3.

Table 9-3 Modal shift carbon emissions for HS2

Mode Type	Scenario A (MtCO ₂ e)	Scenario B (MtCO ₂ e)
Domestic aviation	-9.73	-9.73
Existing rail services	-0.53	-0.07
Long distance road	-3.21	-0.46
Road access ⁶²	+0.57	+0.05
TOTAL	-12.90	-10.21

HS2 carbon emissions in context

Rail and Carbon

9.2.14. In 2014⁶³ the transport sector contributed around 23% of the UK’s greenhouse gas emissions. These emissions were predominantly from road vehicles (around 21%) with trains contributing around 0.5% of UK total emissions and HS2 would be a much smaller proportion of this total rail contribution. National and international studies⁶⁴ confirm that rail transport is consistently amongst the most carbon efficient mass transport modes in terms of emissions per passenger-km; high speed rail is particularly efficient in this respect.

Carbon – traded versus non-traded

9.2.15. Most elements of carbon arising from HS2 fall within the EU’s Emissions Trading System (EU ETS)⁶⁵. This scheme operates across the European Union and sets a steadily decreasing cap on carbon emissions from a specified range of activities. Emissions from the majority of HS2 activities will therefore effectively be absorbed by the EU ETS and will not result in overall carbon increases. Emissions from activities outside this scheme, while covered in the UK by legally binding targets, are not subject to a fixed cap. Emissions from diesel trains and road vehicles are currently outside the EU ETS, whereas those from power generation are inside it. Through modal shift, HS2 would therefore also draw more emissions into this scheme. Figure 9-2 shows the split between traded and non-traded HS2 carbon.

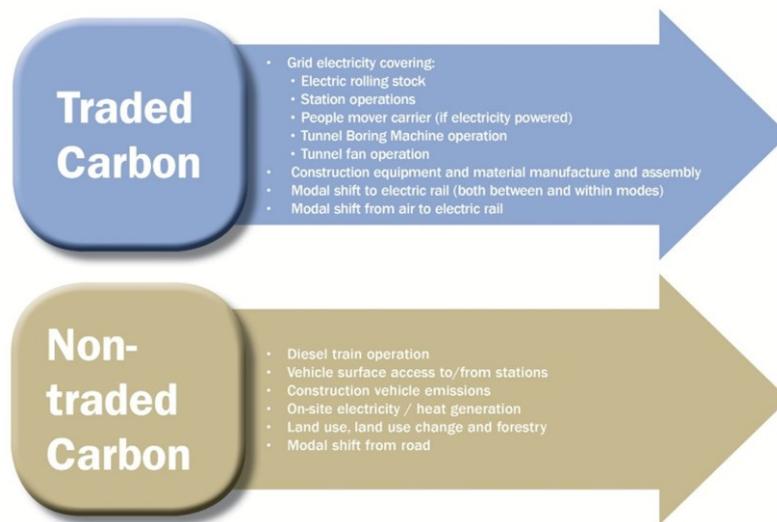
⁶² Where people are travelling to and from HS2 stations.

⁶³ Department of Energy & Climate Change (2016). [‘Final UK greenhouse gas emissions national statistics: 1990-2014’](#).

⁶⁴ Australian Department of Infrastructure and Regional Development (2013). [‘High Speed Rail Study Phase 2, Appendix 5G \(Carbon Emissions\)’](#) ‘Carbon Footprint of High Speed Rail’, Systra for the UIC (2011); ‘Comparing environmental impact of conventional and high speed rail’, Network Rail (2009); ‘Relative carbon performance of rail compared to other modes’, Department for Transport (2007); ‘T618 – Traction Energy Metrics’, Rail Safety and Standards Board (2007).

⁶⁵ The EU referendum result will have no immediate impact on the UK’s participation in EU ETS (which was launched in 2005). The UK remains a member of the EU and giving effect to the referendum result is expected to include a long negotiation process, during which compliance with EU ETS will continue as normal.

