E8

High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 1: Introduction and methodology

July 2017

ES 3.1.1

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Department for Transport

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

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A report prepared for High Speed Two (HS2) Limited:

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Preface

The Environmental Statement

This document is Volume 1 of the Environmental Statement (ES) that accompanies the deposit of the hybrid Bill for Phase 2a of High Speed Two (HS2). Phase 2a comprises the second section of the proposed HS2 rail network, between the West Midlands and Crewe, and is referred to in this ES as the 'Proposed Scheme'. The ES sets out the Proposed Scheme, its likely significant environmental effects and the measures proposed to mitigate those effects.

Phase 2b comprises the remainder of Phase Two, between Crewe and Manchester and between the West Midlands and Leeds, completing what is known as the 'Y network'. Phase 2b will be the subject of a separate hybrid Bill and therefore is not the subject of this ES.

The hybrid Bill for Phase One of the HS2 network, between London and the West Midlands, was the subject of an ES submitted in November 2013, followed by subsequent ESs deposited with Additional Provisions to that Bill in 2014 and 2015. The Bill received Royal Assent in February 2017 and initial works on Phase One have commenced.

Consultation on the Environmental Statement

The public has an opportunity to comment on this ES as part of the hybrid Bill submission. The period of public consultation on the ES extends for at least 56 days (eight weeks) following the first newspaper notices that follow deposit of Bill documents in Parliament.

Structure of the HS2 Phase 2a Environmental Statement

This report is part of the suite of documents that make up the Environmental Statement (ES) for Phase 2a of the proposed High Speed Two (HS2) rail network between the West Midlands and Crewe (the Proposed Scheme). The structure of the ES is shown in Figure 1.

The ES has been prepared by persons who have sufficient expertise to ensure the completeness and technical quality of the statement.

The ES documentation comprises the following:

Non-technical summary

This provides:

- a summary in non-technical language of the Proposed Scheme and the reasonable alternatives studied;
- the likely significant effects of the Proposed Scheme;
- the means to avoid, prevent or reduce likely significant environmental effects; and
- an outline of the monitoring measures to manage the effects of construction and the effectiveness of mitigation post construction, as well as appropriate monitoring during operation.

Glossary of terms and list of abbreviations

This contains terms and abbreviations, including units of measurement used throughout the ES documentation.

Volume 1: Introduction and methodology

This provides:

- a description of HS2, the environmental impact assessment (EIA) process and the approach to consultation and engagement;
- details of the permanent features of the Proposed Scheme and general construction techniques;
- a summary of the scope and methodology for the environmental topics;
- an outline of the general approach to mitigation;
- an outline of the approach to monitoring, including measures to manage the effects of construction, the effectiveness of mitigation post construction, as well as the approach to monitoring during the operational phase; and
- a summary of the reasonable alternatives studied (including local alternatives studied prior to the November 2015 route announcement). Local alternatives studied post November 2015 are discussed in the relevant Volume 2 community area reports.

Volume 2: Community area reports and map books

These cover the following community areas: 1 Fradley to Colton; 2 Colwich to Yarlet; 3 Stone and Swynnerton; 4 Whitmore Heath to Madeley; and 5 South Cheshire. The reports provide the following for each area:

- an overview of the area;
- a description of the construction and operation of the Proposed Scheme within the area;
- a summary of the local alternatives studied since November 2015;
- a description of the environmental baseline;
- a description of the likely significant environmental effects of the Proposed Scheme;
- the proposed means to avoid, prevent or reduce the likely significant adverse environmental effects; and
- the proposals for monitoring, including measures during and post construction, and during the operational phase.

The maps relevant to each community area are provided in separate Volume 2 Map Books. These maps should be read in conjunction with the relevant community area report. These maps include the location of the key environmental features (Map Series CT-10), key construction features (Map Series CT-05) and key operation features (Map Series CT-06) of the Proposed Scheme. There are also specific maps showing viewpoint and photomontage locations (Map Series LV, to be read in conjunction with Section 11, Landscape and visual of the Volume 2: Community area reports) and noise contours (Map Series SV, to be read in conjunction with Section 13, Sound, noise and vibration of the Volume 2: Community area reports).

Volume 3: Route-wide effects

This describes the likely significant environmental effects that are likely to occur at a geographical scale greater than the community areas described in Volume 2.

Volume 4: Off-route effects

This provides an assessment of the likely significant environmental effects of the Proposed Scheme at locations beyond the Phase 2a route corridor and its associated local environment. The maps relevant to the assessment of off-route effects are provided in a separate map book.

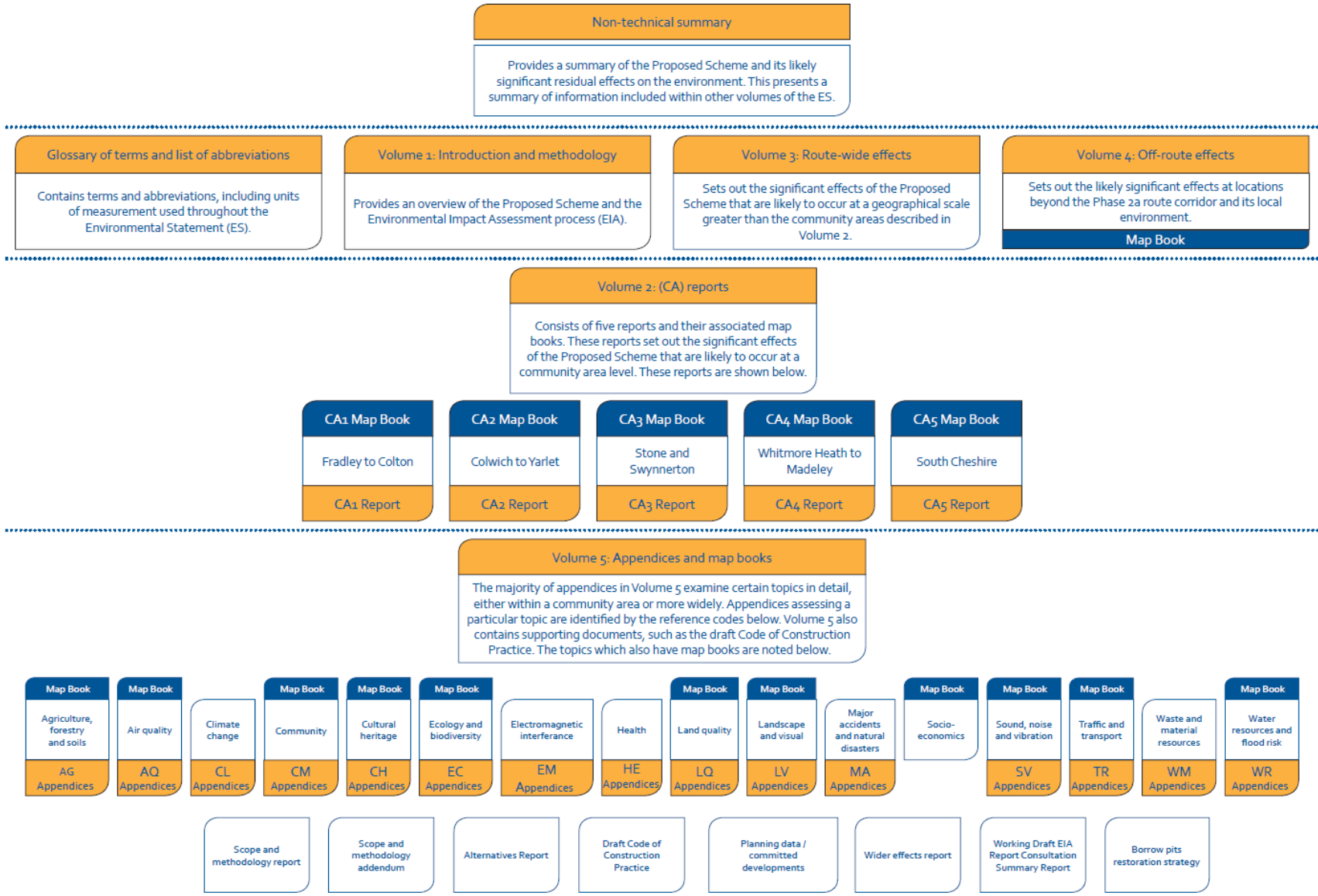
Volume 5: Appendices and map books

This contains supporting technical information and associated map books to be read in conjunction with the other volumes of the ES.

Background information and data (BID)

Certain reports and maps containing background information and data (BID) have been produced, which do not form part of the ES. These documents are available on the HS2 website. The BID reports and maps present relevant survey information, collated from published and unpublished sources, and other relevant background material.

Figure 1: Structure of the HS2 Phase 2a ES



Structure of this report

Volume 1, this report, comprises the following sections:

- Section 1: Introduction- introduces the Proposed Scheme and the process for seeking development consent, including the hybrid Bill and EIA;
- Section 2: Background to HS2- explains how the Government's case for the Proposed Scheme has evolved;
- Section 3: Approach to consultation and engagement- describes the approach to consultation and engagement for the ES and the process going forward;
- Section 4: The Proposed Scheme- provides a summary of the Proposed Scheme's objectives, describes the route, the service pattern and other operational characteristics;
- Section 5: Permanent features of the Proposed Scheme- describes the main features of the Proposed Scheme;
- Section 6: Construction of the Proposed Scheme- describes the general construction methods likely to be used;
- Section 7: Environmental impact assessment- explains how the EIA has been carried out and the scope of the assessment;
- Section 8: Scope and methodology- provides an outline of the approach adopted for each environmental topic;
- Section 9: Mitigation and monitoring- describes the proposed mitigation approach for each environmental topic and the approach to monitoring, including measures to manage the effects of construction, the effectiveness of mitigation post construction, as well as the approach to monitoring during the operational phase;
- Section 10: Strategic, route-wide and route corridor alternatives- provides a summary of the various reasonable alternatives that have been studied at a strategic, route-wide and route corridor level; and
- Section 11: Local alternatives- explains the reasonable local alternatives studied prior to November 2015. Reasonable local alternatives studied after November 2015 are reported in the Volume 2: Community area reports.

1 Introduction

1.1 Overview of High Speed Two

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. Stations in London, Birmingham, Leeds, Manchester and East Midlands and will be served by high speed trains running at speeds of up to 225 miles per hour (mph) (360 kilometres per hour (kph)). Trains will also run beyond the HS2 network to serve destinations including South Yorkshire, Liverpool, Glasgow, Edinburgh, Newcastle and York.

1.1.2 In January 2012, following a consultation exercise, the Government announced its intention to develop a Y-shaped high speed rail network. The network will be brought forward in phases. The 2012 decision confirmed the Government's preferred route for a high speed line between London and the West Midlands, called Phase One. In November 2013, HS2 Ltd deposited a hybrid Bill in Parliament to seek powers for the construction and operation of Phase One. The High Speed Rail (London – West Midlands) Act received Royal Assent in February 2017 and initial works have commenced.

1.1.3 In January 2013, the Government announced its initially preferred route for Phase Two between the West Midlands, Leeds and Manchester. Following some minor amendments in July 2013, the proposed route was subject to a seven-month public consultation until January 2014.

1.1.4 In two reports, *HS2 Plus*[1] and *Rebalancing Britain*[2], Sir David Higgins recommended accelerating the section of the Phase Two route between the West Midlands and Crewe to deliver some of the benefits that HS2 will bring to the region sooner. In the November 2015 Command Paper[3], the Government, announced its intention to bring forward the route between the West Midland and Crewe, with connections to the conventional rail network, and set out the preferred line of route for what is known as Phase 2a.

1.1.5 Accelerating the delivery of Phase 2a will:

- deliver faster journeys between London, Crewe, Manchester, Liverpool, Preston, Warrington, Wigan and Glasgow sooner, by allowing long distance trains to run further on high speed track to Crewe before re-joining the conventional network (as opposed to using the connection to the WCML at Handsacre). Phase 2a will therefore deliver further journey time savings in addition to the journey time savings already delivered by Phase One (see Table 1 for total journey time savings for key destinations);
- allow passengers travelling to or from a wide range of places to connect onto HS2 services given that Crewe is already a major hub on the rail network with

[1] HS2 Ltd., (2014), *HS2 Plus – A report by David Higgins*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf
[2] HS2 Ltd., (2014), *Rebalancing Britain – From HS2 towards a national transport strategy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374709/Rebalancing_Britain_-_From_HS2_towards_a_national_transport_strategy.pdf
[3] Department for Transport (DfT), (2015), *High Speed Two: East and West: The next steps to Crewe and beyond November 2015*. Cm 9157. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf

regional and long distance connections to the wider North West, East Midlands, and North and South Wales;

- mean that the North West and Scotland will see more of the benefits of HS2 more quickly, thus bringing economic benefits sooner, helping to rebalance the economy. Some of these economic benefits will come from businesses being more accessible to one another as well as offering improved accessibility to labour markets, and benefiting the overall level of labour supply; and
- relieve pressure on bottlenecks on the existing WCML at Colwich Junction and around Stafford, which will improve the reliability and performance on the existing main line.

Table 1: Fastest typical journey times between key destinations 'without' and 'with' the Proposed Scheme in operation (Phase One and Phase 2a)

Origin/ destination	**Journey time**		
	Without HS2 (i.e. current)	**With HS2 Phase One**	**With HS2 Phase One and the Proposed Scheme**
London Euston - Crewe	1 hour 30 minutes	1 hour 8 minutes	55 minutes
London Euston – Manchester Piccadilly	2 hours 7 minutes	1 hour 41 minutes	1 hour 30 minutes
London Euston - Preston	2 hours 8 minutes	1 hour 41 minutes	1 hour 30 minutes
London Euston – Liverpool Lime Street	2 hours 14 minutes	1 hour 46 minutes	1 hour 34 minutes
London Euston – Glasgow Central	4 hours 31 minutes[4]	3 hours 56 minutes	3 hours 45 minutes

1.1.6 Given the added benefits of bringing the high speed route to Crewe much earlier than originally planned, the Government decided to pursue Phase 2a.

1.1.7 Phase 2a (referred to as 'the Proposed Scheme'), the subject of this ES, is the western section of Phase Two between the West Midlands and Crewe, comprising approximately 36 miles (58km) of HS2 main line (including the section which would connect with and form the first part of Phase 2b) and two spurs (approximately 4 miles (6km)) south of Crewe that will allow trains to transfer between the HS2 main line and the WCML. This will enable high speed trains to call at Crewe Station and to provide onward services beyond the HS2 network, to the North West of England and to Scotland. The proposed HS2 network highlighting the Proposed Scheme is shown in Figure 2.

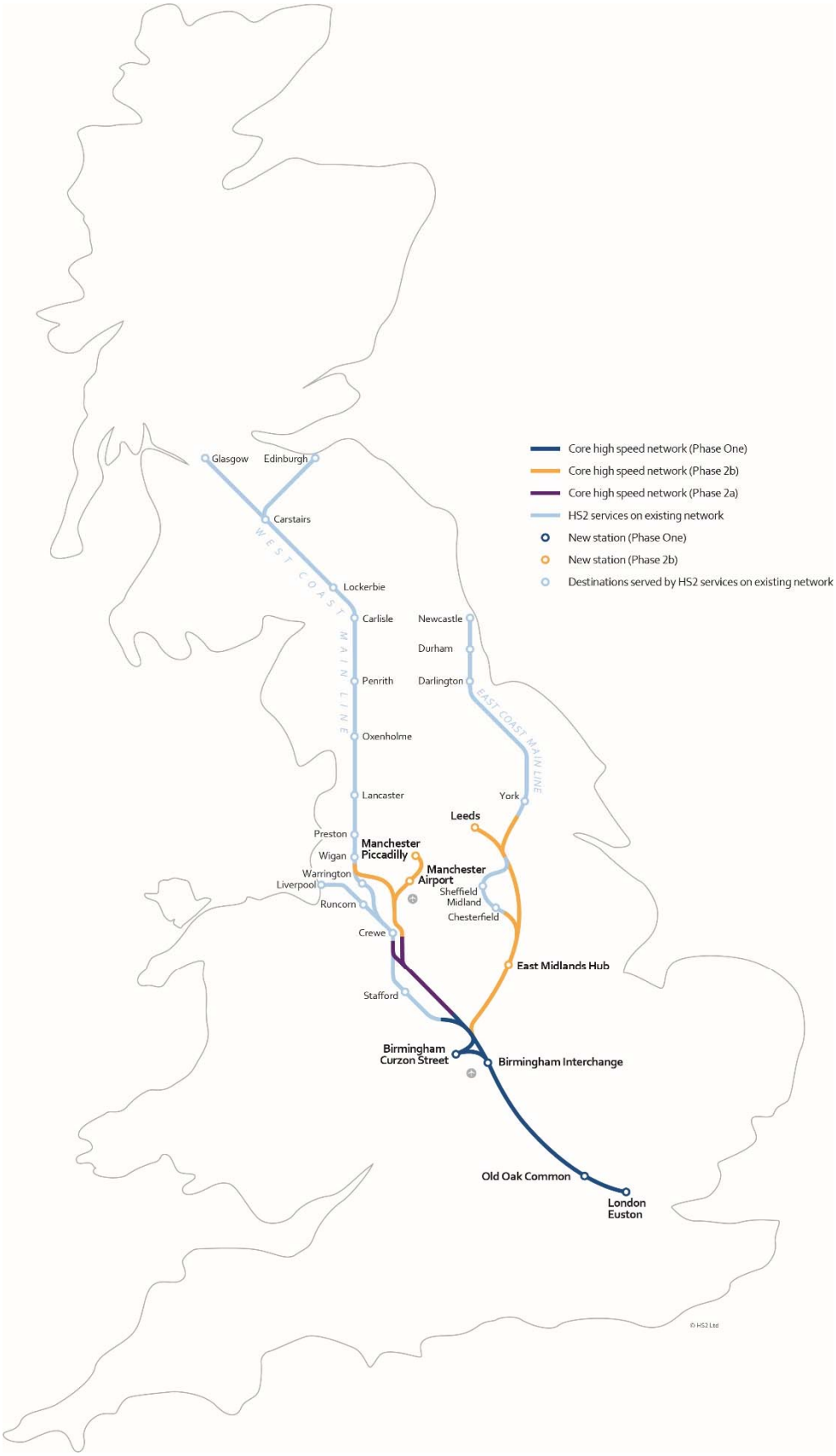
1.1.8 The powers for Phase 2a are being sought through a hybrid Bill ('the Bill'), with the aim of receiving Royal Assent by the end of 2019. Construction of the Proposed Scheme will commence in 2020, ahead of the rest of Phase Two, with operation planned to start in 2027, six years earlier than originally planned.

1.1.9 Phase 2b comprises the remainder of Phase Two, between Crewe (where it would connect to the Proposed Scheme) and Manchester, and between the West Midlands

[4] This route also has a faster train of 4 hours 5 mins (London-Preston-Glasgow) which runs once a day.

and Leeds, completing what is known as the 'Y network'. The powers for Phase 2b will be sought through a separate hybrid Bill that is expected to be laid before Parliament in 2019. Construction of Phase 2b is anticipated to commence in approximately 2023, with operation planned to start by 2033.

Figure 2: The HS2 Network

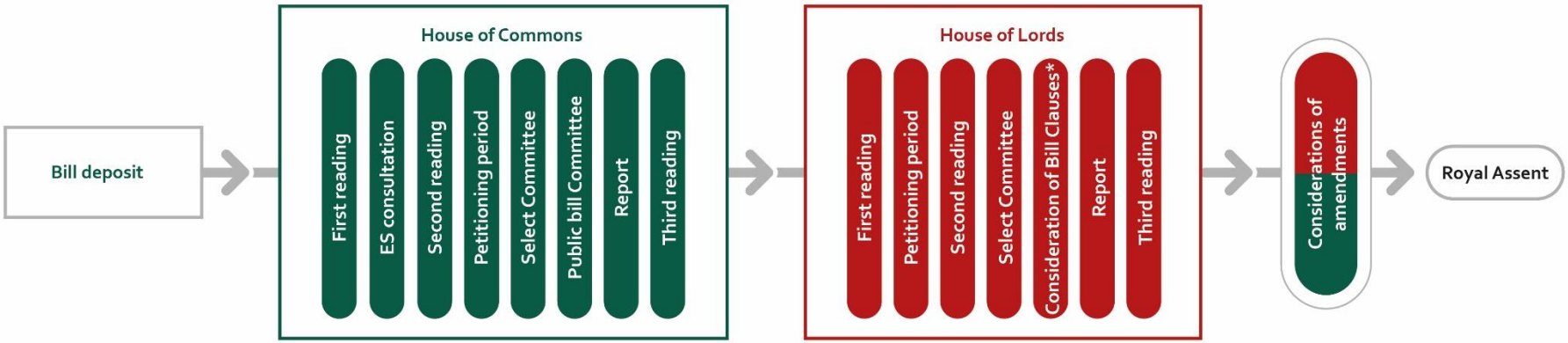


1.2 Hybrid Bill procedure

1.2.1 The Government occasionally uses hybrid Bills to promote major infrastructure projects of national importance. They have been used most recently for Phase One of HS2[5] as well as other rail schemes, such as the Channel Tunnel Rail Link Act 1996[6] (known as HS1) and the Crossrail Act 2008[7]. Use of primary legislation rather than promoting a development consent order under the Planning Act 2008[8] allows the Government to seek the full range of statutory powers and authorisations that a project of this size and complexity requires. This may include revisions to the rail regulatory regime and the planning regime, as well as provisions to enable the making of subsequent orders and regulations by way of statutory instrument. The hybrid Bill process is shown in Figure 3 and described in the following section.

[5] *High Speed Rail (London-West Midlands) Act, (2017).* London, Her Majesty's Stationery Office.
[6] *Channel Tunnel Rail Link Act, (1996).* London, Her Majesty's Stationery Office.
[7] *Crossrail Act (2008).* London, Her Majesty's Stationery Office.
[8] *Planning Act 2008.* London, Her Majesty's Stationery Office.

Figure 3: Hybrid Bill procedure



*This will be via either Grand Committee or Committee of the Whole House

1.2.2 A hybrid Bill is draft legislation that affects public and private interests, and the procedures followed in Parliament in considering such a Bill incorporate aspects of both public and private Bill procedures before it can be enacted.

1.2.3 Private Business Standing Orders of the Houses of Parliament require that the hybrid Bill, when submitted to Parliament, must be accompanied by a set of supporting documents. These documents include Plans and Sections of the Works, a Book of Reference detailing the land interests affected, an estimate of expense and an ES describing the likely significant effects of the Proposed Scheme on the environment.

1.2.4 Following First Reading of the hybrid Bill and the deposit of supporting documents, the Standing Orders require a public consultation on the ES. This formal consultation will be undertaken by the Secretary of State for Transport and held over a period of at least 56 days (eight weeks). A summary of issues raised in responses to this consultation will be provided by Parliament's independent assessor to inform Members of Parliament (MPs) ahead of the Second Reading debate on the Bill.

1.2.5 At Second Reading, the principle of the Bill is debated, including the need for the Proposed Scheme. If the Bill is given a Second Reading, a Select Committee is then appointed[9] to hear petitions against the Bill.

1.2.6 Second Reading is followed by a petitioning period during which those whose property or interests that are specially and directly affected by the Bill can petition[10]. A petition is a summary of objections to particular aspects of the Bill. It is a request to the House of Commons for the petitioner to be allowed to argue their case before the Select Committee. Petitions have to be deposited within a stipulated time in the Private Bill Office and must conform to the rules for petitions against private bills. Guidance on petitioning against hybrid Bills is published by the Private Bill Office of the House of Commons[11]. These petitions are then considered by the Select Committee, which may recommend amendments to the Bill.

1.2.7 A Public Bill Committee of MPs then reviews the Bill, and may make amendments to it. The Bill then progresses to Report and Third Reading stages in the House of Commons, during the first of which further amendments may be made.

1.2.8 The Bill is then sent to the House of Lords where it follows a similar process as in the House of Commons, including a further opportunity for objectors to petition and to appear before a Select Committee. The petitioning period in the House of Lords follows First Reading and petitions must conform to the rules for petitions against private bills.

1.2.9 The Bill returns to the Commons for consideration of any amendments made in the House of Lords, after which it can then receive Royal Assent, becoming an Act of Parliament[12].

1.2.10 The hybrid Bill for the Proposed Scheme includes powers to:

- build, operate and maintain the railway and associated works;

[9] In the House of Commons, Select Committee members are Members of Parliament who have no constituency interest in the Bill.
[10] The petitioning period will be determined during the Second Reading.
[11] More information on who may petition against the Bill, and how to do so, is available on Parliament's website (http://www.parliament.uk).
[12] Parliamentary procedure is determined by Parliament and so is liable to change.

- compulsorily acquire the land required for the purposes of the Proposed Scheme;
- interfere with rights of way, including the realignment of highways and waterways (permanently or temporarily);
- modify infrastructure belonging to statutory undertakers (e.g. utility companies);
- carry out works to listed buildings and buildings in conservation areas; and
- carry out protective works to buildings and third party infrastructure.

1.2.11 Upon enactment, the Bill grants development consent for the Proposed Scheme in the form of deemed planning permission for the proposed works.

1.2.12 The Parliamentary Plans and Sections accompanying the Bill will show, amongst other things, the land required, both permanently and temporarily, the 'limits of deviation' and 'limits of land to be acquired or used'[13] for the construction of the Proposed Scheme, as described in Section 1.3.

1.3 The need for EIA and the role of an ES

1.3.1 The Environmental Impact Assessment (EIA) Directive (2014/52/EU)[14] provides for the assessment of the environmental impacts of public and private projects. The objective of the Directive is to identify and assess the likely significant environmental effects of a project, with a view to informing the decision maker as part of the development consent process.

1.3.2 Under the relevant Standing Orders of Parliament, an ES must be deposited at the same time as the Bill is introduced. The EIA must fulfil the requirements of the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017/571) (the 'EIA Regulations') which reflect European Union (EU) Directive requirements for assessment of the effects of certain public and private projects on the environment.

1.3.3 In March 2017, the United Kingdom notified the EU, under Article 50 of the EU Treaty, that the UK would leave the EU. Until exit negotiations are concluded, the UK remains a full member of the EU and all of the rights and obligations of EU membership apply. Environmental assessment has been and will continue to be integral to the development of the Proposed Scheme.

1.3.4 Standing Order 27A[15] requires that the ES should include:

- information set out in regulation 18 of the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations)[16];

[13] The Parliamentary Plans and Sections show the centreline of works, the Limits of Deviation (LOD) and the Limits of Land to be Acquired or Used (LLAU). The LOD are used to show the limits of the scheduled works, as listed in Schedule 1 of the Bill. These limits show the extent of the scheduled works based on the design developed to the stage necessary for the preparation of the Bill. The LOD provide allowances for contingencies, working spaces and similar factors. The LLAU are used to show additional limits for other works (i.e. ancillary works such as the provision of environmental mitigation).
[14] Official Journal of the European Union, *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.*
[15] House of Commons, (2015), *Standing Order 27A relating to private business (environmental assessment),* House of Commons.
[16] Town and Country Planning (Environmental Impact Assessment) Regulations, (2017). SI 2017 No. 571. London, Her Majesty's Stationery Office.

and

- any of the additional information specified in Schedule 4 to the EIA Regulations as is relevant to the specific characteristics of the particular development or type of development and to the environmental features likely to be significantly affected.

1.3.5 The information required by regulation 18 comprises:

- a description of the proposed development comprising information on the site, design, size and other relevant features of the development;
- a description of the likely significant effects of the proposed development on the environment;
- a description of any features of the proposed development, or measures proposed in order to avoid, prevent or reduce the likely significant adverse effects on the environment;
- a description of the reasonable alternatives studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment; and
- a non-technical summary of the information above.

1.3.6 The 2017 EIA Regulations reflect the broader scope of assessment that is required under the 2014 Directive, including: resource efficiency, sustainability, biodiversity protection, climate change, health and the risks of major accidents and natural disasters. This ES has been compiled in accordance with that broader scope.

1.3.7 The environmental assessment reported in this ES is based on the following:

- the permanent scheme as shown in Map Series CT-06, including the mitigation measures shown therein;
- the construction arrangements, including land requirements, shown on Map Series CT-05 and described in Volume 2: Community area reports, Section 2.3;
- the land required permanently for the scheme, and temporarily during construction, shown on Map Series CT-05 and CT-06, and any additional land requirements outside these shown on the Parliamentary Plans and Sections that accompany the Bill. The Parliamentary Plans and Sections define the maximum extent of land over which rights and powers are sought, (and additional limits are set out in the Bill for the carrying out of safeguarding works), and in some circumstances smaller areas of land might be acquired or used;
- the approach to mitigation and monitoring described in Section 9 of this report;
- the indicative construction programme shown in Volume 2: Community area reports, Section 2 and the construction durations described in the text therein;

- the operational characteristics described in Volume 2: Community area reports, Section 2.4 and in Section 4 of this report; and
- the noise fence barriers shown on Map Series CT-06 and described in the text.

1.3.8 In cases where information is not available for the assessment, the assessment has been based on a precautionary approach using reasonable worst-case assumptions.

1.3.9 The Parliamentary Plans and Sections that accompany the Bill show the vertical and horizontal alignment of the Proposed Scheme and the scheduled works required to construct it. The powers that will be acquired through the Bill process include the power to deviate within 'limits of deviation' from the alignments shown on the Parliamentary Plans and Sections. These limits allow those who are appointed to implement the powers (known as the nominated undertaker) to deviate when constructing or maintaining the Proposed Scheme, in the following directions:

- laterally to any extent within the limits of deviation for that work, as identified on the Parliamentary Plans;
- vertically downwards to any extent from the level shown on the Sections; and
- vertically upwards to any extent not exceeding three metres from the level shown for that work on the sections, except for the Infrastructure Maintenance Base – Rail (IMB-R) and works at Crewe Station (including a new platform and any buildings or structures on that platform), for which specific limits of deviation are given.

1.3.10 Given the powers provided by the Bill to deviate within the statutory limits of deviation, Volume 5: CT-005-000 (Wider effects report) includes a description of any differences to the likely significant effects that will arise and any further mitigation that will be provided were the Proposed Scheme to be built along a different horizontal or vertical alignment within these limits. The extent of changes from the route centre line and vertical alignment is described in Volume 5 (CT-005-000). The changes that have been assessed are those that are likely within the scope of the limits of deviation. Changes that are considered unlikely or impossible have not been assessed.

1.4 Meeting environmental commitments after consent

1.4.1 The Secretary of State for Transport will establish a set of controls known as Environmental Minimum Requirements (EMRs). The nominated undertaker and its contractors will be contractually bound to comply with the EMRs and other controls contained within the Bill and other existing legislation.

1.4.2 During the passage of the Bill, the Secretary of State for Transport will confirm to Parliament the scope of, and the documents forming, the EMRs; and will make a commitment to Parliament to take whatever steps he/she considers reasonable and necessary to secure compliance with them.

1.4.3 The EMRs, together with the controls in the Bill, will ensure that the impacts identified in the ES will not be exceeded, unless:

- this results from a change in circumstances that was not foreseeable at the time the ES was prepared;

- any such changes will be unlikely to have significant adverse environmental effects;
- the relevant works will be subject to a separate consent process and further EIA; or
- any such change results from a change or extension to the project, where that change or extension does not itself require an EIA.

1.4.4 The EMRs will also impose requirements on the nominated undertaker to use reasonable endeavours to adopt measures to reduce the adverse environmental effects reported in the ES, provided that this does not add unreasonable cost or delay to the construction or operation of the Proposed Scheme.

1.4.5 The EMRs will also detail any specific requirements on the nominated undertaker to monitor the impacts of construction; and the post-construction performance of mitigation measures implemented.

1.4.6 The EMRs will also include:

- general principles, in which the Secretary of State for Transport commits that the environmental effects reported in the ES are not exceeded by application of the environmental mitigation assessed in the ES;
- a Code of Construction Practice (CoCP), which will set out measures to provide effective planning, management and control during construction;
- an Environmental Memorandum, which provides a framework for the nominated undertaker and its contractors and stakeholders, such as the Environment Agency and Natural England, to work together to ensure that the design and construction of Phase 2a is carried out with due regard for environmental considerations;
- a Planning Memorandum, which will set out an agreement between the Government and the local planning authorities relating to the processing of detailed planning approvals under the provisions of the Bill, including the design and appearance of bridges, viaducts, tunnel portals, noise fence barriers and earthworks;
- a Heritage Memorandum, which will set out a commitment to limit the impact on the historic environment and will address the elements of the design and construction works that will have a direct impact on heritage assets; and
- any undertakings and assurances given during the passage of the Bill through Parliament and recorded on the Register of undertakings and assurances.

1.5 HS2 and sustainability

1.5.1 The Government's High Speed Rail Strategy and the overall policy framework for the development of the Proposed Scheme are set out in the Command paper *High Speed Two: East and West, The next steps to Crewe and beyond (November 2015)*[17].

1.5.2 Development of the Proposed Scheme has been influenced by the Government's commitment to sustainable development. International and national bodies have set out broad principles of sustainable development. Resolution 42/187 of the United Nations General Assembly[18] defined sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

1.5.3 The Government's commitment to sustainable development builds on the Defra strategy set out in *Securing the Future*[19], which identify five 'guiding principles' of sustainable development, namely:

- living within the planet's environmental limits;
- ensuring a strong, healthy and just society;
- achieving a sustainable economy;
- promoting good governance; and
- using sound science responsibly.

1.5.4 The National Planning Policy Framework (NPPF)[20] sets out the Government's strategic guidance on development planning in England and Wales. The principles of sustainable development underpin the NPPF and its associated technical guidance. It identifies three dimensions to sustainable development, namely:

- economic: contributing to building a strong, responsive and competitive economy;
- social: supporting strong, vibrant and healthy communities, by providing the supply of housing required to meet the needs of present and future generations; and
- environmental: contributing to protecting and enhancing our natural, built and historic environment, and as part of this, helping to improve biodiversity, use natural resources prudently, reduce waste and pollution, and mitigate and adapt to climate change (including moving to a low carbon economy).

1.5.5 The NPPF indicates that these factors should not be considered in isolation, because they are mutually dependent. Economic growth can secure higher social and environmental standards, whilst well-designed buildings and places can improve the

[17] HS2 Ltd (2015), High Speed Two: East and West, The next steps to Crewe and beyond. November 2015. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf
[18] UN General Assembly, (1989), *Implementation of General Assembly resolutions 42/186 and 42/187: resolution/adopted by the General Assembly*. A/RES/44/227.
[19] Defra, (2005), *Securing the future – delivering UK sustainable development strategy* (PB10589).
[20] Department for Communities and Local Government, (2012), *National Planning Policy Framework*.

lives of people and communities. Therefore, to achieve sustainable development, the NPPF requires economic, social and environmental gains to be sought jointly and simultaneously.

1.5.6 These principles have been, and remain, an important influence on the development of the Proposed Scheme[21]. An appraisal of sustainability (AoS) has been used to appraise and report on the sustainability performance of the Phase 2a and 2b proposals throughout their development.

1.5.7 In July 2013, the Government published the HS2 Phase Two Sustainability Statement[22] as part of a public consultation on Phase Two and to inform the Government's decision on the preferred route for Phase Two. The Sustainability Statement described the extent to which the Government's proposed route for Phase Two (including Phase 2a) supported objectives for sustainable development, following the AoS. Four sustainable development priorities were used for the assessment:

- reducing greenhouse gas emissions and combating climate change;
- protecting natural and cultural resources and providing environmental enhancement;
- creating sustainable communities; and
- sustainable consumption and production.

1.5.8 The Phase Two Sustainability Statement 2013 provided a systematic review of the scheme proposals using 18 sustainability topics, each under one of the four headings described above. This informed both the Proposed Scheme designs and the selection of alternative options for Phase Two as a whole, taking into account wider transport and economic objectives, operational requirements, cost and practicality. This was incorporated into decision-making on the development of the route, which helped refine the number of options down to a single preferred route.

1.5.9 Consultation on the proposed route of HS2 Phase Two took place between July 2013 and January 2014. Question 7 of the consultation asked for feedback on the AoS of the proposed Phase Two route, including the alternatives. HS2 Ltd produced the 'Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7) Report for Government to respond to the issues raised. The report was published by Government in December 2015 as part of the decision to proceed with the Proposed Scheme[23]. An updated Sustainability Report[24] was also published, documenting the post-consultation changes to the Phase 2a route. As well as outlining the preferred

[21] The NPPF is not applicable to the Proposed Scheme as consent is being sought through a hybrid Bill. However, for best practice and to achieve a sustainable scheme, the principles within the NPPF have been followed.
[22] Temple-RSK, (2013), *Sustainability Statement - Volume 1: main report of the Appraisal of Sustainability*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401154/pc205_vol_1_sustainability_statement_180713.pdf
[23] This report was subsequently updated in light of developments in policy and legislation, and published in November 2016 as part of the Phase 2b route decision: *HS2 Ltd., (2016), High Speed Two Phase 2b Crewe to Manchester, West Midlands to Leeds Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7)*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/569783/Response_to_HS2_Phase_Two_Consultation_Question_7_report.pdf
[24] Temple-RSK, (2015), *Sustainability Report – Phase Two Post-Consultation Update: West Midlands to Crewe*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480667/Sustainability_Report_Phase_Two_Post-Consultation_Update_West_Midlands_Crewe.pdf

scheme and the associated sustainability impacts, it also summarised the key changes from the 2013 consultation route.

1.5.10 The potential significant effects identified in the Sustainability Statement and the post-consultation Sustainability Report were reviewed during the EIA of Phase 2a and assessed in the context of the Proposed Scheme.

1.5.11 HS2 Ltd's Sustainability Policy (2017)[25] sets out its priority for sustainable design, which will help to reduce adverse environmental effects. The Sustainability Policy sets out the following principles for sustainability in:

- spreading the benefits: Economic growth and community regeneration;
- opportunities for all: Skills, employment and education;
- safe at heart: Health, safety and wellbeing;
- respecting our surroundings: Environmental protection and management; and
- standing the test of time: Design that is future-proof.

1.5.12 Each of the Sustainability Policy principles is further described in the HS2 Sustainability Approach Document[26].

1.5.13 Supporting the Sustainability Policy, an Environmental Policy[27] states HS2 Ltd's commitment to "developing an exemplar project, and to limiting negative impacts through design, mitigation and by challenging industry standards whilst seeking environmental enhancements and benefits". The policy also sets out HS2 Ltd's principles for environmental sustainability, covering the following environmental topics: biodiversity; landscape; noise and vibration; carbon; climate change combined effects; air quality; water resources; historic environment; soils and agriculture; and sustainable materials and waste.

1.6 The acquisition and use of land

1.6.1 The Bill for Phase 2a will include powers for the compulsory acquisition of land or rights in land for the Proposed Scheme. Payment of compensation for land compulsorily acquired will be in accordance with the general statutory framework set out under the Compensation Code[28]. Compensation for land used temporarily for construction will be paid in accordance with the provisions of the relevant schedule to the Bill.

1.6.2 The Parliamentary Plans and Book of Reference will show the extent of land that the nominated undertaker may acquire permanently for the works and any additional land to be acquired or used, either temporarily or permanently, for the construction and operation of the Proposed Scheme. The nominated undertaker will notify the owners and occupiers of such land.

[25] HS2 Ltd., (2017), Sustainability Policy.
[26] HS2 Ltd., *HS2 Supplier Guide*. Available online at: https://www.gov.uk/government/publications/hs2-supplier-guide
[27] HS2 Ltd., (2017), *Environmental Policy*. Available online at: https://www.gov.uk/government/organisations/high-speed-two-limited.
[28] The compensation code is not a single document but a collective term used for the principles set out in Acts of Parliament, principally the Land Compensation Act 1961, the Compulsory Purchase Act 1965, the Land Compensation Act 1973, the Planning & Compulsory Purchase Act 1991 and the Planning & Compulsory Purchase Act 2004.This is supplemented by case law, relating to compensation for compulsory acquisition.

1.6.3 The limits of deviation enable the Proposed Scheme to deviate slightly from the centre line of the works, or of footpaths, shown on the Parliamentary Plans and Sections as may be required following detailed design, but the scheme must remain within the land shown on the Parliamentary Plans and Sections. The nominated undertaker will acquire or use less than the full extent within the limits if, following detailed design, not all of the land is required for permanent works or their construction.

2 Background to High Speed Two

2.1 The need for high speed rail

2.1.1 The case for a high speed rail network has already been accepted in the High Speed Rail (London-West Midlands) Act 2017. A summary of the Government's rationale for pursuing a high speed rail network is set out in Section 10 of this report.

2.1.2 Phase One of HS2 will link London and the West Midlands, and through the connection to the WCML at Handsacre, destinations in the North West and Scotland, greatly improving capacity and connectivity and reducing journey times. Phase One will resolve some of the most pressing challenges around capacity south of Birmingham, but it will not deliver the transformation in connectivity that is required to meet the objective of supporting economic growth in the North. To do this it will be necessary to continue with Phase Two.

2.1.3 Phase Two of HS2 would extend the high speed railway between Birmingham and Leeds and between Birmingham and Manchester, with connections onto the WCML at Crewe and Golborne and to the East Coast Main Line (ECML) approaching York. The Government is committed to completing the full Y network to Manchester and Leeds.

2.1.4 In November 2015, the Secretary of State for Transport confirmed that the section of Phase Two route between the West Midlands and Crewe would be accelerated to commence operation in 2027. It would enable the Secretary of State for Transport to deliver benefits to the north sooner than the rest of Phase Two.

Acceleration of delivery of Phase 2a

2.1.5 Accelerating the delivery of the Proposed Scheme will improve journey times to northern cities sooner, support growth and jobs in the local areas, and help to create the conditions for both the Northern Powerhouse[29] and the Midlands Engine[30]. It will also have a positive financial impact, as set out in the November 2015 *HS2 West Midlands to Crewe Strategic Outline Business Case: Economic Case*[31] and the updated *High Speed Two Phase 2a Outline Business Case: Economic Case*[32].

2.2 Evolution of High Speed Two Phase 2a

2.2.1 The 2015 Command Paper followed many years of analysis and development, which is described more fully in the Alternatives report (Volume 5: Appendix CT-002-000) and summarised within Section 10 of this report.

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[29] The Northern Powerhouse is a proposal launched in a speech by the then Chancellor of the Exchequer in Manchester in June 2014. Its aim is to boost economic growth in the north of England, especially the 'core cities' of Manchester, Liverpool, Leeds, Sheffield and Newcastle. Better transport connections between the northern cities and better links to London underpin the proposal. The transport strategy for the Northern Powerhouse which includes Phase Two of HS2 was set out in: Department for Transport (DfT), (2015), *The Northern Powerhouse: One Agenda, One Economy, One North*. Available online at: http://www.transportforthenorth.com/wp-content/uploads/A-report-on-the-Northern-Transport-Strategy-1.pdf

[30] The Midlands Engine is a proposal by Government to improve and grow the Midlands' economy by £34 billion by 2030 and create a further 300,000 jobs. The prospectus for the Midlands Engine for Growth which refers to the need to exploit and build on the connectivity provided by Phase One and Phase Two of HS2 was launched by the Secretary of State for Business, Innovation and Skills in December 2015.

[31] Department for Transport (DfT), (2015), *HS2 West Midlands to Crewe – Strategic Outline Business Case: Economic Case*. Available on-line at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480718/hs2-west-midlands-to-crewe-sobc-economic-case.pdf

[32] Department for Transport (DfT), (2017), *HS2 West Midlands to Crewe Outline Business Case: Economic Case*. Available online at: https://www.gov.uk/hs2

2.2.2 A summary of the development of the strategic case for a high speed rail network and for the HS2 Phase One route can be viewed in Volume 1 of the HS2 Phase One main ES. The main milestones informing the development of Phase 2a are summarised in Table 2.