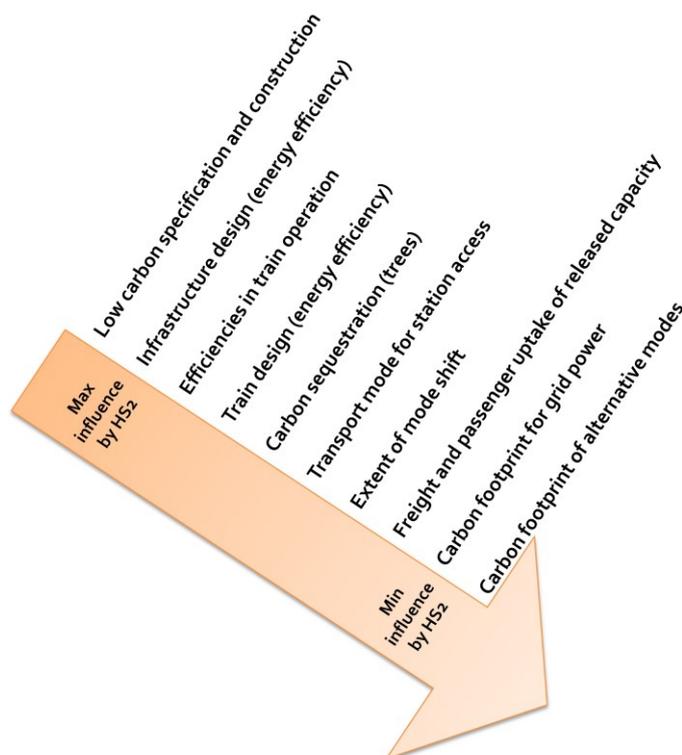
Figure 9.2 Traded versus non-traded HS2 carbon



HS2 Ltd’s influence and control over the scheme’s carbon footprint

9.2.16. There are a number of factors affecting the carbon emissions from or associated with HS2. Some of these would be determined in part by the way the scheme is designed, built and operated. Adoption of a range of carbon saving measures would lead to carbon efficiencies in construction and operation, in line with HS2’s Sustainability Policy, which seeks, amongst other things, to minimise the carbon footprint of HS2 as far as practicable. However, a great many of the scheme’s carbon emissions will depend on other factors either entirely outside the control of HS2 Ltd or only partly within its influence. Figure 9-3 illustrates the extent to which various measures or issues are within HS2 Ltd’s direct control.

Figure 9.3 HS2 Ltd’s influence and control over carbon footprint



Conclusion

- 9.2.17. The carbon assessment has been undertaken to understand the potential carbon impacts of HS2. This is a complex process that relies on numerous factors, some under the direct influence of HS2, some not, and all with various degrees of uncertainty given the long period over which the scheme will operate and the difficulty in knowing how the transport and power sectors will perform over this time.
- 9.2.18. Over the construction and the first 60 years of operation of HS2, it is likely that carbon savings that come about as people switch from other transport modes with higher carbon emissions, and as released capacity on existing railways is taken up by new passenger and freight services at the expense of road vehicles will be less than the carbon emissions, resulting largely from the construction phase. This will depend on the final design for the scheme which for Phase Two is currently at a preliminary level of detail.
- 9.2.19. Over the full lifetime of the scheme, assumed to be 120 years, HS2 would continue to give rise to net carbon reductions from its operations, as well as to carbon increases due to ongoing maintenance, repair and replacement of infrastructure. As a result, the overall carbon trend for HS2 could be a net carbon reduction over its design life, even if the higher value of construction emissions is assumed.
- 9.2.20. In practice, if HS2 did not proceed, other strategic transport alternatives would be required to seek to address the current and emerging transport challenges, each with their own carbon impacts. These alternatives have not been considered as part of this study. However, in comparison with most other transport modes, high speed rail offers some of the lowest carbon emissions per passenger-kilometre, and significantly less than cars and planes. Furthermore, most of the carbon emissions due to HS2 would arise from activities that fall within the EU ETS and would therefore be limited and gradually reduced.
- 9.2.21. In addition to these overarching conclusions, the assessment has identified the relative carbon impacts of different aspects of the scheme. This is being used by HS2 Ltd to better understand how carbon can be reduced through the life of the project. HS2 Ltd has adopted a *Sustainability Policy*, which seeks to minimise the carbon footprint of HS2 and deliver low carbon long distance journeys that are supported by low carbon energy. HS2 Ltd is also a signatory of the governments' Infrastructure Carbon Review (ICR) scheme, committing to reducing carbon and by association, reducing cost.