Table 2: Main milestones in the development of Phase 2a

Date	Activity
January 2012	The Secretary of State for Transport published the Command Paper High Speed Rail: Investing in Britain's Future – Decisions and Next Steps, together with supporting documents. The Command Paper confirmed the Government's intention to develop a Y network. The network was to be brought forward in two phases, with powers sought initially for a London-West Midlands high speed line.
January 2013	Publication of High speed rail: investing in Britain's future phase two - the route to Leeds, Manchester and beyond[33]. The Secretary of State for Transport announced the Government's intention to proceed with the planning and design of Phase Two, and published initial preferred routes for Leeds and Manchester. Published alongside this was the initial preferred scheme sustainability summary and initial preferred route plan and profile maps. Also published were HS2 Ltd's March 2012 advice to Government[34]: • options for Phase Two of the High Speed Network; • options for Phase Two of the High Speed Network appraisal of sustainability; • record of stakeholder engagement for Phase Two of the high speed rail network; • HS2 cost and risk model report; • options for Phase Two of the high speed rail network approach to design; • three Phase Two engineering options reports (West Midlands to Manchester, West Midlands to Leeds and Heathrow); and • selecting an initial preferred scheme for HS2 Phase Two refinement work since March 2012.
July 2013	Launch of public consultation on the proposed route for Phase Two detailing the route from the West Midlands to Manchester, Leeds and beyond. Consultation documents included supporting technical information (including maps) the Sustainability Statement and quick reference factsheets[35].
September 2013	HS2 Ltd published an analysis of the potential scale, range and distribution of regional economic impacts associated with the substantial improvements to the rail network brought about by HS2 (both Phase One and Phase Two) and the use of freed-up capacity on the conventional rail network[36].
October 2013	Publication of the Economic Case for HS2 and Strategic Case for HS2.

[33] Department for Transport (DfT), (2013), *High speed rail: investing in Britain's future phase two - the route to Leeds, Manchester and beyond*. Available online at: https://www.gov.uk/government/publications/high-speed-rail-investing-in-britains-future-phase-two-the-route-to-leeds-manchester-and-beyond

[34] Department for Transport (DfT), (2013), *HS2 Phase Two initial preferences. Available online at:* https://www.gov.uk/government/collections/hs2-phase-two-initial-preferred-route

[35] HS2 Ltd., (2013), *Phase Two Route Consultation*. Available online at: http://webarchive.nationalarchives.gov.uk/20141027142236/http://www.hs2.org.uk/phase-two/route-consultation/document-library

[36] Hs2 Ltd., (2013), *HS2 Regional Economic Impacts.*

Date	Activity
November 2013	The Secretary of State for Transport announced that Sir David Higgins had been tasked with reporting on how to reduce the cost of HS2; how its benefits could be delivered earlier and at a lower cost; and how to ensure that HS2 delivers benefits like jobs and growth[37].
March 2014	Publication of HS2 Plus – a report by David Higgins, which recommended the accelerated delivery of the Phase 2a route to Crewe[38].
October 2014	Publication of Rebalancing Britain: From HS2 towards a national transport strategy, a second report by the Chairman of HS2 Ltd Sir David Higgins[39]. This highlighted the need for greater consideration of transport connectivity across the north of England. It described HS2 as a new spine for the national rail network, and as an important catalyst for a national transport strategy.
March 2015	The Secretary of State for Transport announced that the Government does not intend to build the Heathrow spur[40].
November 2015	Publication of the Strategic Case and Economic Case for HS2 Phase 2a, as part of the Strategic Outline Business Case.
November 2015	Publication of High Speed Two: East and West, The next steps to Crewe and beyond paper. This included the decision on the Phase 2a route, following consideration by Government of the responses to consultation. Publication of the HS2 Phase 2a Strategic Outline Business Case documents Strategic Case, Economic Case and Rail Alternatives to Phase 2a[41]. Publication of the High Speed Rail: Investing in Britain's future. Consultation on the route from the West Midlands to Manchester, Leeds and beyond[42] consultation response analysis report by Ipsos MORI. This reported on the outcome of the consultation on the proposed route for Phase Two. Publication of the HS2 Phase Two Response to HS2 Phase Two Consultation: Appraisal of Sustainability (Question 7). This report provided an HS2 Ltd response to feedback from question 7 of the Phase Two consultation, regarding the Appraisal of Sustainability. Publication of High Speed Rail: Preferred Route to Crewe. Sustainability Report. Phase Two Post-Consultation Update: West Midlands to Crewe. Launch of the High Speed Rail (West Midlands - Crewe) Property Consultation.
January 2016	Publication of the remaining documents that form part of the Phase 2a Strategic Outline Business Case: Financial Case, Management Case and Commercial Case.

[37] Department for Transport (DfT), (2013), *Sir David Higgins to drive down cost of HS2*. Available online at: https://www.gov.uk/government/news/sir-david-higgins-to-drive-down-cost-of-hs2
[38] HS2 Ltd., (2014), *HS2 Plus – A report by David Higgins*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf
[39] HS2 Ltd., (2014), *Rebalancing Britain – From HS2 towards a national transport strategy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374709/Rebalancing_Britain_-_From_HS2_towards_a_national_transport_strategy.pdf
[40] Department for Transport (DfT), (2015), *High Speed 2 Railway Line: Written question- 225879*. Available online at: http://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2015-03-02/225879/
[41] Department for Transport (DfT), (2015), *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570472/hs2-phase-2a-strategic-case.pdf
Department for Transport (DfT), (2015), *HS2 Phase 2a Strategic Outline Business Case: Economic Case*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480718/hs2-west-midlands-to-crewe-sobc-economic-case.pdf
[42] Ipsos MORI, (2014), High Speed Rail: Investing in Britain's future. Consultation on the route from the West Midlands to Manchester, Leeds and beyond. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480397/P2L0R_Ipsos_MORI_FINAL_REPORT.pdf.pdf

Date	Activity
March 2016	Publication of the draft HS2 Phase Two: West Midlands to Crewe EIA Scope and Methodology Report for consultation.
September 2016	Publication of the revised HS2 Phase Two: West Midlands to Crewe EIA Scope and Methodology Report. Publication of the working draft EIA Report[43] for HS2 Phase 2a: West Midlands to Crewe, for consultation. Launch of the HS2 Phase 2a: West Midlands to Crewe Design Refinement Consultation[44].
July 2017	Deposit of the Bill, along with the ES and associated documents. Publication of the outcome of the HS2 Phase 2a: West Midlands to Crewe Design Refinement Consultation[45] Publication of the updated Strategic Case[46] and Economic Case for HS2, Phase 2a[47].

2.2.3 Sections 2.3 and 2.4 of this report outline the main reasons for pursuing the section of Phase Two between West Midlands and Crewe earlier than planned. The reasons presented are taken from the 2015 HS2 Phase 2a Strategic Outline Business Case and High Speed Two: Strategic Case 2017.

2.3 Releasing capacity and improving performance and reliability on the WCML

2.3.1 Demand for passenger and freight services is growing. Passenger rail journeys have more than doubled in the past 20 years, and journeys between London, Birmingham and Manchester have trebled in the same period. Total rail freight volumes have risen by 70 per cent since the mid-1990s. The WCML is now operated at a higher intensity than other major European fast lines, and despite an extensive £9 billion upgrade programme completed in 2008, 60 per cent of the additional peak intercity capacity created was used up by 2014. By 2033 further capacity will be required to accommodate demand.

2.3.2 Despite the significant WCML upgrade work that was completed in 2009 there are a number of infrastructure constraints between the West Midlands and Crewe that currently impact on the capacity and performance of the WCML. Improving these existing bottlenecks has been the focus of a number of Network Rail projects. These projects will create extra capacity, providing the capability to deliver more trains on the route and shortening journey times, and will also reduce congestion and delays in the Stafford area. However, despite these major investments, a number of

[43] The EIA Directive 2014/52/EU uses the term 'Environmental Impact Assessment Report' (rather than 'Environmental Statement') to describe the documentation that presents the findings of an EIA. At the time of writing the working draft EIA Report HS2 Ltd used the term 'EIA Report' for consistency with this EU Directive. Since the publication of the working draft EIA Report this Directive has been transposed through The Town and Country Planning (Environmental Impact Assessment) Regulations 2017. The updated Regulations have maintained the use of 'ES' rather than 'EIA Report', and therefore, ES has been adopted for this suite of documents.
[44] Department for Transport (DfT), (2016) HS2 Phase 2a: West Midlands to Crewe Design Refinement consultation. Available online at: https://www.gov.uk/government/consultations/hs2-phase-2a-west-midlands-to-crewe-design-refinement-consultation
[45] Department for Transport (DfT), (2017). *High Speed Two Phase 2a: West Midlands to Crewe Government response to the Design Refinement Consultation*. Available online at: https://www.gov.uk/hs2
[46] Department for Transport (DfT), (2017), *High Speed Two Phase Two Strategic Case 2017*. Available online at: https://www.gov.uk/hs2
[47] Department for Transport (DfT), (2017), *HS2 West Midlands to Crewe Outline Business Case: Economic Case*. Available online at: https://www.gov.uk/hs2

infrastructure constraints still remain. These restrictions limit the timetable that can be run and the number of train paths available. They also impact on the resilience and performance of the WCML.

2.3.3 The WCML is now very heavily utilised, particularly in the morning and evening peaks – carrying 15-16 trains per hour in the peaks. Such an intensive level of operation impacts reliability and performance when there are incidents, because there is little time and space to recover. There are also missed opportunities to offer new services to passengers, even when the demand is there.

Improved performance and reliability of the WCML

2.3.4 One of the benefits from delivering Phase 2a early is that it effectively acts as a solution for these constraints, reducing the number of trains per hour that pass through Colwich Junction as fast long distance services transfer onto the HS2 network.

Released capacity

2.3.5 After the Proposed Scheme is opened in 2027, long distance services will run on high speed lines from London to just south of Crewe. Six trains per hour could be transferred onto the Proposed Scheme's lines, freeing up capacity on the WCML from Birmingham to Crewe and on the Stoke-Manchester corridor. This means that there could be potential for new local stopping services to be introduced on the WCML at stations between Handsacre and Crewe – such as Rugeley Trent Valley and Stafford[48].

2.3.6 Whilst the capacity released on existing lines by Phase One enables connectivity benefits to the stations between London and Birmingham, its ability to benefit stations along the Trent Valley line is limited by constraints north of HS2 infrastructure. The Proposed Scheme relieves this constraint, giving the opportunity to improve connectivity from Lichfield, Tamworth and Nuneaton to London, Liverpool and Scotland.

2.3.7 Any released capacity delivered by the Proposed Scheme may also be beneficial for freight. Rail freight currently delivers £1.5 billion per annum of economic benefits. In 2011, around 42 freight trains per day used the WCML with 43 per cent of all freight journeys using it at some point. Network Rail's forecasts suggest that demand could nearly double by 2033 to 80 freight trains per day, with the majority of the growth being in intermodal freight.

2.3.8 Although this projected increase in rail freight traffic is good news for the UK economy, it is likely to pose a challenge for the current rail network. Network Rail estimate that the typical utilisation of intermodal freight paths today is around 85 per cent, which effectively means running at or near capacity and so future growth would be restricted. Government is investing in the railway to help meet this demand for freight traffic. However, significant capacity constraints for freight still exist.

2.3.9 Phase One and Phase 2a will provide some extra capacity for freight. However, most of the benefits for freight traffic travelling north of Birmingham are to be delivered

[48] At this stage, no decisions have been taken on the introduction of any new services, but the Government will consider the possible options.

once the whole of Phase Two has been built in 2033, through relinquishing the paths on the WCML that are used until that point.

2.3.10 Delivering the Proposed Scheme by 2027 will unlock some of these freight benefits earlier, contributing sooner to economic growth. The Proposed Scheme is expected to release capacity on the WCML slow lines between Birmingham and Basford yard, a major freight interchange immediately south of Crewe. This released capacity will mean that there is the potential to run additional freight services along this section of the WCML.

2.4 Generating growth

2.4.1 Crewe is already well connected to the local and national UK rail network. It is a significant rail hub where the main trunk of the WCML and four regional rail lines converge, acting as a gateway to the North West, and giving Crewe 360 degree rail connectivity to major destinations including Liverpool; Scotland; Manchester; Stoke-on-Trent; Birmingham; London; Shrewsbury; South and North Wales; and Chester. This makes Crewe a strategically important location on the rail network, for both passenger services and freight.

2.4.2 The number of passengers using Crewe Station has grown, with 3.7 million passengers using the station in 2013/2014 compared to 2.7 million in 2004/05. In addition, in 2013/14 a third of passengers were interchanging between rail services at Crewe. Crewe is amongst the top ten UK stations for the proportion of station users who are inter-changing between trains. Passenger numbers at Crewe are forecast to continue to grow.

2.4.3 By building the Proposed Scheme to Crewe by 2027, people travelling to and from the North West, from places including Chester, North Wales, Stoke-on-Trent and Shrewsbury will also have the option to join faster services to London, and those travelling further afield who currently pass through or change trains at Crewe on their way to or from London will have the option of using high speed services for part of their journey. Accelerating delivery of the Proposed Scheme means that there is the potential for people to benefit from greater improvements to journey times much earlier than originally planned.

2.4.4 Accelerating the delivery of the Proposed Scheme delivers journey time savings of up to 13 minutes in addition to journey time savings already delivered by Phase One.

2.4.5 Delivering the Proposed Scheme will bring wider economic benefits. The Proposed Scheme and the full Y network has the potential to generate significant benefits for the real economy through bringing firms and people closer together to:

- share knowledge and best-practice ('agglomeration benefits');
- reduce transport and production costs ('business user benefits') and increase output (in markets with imperfect competition);
- improve access to jobs and encourage labour market participation.

2.4.6 For the Proposed Scheme, it is estimated that these potential benefits will generate approximately £700m of wider economic benefits.

2.4.7 By building this section of Phase Two earlier than planned, the Proposed Scheme delivers benefits to Northern cities sooner than previously envisaged for Phase Two.

2.4.8 When viewed as a stand-along scheme, the Proposed Scheme has a central benefit cost ratio (BCR) of 1.9 including wider economic impacts. On its own, the Proposed Scheme delivers nearly £4bn of benefits.

2.5 Climate change

2.5.1 The Proposed Scheme has been developed against a background of concern and strengthening policy regarding climate change. This includes consideration of both the need to mitigate climate change through reductions in greenhouse gas emissions, and the need for critical infrastructure and environments to be resilient to climate change impacts and risks.

2.5.2 The Kyoto Protocol of 1997 took the lead in converting this concern into action at an international level. Negotiations in December 2015 on the future of international cooperation on climate change at the 21st Conference of the Parties (CoP21) of the United Nations Framework Convention on Climate Change (UNFCCC) in Paris[49] resulted in a legally binding treaty on climate action. The central aims of the agreement is to strengthen the global response to climate change by keeping global temperature rise this century below 2 degrees Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Limiting global warming to below 1.5 degrees Celsius essentially sets a target for net zero global emissions for the second half of this century. The Paris Agreement was ratified in October 2016.

2.5.3 At a UK level the Climate Change Act 2008[50] established a framework for the UK to achieve its long-term goals of reducing greenhouse gas (GHG) emissions by at least 80% from 1990 levels by 2050. The Climate Change Act 2008 includes an interim target of at least a 34% reduction from 1990 levels by 2020. To ensure that regular progress is made towards the target, the Climate Change Act 2008 also established a system of carbon budgets.

2.5.4 The first five carbon budgets have been set in law. The fifth carbon budget (2028-32) target would reduce UK GHG emissions by 2030 by 57% relative to 1990 levels[51]. In order to meet this target, key priorities for the transport sector are ensuring that carbon efficiency of conventional road vehicles continues into the 2020s, as well as increasing the deployment of electrical vehicles and encouraging a behavioural change towards 'smarter choices' such as the use of more public transport[47].

2.5.5 The Committee on Climate Change (CCC), in its annual progress report to Parliament in June 2016[52], provided a review of recent progress and identified areas where policy should be developed and strengthened if it is to succeed in meeting the fourth and

[49] UNFCCC, (2015), *Conference of the Parties, Adoption of the Paris Agreement*. Available online at: https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf
[50] *Climate Change Act (2008).* London, Her Majesty's Stationery Office.
[51] Committee on Climate Change, (2015), *The Fifth Carbon Budget - The next step towards a low-carbon economy*. Available online at: https://documents.theccc.org.uk/wp-content/uploads/2015/11/Committee-on-Climate-Change-Fifth-Carbon-Budget-Report.pdf
[52] Committee on Climate Change, (2016), *Meeting Carbon Budgets – 2016 Progress Report to Parliament*. Available online at: https://www.theccc.org.uk/publication/meeting-carbon-budgets-2016-progress-report-to-parliament/

fifth carbon budgets. The CCC identified a need for development and strengthening of "national and local policies to reduce demand for car travel, sufficient to deliver car-km reductions of around 5% below the baseline trajectory, including through shifts to public transport, cycling and walking". The CCC also acknowledges, in light of the Paris Agreement, that the current UK targets, whilst ambitious, are not aimed at limiting global temperature to the levels stated by the agreement nor do they stretch far enough. In its UK action plan report[53] in response to the Paris Agreement, the CCC sets out a series of domestic actions for the UK Government to consider. It is expected that the Government will publish a plan for meeting the legislated carbon budgets in the second half of 2017.

2.5.6 The construction of a new high speed rail line would result in substantial greenhouse gas emissions. However, in terms of enhancing inter-urban connectivity, high speed rail is one of the most carbon efficient means of transporting large numbers of people, measured in terms of emissions per passenger kilometre. High speed rail is considered to draw an optimum balance between carbon reduction and economic benefits. Furthermore, the carbon emissions of high speed rail are likely to reduce in future as the energy supply is decarbonised, i.e. as Britain moves away from using gas, oil and coal-fired power stations and towards renewable and low carbon sources of energy. There will be a large carbon benefit associated with the operation of Phase One of HS2. There will be further carbon benefits associated with the operation of Phase 2a.

2.5.7 Encouraging a shift to lower-carbon modes was one of the considerations in rejecting modal alternatives such as increasing domestic aviation capacity. While the Government is encouraging the development of low emission road vehicles, building new motorways would still lead to significantly more transport emissions in the short to medium term.

2.5.8 The Climate Change Act 2008 also created a framework for building the UK's ability to adapt to climate change. The Act gives the Secretary of State for the Environment the power to direct Government Departments and reporting authorities, (i.e. organisations with functions of a public nature and statutory undertakers, which include major transport infrastructure companies), to produce reports on the current and future predicted impacts of climate change on their organisation and to set out proposals for adapting to this change.

2.5.9 The Act requires Government to develop and implement a National Adaptation Programme (NAP)[54], following the publication of the first Climate Change Risk Assessment (CCRA) in 2012[55], to help build this resilience. The NAP and the CCRA must be reviewed every five years - the second CCRA was published in January 2017[56] and the next NAP is due to be published in 2018[57]. Together they set the framework

[53]Committee on Climate Change, (2016), *UK climate action following the Paris Agreement*. Available online at: https://www.theccc.org.uk/wp-content/uploads/2016/10/UK-climate-action-following-the-Paris-Agreement-Committee-on-Climate-Change-October-2016.pdf
[54] Defra, (2013), *The National Adaptation Programme, Making the country resilient to a changing climate*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209866/pb13942-nap-20130701.pdf
[55] Defra, (2012), *UK Climate Change Risk Assessment: Government Report*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69487/pb13698-climate-risk-assessment.pdf
[56] Committee on Climate Change, (2017), *UK Climate Change Risk Assessment 2017 Evidence Report*. Available online at: https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/climate-change-risk-assessment-2017/
[57] Committee on Climate Change, (2016), *Government policy paper on climate change adaptation 2010-2015*. Available online at: https://www.gov.uk/government/publications/2010-to-2015-government-policy-climate-change-adaptation/2010-to-2015-government-policy-climate-change-adaptation#appendix-3-national-adaptation-programme

for how government, businesses, communities and civil society should prepare for and adapt to climate change. As described in the NAP, the design and EIA processes for major infrastructure projects are required to incorporate consideration of climate change implications. More specifically, the NAP states that "[Department for Transport] DfT is the sponsor for the High Speed 2 (HS2) rail route and has required HS2 Ltd to incorporate consideration of climate change implications in its design and Environmental Impact Assessment processes".

2.5.10 The Cabinet Office guidance on 'Keeping the country running'[58] is a key document used in the development of HS2's approach to climate change resilience. There is a resilience objective within the HS2 Sustainability Policy and Environment Agency guidance on climate change allowances to be used in flood risk assessments as set out in the NPPF[59] which has informed the assessment.

2.5.11 Further information is provided in sections 8.4 and 9.4 of this report and in Volume 3: Route-wide effects, Section 4.

2.6 Managing local impacts and effects

2.6.1 The Government acknowledges that constructing a new railway in the UK will inevitably lead to a range of adverse local impacts and effects. However, in developing the route between the West Midlands and Crewe, impacts have been reduced as far as reasonably practicable. Environmental assessment has been integral to route development and design, with reporting initially by way of the AoS and subsequently through preparation of the ES.

2.6.2 Mitigation measures that are considered to be effective and reasonably practicable have been incorporated into the design and management of the Proposed Scheme. A structured approach has been adopted towards mitigation, whereby priority is given to avoiding significant adverse effects. Where that is not achievable, such effects will be reduced or abated, or compensation provided. The approach to mitigation and monitoring is described further in Section 9.

2.6.3 Local impacts were also identified through stakeholder engagement and consultation, which raised a range of environmental issues. Options for addressing these issues were considered as the design of the Proposed Scheme evolved. Further details of the consultation process are set out in Section 3 of this report.

[58] Cabinet Office, (2011), *Keeping the country running: natural hazards and infrastructure*. Available online at: https://www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure

[59] Environment Agency, (2017), *Flood risk assessments: climate change allowances*. Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

3 Stakeholder engagement and consultation

3.1 Background

3.1.1 Stakeholder engagement has been an integral and ongoing part of the process of designing and assessing the Proposed Scheme from its inception. It has enabled the general public, local authorities, statutory bodies and technical and specialist stakeholders to respond to, and inform:

- the development of the design;
- the scope and methodology of the assessment;
- the collection of relevant baseline environmental information and data;
- the assessment of the significant environmental effects arising from construction and operation of the Proposed Scheme;
- the enhancement of the beneficial effects of the project;
- the measures identified to avoid or mitigate significant adverse effects; and
- monitoring arrangements.

3.1.2 This section sets out:

- the range of stakeholders involved;
- how and when engagement and consultation has been undertaken; and
- future opportunities for stakeholder engagement through the consultation and also details of the petitioning process.

3.1.3 A brief summary of how stakeholder feedback has been considered in the development of the design and assessment of the Proposed Scheme is set out in Section 3 (Stakeholder engagement and consultation) of the Volume 2: Community area reports.

3.2 Stakeholders

Directly affected individuals, landowners and businesses

3.2.1 The engagement and consultation focused on directly affected individuals, such as those whose operations, land and/or property will be directly affected by the Proposed Scheme whether permanently or temporarily. They include individual property and land owners, commercial and educational entities, such as Staffordshire County Showground and charitable organisations such as the Conservation, Horticulture, Agriculture for the Disabled Society (CHADS) at Handsacre.

3.2.2 This consultation and engagement has enabled HS2 Ltd to obtain baseline information on the scale and nature of these operations to provide affected parties with the opportunity to raise issues, understand the nature of potential impacts and discuss any mitigation, in relation to the Proposed Scheme.

3.2.3 This group also included farmers and growers. The engagement process provided an opportunity to obtain baseline information on the scale and nature of the farm and forestry operations and related farm-based uses, to share information with farmers and growers as to the potential impacts of the Proposed Scheme and to discuss potential mitigation. For example, the location of environmental mitigation has been refined to reduce the loss of agricultural land and the location of accommodation overbridges across the route have been refined to better reflect the needs of farmers.

3.2.4 Engagement was also undertaken with key representatives for the farmers and growers industry, in particular with the National Farmers Union and Country Land and Business Association.

Communities

3.2.5 Engagement was undertaken with communities, with key community representatives and with a broad range of interest groups within the respective areas. This included local facility and service providers, schools and educational establishments, local authorities and parish councils.

3.2.6 Community stakeholders have been provided with information on the development of the Proposed Scheme, as a basis to identify potential impacts and opportunities for mitigation within the local area, reflecting local conditions and identified issues.

3.2.7 Engagement was undertaken with schools and educational establishments and in particular, those close to the Proposed Scheme and those with specialist interests or catering to the needs of vulnerable people within the community such as Rugeley School (which is linked with Mayfield Children's Home). This has informed the assessment of Community and Health impacts in the ES (which is presented in Sections 6 and 9 of the Volume 2 community area reports and Sections 5 and 8 of Volume 3: Route-wide effects).

Technical and specialist groups

3.2.8 Engagement has been undertaken throughout the design and assessment of the Proposed Scheme with technical and specialist organisations. This engagement has focused on ensuring that technical and specialist stakeholders inform the design and assessment of the impacts of the Proposed Scheme and has helped identify specific mitigation.

3.2.9 This group includes national representatives of environmental statutory authorities (including the Environment Agency, Natural England, Historic England and Highways England) and government departments (Department for the Environment, Food and Rural Affairs (Defra)). Engagement was also undertaken with local authorities, utility companies and other specialist stakeholders, including the Woodland Trust, Staffordshire Wildlife Trust and Cheshire Wildlife Trust, The Canal & River Trust, the National Trust and organisations such as the Cannock Chase Area of Outstanding Natural Beauty (AONB) Unit.

3.2.10 Engagement with local authorities provided valuable technical information to aid the design development and environmental assessment process (including local baseline information) and influence local area mitigation proposals. Local authorities also provided information on communities and other stakeholders within their area, which helped to inform the assessment and design of the Proposed Scheme.

3.2.11 The engagement with local authorities focused on the technical areas that inform the assessment, including air quality, cultural heritage, ecology and biodiversity, landscape and visual, land quality, mineral extraction from borrow pits, sound, noise and vibration, traffic and transport, and water resources and flood risk.

3.2.12 Designated statutory consultees (such as the Environment Agency) for the process of undertaking an EIA have been engaged with throughout the assessment. Specific, dedicated engagement on health has also been undertaken, including with health and wellbeing boards run by local authorities.

3.2.13 Engagement is also ongoing with utility companies and statutory stakeholders such as National Grid, Scottish Power, Severn Trent, Network Rail, and the Oil and Pipelines Agency.

National Environment Forum and Ministerial Environmental Roundtable

3.2.14 The National Environment Forum is attended by members of key statutory organisations to represent the interests of local people and the wider society in respect to specific environmental issues. The forum includes representatives of government departments and relevant statutory authorities such as Historic England, Natural England, Forestry Commission and the Environment Agency.

3.2.15 The forum meets quarterly and provides advice on environmental policy, including project-wide mitigation strategies and principles. Bilateral meetings are also conducted with stakeholders on specific issues on a case by case basis.

3.2.16 The Minister of State for Transport also holds a quarterly Ministerial Environmental Roundtable meeting, with environmental non-governmental organisations (NGOs) and local authority representatives. This forum is hosted by the DfT and provides a regular opportunity for organisations with appropriate expertise and knowledge to discuss national level environmental issues related to HS2 with the Secretary of State for Transport (or representative Minister).

3.2.17 Members of the forum include the Campaign to Protect Rural England, the Campaign for Better Transport, the National Trust, the Woodland Trust, the Wildlife Trusts, Ramblers, National Farmers Union and Local Government Association. The forum provides the opportunity for open discussion about environmental and sustainability issues and considers how the Proposed Scheme could contribute to or enhance the environment it passes through.

Planning forum

3.2.18 A Phase 2a planning forum will be established as the main mechanism for discussing planning matters between HS2 Ltd and the local authorities affected by the Proposed Scheme. It will focus on matters of route-wide interest, initially relating to matters associated with powers contained in the Bill.

3.3 Key stages of stakeholder engagement

Introduction

3.3.1 Direct engagement with stakeholders began in 2009. A variety of mechanisms were used to ensure an open and inclusive approach to engagement and consultation, reflecting the differing requirements and expectations of stakeholders.

3.3.2 Key engagement undertaken is summarised in Table 3. This included consultation on the draft SMR, property consultation and a series of meetings with national and local environmental stakeholders, local authorities, parish councils, individual landowners and organisations.

Table 3: Engagement, consultation and decision points to date for HS2 Phase Two (incorporating Phase 2a)

Year	Engagement, consultation and decision points
2011-2012	Initial consultation on High Speed Rail and the subsequent announcement (in January 2012) of decision to pursue the Y network in two phases and of preferred route for Phase One. Development of the Phase Two route.
2013	Announcement of initial preferred route for Phase Two: • allowed an early opportunity to engage with key stakeholders on potential key issues and concerns about the route and its impacts ahead of consultation; and • publication of background material used to inform the initial preferred route, including an AoS options report setting out the environmental performance of alternative route options. Consultation on Phase Two proposed route: • consultation of the proposed route, stations and depots; and • sought comments on the approach to the environmental appraisal carried out by HS2 Ltd.
2015	Route decision on Phase 2a: • consultation response for Phase 2a, including feedback on the AoS of the proposed Phase Two route via Question 7 of the consultation (December 2015); • confirmation of the preferred route and decision to accelerate construction; • publication of a summary change document reflecting changes made since the consultation; and • publication of a Sustainability Report for the Phase 2a route highlighting differences in environmental performance as a result of changes made. Phase 2a property consultation: consultation with property owners

Year	Engagement, consultation and decision points
	along the route of the Proposed Scheme.
2016	Public consultation on the draft SMR for the EIA, which sets out: • the proposed approach to environmental assessment; and • the approach to considering and reporting on alternatives. Public consultation on: • the working draft EIA Report. A summary explaining how the responses to the working draft EIA Report have been taken into consideration is provided in the Consultation Summary Report (Volume 5: Appendix CT-008-000); and • West Midlands to Crewe Design Refinement Consultation. To support these consultations, a number of events were conducted in local areas along the route of the Proposed Scheme. These events were held on: • 30 September 2016: Whitmore and District Village Hall; • 5 October 2016: Kings Bromley Village Hall; • 7 October 2016: Great Haywood Memorial Hall; • 10 October 2016: Stafford Gatehouse Theatre; • 12 October 2016: Yarnfield Park, Stone; • 15 October 2016: The Madeley Centre; and • 19 October 2016: Wychwood Park, Weston. Further detailed information on community engagement is provided in Section 3 (Stakeholder engagement and consultation) of the Volume 2: Community area reports.

Engagement on the initial preferred route and consultation on the Appraisal of Sustainability

3.3.3 The announcement of the initial preferred route for Phase Two in January 2013 provided an early opportunity to engage with stakeholders on potential key issues and concerns about the route and its impacts ahead of public consultation.

3.3.4 This engagement fed into the analysis of a substantial number of route-wide alternatives to the proposed Phase Two alignment, which was informed by the AoS process. The AoS was used to appraise and report on the sustainability performance of the Phase Two (including Phase 2a) proposals throughout their development, as described in Section 1.5 and Section 2.2.

Property consultation

3.3.5 On 30 November 2015, the Government published for public consultation its proposed package of measures to address the problem of generalised blight in relation to the Proposed Scheme. The principal purpose of the consultation was to inform the

Government's decision whether to extend the package of measures put in place for the Phase One scheme to Phase 2a and if so, as to the timing of bringing such a package into effect. The outcome of this consultation is summarised in HS2 Phase Two: West Midlands to Crewe Property Consultation 2016[60].

3.3.6 A programme of property consultation events has also been undertaken route-wide since November 2015. The purpose of the property consultation events was to give stakeholders the opportunity to speak with HS2 Ltd property, environment and engineering specialists about the details of the Government's proposals for compensation and assistance for property owners.

Consultation on the draft EIA Scope and Methodology Report

3.3.7 The draft SMR[61] was subject to consultation from 8 March 2016 to 13 May 2016. It was issued, as part of the consultation process, to statutory bodies, non-government organisations (NGOs) and local authorities (including parish councils). It was available on the Government's website, allowing comment by local interest groups and the public. The draft SMR was amended in a number of respects in response to the consultation. The revised SMR, and a consultation summary report, was published alongside the working draft EIA Report in September 2016. The assessment reported in this ES is based on the revised SMR and SMR addendum[62].

Consultation on the working draft EIA Report

3.3.8 Consultation on the working draft EIA Report took place from 13 September to 7 November 2016. Copies of the working draft EIA Report were made available in public libraries and on the HS2 Ltd website (www.gov.uk/hs2). Public events were held in communities across the Proposed Scheme as part of the consultation. Feedback from those who attended these events and stakeholders who responded to the formal consultation was used to consider the further development of the Proposed Scheme and its environmental assessment, and is reflected in the ES. A working draft EIA report consultation summary report has been published as part of this ES explaining how the responses to the working draft EIA Report have been taken into consideration (see Volume 5: CT-008-000).

Parliamentary consultation and petitioning

3.3.9 Parliamentary procedure for hybrid Bills allows a period within which members of the public may respond to the ES. Consultees will have at least 56 days (eight weeks) to respond to the consultation after the first publication of the newspaper notices that follows deposit of the Bill documents in Parliament. Parliament will appoint an independent assessor who will assess the responses and provide a report to

[60] Dialogue by Design, (2016), *HS2 Phase Two: West Midlands to Crewe Property Consultation 2015, a report to HS2 Ltd and the Department for Transport*. Available on-line at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/526063/HS2_Phase_2a_Property_Consultation_2015_Response_Summary_Report.pdf

[61] Arup/ERM, (2016), *HS2 Phase Two: West Midlands to Crewe EIA Scope and Methodology Report – draft for* consultation, March 2016. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/506111/HS2_Phase_2a_EIA_Scope_and_Methodology_Report_Final_for_Comms_08-03-2016_WEB_1400.pdf

[62] The SMR addendum outlines where the methodology presented within the SMR has been amended or developed as a result of: legislation or industry best practice guidance having changed; the methodology having undergone refinement in the course of preparation of the ES; and further feedback on the outlined methodology having been received from stakeholders including statutory bodies following the ongoing application of that methodology.

Parliament summarising the responses 14 days before the Second Reading of the Bill in the House of Commons.

3.3.10 Following the second reading of the Bill a Select Committee of the House of Commons will be appointed to hear petitions against the Bill. Persons or organisations whose property or interests are specially or directly affected by the Bill may petition and be heard by the Select Committee. More information on who may petition against the Bill, and how to do so, is available on Parliament's website (http://www.parliament.uk).

4 The Proposed Scheme

4.1 Introduction

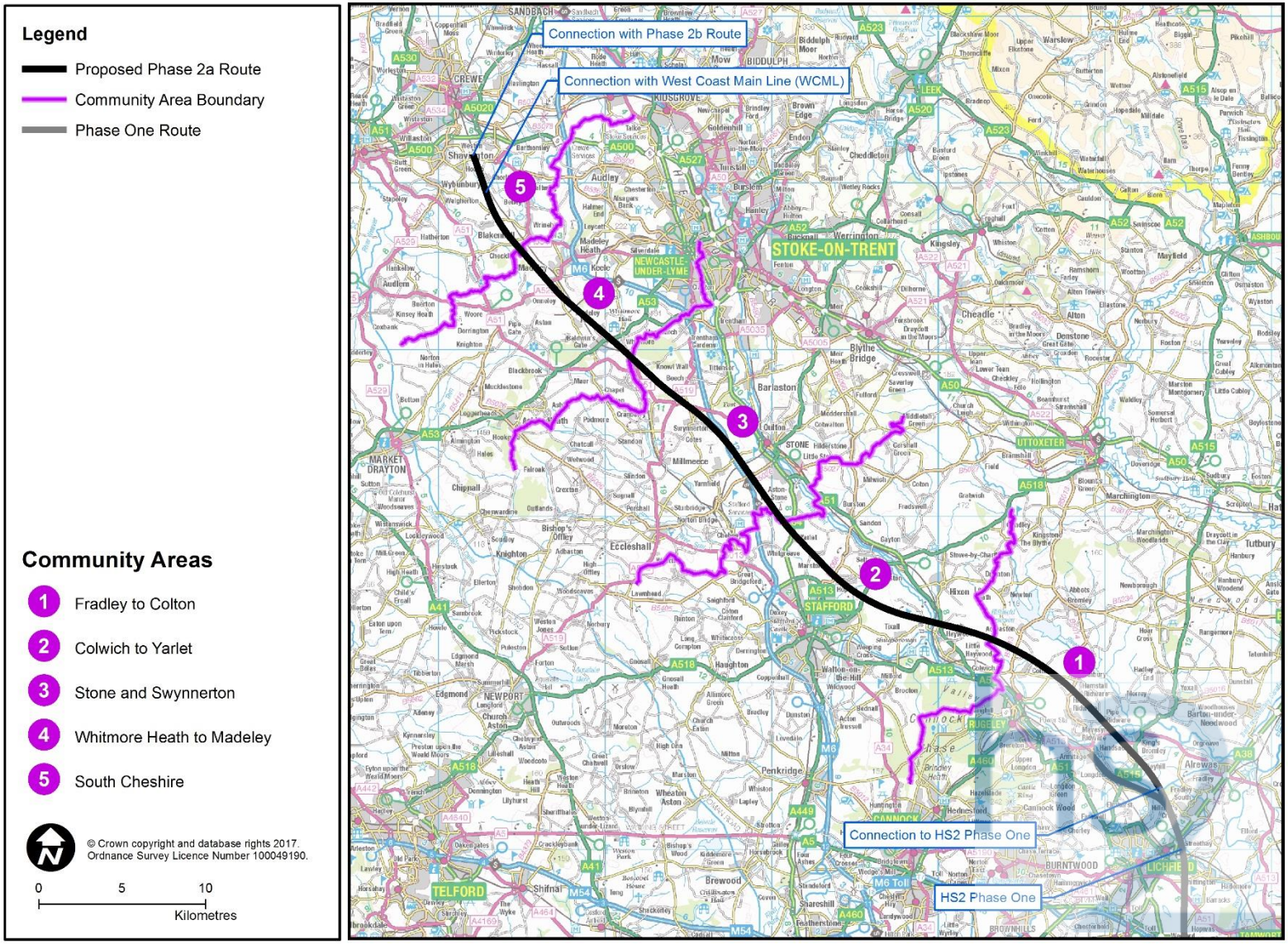
4.1.1 This section provides a summary description of the Proposed Scheme, which is shown in Figure 4. Detailed route descriptions at a local level are contained in Section 2.2 of the Volume 2: Community area reports. The route of the Proposed Scheme has been divided into the following five community areas, for environmental assessment and community engagement purposes:

- community area 1: Fradley to Colton;
- community area 2: Colwich to Yarlet;
- community area 3: Stone and Swynnerton;
- community area 4: Whitmore Heath to Madeley; and
- community area 5: South Cheshire.

4.1.2 These community areas are shown in Figure 4.

4.1.3 Refer to Section 5 for more information on the main permanent features of the Proposed Scheme.

Figure 4: Community areas



4.2 Description of the Proposed Scheme

4.2.1 The Proposed Scheme will comprise a high speed railway line from the end of the Phase One route at Fradley, to Crewe. It will run north-east of Stafford and south-west of Stone, passing through a mainly rural area in Staffordshire and Cheshire East, where a number of small settlements are located.

4.2.2 The route of the Proposed Scheme will connect with the Manchester spur that forms part of Phase One at Fradley, to the north-east of Lichfield. It will continue northwards across the River Trent floodplain, over a series of embankments and viaducts, passing south-east of Kings Bromley over Bourne Brook, the A515 Lichfield Road and the A513 Rugeley Road on viaduct. The route will continue over the River Trent and will run 500m west of Blithbury through multiple cuttings. It will then pass between the villages of Stockwell Heath and Colton and over Moreton Brook on viaduct.

4.2.3 The route will continue in cutting with a retaining wall past Mayfield Children's Home, which occupies the Grade II listed Moreton House, and will emerge onto embankment. The route will cross the A51 Lichfield Road and will run on viaduct over the existing Macclesfield to Colwich Line, adjacent to the Great Haywood Marina, cross the Trent and Mersey Canal and then cross the River Trent, for a second time. The route will then continue on embankment, crossing Lionlodge Covert, an area of deciduous woodland and designated Local Wildlife Site.

4.2.4 The route will run adjacent to Ingestre Park and through Ingestre Park Golf Club in cutting, with Pasturefields Salt Marsh Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) approximately 900m to the north of the route of the Proposed Scheme. The route will then run through an area used for car parking and camping in the southern part of the Staffordshire County Showground in cutting, passing under the A518 Weston Road. It will then continue through Hopton passing through a landscaped retaining wall screened by a false cutting[63] and will then continue in cutting. The route will then pass Marston on embankment, and continue past Yarlet in cutting running beneath the A34 Stone Road.

4.2.5 The route will continue on a series of embankments and cuttings, broadly following the M6 and crossing Filly Brook and the Norton Bridge to Stone Railway on viaduct.

4.2.6 The route will then cross Yarnfield Lane, where an infrastructure maintenance facility referred to as the Stone Infrastructure Maintenance Base - Rail (IMB-R) will be located. Railway access tracks to connect the route with the IMB-R will run along the western side of the route, with a connection to the Norton Bridge to Stone Railway. The route will then cross the M6 on viaduct near Stone and Yarnfield.

4.2.7 The route will pass to the north of Swynnerton on an embankment. Continuing north, the route will pass Swynnerton Old Park in cutting, passing under the A519 Newcastle Road. It will continue into the Meece Valley on embankment and then cross Meece Brook on viaduct, before passing through higher ground west of Whitmore.

4.2.8 The route will pass under the A53 Newcastle Road to the south-east of Whitmore Heath, where it will then enter a short section of cut-and-cover tunnel. This will be followed by a twin bore tunnel under the settlement of Whitmore Heath. The route

[63] A means of screening a linear feature (e.g. a railway) by forming embankments on both sides of the feature.

will pass through Whitmore Wood Ancient Woodland in cutting with a retaining wall on the north-east side to reduce the loss of ancient woodland. The route will enter the River Lea valley on an embankment, then cross the WCML, the Stoke to Market Drayton Railway (also known as the Silverdale line of the Stoke to Market Drayton Railway), the River Lea and the Madeley Chord railway on viaduct. The route will then continue on embankment, passing several historical heritage assets, including the Grade II listed Hey House and Old Madeley Manor Scheduled Monument.

4.2.9 The route will continue towards the village of Madeley passing under the A525 Bar Hill Road before entering a twin bore tunnel, at Bar Hill Ancient Woodland. North of Madeley the route will continue in a shallow cutting before crossing the River Lea and associated floodplain and Checkley Brook on a viaduct.

4.2.10 The route will then run on embankment before transitioning into a shallow cutting, passing under Checkley Lane and will then continue northwards crossing over the realigned Den Lane.

4.2.11 The route will then continue in cutting and will pass under the realigned Newcastle Road before terminating in a retained cutting at a headwall[64] to the south of Crewe. This will form the boundary between the Proposed Scheme and Phase 2b.

HS2 spurs

4.2.12 As well as the main Phase 2a route, the Proposed Scheme will also include two spurs that will allow trains to transfer between the HS2 main line and the existing WCML northbound towards Crewe (northbound spur) and southbound towards London (southbound spur).

4.2.13 The spurs will diverge from the HS2 main line on both sides at the point where the HS2 main line passes into the Crewe South cutting, to the north-east of Grange Farm. The southbound spur will initially run along the east side of the HS2 main line and the northbound spur will initially run along the west side.

4.2.14 The northbound spur will then cross over the HS2 main line on viaduct and the two spurs will then converge on the east side of the HS2 main line, 500m north of the Blakenhall viaduct. The spurs will continue together for 3km before connecting into the existing WCML, 200m north of the Newcastle Road overbridge.

4.2.15 To facilitate the connection of the spurs to the WCML, modifications will be required to the existing WCML infrastructure in the South Cheshire area. This will include a new section of the WCML to incorporate the realignment of an existing northbound track along this line and an extension of the existing connection lines to the Basford Hall sidings.

4.2.16 A number of rail systems modifications will also be required along the WCML and to enable a new island platform at Crewe Station. This will include new track works, realignment of existing tracks, new switches and crossings, the relocation or addition of overhead line equipment, and modifications to signalling, telecommunications, power and other related equipment.

[64] A headwall is the wall where the route of the Proposed Scheme terminates.