Key changes from the 2013 carbon assessment

Overall conclusions from the 2013 assessment remain valid. However, since 2013, a number of components of the overall carbon footprint have changed. These changes include:

- Construction emissions are increased, through changes to the anticipated scheme length of Phase 2b, and design changes to Phase One arising from the passage of the hybrid Bill and Additional Provisions;
- Operational emissions are increased, due to changes to projections of the carbon intensity of grid electricity;
- Modal shift emissions are further decreased (i.e. carbon benefits increase) due to a variety of interacting factors. These include changed carbon intensity projections for electric, petrol and diesel vehicles, coupled with enhanced modal displacement estimates for road vehicle journeys and aviation passengers; and
- Freight uptake of released capacity emissions are decreased (i.e. carbon

benefits increase) due to changes to the long-term future projections for the carbon intensity of conventional rail gas-oil transport.

The net change is beneficial, as the increased benefits from modal shift and freight uptake of released capacity outweigh the increased emissions from construction and operation.

9.3. Climate resilience

- 9.3.1. Consideration of the resilience of the preferred scheme to the wider effects of climate change will be addressed in due course as part of the EIA. HS2 Ltd is committed to ensuring this resilience is considered within the design: one of the seven themes of its Sustainability Policy⁶⁶ is to: “Build a network which is resilient for the long term and seek to minimise the combined effect of the project and climate change on the environment”.

9.4. Safety

- 9.4.1. The introduction of HS2 would increase the choices that people make to travel between locations. Different modes of transport have varying degrees of risk levels associated with them due to the different hazards associated with each mode. Statistical evidence on injury and fatality rates shows that travel via rail or air is generally several times safer than travelling by road.
- 9.4.2. The introduction of HS2 would offer an alternative mode of rail transport, which some people are expected to choose for certain journeys. If there are more people choosing to travel by rail than by air or by road, this would produce an overall shift in the risk levels to which these people are exposed and thus result in a change in overall safety.
- 9.4.3. HS2 could have a positive impact on safety, as relatively more dangerous journeys by car are replaced by much safer rail journeys on HS2 potentially resulting in a lowering of fatalities. Rail travel statistics also show significantly lower major injury rates compared to roads. The net change in injury levels would be a balance between any potential reduction in injury due to modal shift and potential increase in injury due to generated new demand for long distance high speed rail journeys by passengers who do not currently make that journey by road.

9.5. Wider economic issues

- 9.5.1. The more localised effects in terms of jobs and houses supported by new developments expected to come forward around HS2 stations have been described in sections 5.3 and 7.3.
- 9.5.2. The preferred HS2 scheme represents a major transformation in the UK rail network and capacity and a significant public investment in national infrastructure. Such projects have the capacity to transform areas, driving longer-term shifts in economic performance and potentially altering the shape of economic geography.
- 9.5.3. The mechanisms through which HS2 could affect the productive capacity, economic performance, and economic geography of the UK are wide-ranging and complex. Analysis of the full potential economic impacts would need to consider the following ways in which the preferred scheme could increase productivity, and ultimately economic growth:

⁶⁶ HS2 Ltd (2015). [HS2 Sustainability Policy](#)

- Improved market access. Transforming journey times and increasing the frequency and reliability of rail services effectively shrinks distances between key cities and regions of the UK and opens up markets. Businesses would have better access to a wider range of potential customers, suppliers, workers and skills. This would provide the opportunity for efficiency gains through improved sharing and diffusion of knowledge between businesses, which may also drive innovation, increased input-output linkages, and better access to labour with the best skills for the job.
- Increased trade and competition. HS2 would open up opportunities for increased trade and competition between local and regional markets, and also promote wider export opportunities. By increasing access to markets it would reduce barriers to business entry/exit allowing for a more competitive marketplace, and potentially increased output and lower prices. Improved connectivity could also affect the ability of an area to attract foreign direct investment.
- Change in business behaviour. Wider market access and greater opportunities for trade and competition could also drive wider change in business behaviour, such as increased specialisation, potential re-organisation and re-structuring, and changes to investment and location decisions; all of which could lead to potential efficiency gains.
- Improved employment opportunities. Opening up labour markets gives more people access to a wider range of jobs, and could improve the match between individuals' jobs and skills with resulting efficiencies. Potential changes in business behaviour could also lead to changes in the sectoral mix of employment opportunities, and higher density employment that could increase efficiency.