New platform at Crewe Station

4.2.17 To accommodate the additional rail services, the existing Cardiff to Manchester Piccadilly services will be diverted via the Manchester Independent Lines tunnel at Crewe. A new island platform will be constructed at Crewe Station to accommodate this service. This will be constructed as part of the Proposed Scheme.

Modifications to the West Coast Main Line to the north of Crewe

4.2.18 Additional modifications will be required to the WCML to the north of Crewe at Maw Green and Sandbach. This includes railway systems modifications and reconfiguration of track layouts.

Changes to the design since the working draft EIA Report

4.2.19 This section lists the key changes made to the design of the Proposed Scheme since publication of the working draft EIA report (all dimensions are approximate):

- the infrastructure maintenance depot (IMD) previously proposed at Crewe will now be located near Stone on the site of the construction railhead, in the form of the Stone IMB-R. Due to this change, the maintenance loops proposed at Pipe Ridware are no longer required[65];
- the Crewe South portal will be located 340m south of the location previously proposed, 960m south of the A500 Shavington Bypass;
- revisions to the lengths and heights of viaducts and embankments on various sections of the route;
- revisions to the depths of cuttings at various points along the route;
- introduction of a retaining wall at the southern porous portal of Madeley tunnel and associated modification to Madeley cutting;
- development of mitigation, including: noise barriers, landscape bunds[66], compensatory planting, replacement ponds, and green bridges along the route of the Proposed Scheme;
- removal of a 1.4km section of the WCML modifications located near Lower Den Farm;
- introduction of an additional platform (110m in length) at Crewe Station to accommodate rail services;
- revisions to roads and public rights of way (PRoW) works: including the realignment of some roads and provision of additional overbridges and

[65] Maintenance loops were originally proposed as part of the scheme assessed in the working draft EIA Report. This was because an IMD was proposed towards the northern end of the route of the scheme at Crewe. Maintenance loops were therefore required at Pipe Ridware, to enable maintenance trains to be stabled temporarily during the day when maintenance activities would have been undertaken over a number of nights, without having to return to the IMD. However, the maintenance facility (the IMB-R) will now be located more centrally in the Stone to Swynnerton community area, meaning maintenance trains will be better positioned for efficient dispatch for maintenance works across the route in both directions, avoiding the need for maintenance loops.

[66] A bund is an earthworks structure designed to provide either visual screening or noise attenuation to receptors in close proximity.

underbridges;

- revisions to the size and locations of balancing ponds and provision of additional balancing ponds where required;
- a power connection from National Grid Rugeley substation to Newlands Lane auto-transformer feeder station[67] to provide power to the Proposed Scheme (4km in length, with 1.7km underground and 2.3km via overhead line);
- revisions to the location of some tunnel portal buildings; and
- revision to the number and locations of proposed auto-transformer[68] and auto-transformer feeder stations.

4.2.20 The Proposed Scheme now includes six borrow pits, four in the Fradley to Colton community area, one in the Whitmore Heath to Madeley community area and one in the South Cheshire community area, to provide sufficient material of an appropriate quality to construct railway embankments. Further details on borrow pits are included in Section 6.10 of this report.

Interfaces with the Proposed Scheme

Interface with Phase One

4.2.21 The route of the Proposed Scheme will connect to HS2 Phase One at Fradley. The High Speed Rail (London – West Midlands) Bill 2013 received Royal Assent on 23 February 2017 and initial works have commenced. The significant environmental effects of the Phase One scheme were reported in the ES deposited with the Phase One Bill and subsequent additional provisions and supplementary ESs.

4.2.22 As a result of the Proposed Scheme a number of changes to the Phase One design will be required at the interface. Any new or different significant environmental effects arising from these changes are described in this ES, where relevant.

Interface with Phase 2b

4.2.23 The route which will be constructed as part of Phase 2a will terminate at a portal headwall. Provision is made in the design of the Proposed Scheme for the future extension of the route to Manchester as part of Phase 2b.

4.2.24 Development of Phase 2b will require a separate hybrid Bill and ES at a later date. The Phase 2b assessment will consider any potential effects at the interface between the Proposed Scheme and Phase 2b or any cumulative effects that could arise from the construction and operation of both schemes.

Interface with Crewe Hub

4.2.25 Network Rail, working closely with the DfT, Cheshire East Council (CEC) and other stakeholders, are in the process of developing proposals for an enhanced transport

[67] The buildings, switchgear and transformers forming an auto-transformer feeder station will be up to 7.5m in height. Lighting protection masts will be up to 16m in height.
[68] The buildings, switchgear and transformers forming an auto-transformer stations will be up to 5m in height.

hub at Crewe ('Crewe Hub') and will launch a consultation at the same time as Bill deposit.

4.2.26 At the time the assessment of the Proposed Scheme was undertaken, the proposals for Crewe Hub were limited to a preferred location at the existing Crewe Station as announced by the Secretary of State for Transport in November 2016. This reflects the outline proposal for extensive modernisation of Crewe Station in the Borough of Crewe and Nantwich Replacement Local Plan 2011 (Adopted 2005 – saved policies).

4.2.27 Crewe Hub does not form part of the Proposed Scheme. It will be confirmed in due course how any necessary development consent would be secured for these emerging proposals, which would include an assessment of the effects arising from Crewe Hub.

4.2.28 As a proposal for Crewe Hub has some status in local policy, the assessment presented in Community Area 5, South Cheshire, treats it as a "committed development" for the purposes of considering cumulative effects. At this time, the Crewe Hub proposal is at an early stage of development and there is insufficient information on which to base a robust assessment of in-combination construction effects. Nevertheless, the construction assessment for the Proposed Scheme considers the potential combined construction impacts of the Proposed Scheme and the Crewe Hub proposal, in the event that the latter proceeds at the same time as the Proposed Scheme.

4.3 Services and operating characteristics

Overview

4.3.1 Making the most of the additional capacity created by HS2 will be crucial if its full benefits are to be realised. Railway timetables are always evolving in response to demand, and at this stage in the project it is too early to make detailed commitments about how HS2 will operate. However, a provisional service pattern has been identified in order to test the Economic Case and to provide assumptions for an operational specification for the assessment of the Proposed Scheme.

4.3.2 It is envisaged that passenger services will operate between 05:00 and 00:00 from Monday to Saturday and 08:00 and 00:00 on a Sunday. Maintenance and engineering works will occur outside these hours, unless the works can be safely undertaken with trains operating at the same time. Passenger services will start at or after 05:00 from the terminal stations and will progressively increase to the number of trains per hour in each direction on the main lines as discussed below and as detailed within the Volume 2: Community area reports. This number of services is assumed to operate every hour from 07:00 to 21:00. The number of services will progressively decrease after approximately 21:00 and the last service is expected to arrive at terminal stations by 00:00.

4.3.3 From 2033 (following completion of Phase 2b), HS2 could be used by two types of service:

- services running on high speed and existing rail infrastructure will use specially designed high speed trains that are also capable of running on the existing UK rail network (referred to as 'conventional compatible' trains); and
- services operating on high speed infrastructure could also use standard European-sized high speed trains (referred to as 'captive' trains).

4.3.4 To enable conventional compatible trains to operate on the conventional network, they will be equipped with a suitable train control system and will be of a reduced width and height.

4.3.5 Services will comprise two 200m-long trains coupled together or single 200m long trains. A number of trains are expected to be 400m long during peak hours and a mix of 200m and 400m-long trains at other times. Up to approximately 550 passengers will be accommodated on each 200m-long high speed train (i.e. up to approximately 1,100 passengers for each two-unit train).

4.3.6 The expected fastest typical journey times from London are set out in Table 4.

Table 4: Assumed fastest typical journey times with Phase 2a[69]

Destination from London Euston	Fastest journey time (hours: minutes)
Crewe	0:55
Manchester Piccadilly	1:30
Preston	1:30
Liverpool	1:34
Glasgow	3:45

4.3.7 The figures below show the peak hour train flow in each direction across the Proposed Scheme that have been assumed for the purpose of the sound, noise and vibration assessment reported in the ES.

4.3.8 There are three scenarios shown:

- Phase One – peak hour one-way train flow by route section (Phase One year of opening 2026) (see Figure 5);
- Phase One and the Proposed Scheme – peak hour one-way train flow by route section (Phase 2a year of opening 2027) (see Figure 6); and
- Phase One, the Proposed Scheme and Phase 2b – peak hour one-way train flow by route section (with the whole of Phase Two operating) (see Figure 7).

4.3.9 Each scenario shows the number of high speed trains operating in each direction. Note that the number of trains shown on any route section does not necessarily equate to the number in the subsequent sections. This is because the values shown are the number of trains that represent a reasonably foreseeable worst case for the sound, noise and vibration assessment.

4.3.10 The currently assumed initial flows on the main section of Phase 2a is for 6tph in each direction during peak hours upon opening in 2027 (refer to Figure 6) rising to 12tph in the long term with the full Phase Two scheme open (refer to Figure 7). The flows

[69] Department for Transport (DfT), (2017), High Speed Two Phase Two Strategic Case 2017. Available online at: https://www.gov.uk/

principally used for the sound, noise and vibration assessment are those shown in Figure 7 (i.e. with the whole of Phase Two operating).

4.3.11 In order to fully assess the impacts of operating the train services, the noise assessment to support the ES has been undertaken based on the Train Service Specification. This specifies a mix of services of varying lengths that will operate from 2033 over the Proposed Scheme infrastructure.

Figure 5: Phase One – peak hour one-way train flow (Phase One year of opening 2026)

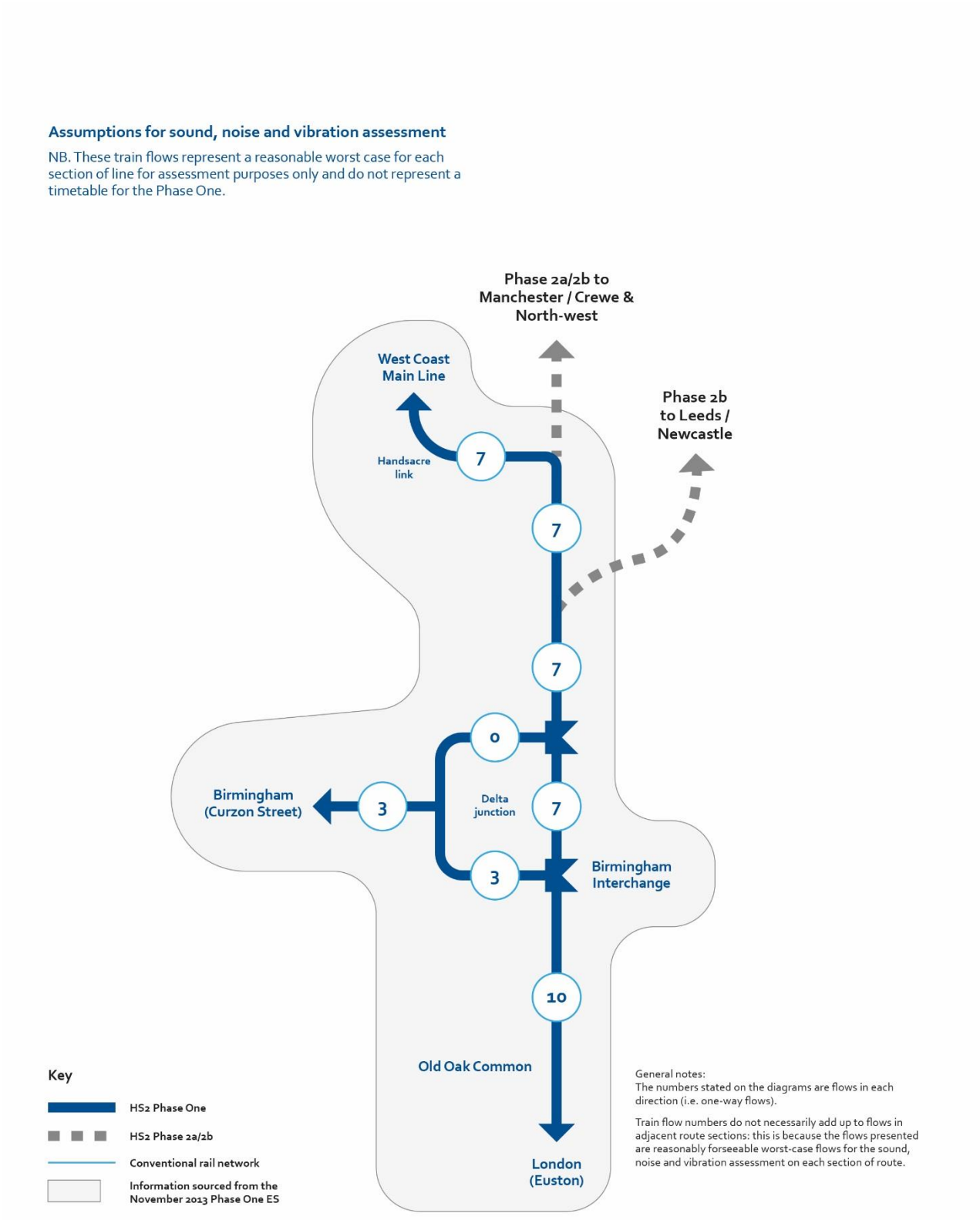


Figure 6: Phase 2a – peak hour one-way train flow (Phase 2a year of opening 2027)

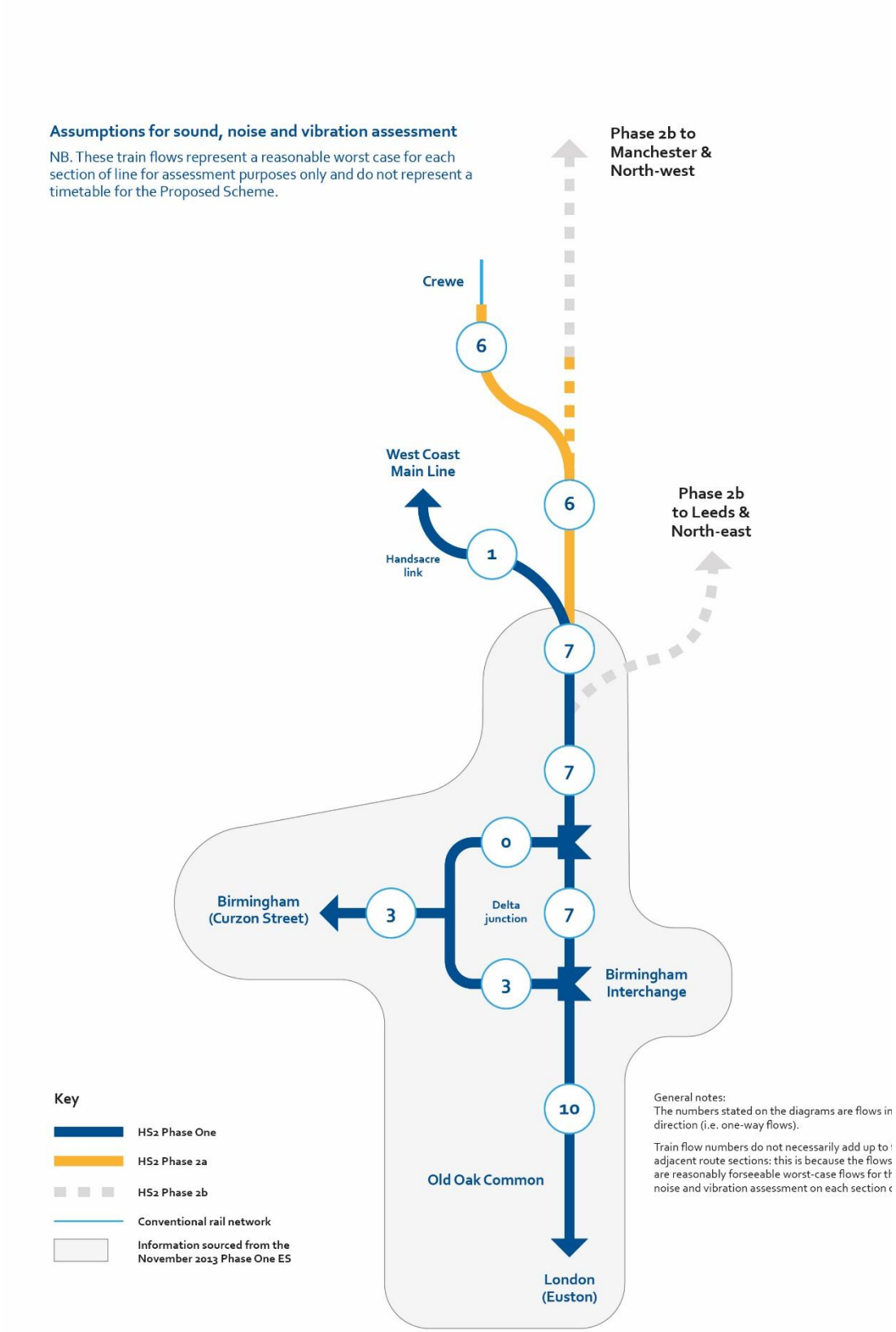
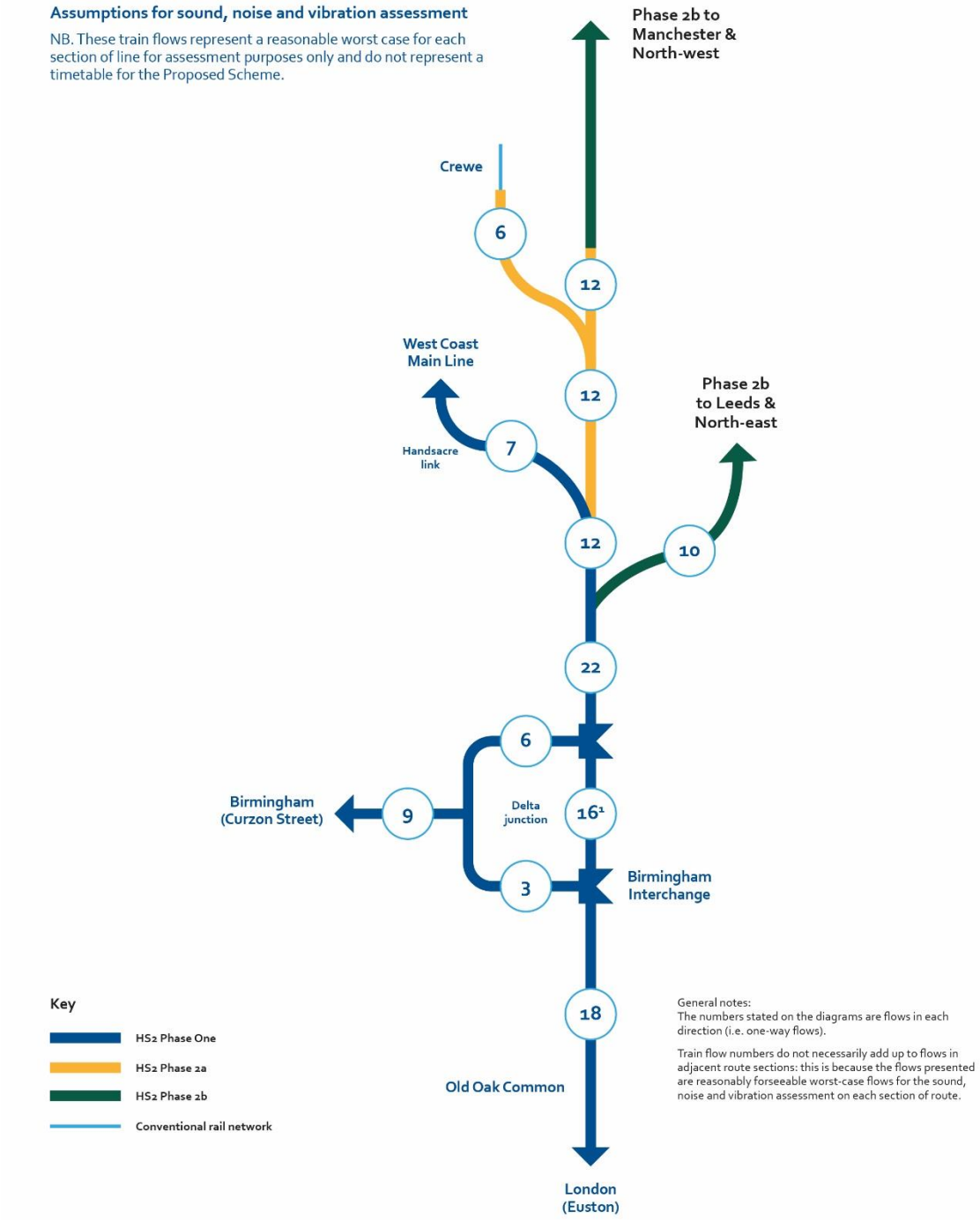


Figure 7: Phase 2a and Phase 2b – peak hour one-way train flow by route section (with the whole of Phase Two operating) for purpose of assessment



4.3.12 Trains on the Proposed Scheme will operate at up to 225mph (360kph)[70]. However, the alignment of the route has been designed to allow for train speeds of up to 248mph (400kph) in the future where there is a commercial justification for doing so. Operation at up to 248 mph (400kph) will require demonstration that improved train design enables services to operate at that higher speed without giving rise to new or different likely significant environmental effects.

4.3.13 The operating speeds over each section of the route are anticipated to be as follows:

- up to 225mph (360kph) on the HS2 mainline between the interface with Phase One (the Handsacre junction) and Crewe; and
- up to 143mph (230kph) on the spurs that will connect HS2 to the WCML, south of Crewe.

4.3.14 The technical and operational specification for the Proposed Scheme is derived from the European Union's Technical Specifications for Interoperability (TSI)[71], which defines the requirements for all new high speed railways and their connections to conventional rail networks.

Maintenance of operational infrastructure

4.3.15 The maintenance regime will include inspection and monitoring to predict and prevent changes to the condition and performance of infrastructure that might affect operation of the Proposed Scheme. This will be achieved through:

- remote condition monitoring of assets;
- measurement systems fitted to passenger rolling stock that monitor that physical interaction between train and rail system assets;
- the frequent operation of infrastructure measurement trains which record the condition of infrastructure assets; and
- inspection staff.

4.3.16 Viaducts and tunnels will be examined using a combination of vehicles equipped with appropriate lifts and access platforms, hi-definition video and laser scan, and drone/unmanned aerial vehicle technologies. Civil engineering assets will be monitored using asset condition monitoring sensors.

4.3.17 Other elements of the maintenance regime will include:

- inspection and maintenance of electrical and mechanical equipment including lineside locations such as auto-transformers;
- preventative maintenance of the track systems will include the use of dedicated works trains for infrastructure maintenance, rail re-profiling and other heavy-duty operations;
- preventative maintenance for other equipment may include 'maintenance by

[70] Timetables are likely to use 200mph (330kph) as a basis for most trains (assumed 90% of services), and 225mph (360kph) for 10% of services.
[71] European Railway Agency, *Multiple Technical Specifications for Interoperability (TSI).* Available online at: http://www.era.europa.eu/Core-Activities/Interoperability/Pages/TechnicalSpecifications.aspx

replacement' whereby components are exchanged, to be serviced offline in a depot or factory;

- planned periodic refurbishment and replacement of assets;
- during the life of the railway, elements of the railway system will need to be replaced on the basis of condition criteria, although civil infrastructure such as tunnels and viaducts will be maintained during their operational life through servicing and repair of structural elements to avoid the need for replacement; and
- update or replacement of control and telecommunication systems and other software-based elements, depending on technological developments and obsolescence.

4.3.18 The assumptions underpinning the maintenance regime include:

- maintenance within the operational rail corridor will take place between the hours of 00:00-04:59 on Monday to Saturday and 00:00-07:59 on Sunday, outside passenger train operating hours, unless it can take place in such a way that allows trains to operate at the same time;
- design, system and process will separate maintenance activity and staff from operating passenger trains;
- safe working areas will be established by isolating traction power supply from the control centre, with coordination between power and traffic control to allow quick and efficient access;
- where reasonably practicable, mechanical and electrical equipment will be located to allow servicing from a safe and secure location and without affecting operations;
- maintenance will be largely mechanised and undertaken from rail-based vehicles, including the use of mobile factory trains[72]; and
- maintenance trains will be of a hybrid type.

Infrastructure Maintenance Base – Rail and operational staff

4.3.19 Infrastructure maintenance operations along the route of the Proposed Scheme, will be managed and resourced from the IMB-R.

4.3.20 Infrastructure maintenance activities will occur when train services are not operating. Any exception to this would be during a serious occurrence that has a major effect on commercial service. The IMB-R will be operational 24 hours a day, 365 days a year. Up to 100 staff will work at the IMB-R in three, eight hour shifts, during each 24 hour period.

[72] A type of maintenance train that carries all the necessary equipment and supplies to carry out specific types of maintenance activities of the track and rail corridor. The trains may be stationed at depots, or on maintenance loop sidings (allowing maintenance at night at more remote locations). It can also carry workers required for maintenance. The use of mobile factory trains avoids the need to have equipment and materials being delivered to the trackside via HGVs or other trains.

4.3.21 Infrastructure maintenance operations, including routine line checks and replacement of track and overhead line equipment (OLE), will be managed and resourced from the IMB-R, which will be located near Stone and forms part of the Proposed Scheme.

4.3.22 Activities managed and resourced from the IMB-R will include: support of rail maintenance vehicles that will carry out track inspections; rail grinding; track maintenance and renewal; overhead line maintenance and renewal; and inspection of structures and earthworks.

4.3.23 These activities, which also routinely take place on the conventional network, will generally occur when train services are not operating. Associated plant and material will generally be stored at the IMB-R and transported to site by rail.

4.3.24 Other maintenance and repair activities for systems such as traction power distribution or train control will largely be carried out away from the operational railway.

Stabling and use of off-route depots

4.3.25 As part of HS2 Phase One, a number of depots/stabling facilities (Edge Hill depot, Liverpool; Longsight depot, Manchester; Longsight International depot, Manchester and Polmadie depot, Glasgow) are expected to require works to accommodate HS2 conventional compatible trains. The impacts of these works were assessed and reported in Volume 4 of the Phase One ES. These depots/stabling facilities will also serve trains using the Proposed Scheme, but no significant changes have been identified over and above those assessed in the HS2 Phase One ES. Therefore, impacts of the Proposed Scheme on off-route depots/stabling facilities are not assessed in this ES.

5 Permanent features of the Proposed Scheme

5.1 Design

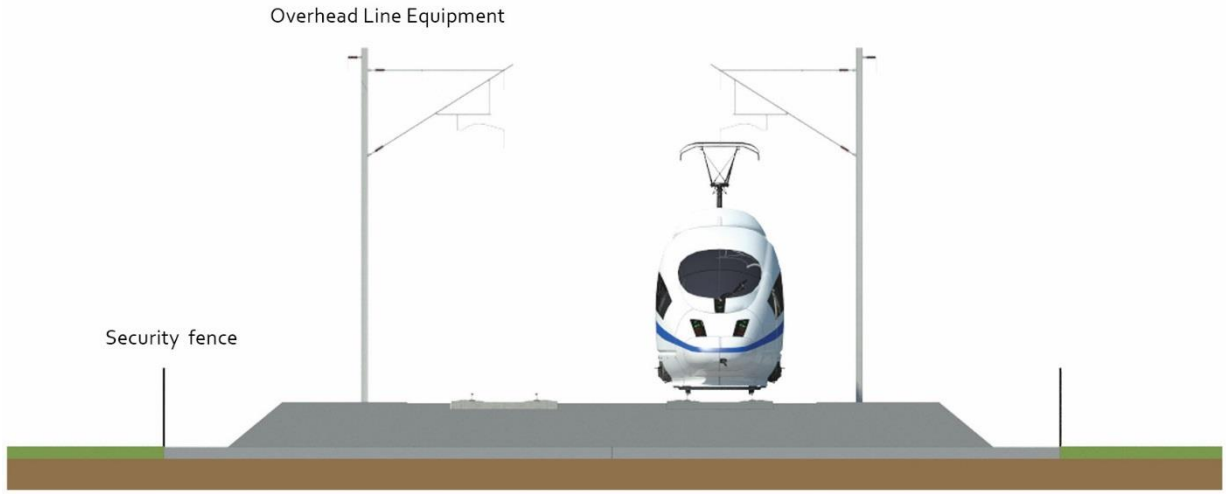
5.1.1 The design of the Proposed Scheme has been developed in line with the HS2 Design Vision[73], which was published in June 2015. The Design Vision sets out nine principles grouped around three themes: People; Place and Time. In addition, the Secretary of State for Transport has established an independent Design Panel, with its own terms of reference and governance structure, to ensure that designs of structures and other related aspects of the new railway will complement local aspirations and contribute to the natural and built environment. The Design Panel will provide professional expertise and independent advice to help HS2 achieve a high standard of design that is also cost-effective and sustainable.

5.2 Rail corridor

5.2.1 In most locations the route will comprise two railway tracks, one for northbound and one for southbound services. The width of the rail corridor may vary along its length to accommodate the topography and cuttings and embankments. The rail corridor will, in general, encompass the two tracks, associated overhead line equipment, track drainage, electricity cables, cable ducting, line-side walkways and noise fence barriers, where required. The rail corridor will be continuously fenced. An integrated approach will be taken when designing fencing layouts since a successful design is dependent on full consideration of numerous design disciplines and physical interfaces.

5.2.2 An indicative cross section through a two-track rail corridor at ground level is shown in Figure 8[74].

Figure 8: Indicative two-track rail corridor



[73] HS2 Ltd, (2015), HS2 Design Vision – Preview Publication. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/475052/HS2_Desgn_Vision_2015.pdf

[74] Illustrations within this document are diagrammatic and show typical scenarios.

5.2.3 In some locations the railway corridor will be wider to accommodate more than two tracks. This will be necessary:

- for sections of the route where different lines converge in Community Area 5: South Cheshire; and
- on the approach to the IMB-R, where additional track work will be provided for trains to enter and exit the facilities.

5.3 Cuttings and embankments

5.3.1 Cuttings will be formed by excavation in areas where the local topography is at a higher level than the desired route alignment. Embankments will be formed by placing fill material where the local topography is lower than the desired route alignment. Embankments will also be used where the route crosses valleys and is not otherwise on bridges or viaducts.

5.3.2 Embankments and cuttings have been named in this ES according to their predominant physical characteristics, i.e. whether it is engineered predominantly above or below ground level. As a result of the topography through which the route of the Proposed Scheme passes, embankments and cuttings vary as to their depth or height. This means that in places across the route, there may be sections of the route described as embankment which lie below existing ground level or sections of cutting which sit above existing ground level.

5.3.3 An illustration of a cutting is shown in Figure 9 and an illustration of an embankment is shown in Figure 10.

Figure 9: Illustration of a generic cutting and cross-section of cutting

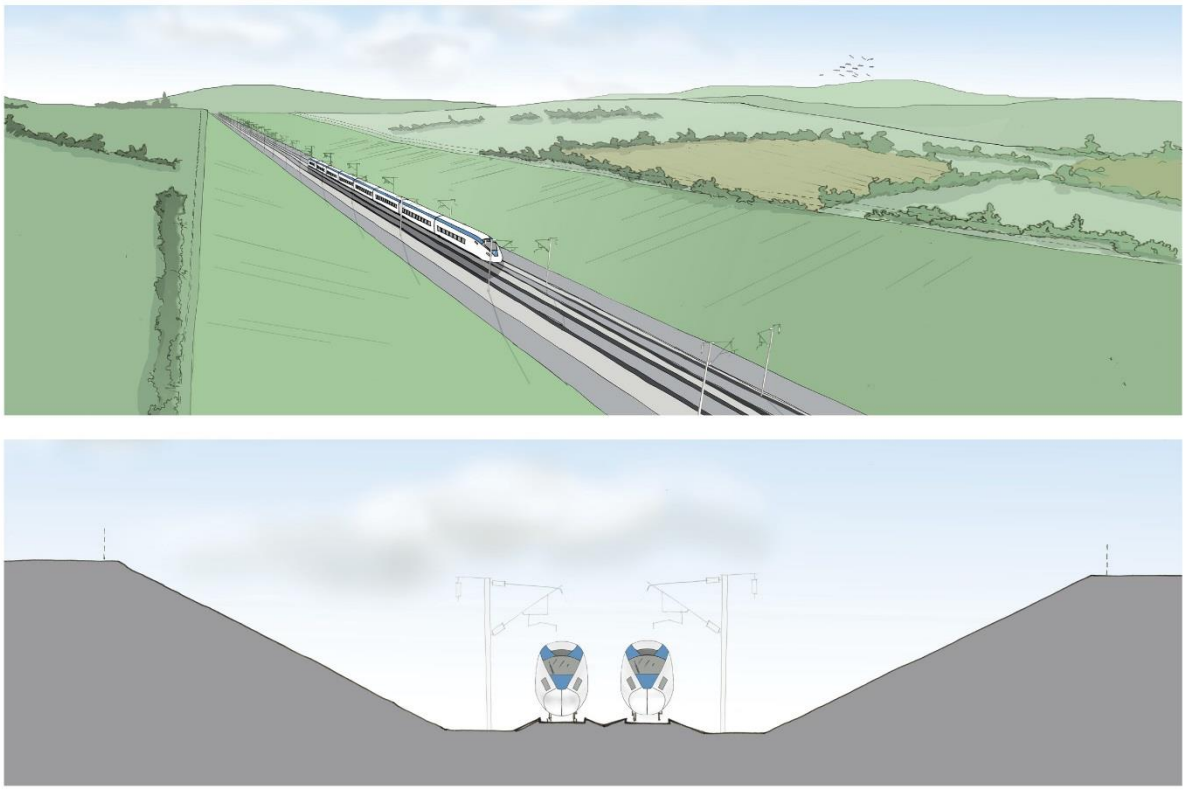
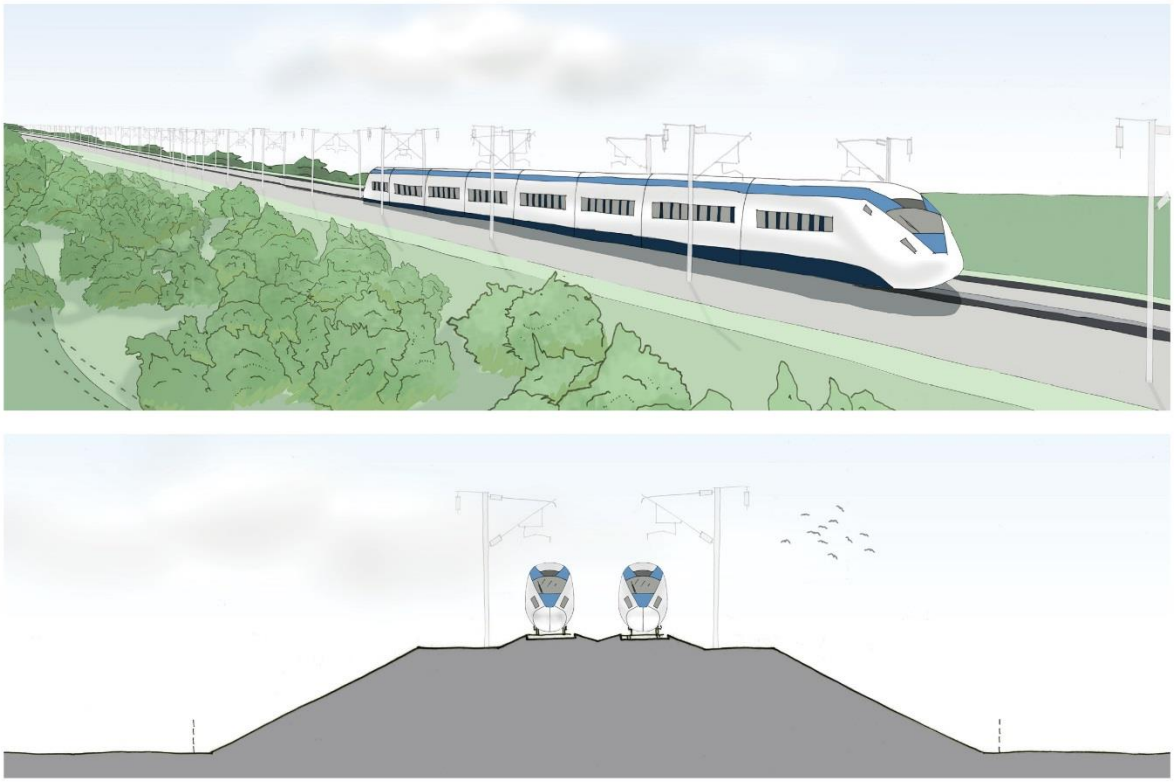
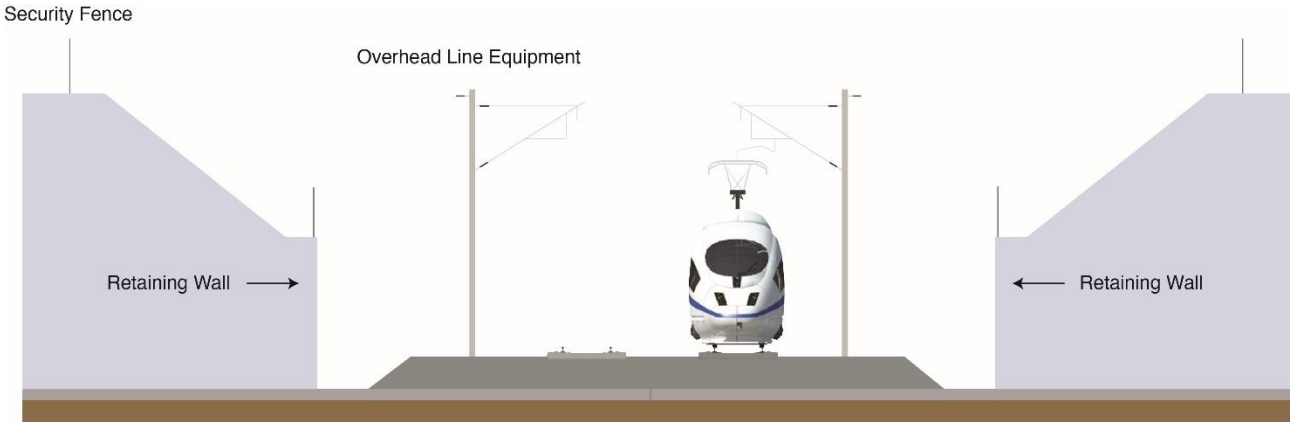


Figure 10: Illustration of a generic embankment and environmental mitigation earthworks and cross-section of embankment



5.3.4 The angle of side slopes for cuttings and embankments, and therefore the overall width of the works, will depend on local ground conditions and topography, and on the quality of excavated material. In general, embankment slopes will be 1:2.5, that is for each metre of depth or height, the width of each slope will be 2.5 times larger. Slopes may be steepened or retaining walls may be used where space is limited; for example, where the area of land required needs to be reduced. An illustration of retaining walls is shown in Figure 11.

Figure 11: Illustration of retaining walls



5.3.5 Slopes will generally be top-soiled and seeded. In unfavourable geological conditions, stabilising elements and/or drainage may be incorporated within slopes. Where mitigation earthworks are proposed to be returned to agricultural use, arable slopes

will be re-graded to no steeper than 1:8, although steeper grades may be adopted for pastoral use.

5.3.6 Priority will be given to reusing material excavated from the Proposed Scheme in the engineering earthworks to form embankments and environmental mitigation earthworks along the route. This is considered to be a more sustainable use of material and will reduce the need to move surplus excavated material[75] off-site, which has associated environmental effects. This approach will also reduce the impact of the Proposed Scheme by making best use of the excavated material to significantly reduce the need to import material. Where additional high quality material is needed for rail embankments this will be obtained from borrow pits located adjacent to the route of the Proposed Scheme. Use of borrow pits will significantly reduce the need for HGVs to use the local road network (see section 6.8).

5.4 Drainage and watercourse realignments

Railway drainage

5.4.1 Drainage parallel to the railway will generally comprise filter drains feeding balancing ponds at intervals along the route. These ponds are of three types: attenuation ponds, infiltration ponds and hybrid ponds. Attenuation ponds will attenuate peak flows so that run-off generated from the railway track discharges at an agreed rate to a nearby watercourse, thereby reducing the risk of localised flooding[76]. Infiltration ponds will allow run-off to be absorbed into the ground where conditions are suitable. Many of the ponds will be a hybrid combining features of both types.

5.4.2 Balancing ponds will typically be unlined and may have banks with a varying profile. Their size will depend on drainage requirements. The balancing ponds will not be designed to hold water permanently, but will be dry most of the time, except following intense rainfall events. They will be designed to accommodate a one in 100 year annual rainfall probability event, with an allowance for climate change.

5.4.3 Surface water run-off within built-up areas may need to be discharged to the urban drainage system for example, a piped combined sewer, at a controlled rate.

IMB-R and tunnel headhouse facilities drainage

5.4.4 Sewage from the IMB-R and facilities at tunnel headhouses will be discharged into adjacent sewers, where available with appropriate capacity. Collection of foul effluent and off-site disposal may be necessary in specific cases.

5.4.5 Surface water run-off from buildings and areas of hardstanding (e.g. accesses and parking) will be infiltrated to ground or will be attenuated and discharged, at a rate agreed with the relevant authority, to a nearby watercourse or a sewer. The design will employ sustainable drainage systems to manage surface water run-off and improve discharge water quality. The drainage system will also incorporate pollution control devices such as oil and silt traps where necessary.

[75] Excavated material will become surplus if its irrecoverable physical, chemical or bio-chemical quality precludes its use in the Proposed Scheme, if there is more material available than fulfils the requirements of the Proposed Scheme, or if the requirement for a type of material is too far away from the point of arising to make its use practicable.

[76] Volume 3: Route-wide effects outlines pollution control measures should pollutants enter these ponds.

Land drainage

5.4.6 In some locations, structural and landscape earthworks will affect existing drainage systems of agricultural and other land adjacent to the new railway. Elsewhere, they will alter the existing overland flow routes helping to drain surface water run-off from fields and areas of woodland, or change the slope of the land. The design will therefore include land drainage measures to address these changes in an appropriate way.

Floodplain storage areas

5.4.7 The Proposed Scheme avoids an increase in the risk of flooding from all sources, taking into account the projected impact of climate change. Where required, the Proposed Scheme will mitigate loss of floodplain by creating replacement floodplain storage areas.

Watercourse crossings

5.4.8 New structures will be required to carry the railway over existing watercourses, ranging from box culverts[77] to underbridges[78]. The length of culverts will be kept to a practicable minimum. Culverts will be designed for a one in 100 year annual rainfall probability event, including an allowance for climate change. Bridge soffits[79] will be raised above the one in 100 year annual rainfall probability event, including allowances for climate change and freeboard[80].

Watercourse realignment

5.4.9 Watercourses will need to be realigned in some cases. Channel flows will be designed and maintained in consultation with the relevant drainage authority. The methods to divert watercourses are described in more detail in Section 6.9 of this report.

5.4.10 Rivers and streams will be reinstated, where reasonably practicable, with a natural-looking appearance, having consideration for the requirements of the Water Framework Directive (WFD). Appropriate access will be provided to watercourses to allow for maintenance.

5.5 Highways (roads) and public rights of way

5.5.1 New, diverted or realigned roads and public rights of way (PRoW, i.e. footpaths, bridleways and byways), will be constructed to the appropriate standard for each location. All alterations to major rural roads will be designed using the UK's national standards given in the Design Manual for Roads and Bridges (DMRB)[81]. These will be applied where new, realigned or diverted routes are required, helping them to retain a similar 'feel' as other roads in the locality. Local authority design standards will also be used, where appropriate, together with national guidance including the Manual for Streets[82]. The shortest practicable route for realignment consistent with design and safety requirements will normally be used. PRoW realignment and replacement will be

[77] A tunnel (pipe or box shaped) that carries a stream or open drain under a road or railway.
[78] A bridge carrying the Proposed Scheme over other features.
[79] The underside of a bridge.
[80] The height from the maximum design level of a watercourse to: a) the adjacent banks of an open channel, to provide a factor of safety against flooding; or b) the soffit (underside) of any culvert or bridge above, to minimise the risk of blockage by floating debris, etc.
[81] Department for Transport (DfT), (2012), Design manual for roads and bridges.
[82] Department for Transport (DfT), (2007), *Manual for Streets*. Thomas Telford publishing, London.

designed into their surroundings as far as possible, and to retain the existing character of the route.

5.5.2 New or enhanced vehicular access will be required at various points to allow access to the Proposed Scheme. Facilities such as the IMB-R will require access at all times. Emergency access will be required to tunnel portals, whilst occasional access will be required for maintenance purposes to features such as balancing ponds, structures, landscaped areas and line-side equipment.

5.6 Tunnels

Introduction

5.6.1 Two tunnels will be constructed along the route, as described in the Volume 2 community area reports, Section 2.2. The following methods of construction will be used:

- bored and mined (for cross passages), which leaves the original surface features intact; and
- cut-and-cover, which requires temporary disruption at the surface whilst the tunnel is constructed, followed by the reinstatement of surface conditions.

5.6.2 All tunnels will have portals (i.e. exit/entrance structures). The different tunnel types and features are described in the following section.

Bored tunnels

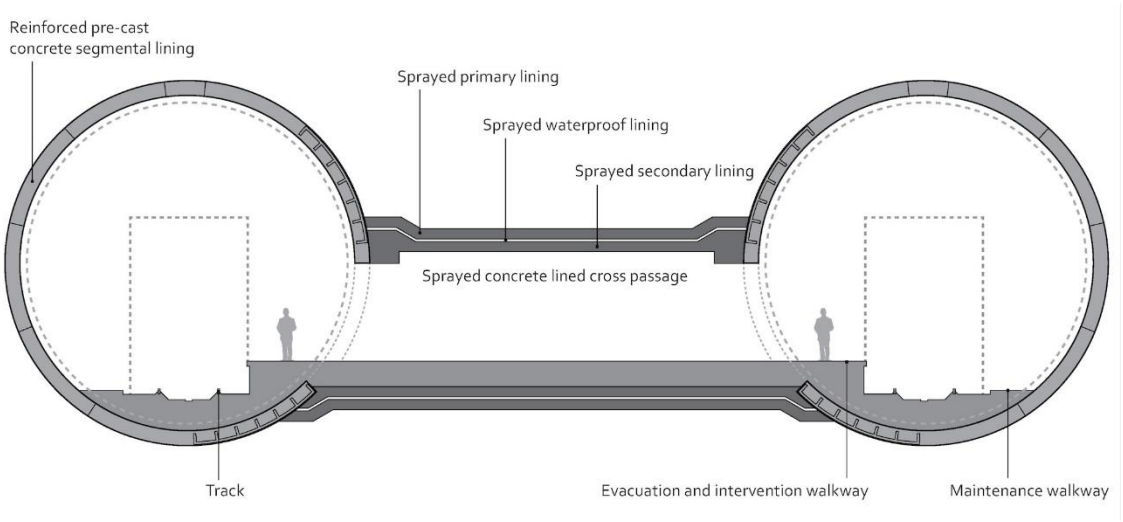
5.6.3 Bored tunnels will generally be constructed where the depth between the railway and existing ground is such that open excavation is not practicable, and where the tunnel length is sufficient to make the use of tunnel boring machine (TBM) equipment viable (the machines used to bore the tunnels). Bored tunnels are currently proposed beneath the settlement of Whitmore Heath for a distance of 690m (with a small section of cut-and-cover tunnel as noted in paragraph 5.6.9), and to the west of Madeley, which will be 670m long (in community area 4, Whitmore Heath to Madeley). These will be twin-bore tunnels comprising two parallel bores, each containing a single rail track.

5.6.4 Tunnel bores will usually have an external diameter of 10.2m and an internal lined diameter of 8.8m. They will be approximately one tunnel diameter apart, except where they approach the portals, and will be connected by cross passages at intervals.

5.6.5 Further detail about the nature and operation of TBMs is provided in section 6.12.

5.6.6 A cross-section of a typical twin-bore tunnel is shown in Figure 12.

Figure 12: Cross-section of typical twin-bore tunnel



Mined tunnels/sprayed concrete lined tunnels

5.6.7 Mined tunnelling/sprayed concrete lined (SCL) techniques will be used for cross passages. The excavation is undertaken in stages, with excavated faces stabilised with sprayed concrete and other supporting measures. Further information on this tunnelling method can be found in Section 6.16 of this report.

Cut-and-cover tunnels

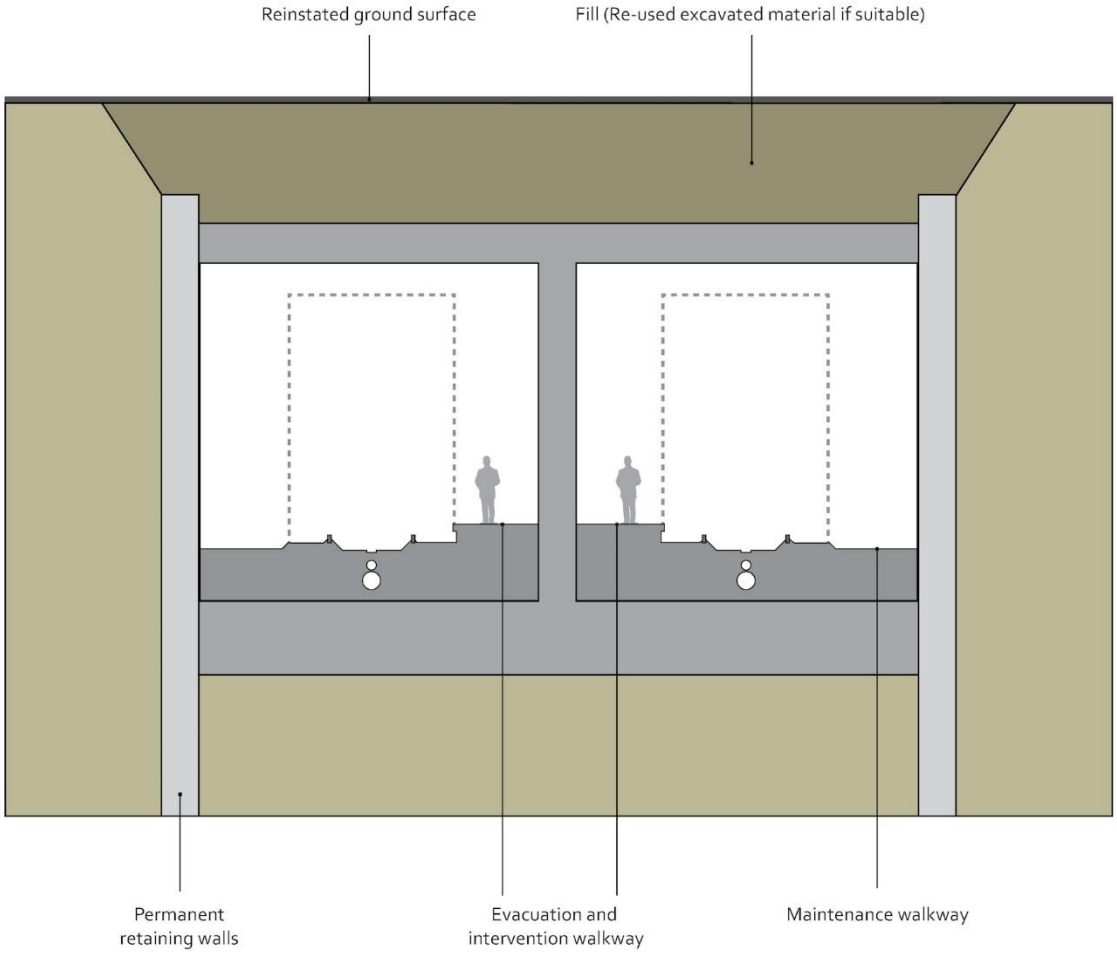
5.6.8 Cut-and-cover tunnels are built by excavating the ground, building a tunnel structure, and then restoring the land over the top. Soil will be spread on top to integrate it with the landscape, thus minimising visual impacts and making the presence of a railway less noticeable. PRoW and access tracks can be replaced over the completed tunnel, vegetation can be replanted and the land returned to its former use.

5.6.9 Cut-and-cover tunnelling will be used on part of Whitmore Heath tunnel. This section of the tunnel will be 240m in length and up to 17m in depth[83] and will then continue in to Whitmore Heath twin-bore tunnel.

5.6.10 A cross-section of a typical cut-and-cover tunnel is shown in Figure 13.

[83] 17m to rail level.

Figure 13: Cross section of a typical cut-and-cover tunnel



5.7 Portals

5.7.1 All tunnels will have portals at each entry/exit. Portals will take different forms, depending on ground conditions, local topography, train speeds and whether they need to accommodate a TBM during construction.

5.7.2 Tunnel portals may incorporate some or all of the following features:

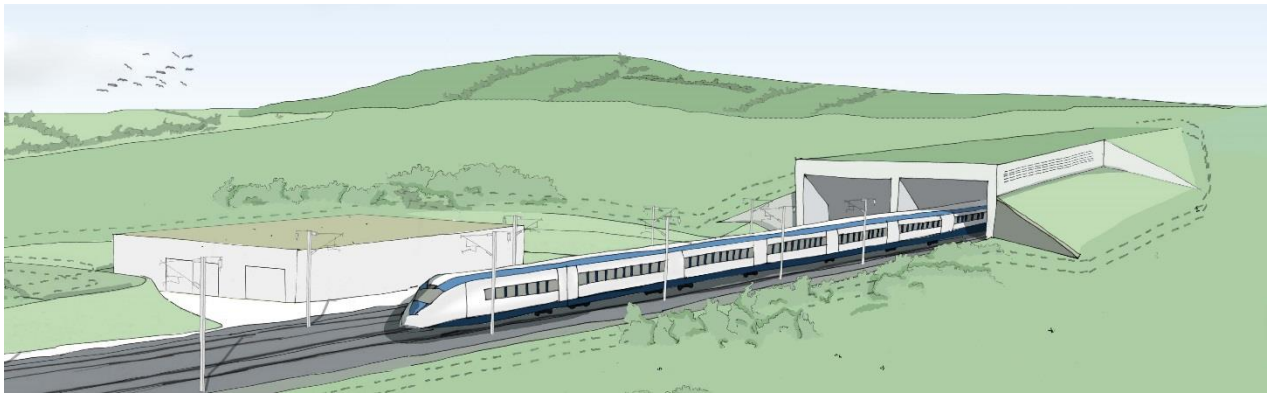
- porous portal (i.e. tapered, perforated, reinforced concrete structures)[84];
- mechanical ventilation[85];
- surface buildings housing services such as power, telecommunications, water supply, fire safety, drainage and ventilation equipment;
- storage tanks;
- road access for emergency services;

[84] Perforated structures at tunnel portals (entrances), usually formed of concrete, designed to allow the passage of air from the tunnel. These reduce both air pressure changes and the noise generated when a high speed train enters or leaves a tunnel.
[85] Ventilation fans will be switched off under normal conditions, but will be activated in the event of a stalled train or a fire, and for maintenance purposes. It is likely that this equipment will only operate for limited testing periods during the daytime.

- escape routes;
- a 550m² area for passengers in the event of an emergency; and
- parking and hardstanding for service vehicles.

5.7.3 An illustrative example of a cut-and-cover tunnel portal in a rural location is shown in Figure 14.

Figure 14: Example illustration of a general cut-and-cover tunnel portal



5.8 Bridges

5.8.1 Bridges are required where the route will pass over or under an existing feature such as a PRoW, road, river, floodplain or existing railway. The height of the bridge will be determined by the route alignment, the topography and the feature being crossed.

5.8.2 Overbridges (i.e. bridges over the Proposed Scheme) will typically be constructed of concrete or weathering steel. Typical height clearances will be 7.15m (i.e. from rail level to the underside of the bridge).

5.8.3 Intermediate piers are likely to be of reinforced concrete construction on pad or piled foundations[86], subject to ground conditions.

5.8.4 Generally, parapets[87] will be 1.8m in height where above the railway lines.

5.8.5 Underbridges (i.e. bridges carrying the Proposed Scheme over other features) are likely to be constructed of reinforced concrete and/or steel. Clearances will vary as required by the type of feature being crossed. For watercourses, underbridges will be designed for a one in 100 annual rainfall probability event, including allowances for climate change and freeboard.

5.8.6 Figure 15 is an illustrative example of a single-span overbridge. Figure 16 is an illustrative example of a pedestrian underbridge.

[86] Pad foundation – A foundation structure that spreads the imposed loads over a sufficient area to reduce stress on foundation material. Often described as shallow foundations. Piled foundation – Deeper foundations such as piles, and diaphragm walls, where loads are distributed through the ground at depth by drilled or driven structures. Often described as embedded or deep foundations.
[87] Low walls along the edges of the bridge, to protect people from falling.

Figure 15: Example illustration of a single-span bridge

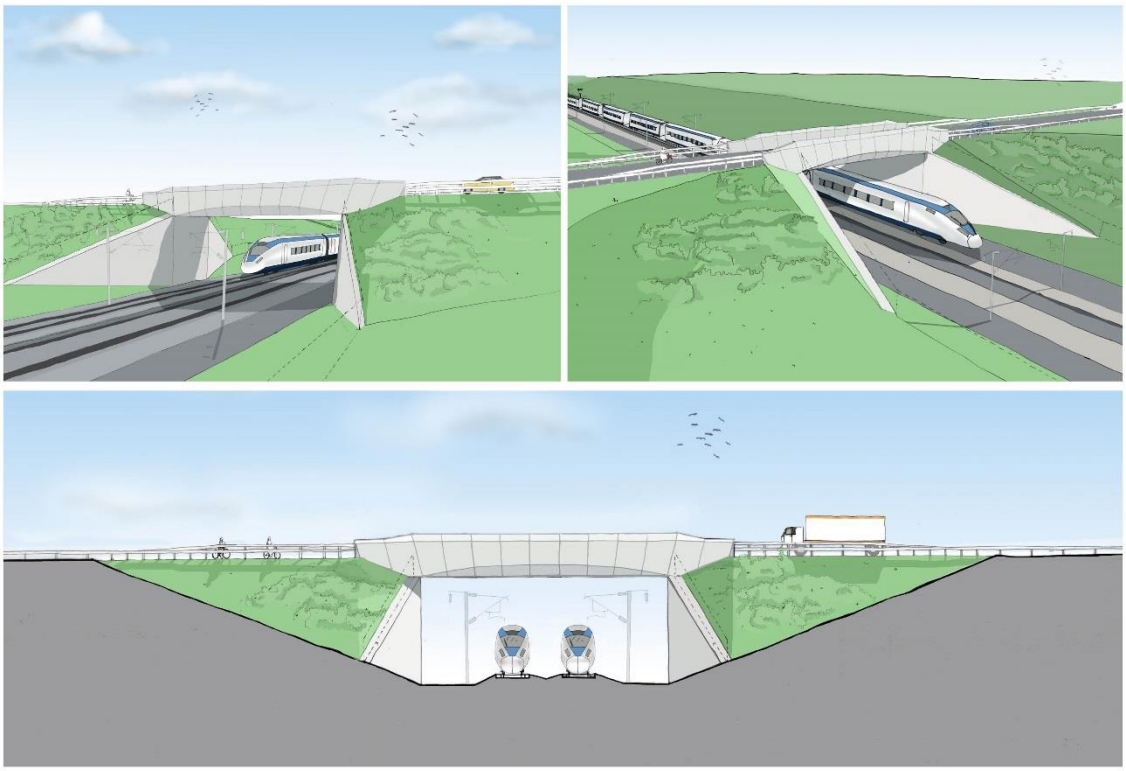
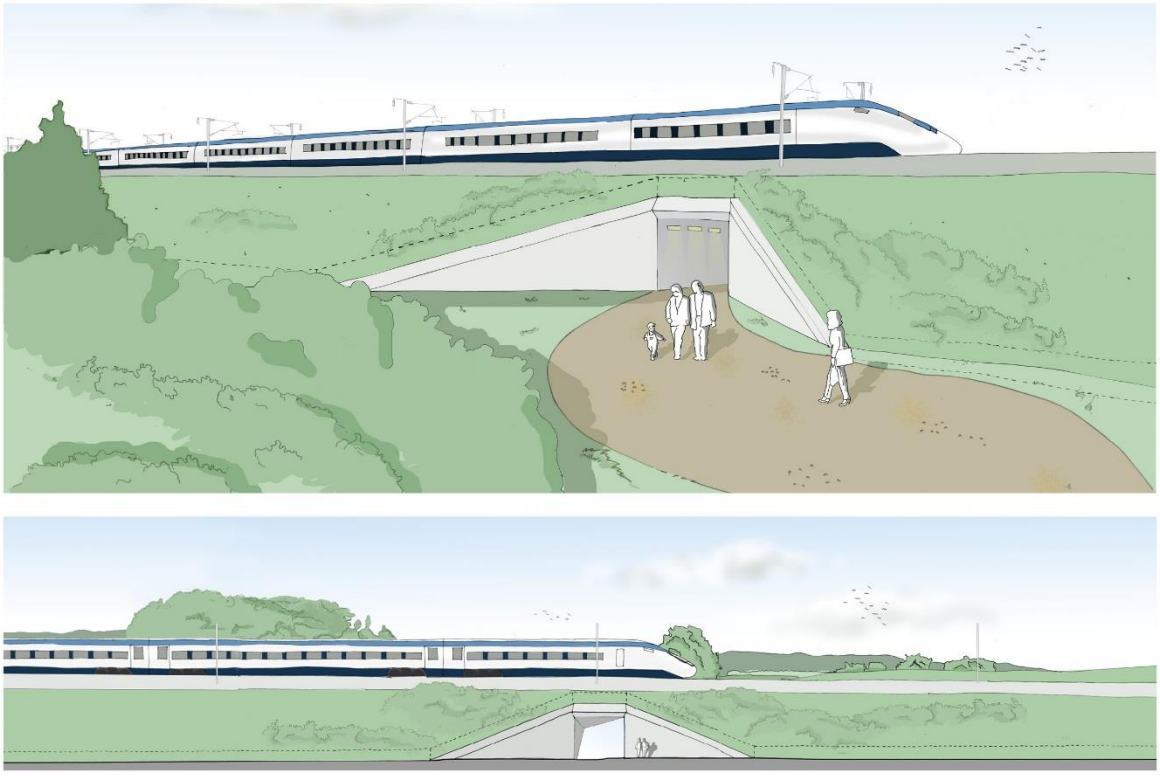


Figure 16: Example illustration of a pedestrian underbridge



Green bridges

5.8.7 Green bridges are bridges which have been designed in order to maintain habitat connectivity, and to enable the safe movement of animals (including bats) from one side of the route of the Proposed Scheme to the other. Typically, these bridges are multi-functional and provide other types of access such as footpath, road or agriculture as their primary purpose. The main difference between a standard bridge and a green bridge is the increased width to allow vegetation, typically including one or two hedgerows comprising a range of local/native species, to be planted across the bridges.

5.8.8 In order to encourage species to use green bridges, planting on and around the entrance to the structures will link to existing vegetation in the local landscape. In some cases the design for planting may include the enhancement of existing vegetation nearby to allow a seamless transition between bridge and land. As well as providing safe passage and habitat links, the addition of vegetation will also help integrate the Proposed Scheme into the surrounding landscape.

5.8.9 Typically green bridges will be unlit to ensure that light sensitive species, such as bats, are not discouraged from using them. Where lighting is considered essential for safety purposes, levels and light spill will be carefully controlled.

5.8.10 There are five green bridges proposed, on a precautionary basis[88], along the route of the Proposed Scheme.

5.8.11 In addition, some underbridges will provide ecological connectivity through their design and planting approach.

5.9 Viaducts

5.9.1 Viaducts are constructed where embankments would not be a practicable or effective solution, such as crossing a river or floodplain. Viaducts will generally be built where a multi-span structure is needed to provide a continuous elevated route across undulating terrain, existing roads or floodplains.

5.9.2 The height of the viaducts will depend on local topography and on the clearances required over existing features. Intermediate piers are likely to be of reinforced concrete construction on pad or piled foundations, subject to ground conditions or the construction methodology. Abutments will be constructed of reinforced concrete on pad or piled foundations. Viaducts over waterways will be designed for a one in 100 annual rainfall probability event, including allowances for climate change and freeboard.

5.9.3 Figure 17 and Figure 18 are illustrative examples of high and low-level viaducts.

[88] Green bridges are proposed on a precautionary basis, based on the current level of information obtained through site surveys. Further site surveys will be conducted and depending on the outcome, some, or all, of the proposed green bridges may no longer be required.

Figure 17: Example illustration of a high viaduct

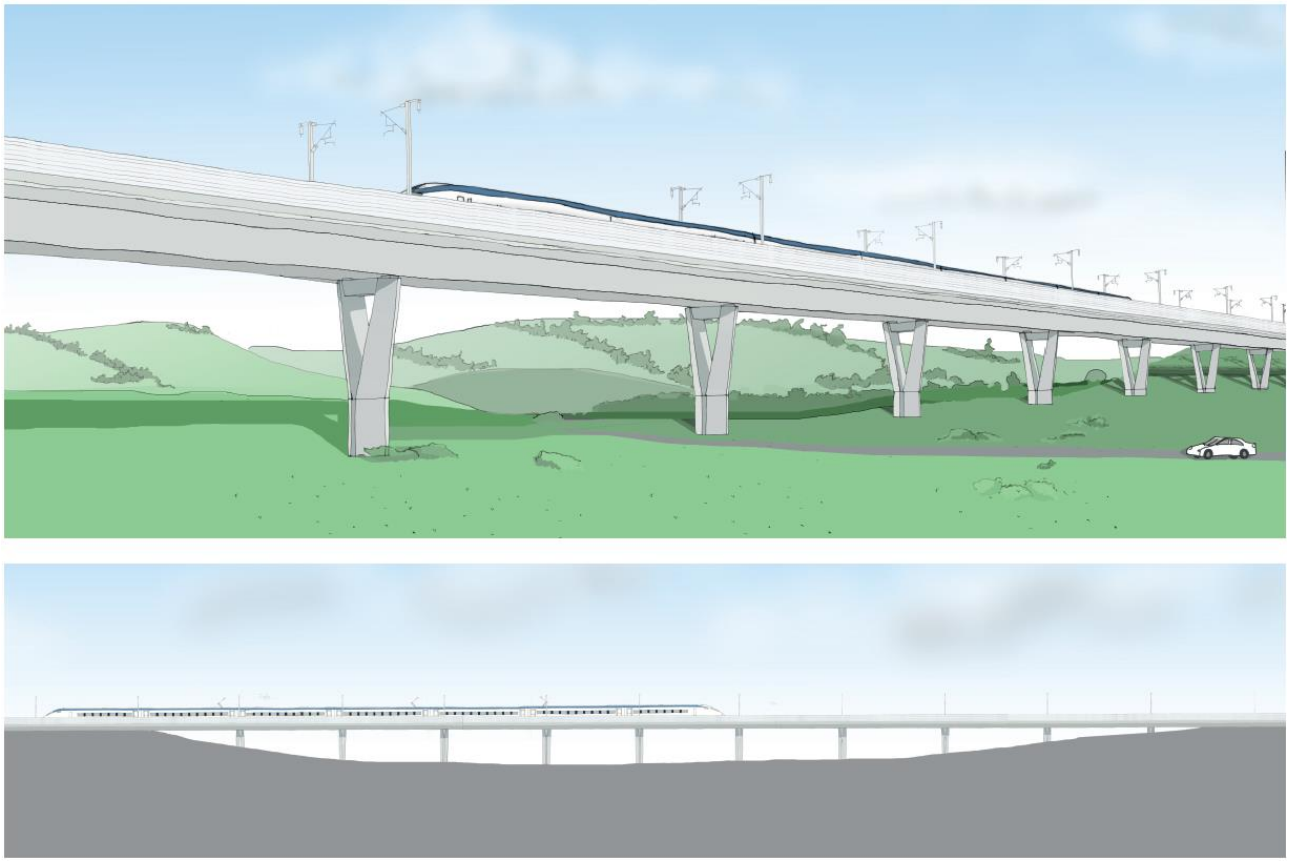
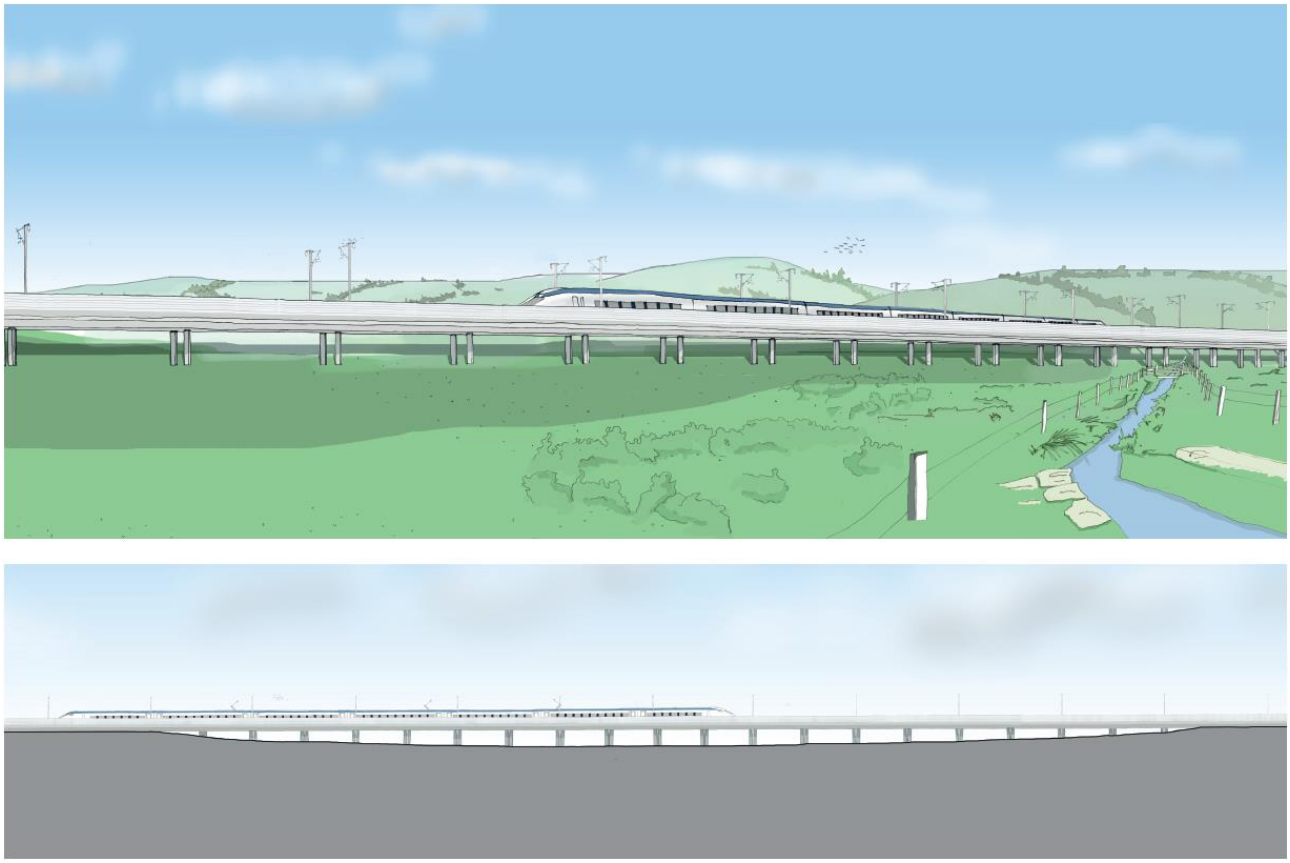


Figure 18: Example illustration of a low viaduct



5.10 Infrastructure Maintenance Base – Rail

5.10.1 The IMB-R is described in Volume 2: Community area 3, Stone and Swynnerton. The IMB-R will be located near Stone at the site of the Stone railhead main compound. This permanent maintenance facility, located on a site of approximately 40 hectares, will provide a central base to carry out maintenance activities on the route of the Proposed Scheme and will maintain Phase 2a infrastructure, as well as the full western section of Phase Two once operational.

5.10.2 Further information on the operational maintenance regime and staffing is provided in Section 4.3 of this report.

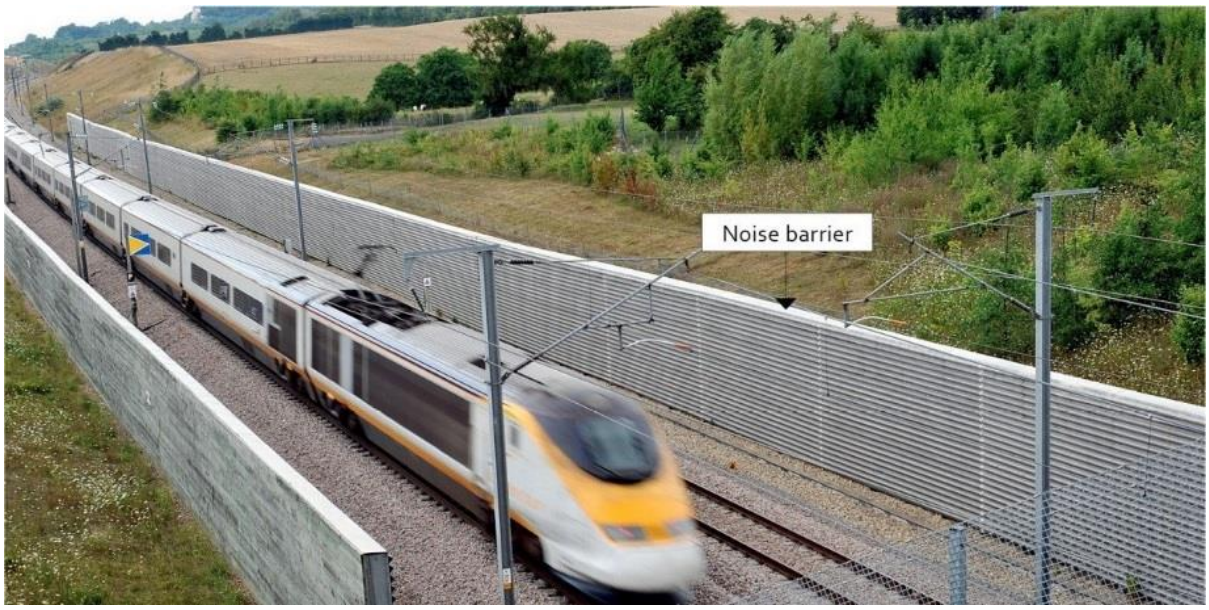
5.11 Noise barriers

5.11.1 The Proposed Scheme will include noise barriers where needed to avoid or reduce significant airborne noise effects. The barriers will generally take the form of landscape earthworks or noise fence barriers. The locations of noise barriers are shown in the Volume 2 Map Books.

5.11.2 The extents and heights of noise barriers are designed to minimise noise effects taking into account considerations such as the benefit of the barrier, its cost; engineering practicability; and other potential impacts such as visual intrusion.

5.11.3 Noise effects will be reduced at many locations along the route by engineering structures, such as cuttings, and by landscape earthworks provided to avoid or reduce significant visual effects. Noise fence barriers will also be located at locations along the route of the Proposed Scheme to reduce noise effects. An example of a noise fence barrier is shown in Figure 19.

Figure 19: Photograph of a noise fence barrier



Source: © Troika

5.12 Site restoration and landscape treatment

5.12.1 All temporary plant, materials, equipment, buildings, access roads and vehicles will be removed from the site when construction is complete.

5.12.2 Land used only for construction purposes will be restored as agreed with the owner of the land and the relevant planning authority once the construction works in that area are complete.

5.12.3 It has been assumed, for the purposes of the environmental assessment, that borrow pit sites will be restored to existing ground level and land use once excavation has been completed. It is anticipated that borrow pits will be restored with cohesive material generated from construction of the Proposed Scheme, typically clay, which does not have suitable characteristics for use as construction or engineering fill. Mitigation design will be developed to respond to the appropriate landscape strategies and design objectives set out in HS2 Ltd's *Landscape Design Approach*[89] (e.g. to conserve, enhance, restore or transform landscapes). The following may be provided within restored areas, to compensate for, or replace, resources adversely affected during construction:

- habitat for wildlife species/habitats; and
- areas of valued landscape character.

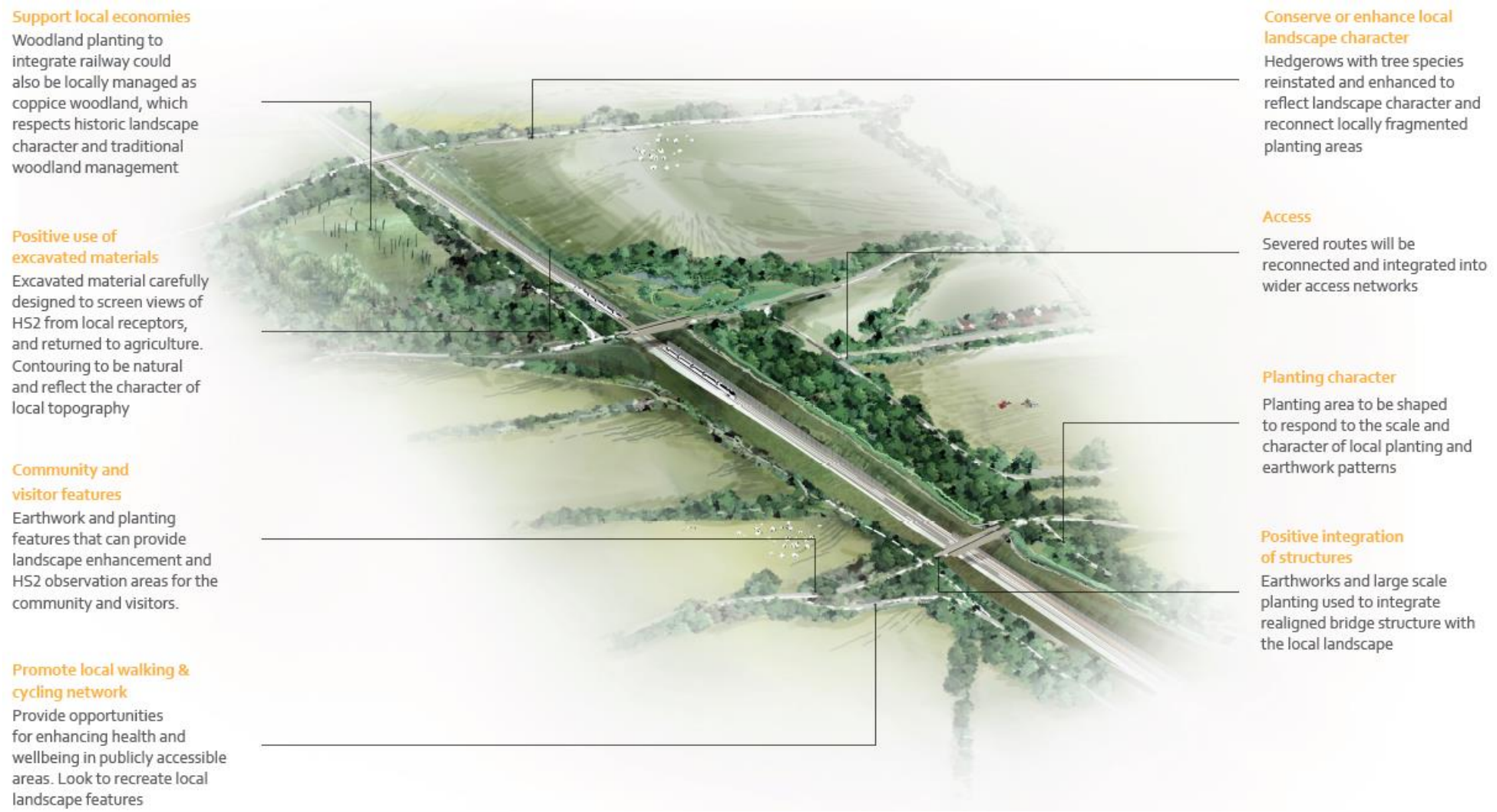
5.12.4 Any areas of replacement habitat will be established and appropriately monitored to maintain the long-term conservation status of the species/habitat.

5.12.5 Landscaped design solutions, as set out in the *Landscape Design Approach*, can provide multiple benefits, including visual screening, noise mitigation, habitat creation, and the protection and enhancement of heritage assets, as indicated in Figure 20. The provision of woodland, for example, can provide:

- screening and visual integration of the Proposed Scheme; and
- an interconnected and multi-functional green infrastructure network (providing enhanced resilience and biodiversity connectivity).

[89] HS2 Ltd., (2016), *HS2 Landscape Design Approach*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/550791/HS2_Landscape_Design_Approach_July_2016.pdf. The Landscape Design Approach was produced to guide and direct professionals in the development of all landscape areas with the aim to achieve an integrated and contextually driven landscape design.

Figure 20: Landscape design solutions



Source: HS2 Landscape Design Approach

5.12.6 Landscape design can assist biodiversity enhancement by linking existing features such as ponds, streams or waterways with woodlands, copses or hedgerows.

5.12.7 Trees and shrubs planted within restored areas will be of local provenance. Section 9 provides further information on the approach to mitigation and monitoring.

5.13 Track

5.13.1 The assessment has been undertaken on the assumption of slab track as the track form for the Proposed Scheme. Slab track will comprise precast concrete slabs supported on a continuous structural layer. A final decision on the track form will be made during the detailed design of the Proposed Scheme. The track and track-bed will be designed to avoid or reduce significant ground-borne noise or vibration effects from tunnels and surface sections of the route.

5.14 Power supply

5.14.1 Figure 21 indicates the process of supplying power to high speed trains.

5.14.2 Power will be supplied from the National Grid 400kV grid supply point (GSP) at Rugeley to an auto-transformer feeder station located adjacent to the route of the Proposed Scheme at Newlands Lane in the Fradley to Colton community area (CA1).

5.14.3 A connection, approximately 4km in length, will be required from the National Grid GSP to the Newlands Lane auto-transformer feeder station. The connection is expected to comprise of new 132kV transmission lines with some sections of underground cables. Two compounds (a cable sealing end compound adjacent to Cawarden Springs Wood and a cable sealing end compound adjacent to Hollow Lane) will be required, each of area approximately 0.3ha, with road access, at the points of transition from overhead line to underground cable and vice versa.

5.14.4 The National Grid GSP will contain switchgear[90], power transformers and ancillary equipment to step down the electrical power from 400kV to 132kV. A section of 132kV underground cable will be installed coming away from Rugeley power station to traverse the West Coast Mainline and the River Trent. The 132kV power supply from the GSP to the auto-transformer feeder station will then be routed via 132 kV overhead lines for the majority of its length.

5.14.5 The auto-transformer feeder station is expected to contain 132kV and 25kV switchgear, traction transformers, provision for load balancers[91] and ancillary equipment. It will be located adjacent to the route of the Proposed Scheme, occupying an area of approximately 2.75ha and will require road access. The 132kV cable will leave the grid supply point at Rugeley on an underground circuit passing underneath the River Trent, WCML and up to the cable sealing end compound near Cawarden Springs wood. From there, the cable will be on an overhead circuit up to the cable sealing end compound adjacent to Hollow Lane, with the final connection to the auto-transformer feeder station via underground cables.

5.14.6 Traction power auto-transformer stations will be provided along the route of the Proposed Scheme at approximately 5km intervals. They will accommodate

[90] Switchgear is electrical equipment used to control and interrupt the flow of electricity to a circuit.
[91] Electrical equipment used to balance the electrical loads so that the unbalance is kept within acceptable limits set by the supply authority.

switchgear, transformers and associated equipment, including cabinets for the communications system and non-traction power, and will require road access. They will each occupy an area of approximately 0.1-0.2ha.

5.14.7 A mid-point auto-transformer station[92] will be located near to Gonsley Green Farm. It will allow the overhead line to be sectioned to create two supply areas. A mid-point auto-transformer station is effectively two auto-transformer stations located on the same site, with each auto-transformer station connected to each supply section. The mid-point autotransformer station will require an area of approximately 0.2ha, together with road access.

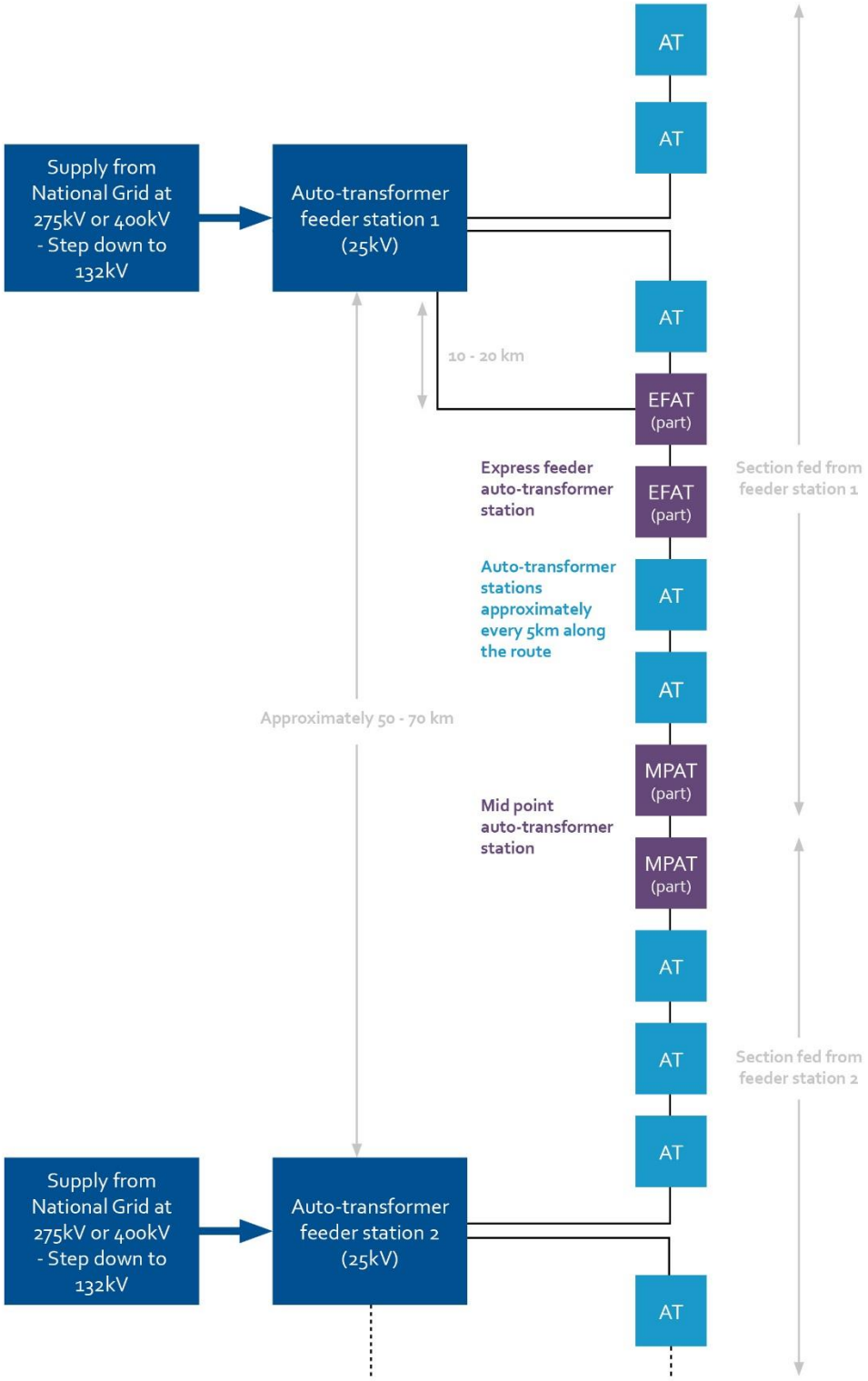
5.14.8 An express feeder auto-transformer station[93] will be located approximately 18.1km to the north of Newlands Lane auto-transformer feeder station at Yarlet. The express feeder auto-transformer station is required to improve the voltage level along the line and to manage the distribution of electrical load in circuits/equipment, by having a direct connection from the auto-transformer feeder station. An express feeder auto-transformer station is a larger form of mid-point auto-transformer station that is connected locally to the overhead line and to the remote auto-transformer feeder station via an express feeder cable located lineside within the railway corridor, and will require approximately 0.4ha of land together with road access.