9.5.4. Given the difficulties in forecasting long term macroeconomic trends, and the complex interdependencies that determine the extent to which the potential economic benefits of a transport investment are realised, any estimate of the potential dynamic economic impacts would be subject to significant uncertainty. This type of analysis is outside the scope of the socio-economic appraisal for an AoS, and some elements of these dynamic economic impacts go beyond the standard transport appraisal set out in the Economic Case for HS2. However, these types of impacts could be significant, and warrant further investigation. HS2 Ltd is continuing to develop analysis and evidence to consider more widely how, as a transformational infrastructure project, HS2 could impact on the economy at the national and regional level.

9.6. Direct employment

9.6.1. Estimates by HS2 Ltd of direct employment have been prepared for HS2 as a whole (Phase One, 2a and 2b). The operational scheme is expected to require an estimated 3,000 permanent jobs. 25,000 private sector jobs are expected to be required to build HS2, with over 1,000 people each year being trained at the new National College for High Speed Rail in Birmingham and Doncaster from 2017.

10. Scheme development and EIA

10.1. Benchmarking performance

- 10.1.1. This Sustainability Statement records how sustainability has been integral to the development of the preferred scheme. It also benchmarks the sustainability performance of the preferred scheme at this preliminary stage of design. Ultimately the proposals will be issued for further consultation and refined and augmented to a level that will support the hybrid Bill and the close scrutiny entailed in the Bill's passage through Parliament.
- 10.1.2. This continued development of the scheme design will be supported by the EIA, through which HS2 Ltd will seek to address and improve further on the predicted environmental performance reported here. The results of the EIA will be reported in an EIA Report⁶⁷ which is required to be deposited in Parliament alongside draft legislation necessary to authorise the proposals for Phase 2b of HS2. The EIA Report will document the more detailed environmental assessments that will take place following this announcement on the route. The EIA Report is required by Parliament's Standing Orders and once deposited will be subject to further consultation to meet those requirements. The EIA Report is a key document that will enable Parliament to be informed about the significant effects of the proposals and the means proposed to overcome or ameliorate those effects.

10.2. EIA and environmental design

- 10.2.1. HS2 is seeking to design, build and operate a scheme that is both responsive to the environment through which it passes and to the people who live and work near the route and its depots and stations. The EIA will be fundamental to achieving this goal. Environmental design considerations have been embedded from the earliest stages of the project. A fundamental part of the environmental design process has been the use of the AoS process to support option selection and the refinement of designs.
- 10.2.2. Going forwards, as potentially adverse impacts are identified the EIA will evaluate their significance and propose mitigation measures to address them. HS2 Ltd will continue to use mitigation principles to avoid an adverse impact, or reduce it to as low as reasonably practicable. The HS2 Design Vision⁶⁸ sets out aspirations for designing the UK's new national high speed rail network.
- 10.2.3. The EIA will involve a detailed assessment of impacts, this will rely on in-depth research, detailed field assessments and consultation information. New EIA regulations will come into force in 2017, and the EIA supporting the Phase 2b scheme will need to reflect these changes.
- 10.2.4. As part of the hybrid Bill process, a number of mechanisms will be introduced to control the environmental impacts of Phase 2b. For example, on Phase One of HS2, the controls contained in the Phase One Environmental Minimum Requirements (EMRs) are a key element of the Government's overall strategy for ensuring that impacts which have been assessed in the Phase One Environmental Statement are not exceeded unless under certain circumstances (e.g. any change would be unlikely to have significant environmental impacts).

⁶⁷ The new EIA Regulations, 2017, mean that the previous term 'Environmental Statement' will be replaced with Environmental Impact Assessment Report (EIAR).

⁶⁸ HS2 Ltd (2015). [HS2 Design Vision](#).

10.2.5. In addition, the Phase One EMRs include a general requirement for any nominated undertaker to use reasonable endeavours to adopt mitigation measures that will further reduce any adverse environmental impacts caused by Phase One, insofar as these mitigation measures do not add unreasonable costs to the project or unreasonable delays to the construction programme. Finally, in addition to the arrangements put in place specifically for HS2 Phase One, there are general legislative controls that will apply to HS2 Phase One in the normal way, such as the existing requirements for prior consent to control construction noise; waste management licences and discharge consents. Similar control mechanisms will be considered for Phase 2b.

10.3. Monitoring Changes

- 10.3.1. Prior to construction, the EIA will be the mechanism used to identify and document the likely significant effects of the scheme, and therefore reflect any key changes in the anticipated sustainability performance of the scheme compared with those reported here. It will also assess a scheme that has numerous mitigation measures embedded within it, including detailed noise mitigation, proposed habitat creation and landscaping.
- 10.3.2. Following the construction and operation of the scheme, HS2 Ltd will monitor the actual significant environmental effects in order to identify unforeseen impacts and, where necessary, to introduce appropriate remedial measures.
- 10.3.3. HS2 could also have some 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. Going forward, a monitoring programme would be established which would address these strategic impacts and define mechanisms for dealing with them.

11. HS2 Combined Impacts

- 11.1.1. In order to provide an understanding of the sustainability performance of HS2 as a whole, this section summarises the potential combined impacts for Phase One, Phase 2a and Phase 2b focusing on the appraisal categories that can be more easily quantified.
- 11.1.2. The Phase 2b data reflects the information reported in this document. Phase One data is drawn from both the Supplementary Environmental Statement 4 and Additional Provision 5 Environmental Statement, Volume 3, Route-wide effects, December 2015⁶⁹. Where no equivalent category is available Table 11.1 reverts to data presented within the HS2 London to the West Midlands Appraisal of Sustainability (AoS) report⁷⁰ to enable a meaningful comparison. In relation to Phase 2a, data is drawn from the High Speed Two Phase 2a: West Midlands to Crewe Working Draft Environmental Impact Assessment Report, September 2016⁷¹. Similarly, where no equivalent category is available, the table reverts to data presented within the Sustainability Report Phase Two Post-Consultation Update: West Midlands to Crewe⁷².
- 11.1.3. The information presented in Table 11.1 is based on various designs for all phases at different stages of the project. This means they have each been worked to different levels of detail and assessment. In all cases, the information presented is a work in progress (for example on Phase 2a this is subject to consultation and further design development, as it is for Phase 2b). Therefore, some of the details will change as further design and assessment are undertaken and as further mitigation is introduced. In particular, it should be noted that impacts reported for Phase 2b (and when used the Phase One AoS and Phase 2a Sustainability Report impacts) are based on the operational scheme footprint only and on a scheme design that is still partly under consultation. At this stage the Phase 2b design does not include construction planning or other ancillary work (e.g. highway alterations, access roads) which have not been designed. Therefore it is likely that these figures may change during future design work. Nonetheless, the information presented in Table 11.1 should be helpful as a broad representation of the magnitude and scale of performance for the combined project.

Table 11.1 Combined Impacts of HS2

	Phase One Total	Phase 2a Total	Phase 2b Total	Combined total
Route characteristics (km)				
Total	216 (39%)	60 (11%)	279.3 (50%)	555.3
At grade	0 (0%)	3.4 (15%)	19.3 (85%)	22.7
Tunnel	49.5 (67%)	2.3 (3%)	21.7 (30%)	73.5
Cutting	74.7 (39%)	26 (14%)	89.4 (47%)	190.1
Viaduct	16.3 (27%)	5.6 (9%)	38.5 (64%)	60.4

⁶⁹ HS2 (2015). (London-West Midlands). [Supplementary Environmental Statement 4 and Additional Provision 5 Environmental Statement. Volume 3. Route-wide effects.](#)

⁷⁰ Booz & Co. Temple (2011). [HS2 London to the West Midlands Appraisal of Sustainability.](#)

⁷¹ HS2 (2016). [HS2 Phase 2a \(West Midlands to Crewe\) Working Draft Environmental Impact Assessment Report.](#)