5.14.9 Power will be transmitted to the trains through overhead line equipment. The overhead line equipment will comprise steel masts and cantilever supports, portal frames where appropriate, catenary wires to transmit the current to the train pantographs[94], catenary support wires, autotransformer feeder wires and earth wires[95]. The masts and frames will be approximately 8.5m high and will be spaced at approximately 45-65m intervals along the track.

5.14.10 Electrical power will be required for other purposes in addition to the traction power supply, including points heating, for rail systems (train control, communications, traction substations etc.), lighting and the operation of equipment in tunnels, and the IMB-R. Arrangements will be made with the local Distribution Network Operator for auxiliary power supplies at each location where they are required.

[92] The buildings, outdoor switchgear and transformers forming a mid-point auto-transformer station will be up to 5m in height.
[93] The buildings, outdoor switchgear and transformers forming an express feeder auto-transformer station will be up to 5m in height.
[94] A device mounted on the roof of a train to provide an electrical and mechanical connection between the train and the overhead contact wire.
[95] A system of wires used to support the contact wire at the correct height above the track.

Figure 21: Diagram showing the indicative process of supplying power to the trains



5.15 Train control and telecommunications

5.15.1 The train control system will be a computer-based interlocking system, controlled from a route-wide network control centre at the Washwood Heath depot in Birmingham (as described in Volume 2: Washwood Heath to Curzon Street report (Community Forum Area 26) of the Phase One main ES[96]).

5.15.2 The Proposed Scheme will not require traditional trackside signals for its operation on the HS2 main line. However, a number of conventional railway signals and associated equipment will be required on HS2 infrastructure where HS2 trains transition onto the conventional railway. HS2 lineside signalling equipment will be required on the conventional railway in and around Crewe Station.

5.15.3 The associated line-side equipment on the HS2 main line will include cable troughs, axle counter equipment, switches and crossings control equipment, marker boards and boards and cabinets, generally no more than 1-3m high.

5.15.4 The route will use radio communications as part of its railway operations and train control systems. This will require radio antennae to be installed at fixed locations along the alignment. The antennae will typically be at a height of up to 10m from track level. The associated radio transmission equipment will be mounted at the base of the antennae masts. A communications backbone will be provided by a network of optical fibre cables. These cables will be laid in troughs beside the track, and will connect all line-side equipment, including the extended communications equipment within the footprints of the electrification compounds (auto-transformer feeder station/auto-transformer station sites), to the control centre.

5.15.5 To facilitate the transition from HS2 to the conventional railway and vice versa, it will be necessary to install HS2 radio system equipment for several kilometres alongside the conventional railway and similarly Network Rail equipment, such as Global System for Mobile Communications- Railways (GSM-R) apparatus alongside the HS2 track.

[96] HS2 Ltd., (2013), *London-West Midlands Environmental Statement, Volume 2 Community Forum Area Report, CFA26, Washwood Heath to Curzon Street*. Available online at: http://webarchive.nationalarchives.gov.uk/20140806172102/http://assets.dft.gov.uk/hs2-environmental-statement/volume-2/Volume_2_CFA26_Washwood_Heath_to_Curzon_Street.pdf

6 Construction of the Proposed Scheme

6.1 Introduction

6.1.1 This section provides an overview of the typical activities and methods that are anticipated to be used during construction. Construction of the Proposed Scheme will commence in 2020, with operation planned to start in 2027. A construction programme for each community area is included within the Volume 2 community area reports.

6.2 Construction land requirements

6.2.1 Land will be required temporarily during the construction period for uses including the following:

- construction compounds, batching plants, land for temporary storage of excavated material/temporary material stockpiles and their access/egress;
- the diversion, realignment and widening of roads and junctions, and/or the provision of temporary alternative routes;
- the diversion and realignment of PRoW and private accesses, and/or the provision of temporary alternative routes;
- the diversion and realignment of existing railways, watercourses and utilities;
- transfer nodes[97], and the railhead[98] will be used for the movement of excavated material and delivery of construction materials and plant; and
- borrow pits for obtaining construction material, which will be restored using excavated material from the Proposed Scheme that is not suitable for engineered embankments.

6.2.2 Land for the temporary storage of excavated material will be required during the earthworks stage, mainly at locations where large volumes of excavated material arise, such as tunnel portals and deep excavations. Temporary material stockpiles will be required at certain sections of the route to limit the distances over which such materials need to be transported. Land will be returned to its pre-construction use, wherever appropriate, or to a condition agreed by the owner of the land and the relevant planning authority.

6.3 Environmental controls during construction

Overview

6.3.1 The nominated undertaker and all construction contractors will be subject to existing applicable legislation and the protective legislative provisions set out in the Bill. As described in Section 1.4, environmental controls and processes contained in the EMRs will provide the mechanisms for meeting environmental commitments following

[97] A transfer node is a location where bulk deliveries or excavated materials leave or enter the construction worksites from public roads.
[98] A railhead is a site at a strategic location along the route with connections to the National Rail network. Railheads will be used as the delivery location for bulk rail-borne materials, such rails and sleepers.

Royal Assent. The nominated undertaker and all construction contractors will be required to comply with the CoCP and a series of local environmental management plans (LEMPs).

6.3.2 Site-specific control measures at a local level will be included within the LEMPs, which will be developed during the Parliamentary process and detailed design stage in consultation with the relevant stakeholders. The Proposed Scheme extends across five local authorities, necessitating engagement with a wide range of stakeholders. The CoCP is, therefore, intended to provide a framework to ensure a consistent approach.

6.3.3 The draft CoCP[99] is presented in Volume 5: Appendix CT-003-000. This section summarises its key elements.

Purpose of the Code of Construction Practice

6.3.4 The draft CoCP sets out a series of proposed measures and standards of work, which will be applied by the nominated undertaker and its contractors throughout the construction period to provide:

- effective planning, management and control during construction to control potential impacts upon people, businesses and the natural and historic environment. This also includes arrangements for monitoring, where appropriate; and
- the mechanisms to engage with the local community and their representatives throughout the construction period.

6.3.5 The nominated undertaker and its contractors will comply as a minimum with applicable environmental legislation at the time of construction, together with any additional environmental controls imposed by the Bill. For this reason the applicable statutory requirements are not repeated within the draft CoCP. Further guidance on specific areas, such as soil handling and dust management, will be considered from industry best practice guidance documents as set out in the draft CoCP.

Environmental management system

6.3.6 The nominated undertaker will develop an environmental management system (EMS) in accordance with BS EN ISO 14001[100]. The EMS will provide the process by which environmental management both within its organisation and in relation to its operations is undertaken to ensure that the relevant findings of the ES are addressed throughout the construction phase. The EMS will set out:

- the procedures to be implemented to plan and monitor compliance with environmental legislation and other relevant requirements;
- the key environmental aspects of the work and how they will be managed;
- staff competence and awareness requirements and how these are to be achieved and maintained;

[99] The CoCP will be in draft form until it is finalised when the Bill receives Royal Assent.
[100] British Standard, (2004), *BS EN ISO 14001:2004 Environmental management systems*.

- record keeping arrangements;
- the procedures to be implemented to monitor compliance with the environmental provisions in the Bill; and
- the procedure to monitor compliance and the effectiveness of the measures included within the draft CoCP.

Lead contractors' environmental management systems

6.3.7 The nominated undertaker will require each of its lead contractors[101] to have an EMS certified to BS EN ISO 14001. Their EMSs will include roles and responsibilities, together with appropriate control measures and monitoring systems to be employed during planning and construction of the works for all relevant topic areas. Where the lead contractor is a joint venture, their EMS will be certified to cover the activities of the joint venture.

6.3.8 Lead contractors will be required, as part of their EMSs, to plan their works in advance to ensure that, as far as is reasonably practicable, measures to reduce environmental effects are integrated into the construction methods and that commitments from the ES and Bill are complied with. The works will also be subject to approval processes set out in the draft CoCP by the nominated undertaker (e.g. suitability of construction phase plans) and by any statutory consents required.

6.3.9 The lead contractors' EMSs will cover the activities of all their contractors. The lead contractors will also be required to coordinate with other contractors and relevant parties relevant to their works. This will be documented in their EMSs, as appropriate.

6.3.10 The lead contractors' EMSs will include procedures to monitor and report on compliance with the project's environmental requirements, together with provisions for any corrective actions required. The detailed provisions of the lead contractors' EMSs will be subject to review and acceptance as being suitable by the nominated undertaker.

Enforcement and local environmental management plans

6.3.11 The requirements set out in the CoCP will be applicable to the whole of the Proposed Scheme. They will apply to each construction contract let by the nominated undertaker. These requirements will be supplemented by a LEMP for each relevant local authority area.

6.3.12 The LEMPs will set out how the Proposed Scheme will adapt and deliver the required environmental and community protection measures within each local authority area, through a series of topic-specific measures that reflect the general requirements of the CoCP.

Monitoring

6.3.13 The lead contractors will undertake the necessary monitoring for each environmental topic to comply with the requirements of the CoCP, the relevant LEMP, any additional consent requirements and their EMSs. Aspects to be monitored will include the

[101] A lead contractor is a construction company that is directly contracted for the works by the nominated undertaker.

impact of the works and the effectiveness of mitigation measures. Any actions that may be necessary for compliance will be identified.

Considerate Constructors Scheme

6.3.14 Lead contractors will be required to sign up and adhere to the Considerate Constructors Scheme[102]. The Considerate Constructors Scheme is a UK-wide initiative that promotes good practice on construction sites through its codes of considerate practice. These commit the users of registered sites to be considerate and good neighbours, as well as being respectful, environmentally conscious, responsible and accountable.

Community relations

6.3.15 The nominated undertaker and its contractors will produce and implement a community engagement framework and provide appropriately experienced community relations personnel to implement it. The role of the personnel will be to provide appropriate information and to be the first point of contact to resolve community issues. The nominated undertaker will take reasonable steps to engage with the community, focusing on:

- those who may be affected by construction impacts, including local residents, businesses, landowners and community resources; and
- the specific needs of protected groups (as defined in the Equality Act 2010)[103].

6.3.16 Regular meetings will be held between the lead contractor, the nominated undertaker, local authority and representatives of the local community or other stakeholders to discuss construction issues and the forthcoming programme of works. The nominated undertaker and its contractors will:

- provide support for local businesses, landowners, voluntary and community organisations that may be affected by the works; and
- consider local employment, apprenticeships and educational initiatives when recruiting staff.

Advance notice of works

6.3.17 The nominated undertaker and its contractors will ensure that local residents, occupiers, businesses, local authorities and parish councils affected by the proposed construction works, as outlined in the ES, will be informed in advance of work taking place using the methods identified in the community engagement framework. The notifications will detail the estimated duration of the works, the working hours and the nature of the works. In the case of works required in response to an emergency, the local authority, parish council, local residents, businesses and community resources will be advised as soon as reasonably practicable. All notifications will include the community helpline number.

[102] Considerate Constructors Scheme. Available online at: www.ccscheme.org.uk
[103] *Equality Act (2010)*. London, Her Majesty's Stationery Office.

6.3.18 Information on the works will also be available on the HS2 website and at appropriate locations along the route. These locations will be identified in the LEMPs.

Core working hours

6.3.19 The contractors will apply for consents for the proposed works from the relevant local authority under Section 61 of the Control of Pollution Act 1974[104]. Applications will include details on proposed working hours.

6.3.20 The draft CoCP outlines the anticipated working hours. Core working hours will be from 08:00-18:00 on weekdays (excluding bank holidays) and from 08:00-13:00 on Saturdays. The nominated undertaker will require its contractors to adhere to these core working hours for each site as far as reasonably practicable, unless otherwise permitted by the relevant local authority under Section 61 of the Control of Pollution Act.

6.3.21 Guidance on site-specific variations to core hours and/or additional hours likely to be required will be included within the LEMPs following consultation with the relevant local authority.

6.3.22 The Section 61 process will also be used to agree, in advance, any work required to be undertaken outside core hours, except in the case of emergency and not including repairs or maintenance.

Start up and close down periods

6.3.23 The nominated undertaker's contractors will require start-up and closedown periods to help maximise productivity during the core hours. A period of up to one hour before and up to one hour after core working hours will be required. Activities within these periods will include (but not be limited to) deliveries, movement to place of work, unloading, maintenance and general preparation works. Activities within these periods will not include operation of plant or machinery likely to cause a disturbance to local residents or businesses. These periods will not be considered an extension of core working hours.

Additional working hours

6.3.24 Tunnelling and activities directly associated with it (such as removal of excavated material, supply of materials and maintenance of tunnelling equipment) will be carried out on a 24 hour a day, seven days a week basis. Where reasonably practicable, material will be stockpiled within the compound boundary for removal during normal working hours.

6.3.25 Work requiring possession of major transport infrastructure may be undertaken during night-time, Saturday afternoons, Sundays and/or bank holidays, for reasons of safety or operational necessity. Such activities will often involve consecutive nights of work over weekend possessions, and on occasion involve longer durations. Activities outside core working hours that could give rise to disturbance will be kept to a reasonably practicable minimum.

[104] *Control of Pollution Act (1974)*. London, Her Majesty's Stationery Office.

6.3.26 Certain operations such as earthworks are season- and weather-dependent. In these instances the nominated undertaker's contractors will seek to extend the core working hours and/or days for such operations to take advantage of daylight hours, with the consent of the relevant local authority.

6.3.27 Certain other specific construction activities will require extended working hours for reasons of engineering practicability. These activities include, but are not limited to, major concrete pours and piling/diaphragm wall works. Surveys, such as for wildlife or engineering purposes, may also need to be carried out outside core working hours.

6.3.28 The relevant local authority will be informed as soon as reasonably practicable of the reasons for, and likely duration of, any works required in response to an emergency or which, if not completed, would be unsafe or harmful to the works, staff, the public or the local environment. This information will also be made available via the HS2 Ltd helpline. Examples of the type of work envisaged include: where pouring concrete takes longer than planned due to equipment failure, or where unexpectedly poor ground conditions, encountered whilst excavating, require immediate stabilisation.

Abnormal deliveries

6.3.29 Abnormal loads or those that require a police escort may be delivered outside core working hours subject to the requirements and approval of the relevant authorities.

Management of construction traffic

6.3.30 Vehicles accessing the construction compounds can be divided into three broad categories:

- heavy goods vehicles (HGV): articulated lorries for plant and materials, concrete trucks, bulk tipper trucks, abnormal/oversize loads;
- light goods vehicles: pickups and small tipper trucks, vans and cars; and
- rail vehicles: used in the construction of works immediately adjacent to or over the existing rail network, or used to deliver material to or from the site.

6.3.31 Construction vehicles carrying materials, plant, other equipment or workforce, or that are empty, will travel on public roads and via the rail network, as well as within the construction area between compounds. Wherever reasonably practicable, the rail network will be used in preference to public roads. The construction compounds will provide the interface between construction areas and the public roads or rail network. Movements between the construction compounds and the working areas will be on designated haul roads within the construction area, often along the line of the new railway or parallel to it.

6.3.32 The transport assessment assesses the impact of construction traffic on the transport network at a local and regional level. Its findings will inform the traffic management plans that will be implemented during construction in consultation with the local traffic and highway authorities and the emergency services. Measures to be considered in these plans include the following, as appropriate:

- site boundaries and the main access/egress points for compounds;
- temporary and permanent closures, diversions or realignments of highways

(i.e. roads and PRoW); and

- the proposed traffic management and logistics strategies.

6.3.33 Lead contractors will be required to ensure that impacts on the local community from construction traffic are reduced to a reasonably practicable minimum and that public access is maintained where reasonably practicable. Traffic impacts will be reduced by identifying clear controls on vehicle types and hours of operation, and agreed routes for HGV. Highway works required to accommodate construction traffic will be identified. The number of private car trips to and from each site (both workforce and visitors) will be reduced by encouraging alternative sustainable modes of transport or vehicle sharing.

6.3.34 The measures in the CoCP will include clear controls on vehicle types, hours of site operation and routes for HGV, to reduce the impact of road based construction traffic. Construction workforce travel plans will be prepared by the lead contractors with the aim of encouraging the use of sustainable modes of transport and discouraging workforce commuting by private car, to reduce the impact of workforce travel on local residents and businesses. General and site-specific traffic management measures will be implemented on relevant roads, PRoW and other points of access as necessary.

Handling of construction material and surplus excavated material

6.3.35 Construction of the Proposed Scheme will generate significant quantities of excavated material. The nominated undertaker will use excavated material in the construction of the Proposed Scheme wherever feasible (as described in section 5.2), thereby reducing the need for imported materials and the off-site disposal of surplus excavated material.

6.3.36 The majority of excavated material that will be generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme.

6.3.37 The nominated undertaker will seek to provide any surplus excavated material that arises which cannot be beneficially reused for the earthworks of the Proposed Scheme for:

- use in other local construction projects where opportunities arise at the time of construction; and/or
- use for restoration of mineral sites, where the transportation of that material does not result in significant environmental effects.

6.3.38 Only if excavated material is not required or is unsuitable for the construction of the Proposed Scheme will it be considered waste.

Waste management

6.3.39 The main waste streams likely to arise during the construction phases will include:

- surplus excavated material from earthworks and tunnelling activities;
- demolition waste;
- construction waste; and

- waste generated by occupants of worker accommodation sites.

6.3.40 Waste management will be based on the principles of the waste hierarchy, whereby priority is given to the prevention of waste generation, followed (where this is not possible) by reuse, recycling and recovery respectively. Disposal to landfill will be undertaken only as a last resort[105].

6.3.41 The principal objectives of sustainable resource and waste management are to use material resources more efficiently, to reduce waste at source and to reduce the quantity of waste that requires final disposal to landfill. 'Designing-out waste' principles will be applied to reduce the quantity of waste generated. An integrated earthworks design approach has been developed in order to minimise the quantity of excavated material generated and use that which is generated to satisfy the necessary engineering and environmental mitigation requirements for the Proposed Scheme.

6.3.42 A site waste management plan will be prepared and maintained by the nominated undertaker's lead contractors in order to identify the specific types and quantities of waste likely to arise during the construction process.

6.3.43 Further information regarding excavated material and waste management is given in the draft CoCP.

Noise and vibration strategy

6.3.44 Construction noise and vibration will be controlled and managed in accordance with the CoCP. The principles of these control and management processes are as follows:

- Best Practicable Means (BPM), as defined by the Control of Pollution Act and Environmental Protection Act 1990[106], will be applied during construction activities to minimise noise (including vibration) at neighbouring residential properties.
- mitigation measures will be applied, as part of BPM, in the following order:
  - noise and vibration control at source: for example, the selection of quiet and low-vibration equipment, review of construction methodology to consider quieter methods, location of equipment on-site, control of working hours, the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings; and then
  - screening: for example, local screening of equipment or perimeter hoarding.
- where, despite the implementation of BPM, the noise exposure exceeds the criteria defined in the draft CoCP, noise insulation or ultimately temporary rehousing will be offered.
- lead contractors will seek to obtain prior consent from the relevant local authority under Section 61 of the Control of Pollution Act for the proposed

[105] Unacceptable material Class U2 material will be disposed of directly to hazardous landfill. Class U2 'hazardous waste', is described in the Manual of Contract Documents for Highway Works, Volume 1- Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clause 3(i); http://www.standardsforhighways.co.uk/ha/standards/mchw/vol1/

[106] *Environmental Protection Act (1990)*. London, Her Majesty's Stationery Office.

construction works. The consent application will set out BPM measures to minimise construction noise, including control of working hours, and provide a further assessment of construction noise and vibration including confirmation of noise insulation or ultimately temporary re-housing provision.

- contractors will undertake and report such monitoring as is necessary to assure and demonstrate compliance with all noise and vibration commitments. Monitoring data will be provided regularly to, and be reviewed by, the nominated undertaker and will be made available to the local authorities.
- contractors will be required to comply with the terms of the CoCP and appropriate action will be taken by the nominated undertaker as required to ensure compliance.

6.3.45 Taller screening will also be used if required to avoid or further reduce significant effects along the edge of the construction site boundary. This is described in the draft CoCP[107].

6.3.46 Noise insulation or ultimately temporary rehousing will enable residents to avoid being significantly affected[108] by levels of construction noise inside their dwellings.

6.3.47 Buildings qualifying for noise insulation or residents qualifying for temporary re-housing will be identified early enough so that noise insulation can be installed, or temporary re-housing provided, before the start of the works predicted to exceed noise insulation or temporary re-housing criteria.

Ground settlement

6.3.48 Excavation for the tunnels and other below ground structures will potentially lead to small ground movements at the surface and below ground. The amount of ground movement will depend on a number of factors including depth and volume of works below ground, soil and groundwater conditions and the presence and nature of building foundations/third party assets. In most cases this will have no material impact on property/third party assets. Very rarely these ground movements may affect properties/third party assets. Techniques for controlling settlement of buildings and protecting buildings from irreparable damage are well developed, based on other tunnelling projects such as the Jubilee Line extension, HS1 and the Elizabeth Line (formerly Crossrail). Appropriate techniques will be implemented to control and limit, as far as reasonably practicable, the effects of settlement.

6.3.49 The nominated undertaker will assess potential settlement along the route of the railway and include the risk of damage to all buildings within the zone affected by settlement. Depending on the level of risk, either no action will be required, buildings will be monitored during construction, or special measures will be implemented where required to protect the buildings.

[107] As described in the draft CoCP, provided as necessary by solid temporary hoarding, temporary earth stockpiles, screening close to the activities or other means to provide equivalent noise reduction.
[108] Information is provided in Planning Practice Guidance– Noise. Available online at: https://www.gov.uk/guidance/noise--2 (for example, the table summarising the noise exposure hierarchy).

6.3.50 Measures to reduce settlement will form part of the EMRs, as will survey and monitoring requirements.

Extreme weather events

6.3.51 The nominated undertaker's contractors will pay due consideration to the impacts of extreme weather events and related conditions during construction. The contractors will use a short- to medium-range weather forecasting service from the Met Office or other approved provider of meteorological data and weather forecast provider to inform short- to medium-term programme management, environmental control and impact mitigation measures. The contractors will register with the Environment Agency's Flood warning information service in areas of flood risk.

6.3.52 The lead contractors will ensure that appropriate measures within the CoCP are implemented, and as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.

6.3.53 The lead contractors' EMSs should consider all measures deemed necessary and appropriate to manage extreme weather events and should specifically cover training of personnel and prevention and monitoring arrangements. As appropriate, method statements should also consider extreme weather events where risks have been identified.

6.4 Advance works

Introduction

6.4.1 Works required in advance of the main construction programme will generally include:

- advance site access works;
- further detailed site investigations and surveys;
- further detailed environmental surveys; and
- advance mitigation works including, where appropriate, the remediation of contamination, the translocation and creation of habitats, and surveys and investigation of archaeology and built heritage.

Further detailed site investigations and surveys

6.4.2 Additional detailed investigations and surveys will be required before construction to gather further information about the land required for construction. This will include the location of construction compounds in order to plan their layout and access and egress arrangements. Investigations and surveys are likely to include:

- ground investigations, such as drilling boreholes, performing in-situ tests, and taking samples for testing to establish geotechnical and geo-environmental parameters; and
- topographical surveys to map ground contours and existing surface features.

Further detailed environmental surveys

6.4.3 Further detailed, site-specific environmental surveys will also be undertaken. These will include:

- ecological surveys to confirm the baseline in areas where no access had been possible to date, and to inform licence applications and proposed works to translocate habitat/species;
- historic building, geophysical and/or trial trenching surveys to confirm the character of archaeological and built heritage assets and to inform the design of detailed mitigation strategies;
- hydrological and hydrogeological surveys to confirm flooding potential, surface water hydromorphological, quality and groundwater conditions; and
- geotechnical investigations to confirm ground and groundwater conditions; and contaminated land surveys, including boreholes, probe holes and trial pits, supported by soil and groundwater sampling and testing for a suite of relevant chemicals, to confirm any possible contamination sources and pathways, and support the design of any remediation works that may be required.

Advance mitigation works

Remediation of contamination

6.4.4 The following further works may be required where surveys identify that contamination is present:

- monitoring of groundwater;
- monitoring and sampling of ground gas;
- remediation works, including:
  - excavation;
  - soil treatment using methods such as soil-washing;
  - groundwater treatment, such as air sparging and vapour extraction
  - monitoring natural attenuation (MNA);
  - bioremediation, in situ chemical treatment and stabilisation;
  - provision of capping layers or ground barriers to prevent the migration of contaminants or ground gases;
  - installation of venting systems for ground gases; and
- off-site disposal of unsuitable soils.

Creation of habitat and translocation of species/habitat

6.4.5 Most of the areas that will be identified for the provision of ecological compensation will be outside the extent of the construction works. Some areas identified for the

translocation of protected or notable species will need to be created in advance, while others may already be suitable as receptor sites.

6.4.6 These works include, but are not limited to:

- the planting of new grassland or woodland habitats;
- the creation of new ponds, hibernacula[109] or basking features[110]; and
- the construction of artificial badger setts.

6.4.7 It may take up to two years to translocate or relocate protected species, where this is required. Translocation/relocation will occur before the start of construction in that area.

6.4.8 In some locations, notably where ancient woodlands are unavoidably affected, the woodland soils that would otherwise be lost will be translocated to identified receptor sites.

Archaeological and built heritage works

6.4.9 A programme of investigation works will be developed as set out in Section 8 of the draft CoCP. Investigation and recording may include historic building recording, archaeological excavation, palaeoenvironmental boreholes and the in-situ preservation of assets.

Planting and other landscape measures

6.4.10 Planting and other landscape measures will be implemented as early as is reasonably practicable where there is no conflict with construction activities or other requirements of the Proposed Scheme. The nominated undertaker will require its contractors to consider where measures can be implemented early and programme the landscape works accordingly, as set out in Section 12 of the draft CoCP.

6.5 Overview of the construction works

6.5.1 The construction works along and adjoining the route will be of two broad types:

- civil engineering works, including:
  - site establishment and erection of temporary fences;
  - establishment of construction compounds;
  - site preparation and enabling works;
  - utility diversions;
  - excavation of borrow pits;
  - main earthworks and structural works;

[109] A hibernaculum is the winter den of a hibernating animal or insect.
[110] Many species habitually seek out external sources of heat or shelter from heat. For example, many reptiles regulate their body temperature by basking in the sun, or seeking shade when necessary.

  - highway realignments and modifications;
  - site restoration (including borrow pits); and
  - removal of construction compounds;
- railway installation works, including:
  - infrastructure installation;
  - connections to utilities; and
  - removal of railway systems compounds.

6.5.2 There are also locations where the existing railway network will need to be modified, which could involve a combination of civil engineering and/or railway installation works.

6.6 Site establishment and temporary fencing/hoardings

6.6.1 Temporary security fencing or hoardings (as appropriate) will be erected on land required for construction, including at construction compounds (as discussed in section 6.7). Fencing could also be used to protect trees and to temporarily delineate field boundaries. Further information relating to site establishment is provided in section 6.8.

6.7 Construction compounds

6.7.1 Construction compounds will be required in various locations along the route, and will generally be sited alongside or adjacent to the relevant works. Each Volume 2 community area report identifies the location and use of the compounds for construction works and railway installation activities within its area.

6.7.2 There will be two types of construction compounds: main and satellite construction compounds. Main construction compounds will act as strategic hubs for core project management activities (i.e. engineering, planning and construction delivery) and for office-based construction personnel. They will include offices, storage for materials (such as aggregates, structural steel, and steel reinforcement) and laydown areas, and maintenance and parking facilities (for site plant, lorries and staff cars), together with the main welfare facilities for construction personnel. Main compounds will typically require approximately 4ha of land (although this may vary depending on site conditions) and will support up to 370 construction personnel.

6.7.3 Satellite construction compounds will generally be smaller, providing office accommodation for construction personnel. Depending on the nature and extent of works to be managed from these compounds they may include local storage for plant and materials, welfare facilities, and car parking for construction personnel. Satellite construction compounds will require between approximately 0.7 and 3ha of land.

6.7.4 A number of compounds referred to as satellite construction compounds will continue to be used as compounds for railway systems works following the completion of civil engineering works at these locations.

6.7.5 The railway systems compounds will facilitate installation, testing and commissioning of the railway systems, including track, overhead line equipment, communication and signalling equipment and traction power supply.

6.7.6 Construction satellite compounds will be managed from an associated main construction compound. Railway systems satellite compounds and railway systems main compounds will be managed from the Stone Railhead or main construction compound.

6.7.7 Some construction compounds will generally act as points of entry to the worksites from the public highway. The Stone Railhead main construction compound will also act as an interface with the existing rail network for receipt and/or disposal of materials by rail.

6.7.8 Construction compounds will also be used for stockpiling of materials such as topsoil, for transfer nodes or railhead and to facilitate transfer of materials to and from the site. Compounds may also include construction works, including pre-cast yards to manufacture and store concrete elements such as viaduct beams. In these situations the Volume 2 community area reports describe the use of the compound and associated area, and where sufficient environmental information is available, any resulting impacts and significant environmental effects.

6.7.9 Buildings within compounds will generally be temporary modular units that will be positioned to maximise construction space and limit the area of land required. In urban areas, or elsewhere where there is limited space, it may be necessary to stack these units.

6.7.10 The total number of compounds per community area and the total number of construction personnel supported at each is provided within Section 2.3 of the Volume 2 community area reports.

6.7.11 Overnight accommodation for construction staff will be provided at the Yarnfield North embankment satellite compound in the Stone and Swynnerton area, the Trent South embankment main compound in the Colwich to Yarlet area; and the Basford cutting main compound in the South Cheshire area. This accommodation will help to reduce daily travel for those not normally based locally.

6.7.12 The siting of construction compounds has been influenced by a number of factors, including:

- proximity to major construction activities;
- proximity to local A roads and rail/bus routes;
- avoiding proximity to sensitive receptors;
- easy accessibility for the local workforce;
- suitable existing topography with minimal requirement for site preparation works;
- proximity to existing utilities for ease of establishing temporary services;
- ease of establishing and maintaining security;

- adequate space;
- the location of floodplains; and
- the existing use of the site.

6.7.13 Construction compounds will be connected to existing local utility services (i.e. electricity, water, data, foul sewers and surface water drainage), where reasonably practicable. This will reduce the need for generators, storage tanks and associated traffic movements.

6.7.14 Security fencing or hoardings will be provided around the perimeter of each construction compound. Areas for offices, welfare and storage within compounds will generally be demarcated and secured with fences and gates. The type and construction of fences will depend on factors such as the level of security required, the likelihood of intruders, and the degree of visual impact. Lighting of construction compounds will be designed to limit light pollution to the surrounding area, in accordance with the requirements of the draft CoCP. Construction compounds, including any areas used for access, will be returned to the most appropriate use as soon as reasonably practicable after completion of the works.

6.7.15 Some of the construction compounds will be used to manage demobilisation/testing and commissioning of the railway after 2027.

6.8 Site clearance, enabling works and site mobilisation

6.8.1 All areas of land required permanently and temporarily for the works will be cleared.

6.8.2 Vegetation will be removed and structures demolished, as necessary, before any excavation works or embankment construction. Any resulting waste material will be removed from site for reuse, recycling, recovery or disposal. Topsoil and subsoil will be stripped down to the top of the subsoil layer and formation respectively, and stored in accordance with best practice. The surfaces of stockpiled material will be formed to prevent degradation of the material and will be managed to control weed growth. Stockpiles will be kept away from sensitive features (including natural and historic features), watercourses and surface drains, as far as reasonably practicable. Elsewhere, stockpiles may be located near the site boundary, where they can help to provide temporary screening.

6.8.3 Where reasonably practicable, trees and hedgerows will not be removed during the bird nesting season, with site clearance for non-critical design elements phased accordingly. European protected species will be translocated where appropriate, following best practice.

6.8.4 Conventional methods will be used for demolitions (e.g. boom-mounted hydraulic breakers[111] and cutters). The best practicable means will be used to recover materials for reuse and recycling. Asbestos and any other hazardous materials identified during surveys will be removed by a specialist contractor prior to demolition, as described in the draft CoCP. A condition survey of building foundations/third party assets will also be undertaken before and after the relevant works where it is agreed with the local

[111] Demolition hammers or shears fitted to hydraulic excavator plant. The hammers/shears are often on long-reach booms to increase the demolition reach.

authority that there is no best practicable means to reduce predicted or measured vibration.

6.8.5 Activities described as 'advance works' may also be undertaken during this stage of construction.

6.9 Utility diversions

6.9.1 A number of utility diversions will be required before construction commences. Utilities that will need to be diverted include water, gas mains, sewers, telecommunications equipment, electricity and fuel pipelines.

6.9.2 Condition surveys are likely to be undertaken prior to diversion. Some utilities may require additional strengthening or replacement.

6.9.3 Discussions with utility providers are underway to confirm whether utility infrastructure will need to be: positioned away from the area of work; protected from the works by means of a concrete slab or similar; or have sufficient clearance from the works that they will not be affected.

6.9.4 An appropriate approach will be agreed with the relevant statutory undertaker (i.e. the utility company) where excavation or piling is required within the exclusion zones for high pressure mains, high voltage cables or fuel mains. The approach will include appropriate protective measures in accordance with the protective provisions included in the Bill.

6.9.5 Ground-penetrating radar surveys will be undertaken and trial holes excavated to identify if underground utilities are in their expected locations (subject to the agreement of the statutory undertaker and local authorities).

6.9.6 Some utility works will require PRoW or highways to be temporarily realigned. This will be managed using a traffic management plan, as detailed in section 6.3.

6.9.7 The height and/or location of pylon towers for overhead line electricity cables will need to be changed in some locations. This will require the erection of temporary towers to carry the cables whilst the new or amended towers are being built. It will also require new power cables to be installed and tensioned, and these cabling works will require works at a number of towers either side of those to be amended. The cabling works are unlikely to necessitate works at ground level in between towers. However, access will be required, and the CT-05 Map Series in the Volume 2 Map Books show the access routes. There may also be some restrictions to non-residential access at ground level between towers where re-cabling is being undertaken, as a precaution.

6.10 Borrow pits

6.10.1 The Proposed Scheme will require high quality aggregate (usually comprising sand and gravel) to construct railway embankments[112]. This material will be provided, in part, through excavation of cuttings and other works (for example, tunnels or

[112] The sands and gravels extracted from the borrow pits are intended for constructing the Proposed Scheme railway embankments. However, if the properties of the materials extracted are suitable, it may also be used to make concrete or other cement bound materials for construction of the Proposed Scheme.

balancing ponds) along the route of the Proposed Scheme, where the quality is appropriate. However, at some locations along the route there is anticipated to be a shortfall of high quality material for use in railway embankment construction. Three options were considered to overcome this shortfall:

- using clay extracted during the construction of the Proposed Scheme, which is unlikely to be of appropriate quality on its own, and stabilising it with cement or lime;
- using high quality aggregate imported from commercial quarries; and
- excavating appropriate high quality material from borrow pits in areas close to the route of the Proposed Scheme.

6.10.2 Stabilising clay with cement or lime could cause unacceptable levels of heave in the treated clays[113]. This would result in the material being unsuitable for use in Proposed Scheme embankments within the constraints of the construction programme.

6.10.3 Obtaining material from commercial quarries would have required the transport of the high quality material by HGV, which would have resulted in impacts on the local road network and communities. These movements would have also necessitated the widening of local roads and associated junction improvements to accommodate the HGVs. Under this option, clays extracted during construction of the Proposed Scheme would have to be transported off-site, increasing HGV movements and again leading to impacts on the local road network and communities.

6.10.4 Excavating borrow pits will enable high quality aggregate to be extracted and processed locally and transported largely on site haul routes within the construction area of the Proposed Scheme. This option will generate lower HGV movements than importing the material from commercial quarries, reducing impacts on the local road network and communities. Using borrow pits will remove a significant number of HGV movements from the highway network. Reducing the amount of HGVs also reduces the need to widen roads and improve junctions, further reducing environmental impacts.

6.10.5 The borrow pits created during excavation will be backfilled with materials generated from the construction of the Proposed Scheme, typically clay, that does not have suitable characteristics for use as railway embankment fill. This presents a more sustainable option, reducing the need to move this material off-site, further helping to limit impacts on the local road network and communities. For these reasons, borrow pits were taken forward as the preferred option in the Proposed Scheme.

Borrow pit excavation and restoration process

6.10.6 Six borrow pits will be required. Table 5 outlines the proposed location, total area, the assumed and maximum depths of extraction of the six borrow pits proposed during the construction of the Proposed Scheme.

[113] The expansion of clay, causing the upward movement of the ground.

Table 5: Borrow pit location, area and assumed average and maximum excavation depths

Borrow pit location	Community area (CA)	Area (ha)	Assumed average depth of mineral extraction (m)[114]	Estimated maximum depth of mineral extraction (m)[115]
Kings Bromley South, located either side of Crawley Lane and to the south of Ashby Sitch, both sides of the Proposed Scheme	Fradley to Colton (CA1)	35	4.1	12.8
Kings Bromley North, located adjacent to the realigned A515 Lichfield Road	Fradley to Colton (CA1)	12	4.1	8.8
Kings Bromley North, located adjacent to the realigned Shaw Lane	Fradley to Colton (CA1)	19	4.3	8.8
Blithbury, located to the north of the River Trent viaduct	Fradley to Colton (CA1)	20	11.1	15.8
West of Netherset Hey Farm	Whitmore Heath to Madeley (CA4)	28	4.3	17.8
North of Checkley Lane	South Cheshire (CA5)	40	3.8[116]	--

6.10.7 The borrow pits will be excavated over a maximum period of four years, which will include their excavation and backfilling, to be followed by a period of restoration activity. Further information on each of the borrow pits, including, where relevant, local alternatives studied can be found within the relevant Volume 2 Community area reports. A restoration strategy for the borrow pits is provided in Volume 5: Appendix CT-009-000.

6.10.8 The following outlines the general process for borrow pit excavation, backfilling and restoration[117]:

- vegetation will be removed, and drainage installed where required;
- topsoil and subsoil will be stripped, handled and stored separately in stockpiles being appropriately located and graded to enable surface water runoff and

[114] The extraction depth includes assumed average topsoil and subsoil depths of 0.8m
[115] The extraction depth includes assumed average topsoil and subsoil depths of 0.8m
[116] If it cannot be confirmed that there is no hydrological connectivity between the proposed borrow pit and Betley Mere SSSI, the extraction of minerals will restricted to a depth one metre above existing groundwater level
[117] This does not present a linear sequence. The borrow pits may be extracted and backfilled in zones. This will avoid the unnecessary storage of material.

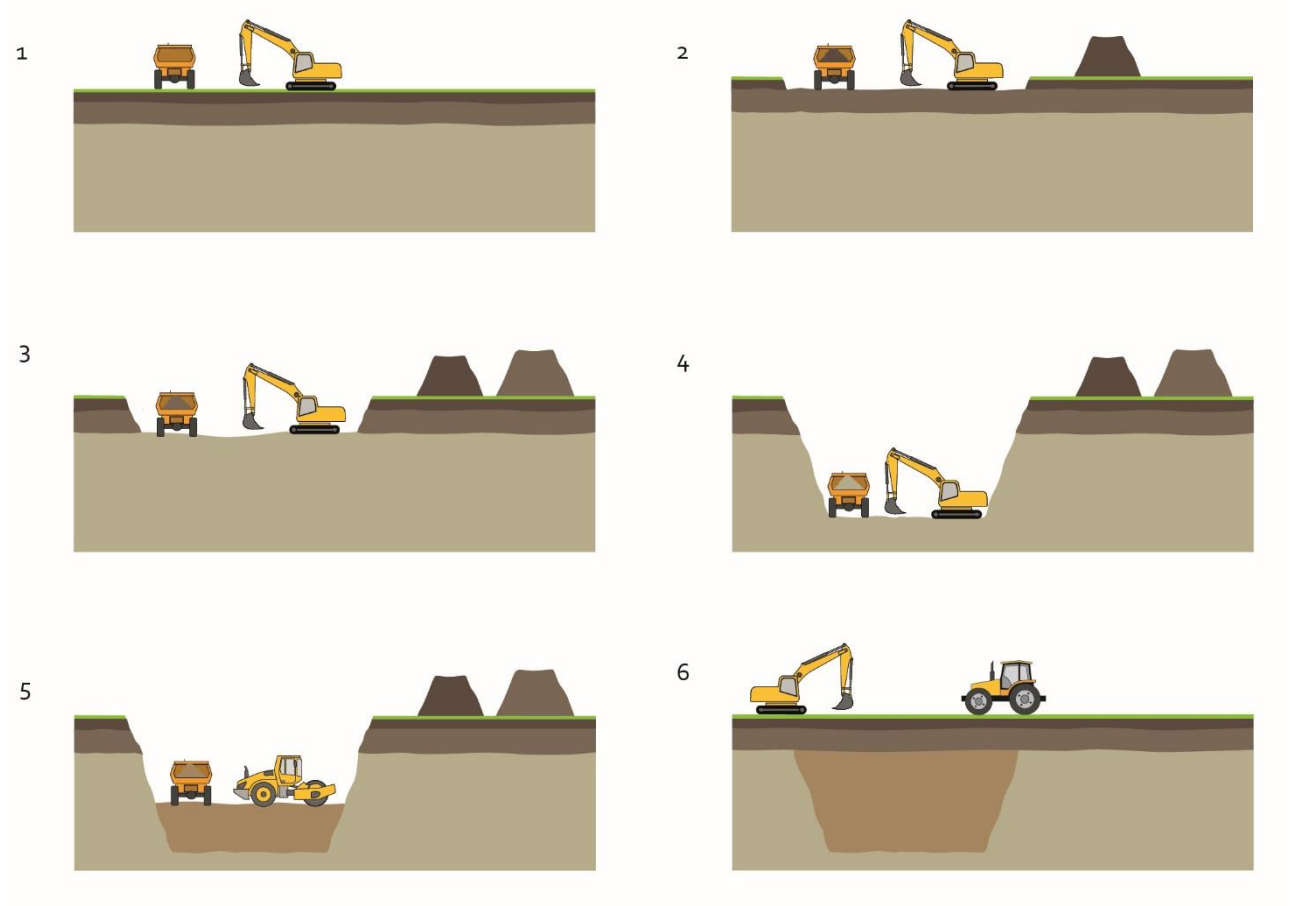
subsequent re-soiling work;

- sands and gravels will be extracted sequentially, in layers, to meet the construction programme needs of the Proposed Scheme. The material may need to be processed (this may include crushing and blending of materials), where necessary, to improve its suitability for use;
- excavations are expected to require some form of dewatering. The exact nature of this will be developed at detailed design stage once ground investigation data is available;
- excavation may be phased by zones, where sufficient space has been retained adjacent to each zone for stockpiling backfill material until the zone is depleted. The exact size and number of zones will be investigated further during detailed design;
- excavated material will be transported directly to the place of deposit using site haul routes. However, it will be necessary to use both site haul routes and the public road network to move backfill material, due to the longer distances involved;
- the void created following extraction will be backfilled with excavated material from construction of the Proposed Scheme;
- backfill material excavated from elsewhere as part of construction of the Proposed Scheme will generally be transported to the borrow pit location as soon as it becomes available. Material may arrive at the borrow pit location before it can be backfilled, in which case, a temporary stockpile will be created on a topsoil stripped area of the borrow pit, so that it can be used as backfill as soon as possible to progress the restoration process; and
- the borrow pits will be restored to the original ground level, using stored subsoil and topsoil. Restoration will be to a condition suitable for their previous land use, except where the land is proposed to be used for other purposes, such as access tracks, balancing ponds and flood compensation areas.

6.10.9 Borrow pit excavation, backfilling, restoration and aftercare will be undertaken adhering to the measures outlined within the draft CoCP and the principles contained in the Borrow pits restoration strategy (Volume 5: Appendix CT-009-000).

6.10.10 Figure 22 shows a summarised sequence of activity to excavate and backfill borrow pits.

Figure 22: General borrow pit excavation and backfilling process.