⁷² Temple-RSK (2015). [Phase Two Sustainability Report Post-Consultation Update: West Midlands to Crewe.](#)

	Phase One Total	Phase 2a Total	Phase 2b Total	Combined total
Embankment	62.5 (32%)	22.7 (12%)	110.4 (56%)	195.6
Property and settlements ⁷³				
Demolitions (residential)	326 dwellings (218 buildings)	72 dwellings ⁷⁴	255	653
Demolitions (community)	19	0	4	23
Demolitions (commercial/retail)	372 units (309 buildings) ⁷⁵	40 units ⁷⁶	209	621 (558)
Demolitions (manufacturing/industrial)				
Total demolitions	717 (546 buildings) ⁷⁷	112 ⁷⁸	468	1,126 (1,126)
Employment and housing				
Jobs supported	30,000 ⁶⁷	Value not available for WDEIAR	51,200 - 73,300	81,200-103,300
Houses supported	5,620 ⁶⁷	Value not available for WDEIAR	6,240 – 9,050	11,860-14,670
Jobs displaced	7,950 ⁶⁷	45	5,050	13,045
Noise				
Potential dwellings subject to noticeable noise increase without additional mitigation	24,300 ⁶⁷	2,800 ⁶⁹	31,200	58,300
Potential dwellings subject to noticeable noise increase with additional mitigation	4,700 ⁶⁷	500 ⁶⁹	5,600	10,800
Landscape				
AONB crossed at surface (km)	7.6	0	0	7.6
Cultural heritage				
Scheduled Monuments directly affected	1	0	1	2
Registered Battlefields directly affected	1	0	0	1

⁷³ Figures reported for Phase 1 and 2a are categorised differently to those for 2b given the difference in the level of scheme design. The figures reported for Phase 2b are based on the operational scheme footprint only and on a scheme design that is still partly under consultation. At this stage the Phase 2b design does not include construction planning or other ancillary work (e.g. highway alterations, access roads) which have not been designed. Therefore it is likely that this figure may change during future design work.

⁷⁴ This figure includes 40 residential properties that are estimated to be either completed or under construction (as of Summer 2016) at the Basford West Development site. An alternative location for a permanent maintenance facility is also being considered within the Stone and Basford Swynnerton community area (CA3). If selected, the Basford West development area would no longer be required and these demolitions would be avoided.

⁷⁵ This figure includes some properties which also provide community resources, e.g. public house, local services.

⁷⁶ Total includes outbuildings at farm holdings.

⁷⁷ This total includes the total number of residential, community, commercial/retail/manufacturing/industrial & miscellaneous buildings.

⁷⁸ This total includes the total number of residential, community, commercial/retail/manufacturing/industrial & miscellaneous buildings.

	Phase One Total	Phase 2a Total	Phase 2b Total	Combined total
Grade I & II* structures directly affected	2	0	0	2
Grade II structures directly affected	17	1	6	24
Registered Parks and Gardens directly affected	2	0	0	2
Conservation Areas directly affected	2	2	5	9
Biodiversity and wildlife				
Natura 2000 sites adversely affected	0	2	0	2
SSSIs directly affected	3	0	1	4
Ancient Woodlands directly affected	32	2 ⁷⁹	10	44
Water resources and flood risk				
Major rivers diverted	8	0	4	12
Route through Flood Zone 3 (km)	12	2.4	18.2	32.6
Cutting or tunnel through SPZ 1 or 2 (km)	6.7	1.1 ⁸⁰	0.7	8.5
Land use resource				
Active landfills crossed	0	0	6	6
Grade 1 and 2 agricultural land (km)	22	9.9	34.5	66.4
Excavated material and material use				
Excavated material (million cubic metres)	63.4	12	16.0	91.4
Concrete (thousand tonnes)	13,040	630 ⁶⁹	4,647	18,317
Steel (thousand tonnes)	1,300	100 ⁶⁹	514	1,914

⁷⁹ There are an additional 10 potential (i.e. not Ancient Woodland Inventory Site (AWIS)) ancient woodland sites. Further assessment of the effects of the Proposed Scheme on AWIS and potential AWIS will be undertaken and reported in the formal EIA Report.

⁸⁰ Includes highway cuttings.