Reporting effects associated with borrow pits

6.10.11 The environmental assessment of the borrow pits is reported in the relevant Volume 2 community area reports and the Volume 3 Route-wide effects report. The minerals data presented in Table 5 has been derived from a geotechnical desk study of available geological information. Prior to construction of the Proposed Scheme, HS2 Ltd will undertake detailed ground investigations to help confirm the depth of granular deposits suitable for construction material, which will inform the surface area and depth of extraction required within the borrow pit area.

6.10.12 The assessment of effects associated with borrow pits is based on the assumed mineral depth plus topsoil and subsoil of an assumed average depth of 0.8m. However, it may also be necessary to excavate deeper in some areas, for example to avoid sterilisation of mineral resources. Therefore, a maximum mineral depth (derived from a geotechnical desk study of available geological information) has also been assessed for relevant topics. The assessment therefore reports significant effects based on extracting to the assumed mineral depth and any new or different significant effects that would arise as a result of extracting to the maximum mineral depth. The powers provided for within the Bill allow extraction to the maximum level. Extracting to the maximum depth would mean that excavation across the full area of the borrow pit sites may not be required in all cases following a reassessment of deposits available after on-site investigations have been undertaken.

6.11 Cuttings and embankments

Cuttings

6.11.1 Cuttings will be excavated using excavators, graders and scrapers.

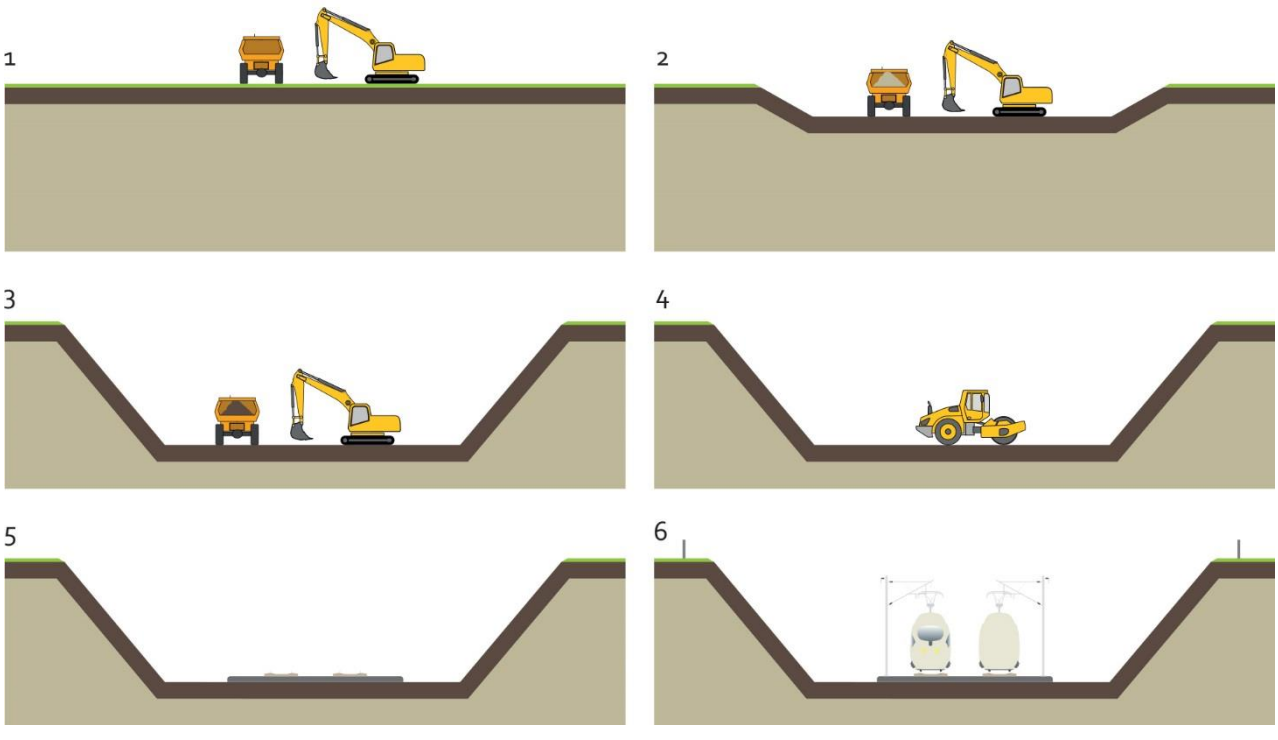
6.11.2 Material excavated from cuttings will be used, where reasonably practicable, to construct embankments, noise bunds and landscape earthworks including false cuttings. The construction of cuttings and embankments will therefore be interdependent, in most cases. This is reflected in the sequencing described below.

6.11.3 Cuttings will generally be constructed in the following sequence:

- vegetation will be removed, and drainage installed where required;
- topsoil and subsoil will be stripped, with temporary material stockpiles being appropriately located and sloped to enable surface water run-off and subsequent re-soiling work;
- the cutting will be excavated sequentially, in layers;
- excavated material will be transported to embankment compound(s), where practicable, or to temporary stockpiles, with the material processed, where necessary, to improve its suitability for use; and
- re-soiling and seeding of the final slope profile – if the slope angle is steeper than that which would normally be adopted to ensure stability, additional measures will be required prior to re-soiling and seeding; for example the construction of retaining structures, soil nailing or slope drainage, either alone or in combination.

6.11.4 Figure 23 shows a generic construction sequence for a cutting.

Figure 23: Illustration of a generic construction sequence for a cutting



6.11.5 Temporary stockpiling of excavated material may be required where it cannot be placed directly into its permanent location. Granular materials such as gravels produced from excavations may need to be processed through crushing and/or screening, to ensure that the material is acceptable for use as drainage, structural fill, backfill or capping material.

Embankments

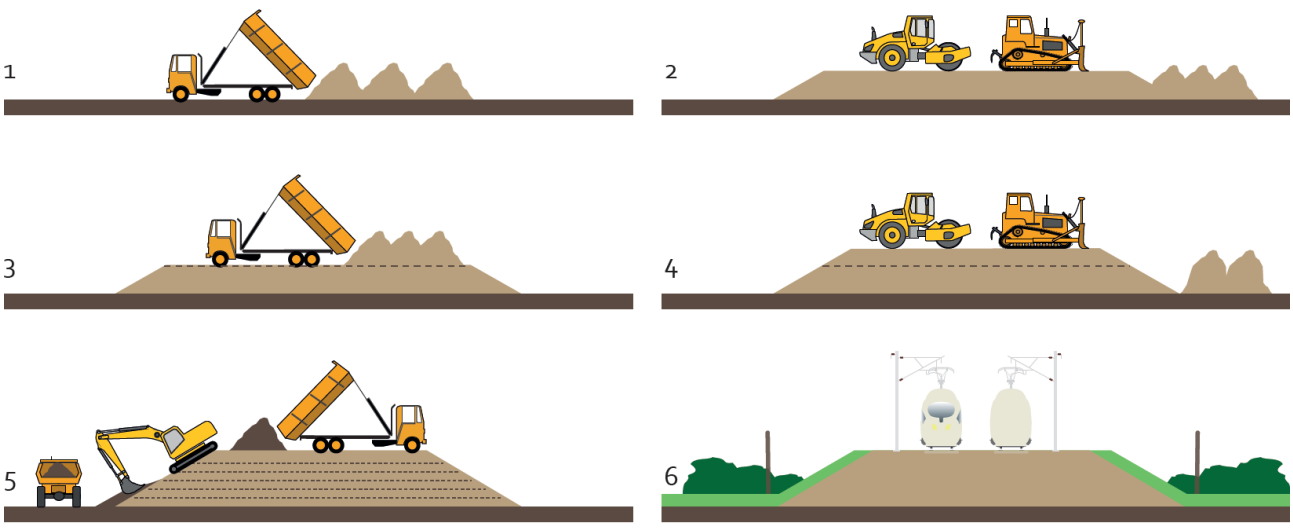
6.11.6 Earthworks will include the bulk excavation of material and placing of that material to create the route alignment. Embankments may be built in stages, commencing early in the construction programme, to allow settlement to occur.

6.11.7 Embankments will typically be constructed in the following sequence:

- vegetation will be removed, and surface water drainage installed where required;
- topsoil and subsoil will be stripped, with temporary material stockpiles being appropriately located and sloped to enable surface water run-off and subsequent re-soiling work;
- excavation to the required formation level meeting design requirements and installation of required granular starter layer, providing a suitable platform for construction;
- spreading, levelling and compacting of excavated material in layers over the area required;
- installation of slope drainage, where necessary, to manage run-off and prevent siltation of waterways or water-bodies;
- trimming and re-soiling of slopes to the required profile; and
- the placing of subsoil and topsoil to the required depth, which will be determined by the proposed use (e.g. as grassland, planted with trees and shrubs or returned to agriculture).

6.11.8 Figure 24 shows a generic construction sequence for an embankment.

Figure 24: Illustration of a generic construction sequence for an embankment



6.12 Drainage and watercourse realignment

6.12.1 Construction will require both temporary and permanent drainage works, including track drainage, culverts, balancing ponds and watercourse realignments. These will involve standard earthmoving techniques and equipment (e.g. backhoe excavators), and may use materials such as pre-cast concrete units, plastic pipes and filter drains.

6.12.2 Smaller culverts are likely to be constructed using pre-cast concrete units, lifted into place by a crane onto a prepared bed of granular material, and then sealed. Headwalls (i.e. the walls around the mouth of the culvert) may be constructed in-situ from reinforced concrete. Larger culverts may be constructed in-situ in reinforced concrete or from prefabricated units.

6.12.3 Where watercourse realignments are required, soft engineering techniques (such as the use of pre-seeded geotextile mats and vegetation rolls) will be used, where reasonably practicable.

6.12.4 Watercourses will generally be realigned to avoid impacts from the Proposed Scheme. A single realigned channel could represent a more sustainable solution where the route would otherwise need to cross a watercourse several times. Minor realignment will be required in many cases to reduce the length of watercourses that need to be culverted or bridged.

6.12.5 Watercourses that require horizontal realignment will generally be constructed by:

- temporarily fencing around the route of the realignment;
- excavating the realigned channel to the required level, leaving existing ground at each end (a 'plug'), or installing sheet pile walling[118], sufficient to prevent inflow from the existing watercourse;
- stabilising the side slopes and channel;
- lining the channel invert, if required;
- sealing with clay or constructing a concrete base and walls, if required;
- removing plugs or sheet pile walls, allowing water to flow into the realigned channel;
- sealing up the ends of the original watercourse and backfilling the channel with suitable material; and
- landscaping or finishing as required.

6.12.6 A crossing and a horizontal realignment of the flow path may be required where areas of surface water are affected by the Proposed Scheme. Vertical and horizontal realignment below existing bed level may be undertaken using drop inlet culverts[119]

[118] Embedded retaining wall utilising standard steel profiles. Used in temporary or permanent conditions. Installed by vibration, impact or push/jack techniques.
[119] A form of culvert used on sloping ground where the water level has to be lowered to pass under the Proposed Scheme, other railways or road access. Drop inlet culverts will be constructed using either an open cascade (a series of steps down the side of a cutting between an adjacent watercourse) or an enclosed chamber on the upstream side only.

and inverted siphons[120]. Pumping may also be necessary in some situations. The choice of method will reflect the sensitivity and size of the flood risk, the availability of land and other physical or environmental constraints.

6.12.7 Site activities and working methods will be managed so as to protect the quality of surface water and groundwater from adverse effects. The quality, rate and volume of run-off will be controlled. Monitoring systems will be used during the construction works. Emergency procedures will be implemented in the case of any pollution incidents.

6.13 Highways (roads) and public rights of way

6.13.1 Existing roads or PRoW that cannot be used because they are crossed by the works will either be stopped up and the traffic diverted onto other existing highways, or new crossings will be built. New crossings, utilising under or overbridges, will either be built on the line of the existing road or PRoW (termed 'online'), thereby requiring its closure or temporary realignment during construction, or alongside or nearby (termed 'offline'), allowing the road to remain open for the majority of construction.

6.13.2 The choice between whether new crossings will be online or offline will depend on factors such as safety, traffic flows, physical or environmental constraints and the presence (or otherwise) of public utilities.

6.13.3 Online crossings will usually be constructed by:

- constructing the temporary layout, if needed;
- temporarily realigning traffic and utilities (if they cannot be retained in their original location) and closing the existing route;
- constructing the new road or PRoW (and associated underbridge or overbridge, where applicable) and installing associated utilities; and
- re-directing traffic back onto the existing alignment.

6.13.4 Offline diversions will generally be constructed by:

- constructing the new permanent road or PRoW (and associated underbridge or overbridge, where applicable);
- diverting utilities onto the new alignment; and
- switching traffic onto the new alignment and stopping up the existing route.

6.13.5 Works to existing roads, including temporary diversions, will be carried out in consultation with the relevant highway authority.

6.13.6 Highway works will involve standard drainage and earthworks techniques, the laying of capping and sub-base materials and paving. Generally, plant will include excavators, dump trucks, bulldozers, rollers, graders and paving machines.

[120] A form of culvert used on level ground where the water level has to be lowered to pass under the Proposed Scheme, other railways or a road access. Inverted siphons will be constructed using enclosed chambers on both sides of the route.

6.13.7 Smaller-scale works to existing PRoW will also be carried out in consultation with the relevant highway authority.

6.14 Haul routes

6.14.1 Where reasonably practicable, movement of construction material, construction machinery and/or construction workers between the construction compounds and work sites would be on designated temporary roads within the area of land required for construction (known as site haul routes), along the line of the route of the Proposed Scheme, or running parallel to it. Using haul routes will reduce the need for construction vehicles to use the existing public highway network, thereby reducing traffic related impacts on the road network and local communities.

6.14.2 Haul routes will be no wider than 10m (including land for any associated infrastructure, such as signalling). Where a haul route crosses a public highway or PRoW, the crossing points will be safely managed by either temporary traffic signals or roundabouts, or manned control points.

6.14.3 Haul routes will be surfaced at the connection point between a haul route and public highway. This will help to maintain the cleanliness of the public highway.

6.15 Piling

6.15.1 Deep foundations will be required where ground conditions are not suitable for the necessary loading or settlement requirements. They are usually required for:

- the piers and abutments of viaducts and bridges;
- retaining walls; and
- other large structures, such as the IMB-R buildings.

6.15.2 Piles and diaphragm walls[121] are the most common form of deep foundation.

6.15.3 A designed piling platform of suitable material will be used as a working platform to ensure the stability of the heavy plant used for piling and diaphragm walling. A piling platform typically consists of compacted crushed or granular material laid on a geotextile membrane[122]. The existing ground surface will be levelled and the material placed in layers of suitable thickness before being compacted.

6.15.4 A number of techniques will be used to form deep foundations. The choice of pile type and installation method will be based upon a piling risk assessment and will generally be dictated by factors such as design loads, ground conditions, proximity of sensitive receptors and speed of installation. Precautions will be taken to prevent soil contamination migrating downwards into aquifers where piling takes place, in accordance with guidance from the National Groundwater and Contaminated Land Centre[123].

[121] A rectangular (in plan) foundation structure used to carry horizontal and vertical loads. Can be installed by excavation using a grab or hydromill. The excavated trench is supported using a bentonite support fluid.
[122] Synthetic (generally) fabric used in conjunction with earthworks. Can be used to provide filter or reinforcement properties.
[123] National Groundwater & Contaminated Land Centre, (2001), *Piling and penetrative ground improvement methods on land affected by contamination – guidance on pollution prevention NGCLC Report NC/99/73.*

6.15.5 Diaphragm walling involves the construction of reinforced concrete walls within the ground using bentonite slurry as a temporary support medium.

6.15.6 Vibratory or silent piling systems will be preferred where displacement piles are used (i.e. steel sheet piling driven into the ground).

6.15.7 Continuous flight auger piles are constructed using a hollow stemmed piling auger. The auger is rotated into the ground to the required depth, then concrete is pumped down the hollow stem as the auger is extracted. The required steel reinforcement cage is then craned into the bore using a vibrating tool, if required. The use of continuous flight auger piles can be restricted by factors such as diameter, depth or by the design of the steel cage.

6.15.8 Bored piles are used to produce larger diameter and deeper piles with more complex steel reinforcement cages. The pile is formed by progressively boring, with the soil being 'spun off' the auger when it is extracted. The stability of the bore in the upper sections is usually maintained by a casing. The material lower down the pile may be self-supporting (e.g. clay) or may require a bentonite support fluid. Once the bore is complete, the steel reinforcement cage is fixed and lowered into the bore and concrete is then placed inside.

6.15.9 Figure 25 shows an example piling rig.

Figure 25: Photograph of an example of a piling rig

6.16 Tunnels

Tunnel boring machines

6.16.1 Tunnels are generally excavated using a TBM. Figure 26 shows a typical TBM.

Figure 26: Photograph of a typical tunnel boring machine

6.16.2 A modern TBM consists of a rotating head called a cutter head, followed by a main bearing, a thrust system and trailing support mechanisms. The type of machine used depends on ground conditions and the amount of groundwater present. Three main types of TBM can be used in soft ground:

- earth pressure balance machine (EPBM);
- slurry shield; or
- open face.

6.16.3 A slurry shield TBM is used where the groundwater table and pressure are higher and there is very wet ground. An EPBM can be used in a wider range of ground types. Both systems use mixing and backfilling systems to maintain optimal pressure and to ensure a stable face in soft ground. Open face TBM are used when the ground is more stable and self-supporting.

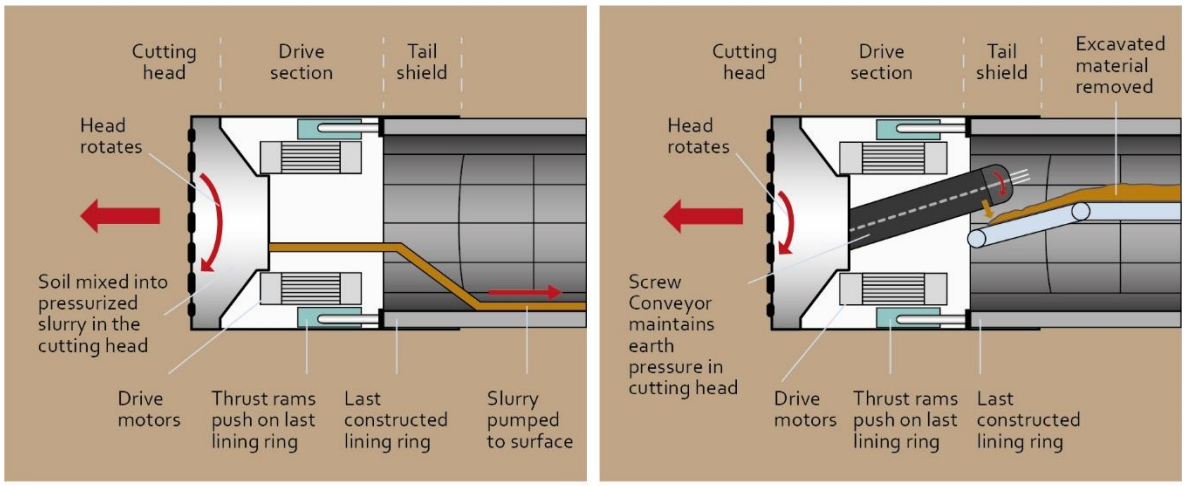
6.16.4 All of these types of TBM work by using thrust cylinders to advance forward by pushing off against concrete segments and support the ground by maintaining a

balance between the earth and the pressure of the machine. The rate of material removed is determined by the rate of machine advance, thereby maintaining a stable environment.

6.16.5 The tunnel lining is erected and back grouted as the TBM is moved forward. A temporary construction railway may be laid in sequence behind the TBM to supply the machines with tunnel lining segments and personnel, using rail-mounted vehicles. This railway will generally be twin-tracked to enable two-way traffic and servicing of cross passage construction.

6.16.6 Figure 27 shows a cross-section of a slurry shield and EPBM TBM.

Figure 27: Cross-section of a slurry shield and earth pressure balance machine



Slurry Tunnel Boring Machine (TBM) Earth Pressure Balance Machine (EPBM)

Bored tunnels

6.16.7 The linings of bored tunnels will typically comprise pre-cast reinforced concrete segments, back-grouted and sealed with gaskets to limit the ingress of groundwater. Ground treatment works, for example dewatering or grouting, may be required prior to and during excavation.

6.16.8 Possible construction methods for particular tunnel features, such as junctions with cross passages, include special cast iron or pre-cast concrete segments. These may be excavated using small machinery and lined with cast iron segments, pre-cast concrete segments or sprayed concrete.

6.16.9 The sequence of a twin-bored tunnel constructed using a single TBM, including the construction of tunnel portals, will be as follows:

- site clearance, enabling works and compound establishment;
- excavation of drive shaft (providing an opening for the lowering of the TBM) or portal, commencing with stripping of topsoil, followed by removal of any hardstanding;
- one portal will act as the drive portal at the start of the tunnel, from where the TBM will be launched, whilst the other portal will act as a reception portal from where the TBM will be recovered once boring is complete;
- the TBM and associated support plant and equipment, such as conveyors and

grout plant, will be delivered and erected on-site;

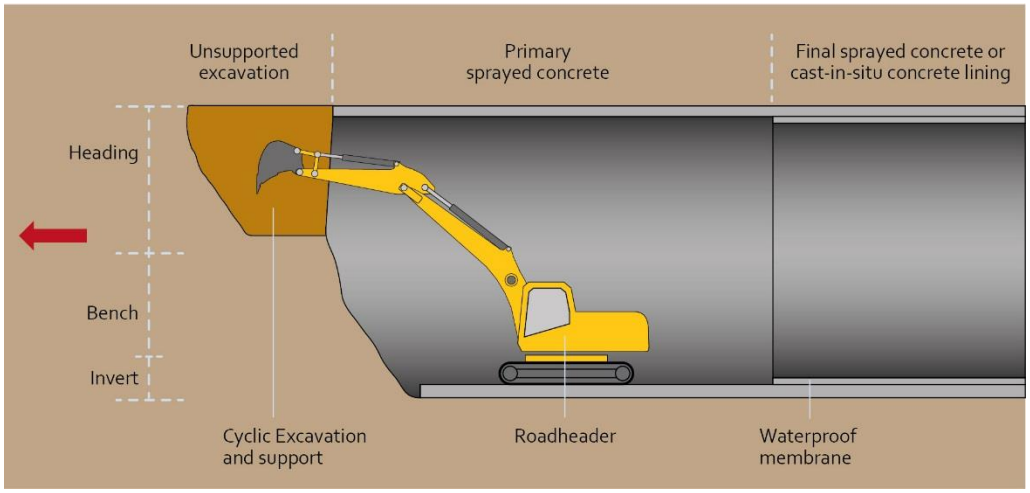
- a concrete batching plant and pre-cast concrete facility may also be installed at the drive portal or at a supporting construction compound;
- the TBM will be moved into position, once it is assembled, and the portal headwall will be broken out;
- tunnelling will be continuous, with excavated material removed by conveyor (or by slurry pipes) to a local stockpile, and the pre-cast concrete tunnel segments delivered as the TBM advances;
- materials, such as tunnel lining segments, are usually transported from the portal or supporting construction compound to the TBM by a temporary, low speed construction railway[124];
- the portal headwall will be broken out, as the TBM approaches the reception portal, ready for the TBM to break through, for which de-watering may be required;
- once the first tunnel drive is completed, the TBM and associated tunnelling train will be dismantled, lifted out of the reception portal, loaded onto trucks, taken via the road network to the drive portal and then reassembled to commence the second drive;
- the process detailed above will be repeated for the second drive;
- as the second bore progresses, cross passages between the bores will be constructed;
- once the second tunnel drive is completed, the TBM, tunnelling train and other associated plant will be dismantled and removed from site; and
- on completion of the tunnelling works, the remaining in-situ concrete works to the base slab, together with the tunnel headhouse slab over the tunnel portal, will be constructed, and the headhouse building will be erected and fitted out.

Mined tunnels

6.16.10 Cross passages will be mined using roadheaders and/or excavators. Following a short advance excavation, primary support is installed, which may comprise rock bolts and sprayed concrete in rocky conditions or sprayed concrete for clays and soils. This initial excavation is then sequentially enlarged by cyclic excavation and lining to form the required tunnel geometry. Figure 28 shows how conventional mined excavation may be undertaken.

[124] Ground-borne noise and vibration will be controlled by the design and maintenance.

Figure 28: mined excavation by conventional methods



Cut-and-cover tunnels

6.16.11 Construction of cut-and-cover tunnels will involve excavation, construction of a box structure and backfilling with fill material and soil. The land surface above will be graded to match the natural terrain and landscaped or restored to the original or an alternative use, in agreement with the landowner and the local planning authority.

6.16.12 Two main construction methods are likely to be used. For the first option an excavation is created from the surface in a conventional manner and may include installation of a temporary retaining wall. Once the final depth is reached, the tunnel floor is built, followed by the walls and roof. Finally, the entire structure is buried and the surface restored. Reinstatement will be carried out, where possible, using stored material from the cut or excavation stage.

6.16.13 Option one will be constructed by:

- site clearance, enabling works and compound establishment;
- excavating to the required depth;
- constructing a 'box' structure from reinforced concrete;
- backfilling around the sides and across the top of the structure, to suit the intended land use, and completing the landscaping works;
- diverting and installing utilities and laying road surfaces, as required; and
- removing temporary works, including any diversion/ realignments of roads and PRoW.

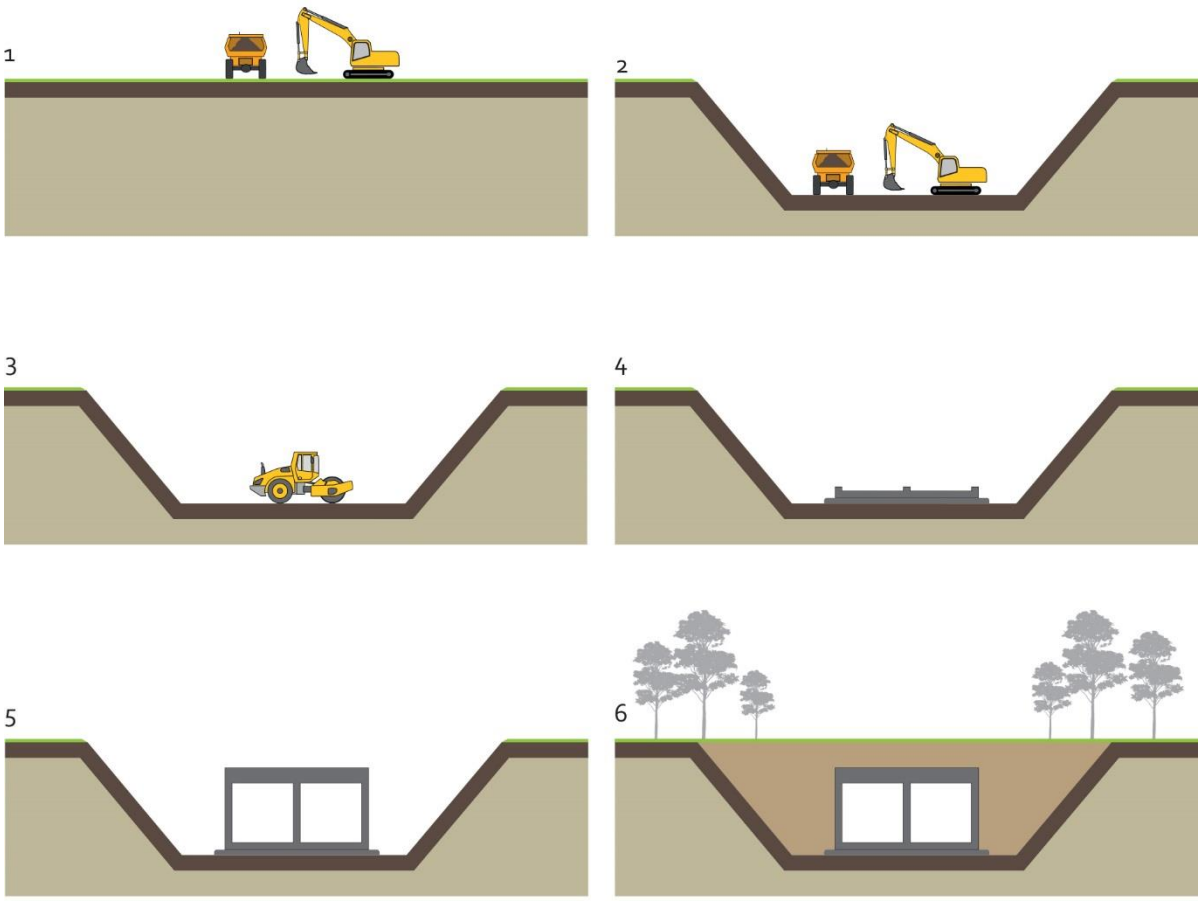
6.16.14 Side slopes may be strengthened during excavation to allow them to be cut at steeper gradients, reducing the area of land required and the potential import and export of materials. Alternatively, temporary retaining structures may be designed to further reduce the extent of excavation and the area of land required for construction and/or operation. Scaffolding, falsework[125], formwork[126], steel reinforcement and other

[125] Temporary structures such as scaffolding used to support the permanent works.
[126] Temporary or permanent moulds into which concrete or similar materials are poured.

materials will be placed using cranes before the reinforced box structure is constructed. Concrete delivered by mixer trucks will be placed either directly within the excavation or by concrete pumps located at ground level.

6.16.15 An illustration of this construction sequence is shown in Figure 29.

Figure 29: Cut-and-cover construction method – option one



6.16.16 For the second option, the walls will be constructed first using diaphragm walling[127] or bored piling, followed by excavation and construction of the roof. Excavation of the tunnel is then undertaken beneath the roof slab from the open ends of the box.

6.16.17 This method is likely to be adopted where space limitations restrict the width of an open excavation with side slopes.

6.16.18 Option two will be constructed by:

- constructing the walls, with vertical retaining panels (i.e. piles or diaphragm walls) installed along the perimeter of the intended excavation from the surface downwards;
- excavating down to the level of the roof slab of the intended structure, which may require the propping of retaining walls, if installed;
- constructing the tunnel roof, whereby the roof slab is put in place and connected to the perimeter retaining wall, followed by backfilling and

[127] Embedded walls inserted into the ground which can be used as foundation walls, groundwater barriers or to isolate portions of contaminated ground.

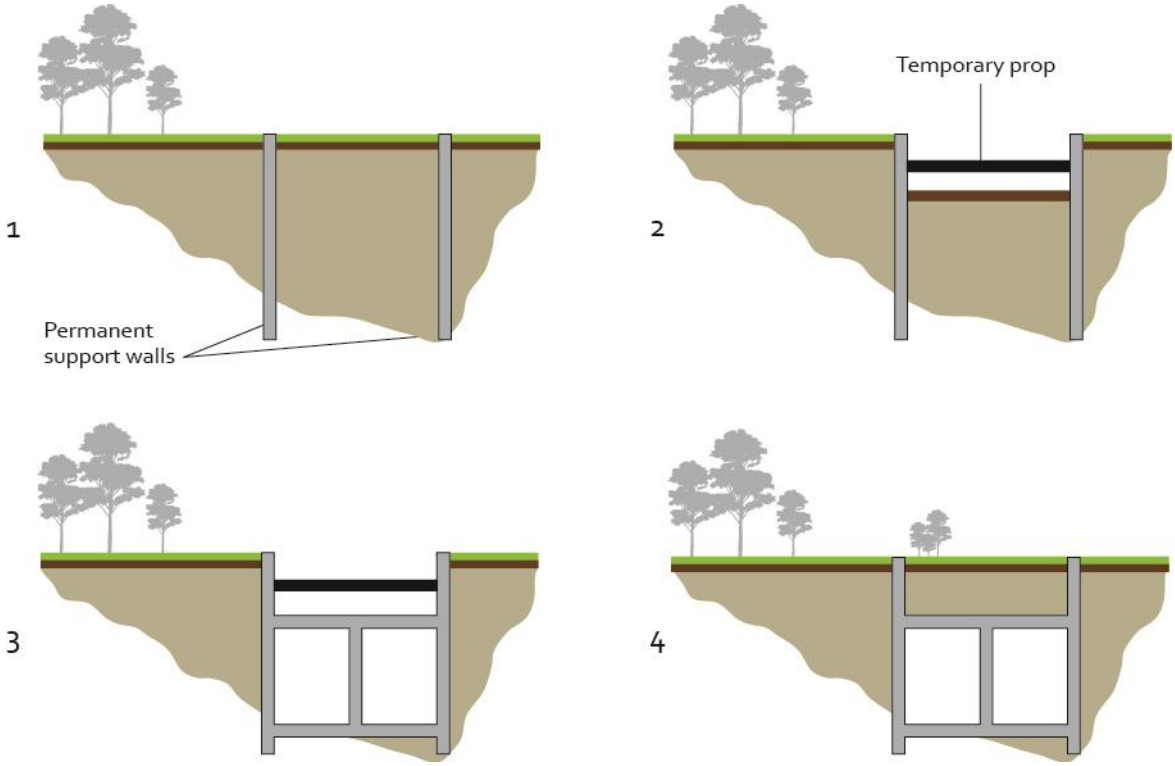
reinstatement of the surface;

- excavating and constructing the floors below roof level;
- excavating beneath the roof slab by means of a ramp formed at the portal end;
- casting the permanent base slab;
- removing any temporary props;
- diverting and installing utilities and laying road surfaces as required; and
- removing temporary works, including any diversion/realignments of roads and PRoW.

6.16.19 The excavation beneath the roof slab will be executed in stages if temporary props are required, with these being installed progressively.

6.16.20 An illustration of this construction sequence is shown in Figure 30.

Figure 30: Cut-and-cover construction method – option two



6.17 Portals

6.17.1 Portals in rural locations will typically be constructed by open excavation, with soil and rock slopes benched (i.e. cut in steps) and reinforced as necessary. Reinforced concrete headwalls and wing walls[128] will be formed around the tunnel entrances.

6.17.2 Portals will be constructed by open cut where the excavation is relatively shallow. Diaphragm wall or contiguous bored pile[129] techniques will be used for deeper excavations, requiring support by propping beams or a cover slab for the deepest excavations. A slab up to 120m long will also be required where portals are required to accommodate a TBM, to allow the back-up equipment for the TBM to be established.

6.18 Viaducts

6.18.1 The following methods of constructing viaduct decks are likely to be used:

- launched construction, in which a reinforced concrete deck is constructed in sections then launched over the piers, before the next section of deck is constructed behind and the process repeated;
- in-situ construction, in which the entire deck is constructed in reinforced concrete on temporary falsework, which is then removed; and
- beam and deck construction, where deck or portions of the deck are built off-site and placed in position by a crane.

6.18.2 The deck in beam and deck construction is made of either structural steel beams/girders or pre-stressed concrete beams, with a concrete deck acting compositely with the primary beams to enhance structural efficiency.

6.18.3 The choice between these options will depend on the geometry of the structure, the opportunity to construct falsework, which will vary depending on ground conditions, the type of feature being crossed, and the time available to undertake the work.

6.18.4 Launched construction may be used for longer viaducts. This method is made more economic by the incorporation of regular geometry (span arrangements and horizontal alignment).

6.18.5 In-situ construction is more economic for low, bespoke, shorter span structures with high degrees of geometric complexity. The beam and deck solution is convenient for bridging over obstructions, for example railways or rivers, especially where construction headroom is restricted.

6.18.6 Viaducts will generally be constructed by:

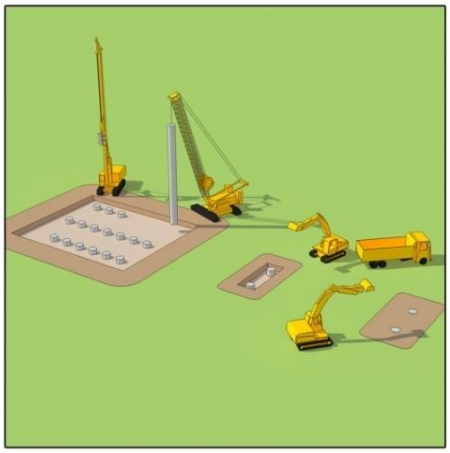
- installing the construction access and working platform;
- constructing foundations and piers from the platform, installing concrete piles, excavating pile caps and constructing pile caps and support piers, followed by backfilling of excavations;

[128] A smaller wall attached or next to a larger wall or structure.
[129] Closely spaced, bored piles used to form an underground wall, for the construction of a deep basement or cut-and-cover tunnel.

- constructing abutments, including excavating and constructing the pile mat, installing piles, constructing the abutment base and wall, and backfilling; and
- constructing the deck using either launched, in-situ construction or beam and deck solution.

6.18.7 An illustration of this construction sequence is shown in Figure 31.

Figure 31: Generic sequence for constructing a beam and deck viaduct



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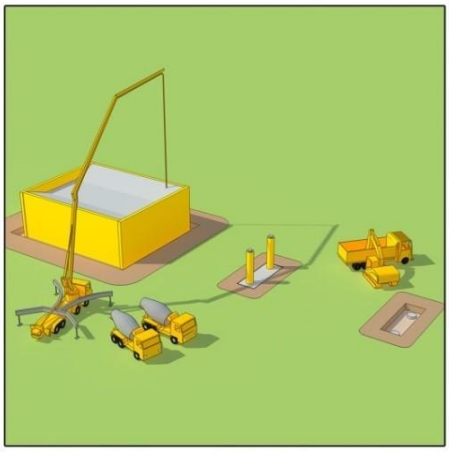

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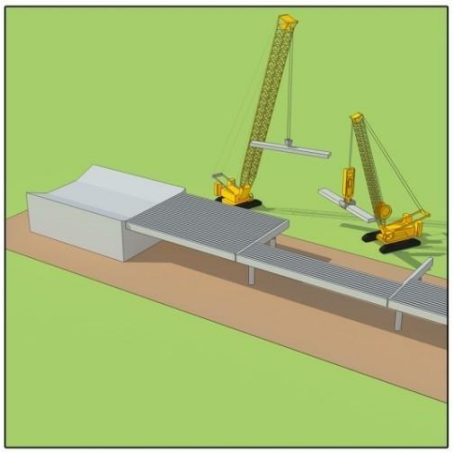

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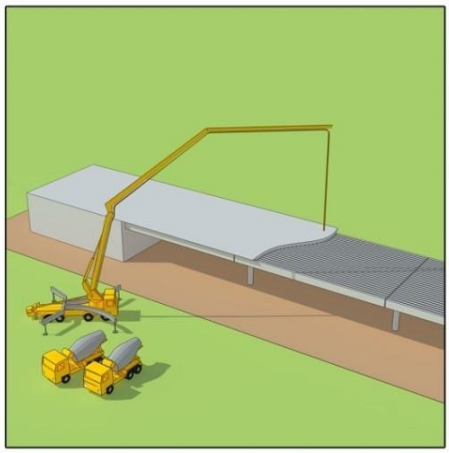

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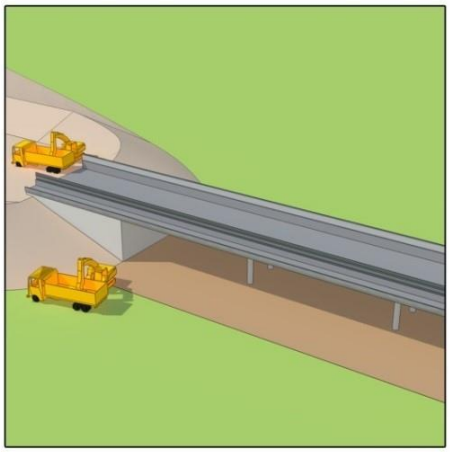

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6.18.8 The following sequence will be repeated, for in-situ construction, until the viaduct deck is completed:

- installing falsework and formwork, reinforcement and stressing tendons[130];
- casting the concrete deck;
- post-tensioning the structure; and
- removing formwork and falsework.

6.18.9 The launch formwork for launched construction will be manufactured off-site and delivered to site in 10-30m components. The following sequence will then be repeated until the viaduct deck is completed:

- installing a temporary intermediate pier in some instances (e.g. where the permanent spans exceed 40m);
- establishing a concrete casting yard behind the abutment wall at each end of the viaduct;
- setting up the formwork in the casting yard;
- assembling the launching nose for the deck section;
- installing the superstructure formwork with an antifriction layer on supports;
- fixing the sliding equipment on the pier heads;
- fixing the section of deck reinforcement, placing the tendons, pouring the concrete, and attaching the launching nose to the front of the deck section; and
- forward launching of the deck section using hydraulic jacks.

6.18.10 Final post-tensioning will be installed to the deck on completion of deck launching, and the temporary supports removed.

6.18.11 The following sequence will be repeated, for the beam and deck solution, until the viaduct deck is completed:

- placing the precast/steel beams using cranes;
- placing the precast permanent soffit slabs, reinforcement and tendons;
- concreting the top slab; and
- post-tensioning connections between beams.

6.19 Bridges

6.19.1 Bridges to carry the railway over rivers or other features (underbridges), or to carry those features over the railway (overbridges), will generally be constructed in advance of the main earthworks.

[130] High yield steel bar used to apply a compressive force to concrete such that under service conditions there is no net tension within the element.

6.19.2 The construction sequence for overbridges and underbridges is generally the same. It consists of the following steps:

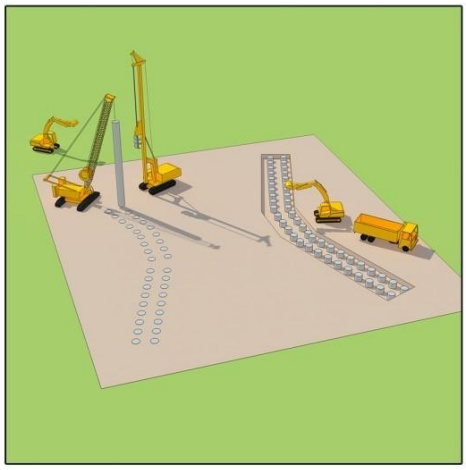
- excavating and installing foundations;
- constructing piers, abutments and wing walls;
- backfilling of abutments and wing walls;
- installing bearings and deck beams;
- casting of the deck slab; and
- installing parapets, expansion joints and finishes.

6.19.3 The backfilling operation for integral bridges[131] will generally take place after the deck is constructed.

6.19.4 Figure 32 shows a generic sequence for constructing an overbridge. Figure 33 shows a generic sequence for construction an underbridge.

[131] A bridge that does not need bearings and movement joints and is designed as one whole structure produced of reinforced concrete or reinforced concrete and steel deck beams. The normal stresses and strains are accommodated in the structure without allowing free movement. This is beneficial as these bridges do not include bearings and joints, which usually only last 20-25 years.

Figure 32: Generic sequence for constructing an overbridge



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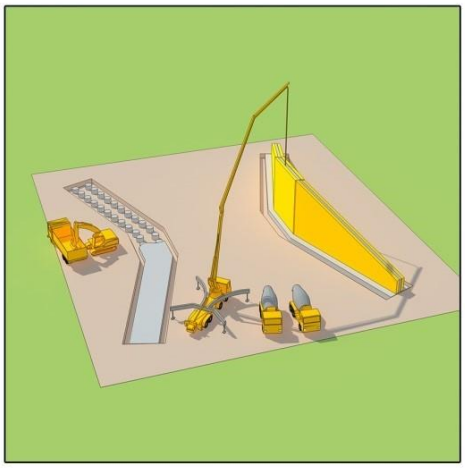

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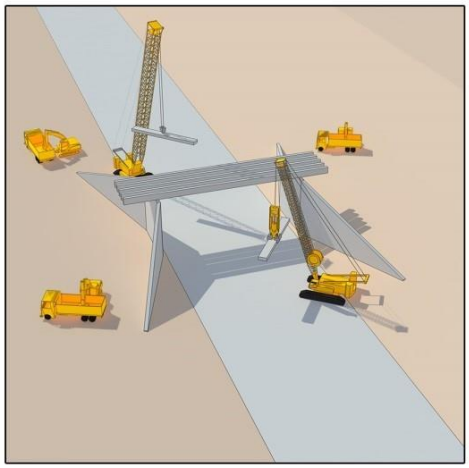

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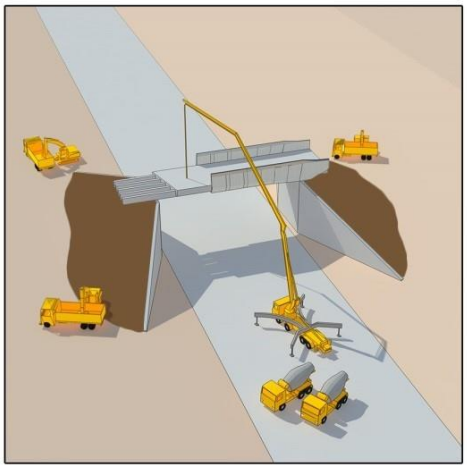

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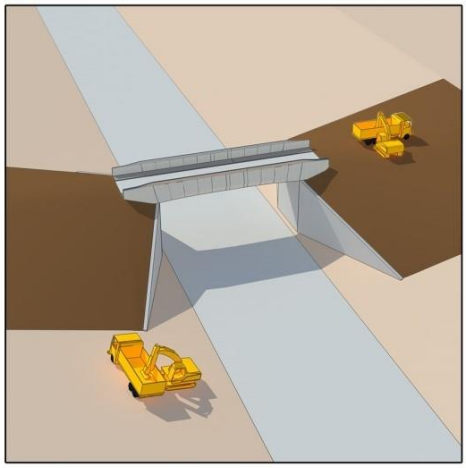

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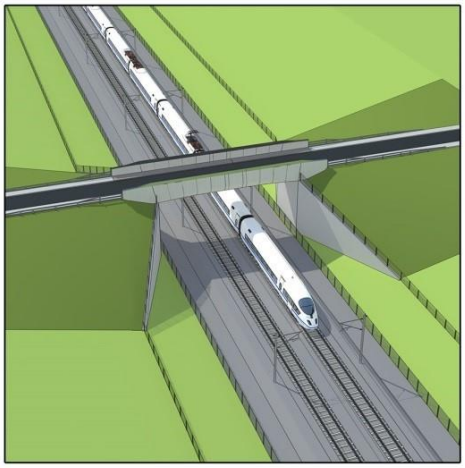

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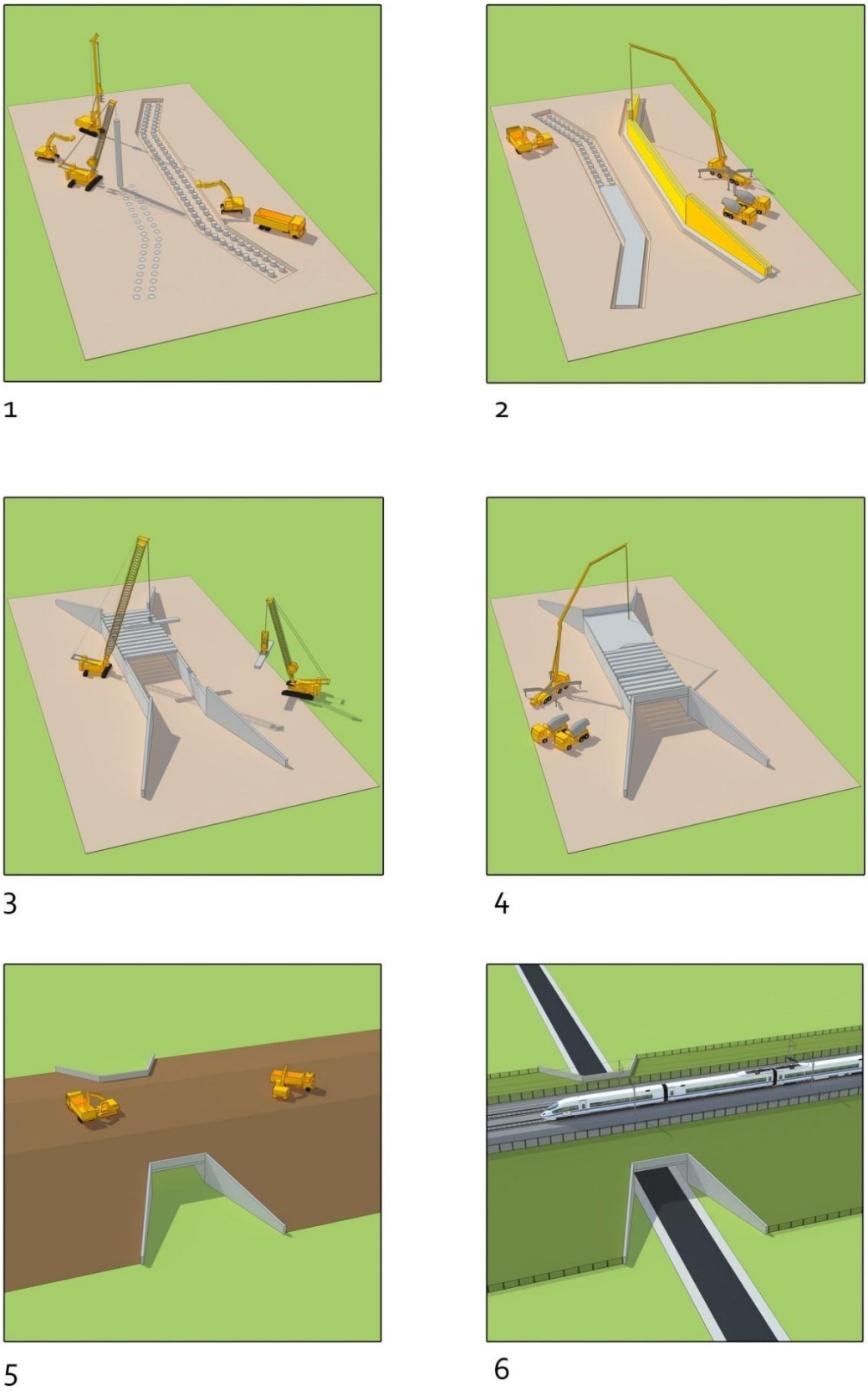
Figure 33: Generic sequence for constructing an underbridge



6.20 Railhead

6.20.1 The railhead will be situated on land between the route of the Proposed Scheme and the M6, near to Stone and Yarnfield. The railhead will connect with the existing railway network via the Stone to Norton Bridge Railway for the delivery of materials to be used for construction of the Proposed Scheme. During installation of rail systems equipment, the railhead will operate between January 2025 and June 2026 and will be used for the import and movement of material along the route of the Proposed Scheme. Use of the railhead will reduce the number of HGVs using the public road network. Installation of the railway, to the north and south, will also be managed from this location. Prior to this, the connection to the conventional Norton Bridge to Stone Railway will be used to facilitate movement of material via the conventional railway to reduce road transportation, where practicable.

6.20.2 Facilities at this railhead will include offices, storage, a rail marshalling yard and pre-assembly depot and rail reception maintenance loops. Rail deliveries into the railhead will be undertaken both during day and night time hours and at weekends, though unloading will be undertaken during standard working hours, where reasonably practicable. The railhead will operate 24 hours a day, seven days a week. Further information is provided in the Volume 2: Community area 3, Stone and Swynnerton.

6.21 Infrastructure Maintenance Base – Rail

6.21.1 The IMB-R will share the footprint of the railhead and majority of its infrastructure. Between July 2026 and September 2027, on completion of construction, the railhead will be converted for use as the IMB-R.

6.21.2 Construction details for the IMB-R are described in Volume 2: Community area 3, Stone and Swynnerton.

6.22 Noise barriers and bunds

6.22.1 Earth bunds used for noise mitigation will be constructed in the same way as embankments, as described in Section 6.10 of this report. Bunds will be designed with a flat top for the construction of environmental barriers, where required. On completion of the bund, top soiling and landscaping will be undertaken.

6.22.2 Noise fence barriers will be installed in-situ or as pre-fabricated panels. On completion of the barrier, top soiling and landscaping will be undertaken at these sites.

6.23 Site restoration and landscape treatment

6.23.1 Landscape mitigation such as planting will be established at the earliest reasonably practicable opportunity during construction. Planting away from the route will be undertaken to reduce adverse landscape and visual effects, and to increase habitat and biodiversity value.

6.23.2 Land used only for construction purposes will be appropriately restored once the construction works in that area are complete. Land will be returned to its pre-construction use, wherever appropriate, or to a condition as agreed with the owner of the land and the relevant planning authority. This will involve the removal of temporary structures, plant, materials and equipment. Any required infilling will be completed, followed by landscaping. The engineered embankments and/or cuttings

will be reshaped, where appropriate, to integrate the alignment sympathetically into the character of the surrounding landscape.

6.23.3 The remainder of the permanent fencing will be erected as part of the landscaping works. Additional information regarding the approach to mitigation and monitoring is contained within Section 9.

6.24 Track

6.24.1 The assessment has been undertaken on the assumption of slab track as the track form for the Proposed Scheme. Slab track will comprise precast concrete slabs supported on a continuous structural layer. A final decision on the track form will be made during the detailed design of the Proposed Scheme.

6.24.2 Slab track will usually be constructed by:

- constructing the hydraulic bound layer[132];
- placing the track slab on the hydraulic bound layer;
- installing the rails;
- adjusting the track to final position, and grouting into place; and
- stressing the rails and welding the joints.

6.24.3 It is expected that the completed sections of line will be used for delivery of materials, such as catenary wire, cables and granular fill, to the point of installation.

6.25 Power supply

6.25.1 Access for construction of the traction power supply system will be via the local road network, although some elements may be delivered from the rail corridor.

6.25.2 Construction of the equipment compounds or feeder stations will begin with installation of the construction compound and security fencing, followed by the forming of concrete foundations and slabs, including under-slab ducts.

6.25.3 Road access will be suitably designed to take delivery of the plant and equipment required at each location. This may require widening part of the planned route from the nearest public highway and installation of a suitable foundation for cranes to use.

6.25.4 Secondary fit-out for traction power and associated switch rooms will then take place.

6.25.5 Switch rooms and external transformers will be off-loaded by crane or slid from large vehicles.

6.25.6 The overhead line equipment will be installed by specialised machines, where construction phasing allows. The masts supporting the overhead line equipment will require foundations, such as concrete pads or monopiles[133], pre-cast piles[134] or steel

[132] Soil type materials (granular or cohesive) improved by the addition of various cementitious/asphaltic materials. It can be produced in-situ or elsewhere.
[133] A single large diameter pile with significant vertical and lateral load carrying capacity. It is used as an alternative to a pile group.
[134] A driven pile produced from pre-cast concrete.

screw piles[135] with reinforced concrete pile caps[136]. The masts will be lifted into place and bolted to the foundations from specialised equipment, followed by installation of the overhead line equipment.

6.25.7 Installation of the power supply system will be co-ordinated and timed to achieve phased 'powering on' milestones for each section of the Proposed Scheme.

6.26 Train control and telecommunications

6.26.1 Train control and telecommunication equipment will generally be installed after the track is laid and the overhead line equipment system installed. This will involve the laying of cabling into the trough system throughout the route, and the installation of line-side cabinets and signage.

6.26.2 The line-side telecommunications equipment will be constructed from within the railway corridor and access points along the route.

6.26.3 The radio masts and antennae will be installed from within the railway corridor where suitable for construction. The equipment will be delivered to site and lifted into place onto the foundations and cranes may be required for lifting of telecommunications masts.

6.26.4 The workforce will access the equipment from the permanent points of maintenance access for the rail corridor, where further fit-out is required.

6.26.5 Final installation of telecommunications systems will occur during the testing and commissioning phase.

6.27 Interfaces with the conventional rail network during construction

6.27.1 The construction of the Proposed Scheme will involve physical and operational changes to the conventional network.

6.27.2 The main points of interface with the conventional network during the construction phase are identified in Table 6.

Table 6: Construction interfaces with the National Rail network

Location	Summary of work
Great Haywood: Macclesfield to Colwich Line	Construction of a viaduct over the existing conventional railway. Minor modifications to overhead line equipment will also be required.
West of Stone: Norton Bridge to Stone line	Construction of two bridges over the existing conventional railway. Work to the conventional railway will be required to install connections to new 'reception sidings', which in turn connect to the Railhead, and later the IMB-R.

[135] A displacement pile screwed into the ground in order to transfer vertical load into the ground.
[136] A concrete structure used to link a number of discrete pile elements into a single arrangement to support significant loads that the pile elements are not capable of supporting individually.

Location	Summary of work
South of Madeley: WCML and the Stoke to Market Drayton Railway, and the Madeley Chord	Construction of a viaduct over the existing conventional railway lines.
South of Crewe: WCML	The Proposed Scheme will connect to the conventional railway to the south of Crewe. These connections will require one of the conventional lines to be re-built to the west of the existing railway. An additional two lines will be required to divert conventional freight trains off the WCML before the connection with the Proposed Scheme. HS2 spurs will pass over these three conventional rail lines on a viaduct, which will be built before the new lines are opened. Some additional infrastructure will be needed between Madeley and Crewe to enable trains to cross between the lines.
Crewe Station	In order to accommodate additional rail services at Crewe Station, the existing Cardiff to Manchester Piccadilly services will be routed via the Manchester Independent Lines tunnel at Crewe. A new 110m long island platform will be constructed at Crewe station to accommodate this service, along with a new footbridge to provide passengers access to this platform.
North of Crewe: various rail lines	Some modifications to signalling and communications infrastructure may be required on the existing railway to facilitate the increased number of trains that will run through this area. Rail systems modification works are proposed at two locations, Sandbach and Maw Green, on the Crewe to Manchester railway line, which is part of the WCML. These works are required to facilitate train operations that will occur as a result of HS2 Phase 2a services using this line prior to HS2 Phase 2b operations. The proposed works will also ensure that best use is made of existing capacity while maintaining operational flexibility. The works require the installation of new at-grade track switches and crossings, replacement of crossings, the raising of an existing footbridge at Sandbach station and supporting infrastructure as required.

6.28 System testing and commissioning

6.28.1 The railway will be fully tested to ensure it can operate safely and reliably. Testing and commissioning of the Proposed Scheme will be aligned to the construction programme, moving through commissioning into trial operation in stages. The period of testing, commissioning and trial operation is expected to extend over approximately one year and two months, commencing by 2026 and completing in 2027.

6.28.2 The programme of testing and commissioning will be divided into a number of phases, as defined below.

6.28.3 A certificate will be issued at the end of each phase of testing to confirm that the tests have been successfully completed and that the next phase can start. The phases include:

- phase 1: off-site testing – factory tests;
- phase 2: on-site testing – static tests;
- phase 3: on-site testing – commissioning;

- phase 4: on-site testing – integration tests;
- phase 5: on-site testing – migration tests;
- phase 6: rolling stock acceptance tests;
- phase 7: performance and operational tests; and
- phase 8: handover and acceptance.

6.28.4 Each of the systems to be tested will be broken down into commissioning lots. Each commissioning lot will be subjected to each test phase in sequence and is the smallest element that will be subjected to formal inspection. When breaking down the systems, due regard will be taken of the interfaces and dependencies between the systems and between the commissioning lots within each system. This will allow for the test sequence logic and test programme to be developed.

6.28.5 Rolling stock acceptance tests will take place once a sufficient length of route has been commissioned, and will be followed by performance tests involving multiple trains to confirm operability. The conventional compatible trains will be tested and commissioned on conventional infrastructure at the same time. Final installation of telecommunications systems will also occur during the testing and commissioning phase.

6.28.6 Trial operations will allow operational procedures to be tested and refined at the same time as staff are trained.

7 Environmental impact assessment

7.1 Overview

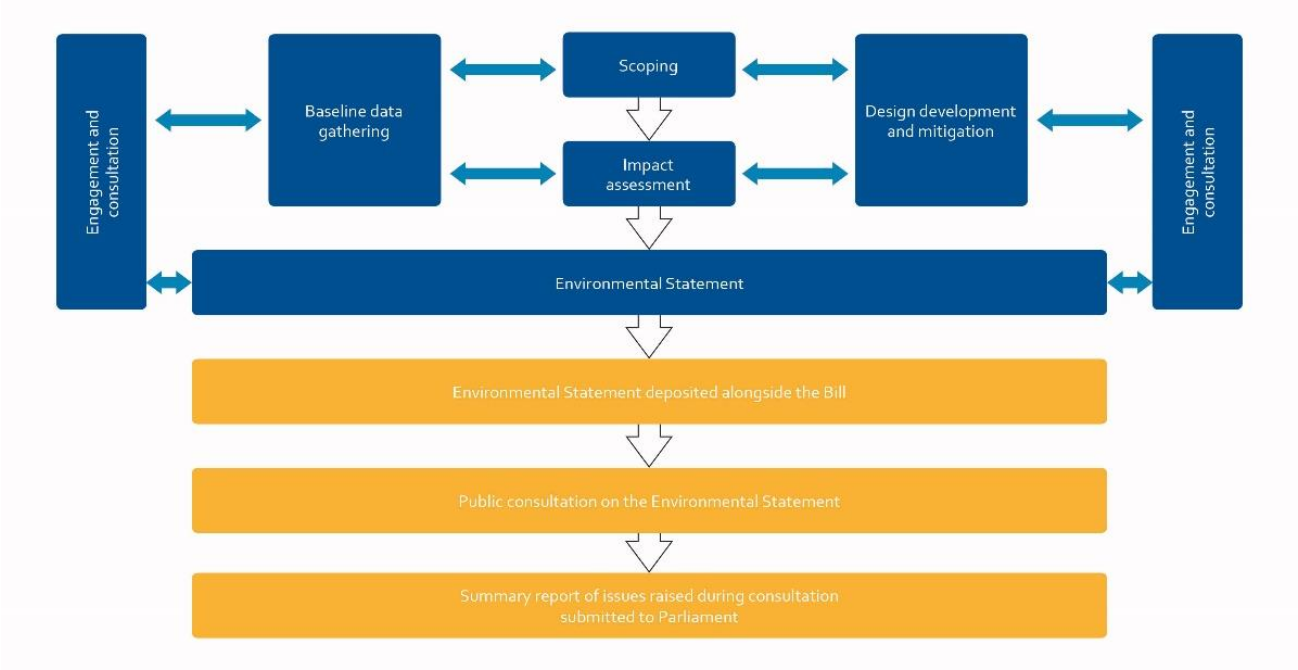
Introduction

7.1.1 The purpose of EIA is to identify the likely significant effects of a proposed development on the environment. In simple terms, it does this by identifying the current (baseline) conditions, anticipating how these may change in the future, and predicting the potential impacts of the development across a range of topics. This section describes the general approach adopted for the EIA of the Proposed Scheme. Further information on the scope and methodology approach for each topic is summarised in Section 8.

Preparation of the Environmental Statement and deposit to Parliament

7.1.2 The main steps in the preparation of the ES and deposit to Parliament are shown in Figure 34 and set out below.

Figure 34: Environmental assessment process for Phase 2a



Scoping

7.1.3 The scoping phase established the overall scope and methodology for the assessment, including the range of environmental topics to be addressed, and included an initial round of stakeholder consultation. Initial scoping was carried out on an informal basis, as set out in the SMR (Volume 5: Appendix CT-001-001) which was finalised through engagement and consultation with local authorities, a wide range of environmental organisations and the public. Since September 2016 there have been further refinements to the scope and methodology. These are set out in the SMR addendum (Volume 5: Appendix CT-001-002) which forms part of this ES.

Collection and presentation of baseline data

7.1.4 Studies have established the current baseline conditions, comprising the environmental conditions that exist in the vicinity of the Proposed Scheme and across the study areas for each topic. These studies comprised desk-top research to gather and evaluate previous environmental work and publicly available information, together with new environmental surveys and consultation with local groups. Relevant policies, guidelines and legislation, together with industry-accepted practice, were also identified as part of this stage.

7.1.5 The current baseline is being extrapolated, where appropriate, into the future to take account of predicted or anticipated variations due to factors such as changing climatic conditions (based on trends within the UKCP09 projections[137]), policy, legislation, advances in technology and future developments. This is known as the future baseline. Future baseline conditions may also be altered by other developments. The identification of future developments includes those that may occur before or during the construction of the Proposed Scheme, with the potential to result in significant impacts and resultant effects.

7.1.6 Due to the inevitable uncertainty of predicting effects based on future baseline conditions and/or where there is limited data, a reasonable worst-case approach has been adopted.

7.1.7 Future developments have been identified where they may introduce new environmental receptors[138] that could be significantly affected by the Proposed Scheme. Any mitigation proposed can be amended at a later date, in the event that the anticipated development does not take place, to reflect the change from the future baseline position.

7.1.8 Volume 2 Map Books and Volume 5 of the ES contains supporting environmental information and map books to be read in conjunction with the other volumes of the ES. In addition, certain reports and maps containing background information and data (BID) have been produced alongside the ES, which do not form part of the ES. These present survey information, collated from published and unpublished sources and are numbered with the prefix BID. Wherever referred to within the ES, a full reference is provided under 'References' and the documents are available on the HS2 website (at www.gov.uk/hs2).

Impact assessment

7.1.9 Assessment of the impacts and effects of the Proposed Scheme has been undertaken in accordance with the methodology outlined for each environmental topic in the SMR and SMR Addendum. This is also summarised within Section 8 of this report. The assessment has identified the likely significant effects, the measures proposed to mitigate adverse effects, and the likely significant residual effects (i.e. effects remaining following mitigation), for the construction and operation phase.

[137] UKCP09 (2009), *UKCP09 Climate Change Projections Report*. Available online at: http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87894&filetype=pdf

[138] Receptors are defined as a component of the natural or built environment (such as human beings, water, air, a building, or a plant) that is affected by an impact of construction and/or operation of a proposed development. Residents of a new housing development close to the route are an example of a new receptor.

7.1.10 The ES has taken account of relevant policies, guidelines, legislation and industry accepted practice in assessing impacts for each environmental topic, as well as the experience and professional judgement of specialists.

Mitigation and monitoring

7.1.11 Mitigation measures and procedures for monitoring (including measures to manage the effects of construction, the effectiveness of mitigation post construction, as well as monitoring during the operational phase) have been identified throughout the development and assessment of the Proposed Scheme. More information on the approach to mitigation and monitoring is set out in Section 9.

Consultation and engagement

7.1.12 Stakeholder engagement has taken place throughout the design process and preparation of the ES, and consideration has been given to consultation responses following the public consultation on the working draft EIA Report as described in Section 3.

Consideration of reasonable alternatives

7.1.13 A number of reasonable alternatives to the Proposed Scheme have been studied in the development of the Proposed Scheme. The strategic, route-wide and route corridor alternatives are described in Section 10. Local alternatives studied prior to November 2015 are outlined in Section 11. A more detailed account of the reasonable alternatives studied, how they were studied and the reasons for the choices made can be found in the Alternatives report (Volume 5: Appendix CT-002-000). Local alternatives studied since November 2015 are addressed in the Volume 2: Community area reports and these are also presented in the Alternatives report.

Deposit to Parliament and subsequent steps

7.1.14 In accordance with House of Commons Standing Order 27A[139], the ES is to be deposited in Parliament and will include the information set out in Section 1.3 of this report. Copies of the ES (containing the non-technical summary) deposited will be made available for inspection, and for sale at a reasonable price, in accordance with the standing order.

7.1.15 Also, in accordance with Standing Order 224A[140], public participation on the ES allows for a period of at least 56 days (eight weeks) within which members of the public and other stakeholders may comment on the ES. An independent assessor will then prepare a report summarising the issues raised during that period. This report will then be submitted in Parliament ahead of Second Reading by the Examiner.

7.2 Scope of the assessment

Introduction

7.2.1 The scope determines what is included within the assessment of the Proposed Scheme, in terms of:

[139] House of Commons, (2015), *Standing Order 27A relating to private business (environmental assessment)*, House of Commons.
[140] House of Commons, (2015), *Standing Orders- Private Business*, House of Commons.

- time periods – 'the temporal scope';
- areas – 'the geographic scope'; and
- topics – 'the technical scope'.

Temporal scope

7.2.2 The main construction works are expected to take place between 2020 and 2026 (including a period of testing and commissioning), although the duration, intensity and scale of construction along the route will vary over this period. The Proposed Scheme is expected to become operational in 2027. Topics have generally assessed the period of maximum intensity over the construction period and compared it to a defined baseline year.

7.2.3 The maximum level of operational activity (i.e. the number and frequency of trains and passengers) using the Proposed Scheme will be reached after the opening of the full Y-network, following construction of Phase 2b, which is expected in 2033. Therefore, consideration has been given to the implications of the operational rail traffic and passenger numbers associated with the full Y-network for relevant environmental topics. These topics include: traffic and transport; sound, noise and vibration; community; and air quality (insofar as transport-related emissions are concerned). The noise and vibration implications for receptors along the route of the Proposed Scheme, and any transport implications associated with passenger movements at stations and on other modes, are being assessed on the basis of the operational assumptions set out in Section 4.3 of this report. Transport implications associated with increased passenger movements at off-route stations have been assessed and are reported in Volume 4: Off-route effects, where relevant.

7.2.4 The EIA compares the future patterns of movement of transport and passengers resulting from the Proposed Scheme with the predicted transport and passenger movements without HS2, otherwise known as the 'do minimum case' (or 'future baseline' case).

7.2.5 The do minimum case refers to the future that would exist if the Proposed Scheme were not developed. This scenario takes account of other changes to transport infrastructure, including:

- electrification of the Midland Main Line from St Pancras Station, London, thereby providing increased capacity and faster journey times to the East Midlands;
- use of Intercity Express Rolling Stock on the ECML, resulting in increased capacity and faster journey times;
- improvements to WCML infrastructure and the WCML timetable to provide additional trains and faster running speeds; and
- development of the East West Rail scheme between Oxford and Milton Keynes to provide new local services and faster cross country services.

Geographic scope

7.2.6 The geographic (or spatial) scope is the area over which changes to the environment are likely to occur. This distance is influenced by the physical extent of the works, the nature of the baseline environment and the manner in which the effects are propagated. It takes account of both the land required permanently for rail infrastructure and the additional land required temporarily for construction.

7.2.7 Each of the environmental topics identifies the area within which impacts and effects have been assessed. This is summarised in Section 8 and further explained within the SMR and SMR addendum.

7.2.8 The reporting of likely significant effects of the Proposed Scheme is presented in the Volume 2 community area reports. Volume 2 is split into five community area reports, each of which is based on a distinct geographical area, as shown in Section 3.3 of this report.

7.2.9 The assessment of environmental impacts and effects that cover a wider geographical area is reported in Volume 3. The effects reported in Volume 3 are those considered to be appropriately assessed at a geographical scale greater than that presented within the Volume 2 community area reports.

7.2.10 The assessment of environmental impacts and effects that may occur beyond the route corridor is reported in Volume 4. These off-route impacts and effects have been considered at a regional or national level, and include the effects of:

- increased passenger numbers at off-route rail stations, as a result of the Proposed Scheme;
- modifications to the Crewe to Manchester conventional railway line (part of the WCML) at Maw Green and Sandbach; and
- modifications to off-route highways.

Technical scope

7.2.11 The technical scope refers to the environmental topics that have been addressed in the assessment, which are as follows:

- agriculture, forestry and soils;
- air quality;
- climate change;
- community;
- cultural heritage;
- ecology and biodiversity;
- electromagnetic interference;
- health;
- land quality;

- landscape and visual;
- major accidents and natural disasters;
- socio-economics;
- sound, noise and vibration;
- traffic and transport;
- waste and material resources; and
- water resources and flood risk.

7.2.12 These topics have been evaluated during the scoping process to determine the extent to which they require inclusion/consideration within the ES, having regard to whether they are likely to give rise to significant effects. It was determined as part of this process that all topics, with the exception of electromagnetic interference, could potentially give rise to significant effects.

Electromagnetic interference

7.2.13 Specific assessment of potential electromagnetic effects is not required as part of the EIA, since these effects can be 'designed out' of the Proposed Scheme. Further explanation is provided in Volume 5: Appendix EM-001-000 and summarised in this section.

7.2.14 High voltage electrical equipment creates electromagnetic fields (EMF), which can potentially have implications for human health and may cause electromagnetic interference (EMI) to other electrical/electronic equipment (e.g. communications) or infrastructure (e.g. power lines). In addition, features such as tower cranes can cause temporary interference to TV reception.

7.2.15 The main potential source of EMI associated with the Proposed Scheme will be the traction power system, comprising the overhead line equipment along the route and supporting infrastructure such as feeder stations. The railway communications system will, in addition, generate radio signals.

7.2.16 The railway's own operating systems will need to be immune to EMI and radio interference, whilst levels of exposure for passengers and staff must be acceptable. This will be achieved by ensuring that all electrical equipment complies with the relevant standards for electromagnetic compatibility (EMC) and personal protection, for example BS EN 50121-5-2017[141] and BS EN 50122-1- 2011[142] and EU Directive 2013/35/EU[143] Electromagnetic Fields (EMF) limits, which is closely based on ICNIRP (International Commission on Non-Ionising Radiation Protection) guidance[144].

[141] British Standards Institute, (2017), *BS EN 50121-5-2017 Railway Applications, Electromagnetic Compatibility*.
[142] British Standard, (2011), *BS EN 50122-1-2011 Railway Applications, Fixed installations – Electrical safety, earthing and the return circuit. Part 1: Protective provisions against electric shock.*
[143] Official Journal of the European Union, *Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).*
[144] International Commission on non-ionizing radiation protection (2010), *ICNIRP Guidelines*.

7.2.17 EMF extend over relatively short distances. Any residual risk to nearby receptors (e.g. residential properties, businesses or communications infrastructure) will not be significant, on the assumption that acceptable levels are achieved on the railway itself.

7.2.18 Equipment used during construction of the Proposed Scheme will also comply with applicable standards for EMF and EMC. Assuming that this equipment is installed, operated and maintained correctly, levels of electromagnetic emissions are unlikely to exceed the acceptable limits for workers or the public, or to cause EMI. Power supplies used for construction are generally insufficient to cause any significant EMI.

7.2.19 Tower cranes will be used in some locations during the construction phase. If complaints about interference are received (e.g. in relation to TV reception), appropriate remedial action will be taken to restore signal integrity at affected properties (e.g. by replacing aerials or boosting signal strength). However, the likelihood of such effects is decreasing as more people switch to digital or cable networks.

7.3 Impacts and effects

7.3.1 The ES identifies both beneficial and adverse impacts on environmental and community resources or receptors. The likelihood that an impact will give rise to a significant environmental effect depends on a number of factors, such as the magnitude of the impact and the sensitivity of the receiving environment and community. The ES identifies the likely significant effects of the Proposed Scheme. It also:

- identifies the level of impact that gives rise to the significant effects;
- explains how significant adverse effects will be mitigated; and
- identifies proposed monitoring arrangements.

7.3.2 The predicted impacts have generally been classified according to whether they are beneficial, adverse or negligible. Impacts and effects have generally been further categorised as low/minor, medium/moderate or high/major. Whilst the definition of each category varies by topic, as shown in the SMR and the SMR Addendum, these terms have generally been defined as follows, unless otherwise specified:

- beneficial: advantageous or positive change to an environmental resource or receptor;
- adverse: detrimental or negative change to an environmental resource or receptor;
- negligible: imperceptible impacts to an environmental resource or receptor;
- low/minor: slight, very short-term and/or highly localised impact;
- medium/moderate: limited impact (by extent, duration and/or magnitude); and
- high/major: considerable impact (by extent, duration and/or magnitude) of more than local importance or in breach of recognised standards, policy or legislation.

7.3.3 The duration of impacts has been defined as either temporary or permanent. Impacts can occur either directly or indirectly. Direct impacts are those that will arise directly from construction or operation of the Proposed Scheme (e.g. due to the land required or to train movements). Indirect impacts are those that arise from consequential changes associated with the Proposed Scheme (e.g. the impacts on conventional rail services). Examples of such consequential indirect changes and where these are reported in the ES, are listed below:

- consequential changes to rail services on other lines, especially on the WCML, as a result of new and improved journey opportunities the Proposed Scheme will offer. This is called 'released capacity' on those lines (Volume 3: Route-wide effects);
- the socio-economic benefits resulting from the operation of the Proposed Scheme. For example, the Proposed Scheme will create indirect employment opportunities associated with the IMB-R (through for example, expenditure on supplies and services necessary for the operation of the Proposed Scheme (Volume 3: Route-wide effects, Section 12);
- the changed traffic flows on highways resulting from people's decisions to travel on HS2 rather than by road (Volume 3, Route-wide effects, Section 14);
- impacts upon traffic congestion and delays associated with change in use (measured in terms of station footfall) of stations located off-route (Volume 4: Off-route effects).

7.3.4 Impacts have been assessed qualitatively, based on professional judgement, in instances where quantification was not possible. Section 8 indicates where uncertainty exists, and the assumptions that have been made.

7.3.5 Effects deemed to be significant have been evaluated against recognised standards and accepted criteria for each environmental topic, where these are available. Professional judgement has been used in instances where no recognised standards or criteria exist, taking account of factors such as:

- spatial extent (e.g. local, district, regional, national or international);
- magnitude;
- duration (whether short, medium or long-term);
- frequency of occurrence;
- nature of the effect (whether direct or indirect, permanent or reversible);
- whether it occurs in isolation, is cumulative or interactive;
- sensitivity and number of receptors affected;
- value of a resource affected;
- performance against environmental quality standards; and
- compatibility with environmental policies.

7.4 Cumulative effects

Introduction

7.4.1 Cumulative effects are broadly defined as incremental effects that result from the accumulation of a number of individual effects. They may result either from:

- a combination of effects arising from the Proposed Scheme (intra-project effects). For example, intra-project effects may arise during construction in cases where the occupiers of a group of neighbouring residential properties experience noise, visual and traffic effects, resulting from construction activities and the passage of construction vehicles on the local road network; or
- from an interaction between the effects of the Proposed Scheme with the effects of other developments that are likely to be under construction or to have been completed during construction or operation of the Proposed Scheme (inter-project effects). For example, construction of the Proposed Scheme and Phase One may give rise to inter-project effects at the interface between the two schemes.

7.4.2 Cumulative effects can be either temporary or permanent and can broadly arise from:

- the combined effects on a single receptor of a number of individual environmental impacts, for example noise, dust and traffic;
- the effects of existing and/or approved projects in the vicinity of the Proposed Scheme which are under construction or have been consented, including HS2 Phase One, which when combined with the effects of the Proposed Scheme may have an incremental significant effect; and
- the cumulation of individual effects on a receptor which when summed (including in a regional context or over the length of the Proposed Scheme), result in an effect of greater significance than the sum of the individual effects (i.e. synergistic effects).

7.4.3 Developments expected to be completed between 2020 and 2027 (i.e. before the Proposed Scheme is operational), may give rise to cumulative effects. However, smaller projects are unlikely to give rise to significant cumulative effects, as the scale of their construction impact, in combination with the Proposed Scheme, will not generate any noticeable increases in effects.

7.4.4 People living in developments to be completed before 2020 are included as receptors of construction of the Proposed Scheme and those in developments to be completed before 2027 are included as receptors of the operational effects of the Proposed Scheme.

7.4.5 Developments that may be completed after 2027 have generally not been taken into account. This is because development planning generally does not extend so far into the future and even where such developments can be identified, there is generally insufficient information available for an assessment of cumulative effects. In these cases it is assumed that the planning process for those developments will take the

Proposed Scheme into account (and will therefore consider any cumulative effects at that time).

7.4.6 Committed developments are defined as developments that have planning permission or for which sites have been allocated in adopted development plans, which are on or close to the Proposed Scheme. Planning applications yet to be determined and sites where proposed allocations in development plans are yet to be adopted, are termed proposed developments and have not been included in the assessment. However, the progress of these proposals will continue to be monitored by HS2 Ltd.

7.4.7 Consideration has been given to potential cumulative effects of the Proposed Scheme and other committed developments. This includes HS2 Phase One, where relevant, which received Royal Assent in February 2017.

7.4.8 A list of committed and proposed developments is contained within Volume 5: Appendix CT-004-000[145]. Committed developments are also shown on Map CT-13-00. The Volume 2 Community area reports set out the committed developments that have been considered in determining the future baseline and/or in assessing the cumulative effects for each topic.

Phase One, Phase 2a and Phase 2b

7.4.9 Construction of HS2 Phase One commenced in 2017 and is scheduled to be operational in 2026. The Phase 2a scheme is due to commence construction in 2020 and open a year later than Phase One, in 2027. There will, therefore, be some overlap between the construction (and commissioning) phases for Phase One and Phase 2a. These matters are reported in Volume 2: Community area 1, Fradley to Colton report.

7.4.10 The operational effects of the Proposed Scheme were assessed on the assumption that the full Y network will be operational, so as to provide a reasonable worst-case basis on which to assess effects such as those relating to train noise. In this sense, these effects are cumulative, in that they reflect the combined operation of all phases of HS2.

7.4.11 A summary of the combined impacts of Phase One, Phase 2a and Phase 2b of HS2 is presented in Volume 3, Route-wide effects.

7.5 Assumptions and limitations

7.5.1 A precautionary approach is used in the EIA of the Proposed Scheme in identifying impacts and effects in instances where there is uncertainty or limited information. Any assumptions and limitations which affect the assessment of significant environmental effects of the Proposed Scheme are described in the relevant environmental topic sections within the ES.

[145] Generally, the assessment of committed and proposed development was undertaken up to 31 December 2016.

8 Scope and methodology summary for environmental topics

8.1 Introduction

8.1.1 This section provides a summary, by environmental topic, of:

- assessment scope and methodology; and
- the key assumptions and limitations underpinning the assessment methodology.

8.1.2 The full scope and methodology is contained within the SMR (Volume 5: Appendix CT-001-001) and SMR Addendum (Volume 5: Appendix CT-001-002). The SMR addendum also includes a series of technical notes. These have been prepared for each environmental topic, except agriculture, forestry and soils and sound, noise and vibration.

8.2 Agriculture, forestry and soils

Scope

8.2.1 The assessment covers the environmental topic areas of agriculture, forestry and soils, which includes assessments on agricultural land quality, farm holdings and enterprises, forestry enterprises and soil resources. The impacts on these resources and receptors result directly from land required (both temporarily and permanently) for the construction and operation of the Proposed Scheme, from severance, and from construction activities on adjacent agricultural land.

8.2.2 Effects were identified for all agricultural and forestry land that will be required for the construction and operation of the Proposed Scheme, and for all holdings that include such land.

8.2.3 Most effects on agriculture, forestry and soils will arise during the construction phase and will be either temporary or permanent. Temporary effects include land that will be used during construction and available for restoration to agricultural use using conserved soil resources on completion of construction (in agreement with the landowner). Where agricultural uses are to be resumed on land disturbed during the construction of the Proposed Scheme, the design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land, through the adoption of good practice techniques in handling, storing and reinstating soils on that land. Other temporary effects include the severance of land during construction, and the potential effects of construction noise and dust on adjacent agricultural activities. Permanent effects will be those that remain following the construction of the Proposed Scheme, including the land permanently required, and the permanent severance of land and effects on farm infrastructure. Operational impacts relate primarily to the effects of operational noise on agricultural and related enterprises and the ongoing management of operational railway land.

Baseline

8.2.4 Information on current agricultural land quality was derived from an interpretation of geological, topographical, soil, agro-climatic and existing detailed and predictive Agricultural Land Classification (ALC) information. This ALC information was augmented by field surveys to provide further detailed ALC information and to validate the findings of the predictive desk exercise, where required and where access was available. Desktop research was also used to identify relevant agri-environmental schemes and woodlands. Details of land use and farming practices were obtained primarily from interviews with landowners and farmers.

Methodology

8.2.5 Significant effects were derived from the interaction between the magnitude of impact, the sensitivity of the affected resource/receptor and the relative scarcity or abundance of the resource/receptor in the locality. Impact magnitude is essentially a matter of its extent, duration or severity (e.g. the proportion of a holding subject to land required for construction and/or operation). Sensitivity reflects the resilience of a soil resource or business to accommodate change, whilst scarcity relates to the relative abundance of a resource/receptor (e.g. best and most versatile (BMV) land in the locality or a niche business).

8.2.6 The areas of land required to construct and operate the Proposed Scheme were calculated on the basis of the maximum extent of the permanent infrastructure and temporary works (including soil storage areas).

Assumptions and limitations

8.2.7 It was assumed, as part of the assessment, that:

- there will be no reduction in long term capability or agricultural quality of land used temporarily for construction of the Proposed Scheme, by adopting good practice techniques in handling, storing and reinstating soils on the land;
- agricultural land required for temporary purposes during construction, which is to be re-instated as agricultural land, will be returned to its original landowner;
- all agricultural soil resources generated by the Proposed Scheme will be used appropriately and on-site to fulfil one or more of the recognised functions of soil;
- all borrow pits will be available for restoration to agricultural use, with good practice techniques used to restore agricultural soils to a condition suitable for return to its existing land use and with land drainage to be installed to ensure ongoing agricultural management of the restored land;
- displaced ancient woodland soils will be translocated as appropriate to form the basis of new woodland planting and that all other woodland soils will be reused as appropriate, including as the basis for new woodland planting;
- land required for environmental mitigation measures will no longer be available for agricultural use, which is a worst-case assumption, although some land such as grasslands may be managed on a low input basis by agricultural

interests;

- farm buildings and dwellings to be demolished as part of the Proposed Scheme will not be replaced[146]; and
- severed land will continue to be used by the holding where access is available to that land, and that, where required, new field accesses to severed parcels of land will be created from public highways.

8.3 Air quality

Scope

8.3.1 The air quality assessment includes consideration of the potential effects of construction and operation. Construction effects will occur as a result of the construction activities, the use of borrow pits, associated traffic movements and highway interventions. Operational effects on air quality will occur as a result of changes to road layouts and traffic flows.

8.3.2 The key pollutants considered were: dust, oxides of nitrogen (NOx), including nitrogen dioxide (NO_2), and particulate matter (PM_{10} and $PM_{2.5}$). Traffic effects were assessed for the peak years during the construction period and for the year of opening for operational effects.

8.3.3 The spatial scope of the assessment reflects the area over which effects are likely to be measurable, ranging from the immediate vicinity of the works (e.g. for dust emissions), to air quality management areas and the local authorities within which local air quality is monitored and managed. Criteria from the Design Manual for Roads and Bridges (DMRB) were used to determine the relevant extent of the highway network to be assessed for traffic emissions.

Baseline

8.3.4 Information on current air quality has been obtained primarily from:

- local authority air quality review and assessment reports;
- monitoring data available from the national Automatic Urban and Rural Network (AURN);
- the Department for Environment, Food and Rural Affairs (Defra) Air Information Resource website; and
- the UK Air Pollution Information System.

Methodology

8.3.5 The effects from dust during construction were assessed using an approach developed from the guidance produced by the Institute of Air Quality Management (IAQM)[147]. This guidance assigns the scale of an effect according to the scale of the construction works and the number, proximity and sensitivity of the receptors. The effect is a

[146] Compensation will be payable to landowners whose farm buildings and dwellings are demolished as part of the Proposed Scheme.
[147] Institute of Air Quality Management, (2014) *Guidance on the assessment of dust from demolition and construction*, IAQM, London.

combination of the likelihood of significant levels of dust occurring at receptors (i.e. dust impacts) and the extent of inconvenience or annoyance that may be caused, and as such is an assessment of risk (the probability of an event happening combined with the severity of it).

8.3.6 The assessment assumes that dust control measures will be applied to the construction activities, through the CoCP, so that dust levels at sensitive receptors are kept as low as reasonably practicable. For ecological receptors (such as nature conservation sites), the determination of the level of effect takes account of the potential level of impact, the sensitivity of the receptor to dust impacts, and the designation of the receptor.

8.3.7 The effects from dust and particulates from mineral extraction operations during construction were assessed using an approach development from the guidance produced by the IAQM[148]. This guidance uses a source-pathway-receptor approach to derive the likely magnitude of the effect that will be experienced at a sensitive receptor.

8.3.8 The assessment assumes that dust control measures will be applied to the borrow pit operation, through the CoCP, so that dust levels at sensitive receptors are kept as low as reasonably practicable.