12. Summary

12.1.1. Table 12.1 summarises the impacts across the Phase 2b preferred route compared to the consultation route presented in 2013. The first and third columns display impacts for the consultation route; western leg (Crewe to Manchester) and the eastern leg respectively. The second and fourth columns display impacts for the preferred route; western leg (Crewe to Manchester) and the eastern leg respectively. The fifth column totals impacts for the Phase 2b preferred route.

Table 12.1 Phase 2b Preferred Route Impacts

	Phase Two: Western Leg Consultation Route ⁸¹	Phase 2b: Western Leg Preferred Route	Phase Two: Eastern Leg Consultation Route	Phase 2b: Eastern Leg Preferred Route	Phase 2b: Preferred Route Total ⁸²
Route characteristics (km)					
Total	87.9	81.5	184.8	197.8	279.3
At grade	11.8	3.5	7.3	15.8	19.3
Tunnel	15.7	16.8	9.7	4.9	21.7
Cutting	29.1	18.1	75.1	71.3	89.4
Viaduct	7.3	6.9	32.7	31.6	38.5
Embankment	24.4	36.2	60.0	74.2	110.4
Property and settlements					
Total demolitions	221	206	279	262	468
Demolitions (residential)	121	111	139	144	255
Demolitions (community)	1	2	3	2	4
Demolitions (commercial/ retail)	97	91	128	108	199
Demolitions (manufacturing/ industrial)	2	2	9	8	10
Isolation and severance (number of dwellings)	42	3	234	209	212
Dwellings within 100m	600	600	3,300	1,900	2,500
Employment and housing					
Jobs supported	30,000 - 43,600	30,000 - 43,600	18,700 – 26,700	21,200 - 29,700	51,200 - 73,300
Houses supported	3,100 – 4,100	3,100 – 4,100	2,100 – 3,500	3,140 - 4,950	6,240 – 9,050
Jobs displaced	1,900	1,900	2,900	3,150	5,050
Noise					
Potential dwellings subject to noticeable noise increase without additional mitigation	3,000	4,400	28,100	26,800	31,300 ⁸³

⁸¹ Impacts for Phase 2a have been removed to allow comparison between the consultation route and the preferred route.

⁸² Impacts are provided for operational impacts.

⁸³ Due to rounding total does not add.

	Phase Two: Western Leg Consultation Route ⁸¹	Phase 2b: Western Leg Preferred Route	Phase Two: Eastern Leg Consultation Route	Phase 2b: Eastern Leg Preferred Route	Phase 2b: Preferred Route Total ⁸²
Potential dwellings subject to noticeable noise increase with additional mitigation	600	1,100	7,800	4,500	5,600
Landscape					
AONB crossed at surface (km)	0	0	0	0	0
Cultural heritage					
Scheduled Monuments directly affected	0	0	1	1	1
Registered Battlefields directly affected	0	0	0	0	0
Grade I & II* structures directly affected	0	0	0	0	0
Grade II structures directly affected	3	2	5	4	6
Registered Parks and Gardens directly affected	0	0	0	0	0
Conservation Areas directly affected	1	1 ⁸⁴	6	4	5
Biodiversity and wildlife					
Natura 2000 sites adversely affected	0	0	0	0	0
SSSIs directly affected	0	0	1	1	1
Ancient Woodlands directly affected	4	4	9	6	10
Water resources and flood risk					
Major rivers diverted	0	3	5	1	4
Route through Flood Zone 3 (km)	3.1	1.8	23.0	16.4	18.2
Cutting or tunnel through SPZ 1 or 2 (km)	1.3	0.7	0.0	0.0	0.7
Land use resource					
Active landfills crossed	2	2	3	4	6
Grade 1 (and 2) agricultural land (km)	0.9 (7.2)	0.9 (19.8)	0.0 (30.1)	0.0 (28.1)	0.9 (47.9)
Excavated material and material use					
Excavated material (million cubic metres)	8.0	2.4	12.4	13.6	16.0
Concrete (thousand tonnes)	2,284	2,046	3,662	2,601	4,647
Steel (thousand tonnes)	221	187	410	327	514

⁸⁴ The Trent & Mersey Canal Conservation is affected at three locations in close proximity



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