8.3.9 The level of effects from traffic emissions on individual receptors (e.g. residential properties close to roads) has been identified on the basis of air quality standards (EU/UK air quality limit values and objectives), in accordance with the descriptors used in the IAQM/Environmental Protection UK (EPUK) *Land-Use Planning & Development Control: Planning for Air Quality*[149].

8.3.10 Changes to traffic flows and road alignments have been screened using the DMRB criteria. Where the changes exceeded the thresholds, traffic related effects at receptors have been predicted using dispersion modelling. The likelihood of nitrogen deposition on sensitive sites (e.g. protected habitats) has been assessed in accordance with the DMRB guidance.

Assumptions and limitations

8.3.11 Assumptions necessary to undertake the air quality assessment are set out in the SMR and SMR addendum and in individual sections in the Volume 2: Community area reports.

8.4 Climate change

Introduction

8.4.1 Climate change was assessed in three ways as part of the EIA:

- a Greenhouse Gas (GHG) assessment;
- an in-combination climate change assessment; and

[148] Institute of Air Quality Management, (2016) *Guidance on the assessment of mineral dust impacts for planning*, IAQM, London.
[149] Moorcroft and Barrowcliffe, (2017), *Land-Use Planning & Development Control: Planning for Air Quality*, IAQM, London

- a climate change resilience assessment.

GHG assessment

Scope

8.4.2 The scope of the GHG assessment included the following stages: before use (also referred to as construction emissions), use (also referred to as operational emissions), end-of-life, and carbon benefits (e.g. from modal shift (such as shifting from cars to trains) and loads (such as journeys by car to a station served by HS2) beyond the Proposed Scheme's boundary. For further detail on the scope of the GHG assessment refer to the GHG technical note included in the SMR addendum.

Baseline

8.4.3 The existing and future environmental baselines for the Proposed Scheme are based on a 'without the Proposed Scheme' scenario (i.e. the Proposed Scheme is not built) and there are no associated carbon emissions.

Methodology

8.4.4 The GHG assessment takes a life cycle assessment (LCA) approach consistent with the principles set out in BS EN 15978[150] , BS EN 15804[151] and PAS 2080[152] standards, which is detailed in the Scope and Methodology Report (SMR) Addendum (Volume 5: Appendix CT-001-002). The GHG emissions associated with the construction and operation of the Proposed Scheme are reported in the form of the 'carbon footprint' - reported in tonnes of carbon dioxide equivalent (tCO_2e).

Assumptions and limitations

8.4.5 There is a level of uncertainty behind the GHG assessment primarily due to the long time periods involved (i.e. 120-year design life). Projections on the carbon intensity of UK grid electricity generation vary, whilst there are numerous sources of information on the carbon intensity of concrete and steel manufacturing. These limitations have been addressed by analysing the sensitivity of the Proposed Scheme's carbon footprint to alternative assumed future scenarios.

In-combination climate change impacts assessment

Scope

8.4.6 As set out in the SMR Section 8, the technical scope of the in-combination climate change impacts assessment has incorporated:

- an initial assessment of potential climate change effects for all EIA topics during construction and operation; and
- an assessment of significant in-combination climate change effects for

[150] British Standard, (2011), *Sustainability of Construction Works – Assessment of environmental performance of buildings – Calculation method*, BSI Limited, London, UK.
[151] British Standard, (2012), *Sustainability of Construction Works – Environmental Products Declarations. Core Rules for the product category of construction products*, BSI Limited, London, UK.
[152] Construction Leadership Council & the Green Construction Board, (2016), *PAS 2080: 2016: Carbon Management in Infrastructure*, BSI Limited, London, UK.

relevant topics during construction and operation.

8.4.7 The physical scope of the in-combination climate change impacts assessment comprised the five community areas along the route of the Proposed Scheme and the distances either side of the Proposed Scheme within which other topics undertook their own assessments of effects. The temporal scope of the in-combination climate change impacts assessment assessed effects for the '2020s' (construction and start of operation) and the '2080s'[153] (operation).

Baseline

8.4.8 The trends within the UKCP09 climate change projections indicate changes to long-term, seasonal averages such as warmer and drier summers, milder and wetter winters, an increase in annual average temperature, and fewer days with frost.

8.4.9 Climate change is also expected to result in more extreme weather, including more very hot days, more intense rainfall, and an increase in dry spells. In addition, the probability of short periods of intense cold weather and of more frequent storms and high winds is also likely to increase but with a higher level of uncertainty. These changes in climatic averages and extreme weather events are likely to become more pronounced during the operation phase of the Proposed Scheme.

Methodology

8.4.10 The approach to the in-combination climate change impacts assessment was informed by good practice and guidance including that from the European Commission[154], the Institute of Environmental Management and Assessment (IEMA)[155] [156], and topic specific guidance published by the Food and Agriculture Organisation[157], Woodland Trust[158], the Forestry Commission[159], the Landscape Institute[160], the Health Protection Agency[161] and Defra[162].

8.4.11 Potential climate change impacts and effects were considered at the route-wide level for all topics and community areas. This initial in-combination climate change impact assessment then identified EIA topics to be scoped in for a more detailed assessment. This more detailed assessment determined whether there were any significant in-combination effects to report.

[153] The '2020s' refers to the period between 2011 and 2039. The '2080s' refer to the period between 2071 and 2099.
[154] European Commission, (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment.* Available online at: http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf
[155] IEMA, (2010), *IEMA Principles Series: Climate Change Mitigation and EIA, IEMA; EIA and Climate Change*. Available online at: https://www.iema.net/
[156] IEMA, (2015), *IEMA guide to climate change resilience and adaptation*. Available online at: https://www.iema.net/
[157] Environment Agency, (2016), *Guidance - Flood risk assessments: climate change allowances*. Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
[158] Woodland Trust, (2015), *Climate change - the Woodland Trust's position*. Available online at: https://www.woodlandtrust.org.uk/publications/2015/06/climate-change
[159] Forestry Commission, (2016), *Forests and climate change*. Available online at: http://www.forestry.gov.uk/climatechange
[160] Landscape Institute, (2008), *Landscape architecture and the challenge of climate change*. Available online at: http://www.landscapeinstitute.org/PDF/Contribute/LIClimateChangePositionStatement.pdf
[161] Health Protection Agency, (2012), *Health Effects of Climate Change in the UK*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/371103/Health_Effects_of_Climate_Change_in_the_UK_2012_V13_with_cover_accessible.pdf
[162] Defra, (2011), *The England Biodiversity Strategy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf

Assumptions and limitations

8.4.12 Assumptions which have informed the in-combination climate change impacts assessment are as follows:

- mitigation measures for effects assessed by other topics will be implemented effectively; and
- the CoCP will provide appropriate mitigation measures for extreme weather related effects during construction.

8.4.13 Limitations of the in-combination climate change impacts assessment are as follows:

- the inherent uncertainty around climate change projections and the variation in information availability for different climate hazards;
- the design life extending beyond the time horizons available from UKCP09 projections; and
- the lack of guidance for some topics in comparison to in-depth information for others which may lead to potential differences in the depth and breadth of assessments.

Climate change resilience assessment

Scope

8.4.14 The technical scope of the climate change resilience assessment has incorporated an assessment of potential climate hazards and risks for all infrastructure and assets associated with the Proposed Scheme to the end of their design life taking into account existing or embedded mitigation measures.

8.4.15 The physical scope of the climate change resilience assessment comprises the five community areas along the route of the Proposed Scheme. The temporal scope of the climate change resilience assessment will assess impacts for the 2020s (construction) and the 2080s (operation).

Baseline

8.4.16 The baseline for the climate change resilience assessment is the same as that for the in-combination climate change impacts assessment.

Methodology

8.4.17 The approach to the climate change resilience assessment was informed by good practice and guidance including that from the European Commission[163], the IEMA[164],[165], RSSB[166], Network Rail[167] and the Cabinet Office[168].

8.4.18 The climate change resilience assessment was initially considered at a route-wide level and included all relevant assets associated with the Proposed Scheme. It was based on a high level climate change risk assessment which uses the projections of changes in climate averages and extreme weather events provided in UKCP09 to qualitatively assess the impacts of climate change on the Proposed Scheme using professional expertise and judgement.

Assumptions and limitations

8.4.19 The climate change resilience assessment assumed that the Proposed Scheme will be designed to be resilient to impacts arising from current weather events and climatic conditions, and that it will be designed in accordance with HS2 technical requirements that are built upon best practice engineering codes and adapted to consider climate change where appropriate. These climate change adaptations were developed during the design of Phase One of HS2 and are considered 'embedded mitigation' for Phase 2a. The limitations of the climate change resilience assessment relate to:

- the inherent uncertainty around climate change projections and the variation in information availability for different climate hazards; and
- the design life extending beyond the time horizons of climate change projections available from UKCP09.

8.5 Community

Scope

8.5.1 The community assessment addresses the likely effects on residential properties (and their occupants), community facilities, including recreational facilities, open space and promoted PRoW (and their users) and communities as a whole. Effects may result from:

- a loss or gain as a result of the land required for the construction or operation of the Proposed Scheme;
- isolation as a consequence of barriers (physical, psychological and social) that communities would face resulting from construction or operation of the

[163] European Commission, (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*. Available online at: http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf
[164] IEMA, (2010), *IEMA Principles Series: Climate Change Mitigation and EIA, IEMA; EIA and Climate Change*. Available online at: http://www.iema.net/eia-climate-change
[165] IEMA, (2015), *IEMA guide to climate change resilience and adaptation*. Available online at: http://www.iema.net/eia-climate-change
[166] RSSB, (2016), *Tomorrow's Railway and Climate Change Adaptation*. Available online at: https://www.rssb.co.uk/Library/research-development-and-innovation/2016-09-T1009-Final-Report.pdf
[167] Network Rail, (2015), *Climate change adaptation report*. Available online at: http://www.networkrail.co.uk/wp-content/uploads/2016/11/Climate-Change-Adaptation-Report-2015_FINAL.pdf
[168] Cabinet Office, (2011), *Keeping the country running: natural hazards and infrastructure*. Available online at: https://www.gov.uk/government/publications/keeping-the-country-running-natural-hazards-and-infrastructure

Proposed Scheme;

- in-combination effects relating to a change in the amenity value of community resources, as a consequence of a combination of factors (noise and vibration, HGV traffic, air quality and visual impacts); and
- the temporary presence of construction workers and their demands on community facilities.

8.5.2 Effects relating to the severance of PRoW and highway and pedestrian diversions, are assessed as part of the traffic and transport topic. However, where PRoW are 'promoted' destinations in their own right as a recreational resource, they have been considered within the community assessment. Where impacts on open space and PRoW are considered, these have been informed by surveys of their use.

8.5.3 Open space that is privately owned and not available for use by the general public (e.g. woodlands on farmland) has been excluded from the assessment. However, land that is privately owned but open for public use (e.g. parks or gardens surrounding country houses) has been included in the assessment.

8.5.4 All significant community effects are reported. Non-significant effects that are considered to be of importance in the study area have also been reported in Volume 2.

Baseline

8.5.5 Information was collected on the current location and use of community resources. Sources of information include:

- published sources such as Census data and Office for National Statistics – Neighbourhood Statistics;
- existing studies such as open space;
- data from other relevant assessment topics;
- specific supplementary surveys (e.g. of open space or PRoW use); and
- consultation with community organisations, user groups, owners/operators of community facilities and local/national government.

8.5.6 Community resources are described in the environmental baseline only where they contribute to the local context or where they may be affected by the Proposed Scheme. Consequently, not all community resources within the study area are described.

Methodology

8.5.7 There are no industry-wide accepted methods for assessing community effects. The method that has been developed for predicting and assessing effects draws on existing guidance, analysis and methods established for other large infrastructure projects, including Phase One of HS2.

8.5.8 Effects have been derived from the interaction between the magnitude of impacts (which broadly reflect their severity, duration or extent) and the sensitivity of the

resources and receptors (which broadly reflects their ability to accommodate impacts without fundamentally changing their functionality or amenity value).

8.5.9 The community assessment is largely based on qualitative information. However, relevant quantitative inputs have been used wherever possible (e.g. numbers of properties affected or percentage of open space displaced by land required for construction and/or operation). Opportunities to mitigate community effects have been identified during the course of the Proposed Scheme development and consultation. Where replacement open space or other land is to be provided as part of the Proposed Scheme, this has been taken into account in the assessment.

8.5.10 The assessment also draws on other topics for the assessment of in-combination effects. This takes into account the significant residual effects reported by other topics (e.g. sound, noise and vibration, air quality, landscape and visual and traffic and transport) and professional judgement about the sensitivity of the resource and receptors.

8.5.11 The spatial scope of the assessment varies, depending on the nature of the receptors and the impacts being considered. The effects of construction on the land used for construction and/or operation are confined to the immediate vicinity of the route. Effects resulting from a combination of effects or relating to the overall functionality of a community will typically apply to wider areas such as neighbourhoods or whole settlements.

8.5.12 The impacts and effects of the Proposed Scheme were assessed for the construction phase (2020-2026) and the first year of operation (2027), with one exception: the assessment of in-combination effects, since the operational noise assessment is based on the service frequency of the fully operational Y network, which would not occur until some years later. For other topics, it is generally assumed that effects are unlikely to persist into the future. This is because new or replacement community facilities will have been provided where necessary and communities will adjust to the presence of the Proposed Scheme.

8.5.13 Significant in-combination effects arise from the combination of two or more residual significant effects reported by other disciplines on a group (street, hamlet or village) of residential properties or on community facilities. Generally, the assessment methodology excludes, for the purposes of reporting in-combination effects, residential properties where the total number of dwellings affected in a group is fewer than five. Impacts on individual properties or groups of less than five properties do not constitute a significant community effect[169].

Assumptions and limitations

8.5.14 Key assumptions underlying the assessment include the following:

- the baseline characteristics established during the EIA process will remain largely unchanged; and
- the different assessments within the community section (e.g. isolation and in-

[169] Where fewer than five residential properties are lost or subject to an in-combination effect, but the losses/effect are considered to represent a high proportion of the community, then this will also constitute a significant community effect.

combination effects) are not directly comparable in terms of determining significance of effect. Assessments are considered in aggregate as part of the community-wide analysis that is presented.

8.6 Cultural heritage

Scope

8.6.1 Impacts on the following types of heritage asset were assessed as part of the EIA:

- archaeological and palaeoenvironmental remains[170] including geological deposits that may contain evidence of the human past;
- historic landscapes; and
- historic buildings and the historic built environment.

8.6.2 Designated and non-designated heritage assets have been assessed. Effects arising from both construction and operation of the Proposed Scheme have been considered (e.g. effects arising from the requirement for land during construction or from visual intrusion into the setting of assets).

8.6.3 The study area for the assessment of heritage assets consists of the land required for construction (both temporary and permanent), plus 500m on each side.

8.6.4 The study area for the assessment of the settings of designated heritage assets has taken account of the zone of theoretical visibility (ZTV), as described in Section 8.10, and has been extended up to 2km from the land required, both temporarily and permanently, for the Proposed Scheme. A degree of professional judgement has been used to determine the extent of the study area within urban areas, to ensure that the assessment of the setting of designated heritage assets remains both proportionate and appropriate.

Baseline

8.6.5 Information about heritage assets was obtained from a range of sources, including:

- registers of designated heritage assets held by Historic England;
- historic environment records;
- historic landscape character mapping;
- conservation area appraisals; and
- historic maps and aerial photography.

8.6.6 Information was also gathered from specific surveys and research such as:

- light detection and ranging (LiDAR) surveys;
- site reconnaissance visits; and

[170] The organic remains of plants, animals and sediments which are studied in order to examine past environments and human interaction with past environments.

- field-walking and geophysical surveys.

8.6.7 Survey work was discussed with Historic England and local authority archaeologists on a case-by-case basis.

Methodology

8.6.8 There is no national guidance on the methodology for assessment of impacts on the historic environment and heritage assets. However, DMRB Volume 11[171] (Environmental Assessment) provides an approach to highway schemes and is of relevance to the Proposed Scheme. Also pertinent is the draft guidance on heritage impact assessments for Cultural World Heritage Sites (International Council on Monuments and Sites)[172], and a range of guidance from Historic England. These existing methodologies and guides have been considered during the development of the assessment methodology for the cultural heritage topic.

8.6.9 The NPPF requires that impacts on heritage assets are assessed in relation to the significance of the asset. This significance can be reflected in a range of ways; for example, evidential or historical, and can also be influenced by its setting.

8.6.10 Effects on the significance of heritage assets were assessed on the basis of the type and magnitude of impact, and the severity of the effects, such as whether construction and/or operation of the Proposed Scheme will entail the removal of the heritage asset or intrusion into its setting. Appropriate mitigation measures were identified and taken into account.

Assumptions and limitations

8.6.11 It has been assumed that all construction activity within the land required, temporarily or permanently, for the Proposed Scheme, will result in the removal of archaeological assets. The ES identifies opportunities for the preservation of archaeological assets in-situ. Surveys to confirm or update the cultural heritage baseline from that presented in the ES will be required prior to construction. It is assumed that access will be available for these surveys and that the programme of investigation and recording will apply to these works.

8.6.12 The assessment of impacts has taken account of incorporated mitigation such as noise fence barriers, landscaping and planting. During the construction phase it is assumed mitigation measures will be in accordance with the draft CoCP.

8.6.13 Other assumptions and limitations of the cultural heritage impact assessment include:

- the LiDAR data do not encompass the entire Proposed Scheme; and
- planting as a means of visual screening for heritage assets such as built heritage will not be fully effective until maturity.

[172] International Council on Monuments and Sites (ICOMOS), (2011), *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties*. Available online at: https://www.icomos.org/world_heritage/HIA_20110201.pdf.

8.7 Ecology and biodiversity

Scope

8.7.1 The ecological impact assessment considers all ecological receptors which have the potential to be affected by the construction and/or operation of the Proposed Scheme. The assessment includes the consideration of effects arising from habitat loss and fragmentation, severance of ecological corridors and networks, noise and visual disturbance (including disturbance from lighting), barrier effects to movement of fauna, changes in water quality and quantity, air pollution, and wildlife mortality as a result of collisions with trains.

8.7.2 The scope is limited to effects on the 'ecological value' of receptors. The social and economic value of ecological receptors such as nature reserves is considered separately in the community and socio-economic sections of the ES.

8.7.3 The spatial scope of the assessment depends on the ecological receptor under consideration and the magnitude and nature of the potential impacts. It has, as a minimum, included areas located within and adjacent to the land required for the construction of the Proposed Scheme. More information on the spatial scope of individual aspects is provided within the SMR and the SMR addendum.

Baseline

8.7.4 Existing biological data for the Proposed Scheme have been obtained from relevant Local Biological Records Centres and from national and local specialist data sources, such as barn owl groups. National and local biodiversity action plans and ancient woodland inventories have also been consulted. The geographic extents of search areas have varied, based on the likely value and mobility of the receptor involved.

8.7.5 A wide range of field surveys have been conducted to inform the EIA. The survey methodologies used have been based on recognised best practice.

Methodology

8.7.6 The ecological impact assessment has taken account of the guidance published by the Chartered Institute of Ecology and Environmental Management (CIEEM)[173].

8.7.7 Each potential ecological receptor has been assigned a value according to one of the following geographical frames of reference: international; national; regional; county; district/borough; local/parish; and negligible. Individual effects considered to be significant at the local/parish level or below are as a general rule only reported in Volume 2: Community area reports in relation to designated sites and European protected species. Potential cumulative and in-combination effects of multiple local/parish level effects are addressed in Volume 3: Route-wide effects. Lists of local/parish level effects are provided within Volume 5: Appendices EC-016-001 to EC-016-005.

[173] Chartered Institute of Ecology and Environmental Management, (2016), *Guidelines for Ecological Impact Assessment in the UK and Ireland – Terrestrial, Freshwater and Coastal.* Available online at: https://www.cieem.net/data/files/Publications/EcIA_Guidelines_Terrestrial_Freshwater_and_Coastal_Jan_2016.pdf

8.7.8 In line with the CIEEM guidance, the evaluation of species receptors has been based on the distribution and status of the species concerned, rather than being based solely on the legal protection afforded to that species.

Assumptions and limitations

8.7.9 A precautionary approach to valuation has been used for instances where baseline information is incomplete, to ensure that all likely impacts of the Proposed Scheme have been identified. Precautionary valuations have been based on all available information. These valuations are based on a consideration of available desk study data (including aerial photography and information from stakeholders), a comparison with similar habitat areas occurring in the wider local area, and a qualitative consideration against any factors that indicate suitability for the particular habitat or species in question. The degree of precaution built into the assessment for each receptor reflects the level of confidence in the existing data available.

8.7.10 The ecological assessment of off-route effects is based largely on information available from existing sources, recognising the constraints of such an approach. These effects are reported in Volume 4: Off-route effects.

8.7.11 Other assumptions made for the purpose of the ecological impact assessment include the following:

- all habitats and features within the land required for the construction of the Proposed Scheme will be lost except for areas included only for the purpose of ecological enhancement[174];
- all construction activity will occur concurrently across the entire length of the Proposed Scheme and will start at the beginning of the construction period – a worst-case scenario;
- by the time the Proposed Scheme is operational, otter will be present in all watercourses suitable for the species;
- the nominated undertaker will ensure that ongoing management of all mitigation and compensatory habitat is provided, either directly or through suitable legal and financial agreements with third parties; and
- the nominated undertaker will commit to monitoring habitats and species to ensure that predictions of effects are accurate and that mitigation/compensation is successful.

8.8 Health

Scope

8.8.1 Health is a new EIA topic in the ES, introduced as a result of Directive 2014/52/EU. The definition of health used in the assessment follows that of the World Health

[174] The re-instatement and landscaping of these areas on completion of construction are considered as part of the proposed 'other mitigation measures, described in the Volume 2 community area reports. For the purposes of the ecological impact assessment 'other mitigation measures' is the term used to describe all mitigation, compensation and enhancement provided in addition to that which is inherent to the engineering design of the Proposed Scheme.

Organization, which describes health as 'a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity'.

8.8.2 The health status of a population is governed, in part, by a wide range of environmental, social and economic determinants. The Proposed Scheme will impact on a number of health determinants, which in turn will affect health and wellbeing. Health effects have been assessed at local (community area) or route-wide level, depending on the nature of the health determinant, as described in the following paragraphs.

8.8.3 The health effects resulting from impacts on the following determinants have been assessed at local (community area) level. These effects which are reported in Volume 2: Community area reports relate to:

- neighbourhood quality;
- access to services, health and social care;
- access to green space, recreation and physical activity;
- (places of) education; and
- social capital.

8.8.4 The health effects resulting from impacts on the determinants listed below have been assessed at a route-wide level, because of their diffuse geographical nature or, in some cases, because it is only meaningful to report the health effects for a large population. These effects which are reported in Volume 3: Route-wide effects are:

- employment and income;
- housing;
- transport (traveller stress and road safety); and
- sound, noise and vibration (railway noise).

8.8.5 Health assessment is a multi-disciplinary activity that cuts across the boundaries of health, public health, social sciences and environmental sciences. Many of the potential impacts on health determinants are described elsewhere in the ES and the assessment of health effects has drawn on this analysis in an integrated process.

8.8.6 The study area for the assessment of health and wellbeing effects is aligned with the study areas for related EIA topics, where relevant.

Baseline

8.8.7 Baseline data were collected from a variety of sources. The data were used to construct a community health profile, which provides an overview of the prevailing socio-economic and health status of the population. The analysis of data includes the identification of vulnerable sub-groups that may be particularly sensitive to health and wellbeing effects.

Methodology

8.8.8 Impacts on health determinants have been assessed using a set of criteria to describe the nature of an impact, its intensity, and the size of the population exposed. This approach has been informed by available guidance and precedent from other large scale health assessments. The assessment criteria and methodology were reviewed during the process of engagement with stakeholders in the health sector.

8.8.9 The assessment of health effects was based on a review of scientific evidence linking impacts on determinants with health outcomes. The findings of this review are reported in Volume 5: Appendix HE-003-000 (Route-wide commentary on health evidence base). Most health effects have not been quantified, since either there are currently no robust or scientifically widely agreed upon methods for doing so, or because the types of data required cannot realistically be obtained. Therefore, the assessment is largely qualitative in its description of health effects. However, the health effects resulting from operational railway noise have been quantified, since the Government has published a methodology which enables a reliable quantitative assessment to be undertaken.

Assumptions and limitations

8.8.10 Over the timescale of the Proposed Scheme's delivery, the profile of affected communities will change, influenced by wider social, economic and health policy and demographic trends. The likely future community profile was considered in instances where data and forecasts were available. It was necessary, for assessment purposes, to assume that the baseline characteristics established during the health assessment process will remain largely unchanged where such data and forecasts were unavailable.

8.8.11 The community profiles were informed by publicly available data and consultation and stakeholder engagement.

8.8.12 The assessment was supported by a review of published research relating to each of the identified health determinants, using the most up to date and credible sources. The evidence for health effects ranges from strong, where this is well supported by research evidence, to weak, where evidence is sparse or conflicting. Consequently, professional judgement was necessary to assess the likely health effects.

8.9 Land quality

Scope

8.9.1 Potential effects include disturbance of ground and groundwater contamination that could occur as a result of the Proposed Scheme. The main potential for impacts will occur during the construction phase, from disturbance of pre-existing contamination. Operational sources were also considered (e.g. leaks or spillages within the IMB-R from line-side equipment or from trains). The assessment also includes consideration of any areas of geological significance, such as geological SSSI, local geological sites (LGS) and mineral resources or mining activity.

8.9.2 Potentially contaminated sites were identified within the footprint of the Proposed Scheme and within 250m of the boundary of the construction works. Consideration has also been given to the possibility of disturbance to contamination, resulting in

impacts at greater distances from the route (e.g. via pathways such as watercourses or aquifers), where appropriate.

8.9.3 Land contamination issues are closely linked with those involving waste and water resources. Issues regarding groundwater resources not related to land contamination are addressed in Section 8.15 (waste and material resources) and Section 8.16 (water resources and flood risk) of this report, and Section 15 (water resources and flood risk) of the Volume 2: Community area reports. Issues regarding the management of waste, including contaminated soils, are addressed in Volume 3: Route-wide effects, Section 15 (Waste and material resources).

Baseline

8.9.4 Baseline information was obtained from desktop sources, site visits and where available, previous ground investigations. Desktop sources include published geological/hydrogeological mapping, information from the Environment Agency and other organisations (particularly for existing and historical landfill sites), historical mapping, and local authority data. Site visits were targeted at locations where a greater potential for current or historical contamination has been identified.

Methodology

8.9.5 A conceptual site model (CSM) and risk assessment approach has been used, in line with the Environment Agency guidance document CLR 11[175]. The CSM model provides an initial understanding of the types of contaminants that may be present, the receptors (i.e. people, buildings and the wider environment) that may be affected and the likely pathways by which contaminants can impact receptors.

8.9.6 This contaminant/pathway/receptor model was used to assess the potential for pre-existing contamination to cause a risk of impact on defined receptors at each location, for the period prior to, during and following construction (once any remediation has been carried out). The significance of effects was derived from the change in level of risk, taking account of the sensitivity of the receptor.

8.9.7 The remediation of existing contamination, as part of the construction works, would be regarded as beneficial.

8.9.8 The methods for assessment of the significance of effects arising from the Proposed Scheme (including the development and use of borrow pits) on geological sites and mining/mineral resources are set out in the SMR. These take into account the degree of impact that the construction activities may have on such sites, their sensitivity and importance.

Assumptions and limitations

8.9.9 No site-specific intrusive site investigations have been undertaken as part of the baseline data collection. Intrusive investigations will be undertaken during the detailed design process to provide contamination data for risk assessments, and where necessary, for detailed remediation design.

[175] Environment Agency, (2004), *Model Procedures for the Management of Land Contamination CLR 11*.

8.10 Landscape and visual

Scope

8.10.1 The assessment includes consideration of the effects on landscape and on visual receptors within the study area. The landscape and visual assessment was undertaken for the following years:

- construction – an assessment of effects in winter during the peak period[176] of the construction phase;
- operation year 1 – an assessment of effects in winter and summer during operation year 1;
- operation year 15 – an assessment of effects in summer during operation year 15, once any vegetation planted as part of the Proposed Scheme has matured or has achieved its design intention; and
- operation year 60 – to consider the benefits and/or negative effects in summer of maturity of tree planting.

8.10.2 A zone of theoretical visibility (ZTV) has been prepared to aid understanding of the potential visibility of the Proposed Scheme during both construction and operation. This helps to determine the study area for the landscape and visual assessment and also supports the assessment of effects on the setting of cultural heritage assets. The ZTV shows the extent to which elements of the Proposed Scheme may be visible, but does not show the extent over which landscape and visual effects may be experienced, since the latter requires consideration of the extent to which visibility of the Proposed Scheme will beneficially or adversely affect a view from a particular receptor, using professional judgement.

8.10.3 The ZTV is based on visibility of the Proposed Scheme from the eye height of someone standing at ground level and takes account of the following factors:

- the existing topography;
- existing buildings, excluding any that will be demolished as part of the construction of the Proposed Scheme; and
- existing tree cover, excluding any trees that will be removed as part of the construction of the Proposed Scheme.

8.10.4 Thin bands of trees narrower than 10m are excluded as, during winter, these will provide only minimal screening.

8.10.5 The ZTV for the construction phase takes account of the tops of activities or structures that will be present during construction, including:

- construction plant along the route of the Proposed Scheme, in compounds, at tunnel portals, cut-and-cover tunnels, the IMB-R, road diversions and any

[176] The period during which the main construction works will take place, including the establishment of compounds, main earthworks and structure works.

other known works;

- temporary fencing and hoarding;
- temporary stockpiling of materials;
- welfare facilities and storage;
- structures being demolished; and
- new permanent structures under construction.

8.10.6 Very tall construction plant (e.g. cranes) is excluded from the ZTV, since they rarely give rise to significant effects if they are the only elements visible.

8.10.7 The ZTV for the operation phase shows the visibility of the high speed trains and permanent structures, including:

- the IMB-R;
- road/pedestrian diversions
- bridges and viaducts; and
- fencing and noise fence barriers.

8.10.8 The overhead line equipment is excluded from the model on the basis that this rarely gives rise to significant effects if it is the only element visible.

8.10.9 The ZTV for year 15 of operation (2042) will illustrate how planting proposed along the route will reduce visibility of the Proposed Scheme.

8.10.10 Landscape and visual receptors within 500m of the Proposed Scheme have been considered. However, this study area was varied locally to take account of variations in visibility as indicated by the ZTV (e.g. with views likely to be more limited in urban areas and more extensive in open countryside or from elevated locations).

Baseline

8.10.11 Baseline information was obtained from a combination of desktop research and fieldwork. Desktop sources include the Cannock Chase AONB Management Plan, published landscape character assessments (county level landscape character assessments), the National Character Areas and local development frameworks.

8.10.12 County level landscape character areas (LCA) were used in the assessment. Fieldwork was used to identify visual receptors. Fieldwork has been undertaken in both summer and winter to capture best and worst case, and is accompanied by a comprehensive photographic record.

Methodology

8.10.13 The assessment has taken account of relevant guidance such as the Landscape Institute's Guidelines for Landscape and Visual Impact Assessment (3rd edition)[177] and DMRB Volume 11, Section 3, Part 5. The desktop and field studies have been used to

[177] Landscape Institute, (2013), *Guidelines for Landscape and Visual Impact Assessment*.

identify a series of LCAs along the route. The value of each LCA and its susceptibility to change resulting from the Proposed Scheme has been assessed, from which an evaluation of overall landscape sensitivity has been made. The significance of landscape effects was derived from the interaction between the magnitude of change (e.g. extent of land required for construction and/or operation or loss of features within a character area, plus introduction of new features) and its sensitivity.

8.10.14 The assessment viewpoints were agreed with stakeholders (or competent authorities) during the course of consultation, so as to be representative of the range of views experienced by the relevant receptor groups in each location. The significance of visual effects was derived from the interaction between the magnitude of change to these views and the sensitivity of receptors. Where views have a recorded value (e.g. protected views) this is also captured. Impacts on selected views have been illustrated by preparing verified photomontages from locations agreed with stakeholders.

Assumptions and limitations

8.10.15 Assumptions necessary to undertake the landscape and visual assessment are set out in the SMR and in individual sections of the Volume 2: Community area reports and is summarised in the following paragraphs.

8.10.16 The landscape and visual assessments have been based on professional judgement and take into account both the adverse and beneficial contribution that new development can have upon the existing landscape character and on the visual resource of surrounding receptors.

8.10.17 All baseline surveys have been carried out on publicly accessible land and in line with industry accepted guidance. In instances where site access was not available, professional judgement has been used to approximate the likely views from these locations.

8.10.18 The extent of the study area has been informed by the construction and operational phase ZTV. The ZTV have been produced in line with the methodology described in the SMR and SMR addendum, and are an indication of the theoretical visibility of the Proposed Scheme. In some locations, extensive vegetation cover will mean the actual visibility is substantially less than that shown in the ZTV, and professional judgement on site visits has been used to further refine the study area to focus on likely significant effects.

8.10.19 Landscape and visual receptors within approximately 500m of the Proposed Scheme have been assessed as part of the study area. Long distance views of up to 1km have been considered at settlement edges.

8.11 Major accidents and natural disasters

Scope

8.11.1 Major accidents and natural disasters is a new EIA topic in the ES, introduced as a result of Directive 2014/52/EU and the Town and Country Planning (EIA) Regulations 2017. The EIA Regulations require an EIA to include an assessment of 'the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned'.

8.11.2 For the purposes of this assessment, vulnerability is defined as the potential weakness of the Proposed Scheme to the risks to which it is exposed. A risk is defined as the consequences of an event, factored by how likely it is to take place.

8.11.3 Major accidents or natural disasters are events or situations that have the potential to affect the Proposed Scheme causing immediate or delayed serious damage to human health, welfare and/or the environment, and include accidents during construction and operation caused by operational failure or natural hazards.

8.11.4 The assessment of 'significant adverse effects' includes consideration of all factors identified in the EIA Regulations (i.e. population and human health, biodiversity, land, soil, water, air and climate and material assets, cultural heritage and the landscape).

8.11.5 The scope of this assessment follows that set out in the SMR and the SMR addendum, and addresses those unplanned events or situations that have been determined as being relevant to the Proposed Scheme, and are considered to be major in scale and have been identified as having the potential to result in a significant adverse environmental effect.

Baseline

8.11.6 The baseline relevant to this topic comprises:

- features external to the Proposed Scheme that contribute a potential source of hazard to the Proposed Scheme;
- sensitive environmental receptors at risk of significant effect; and
- current (without the Proposed Scheme) major accident and natural disaster risks.

Methodology

8.11.7 The assessment required interaction with other assessment topics, in particular climate, community, ecology and biodiversity, health, traffic and transport, and water resources and flood risk.

8.11.8 The assessment was undertaken with reference to the regulatory requirements, legislation and design standards in place for the construction and operation of the Proposed Scheme.

8.11.9 The baseline for the assessment took account of the regulatory requirements in place and did not reproduce for example the safety risk assessment that must be in place for the licence to use and operate the railway under the Common Safety Method for Risk Evaluation and Assessment (CSM-RA)[178].

8.11.10 The framework for the environmental risk assessment followed a standard source-pathway-receptor approach, where sources (accidents and disasters) were based on existing risk assessments, and receptors include:

- members of the public and local communities;

[178] European Commission, (2013), *EU Regulation 402/2013 (as amended) on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009.*

- infrastructure and the built environment;
- the natural environment, including ecosystems, land and soil quality, air quality, surface and groundwater resources and landscape; and
- the historic environment, including archaeology and built heritage.

Assumptions and limitations

8.11.11 Key assumptions for the major accidents and natural disasters assessment are:

- the new railway will not carry hazardous materials; and
- only those hazardous events with a feasible source-pathway-receptor model were considered.

8.12 Socio-economics

Scope

8.12.1 The potential socio-economic effects of the Proposed Scheme relate to three main areas: employment, businesses and the economy. Effects on employment levels are reported at a route-wide level within Volume 3, whilst effects on the local economy are reported by community area within Volume 2. Wider economic benefits are reported within Volume 3: Route-wide effects.

8.12.2 The effects can be beneficial (e.g. through direct job creation or via procurement of goods and services from local businesses) or adverse (e.g. due to land required for construction and/or operation requiring the relocation of businesses). The assessment has included consideration of effects arising during the construction and operation phases.

8.12.3 The route-wide assessment identifies effects resulting from land required for construction and/or operation, in-combination effects (e.g. as a consequence of the combination of significant residual effects from air quality, noise and vibration, visual impacts or construction traffic) and isolation effects on existing businesses and organisations, together with potential opportunities for construction and operational employment.

Baseline

8.12.4 Baseline information was obtained for a series of areas representative of the local economy where data is readily available. These relate to the areas across which economic functions and data can be readily understood. Data was collected within these areas across a range of socio-economic indicators, including business demography, employment, labour supply characteristics, skills, property market and where applicable, local economic policy. Sources include official national data sets, local government, individual businesses and commercial property data sets.

Methodology

8.12.5 The assessment has drawn on guidance such as the Treasury Green Book[179], DfT WebTAG guidance[180] HCA Employment Density Guide[181] and the Homes and Communities Agency (HCA) Additionality Guide[182].

8.12.6 The magnitude of effects was assessed based on the interaction between the magnitude of impacts (e.g. their spatial extent and duration) and the sensitivity of the receptor (essentially the ability of a business, economy or market to absorb adverse change or to respond to beneficial change) taking into consideration the strength of the local economy and the availability of alternative premises.

Assumptions and limitations

8.12.7 Key assumptions underlying the assessment are described below.

8.12.8 Changes to the environmental conditions within which businesses are located can affect a business operationally. Certain types of business are more likely to be sensitive to changes in their environmental condition than others e.g. those dependent upon attracting recreational visitors. Changes in turnover resulting from a loss of trade may have an effect on employment (assuming that there is a positive relationship between growth/contraction in a business's turnover and growth/contraction in employment at that business).

8.12.9 It is assumed that the employment within businesses affected by land required for the Proposed Scheme will either be relocated or lost. The employment implications are less clear for resources affected by isolation and/or changes in the combined effects of significant noise, air quality, visual and HGV congestion on trading conditions. Any employment implications are assessed at route-wide level, whilst impacts are assessed and reported at an individual resource level.

8.12.10 It is assumed that 88% of businesses required to relocate will do so, and it is assumed that no employment at these businesses will be lost. The rate of closure of directly affected businesses is therefore assumed to be 12% and it is assumed employment within these businesses would be lost[183].

8.12.11 It is assumed that a business experiencing an adverse effect on trade due to isolation or changes in the combined effects of significant noise, vibration, air quality, visual and HGV congestion can adopt a number of strategies before reducing employment. These strategies include cancelling/postponing investment in premises and stock; reducing staff working hours; cancelling/postponing plans to expand business; temporarily laying-off staff; renegotiating loans or mortgage; and increasing marketing or advertising activity. Any reduction in employment has been calculated by:

- estimating the total employment of the business(es) affected; and

[179] HM Treasury (2003), *The Green Book: Appraisal and Evaluation in Central Government*. London, Her Majesty's Stationery Office.
[180] Department for Transport (DfT), (2013), *WebTAG Home, Transport Analysis Guidance*. Available online at: http://www.dft.gov.uk/webtag/
[181] Homes and Communities Agency (HCA), (2015), *Employment Density Guide*.
[182] Homes and Communities Agency (HCA), (2014), *Additionality Guide*.
[183] Research undertaken by London Development Agency (LDA) in relation to businesses required to relocate due to land requirements for the London 2012 Olympics , (30th June 2008), Request for Information/Freedom of Information Act by Mr Julian Cheyne, FOI291.

- applying a percentage, based on the type of business activity/sector, to represent the likely proportion of employment that could be significantly affected by changes in the combined effects of significant noise, vibration, air quality, visual and HGV congestion or isolation on trading conditions.

8.12.12 It is assumed that the demand for and supply of construction labour in the rail sector will remain largely the same up to the commencement of the Proposed Scheme.

8.12.13 Operational employment on the conventional network is assumed to remain the same as present as released capacity is utilised by new services.

8.13 Sound, noise and vibration

Scope

8.13.1 The assessment of sound, noise and vibration considers the likely significant noise and vibration effects arising from the construction and operation of the Proposed Scheme on:

- people, primarily where they live ('residential receptors') in terms of health and quality of life a) on an individual dwelling basis and b) on a community basis, including any shared community open areas[184]; and
- community facilities such as schools, hospitals, places of worship, and also commercial properties such as offices and hotels, collectively described as 'non-residential receptors' and 'quiet areas'[185].

8.13.2 Potential noise effects on animals, cultural heritage and tranquillity are reported in the respective ecology and biodiversity, cultural heritage and landscape and visual sections of the ES, as appropriate.

8.13.3 In this assessment significant noise or vibration effects may be:

- adverse from an increase in sound levels or beneficial from a decrease in sound levels caused by the Proposed Scheme;
- temporary from construction or permanent from the operation of the Proposed Scheme;
- direct, resulting from the construction or operation of the Proposed Scheme, and/or indirect, resulting from changes in traffic patterns on existing roads or railways that result from the construction or operation of the Proposed Scheme; and
- off-route, caused by the Proposed Scheme outside of the study area around the new railway and associated infrastructure.

8.13.4 HS2 Ltd has engaged with the environmental health practitioners acting for the local and county authorities along the line of route. The purpose of this engagement has

[184] Shared community open areas are those that the National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park to local green space) that is nearby.
[185] Quiet areas are defined in the Scope and Methodology Report as either Quiet Areas as identified under the Environmental Noise Regulations or are resources which are prized for providing tranquillity.

been to obtain relevant information regarding residential and non-residential resources and existing baseline sound levels, and to discuss the development of the mitigation to be included in the Proposed Scheme.

8.13.5 The term 'sound' describes the acoustic conditions which people experience as a part of their everyday lives. The assessment considers how those conditions may change through time and how sound levels and the acoustic character of community areas is likely to be modified through the introduction of the Proposed Scheme. Noise is defined as unwanted sound and hence adverse effects are termed noise effects rather than sound effects, and mitigation is, for example, termed 'noise' barriers.

Baseline

8.13.6 Information on the existing airborne sound environment was obtained from desktop research and extensive field surveys. Sound level monitoring was also undertaken at locations suggested by local communities, where the monitoring provides further information relevant to the assessment. The aim was to obtain empirical data that describe the existing sound environment that is supported by an assessment of the soundscape at each location.

8.13.7 Future changes in the airborne sound baseline were considered where significant effects of the Proposed Scheme might occur and where the future baseline is predictable with reasonable certainty, for example, due to growth in traffic flows or the introduction of committed developments.

8.13.8 It is likely that the majority of receptors adjacent to the route are not currently subject to ground-borne noise or vibration. Major existing railways are the only likely sources. Baseline vibration surveys have not been undertaken. The assumption that there is no baseline vibration provides a reasonable worst-case basis for the assessment of likely significant effects.

Methodology

8.13.9 The assessment identifies likely significant noise and vibration effects (both beneficial and adverse) and describes the measures proposed to avoid or reduce these significant effects.

8.13.10 The method for identifying significant noise or vibration effects from the construction and operation of the Proposed Scheme draws on best practice from other major infrastructure projects, and is consistent with current Government noise policy[186], and planning guidance noise[187]. The assessment is consistent with the approach set out in HS2 Ltd's draft sound, noise and vibration control policies[188] which will ensure that as the design of the Proposed Scheme progresses, the requirements of the current Government noise policy and guidance will continue to be met. The assessment takes

[186] Defra (2010), *Noise Policy Statement for England* (NPSE) and Department for Communities and Local Government (2012), *National Planning Policy Framework*.
[187] Department for Communities and Local Government, (2016), National Planning Practice Guidance – Noise. Available online at: http://planningguidance.planningportal.gov.uk
[188] HS2 Ltd., (2017), *Information Paper E9: Control of Airborne Noise; Information Paper E10: Control of ground-borne noise and vibration for the operational of temporary and permanent railways; Information Paper E11: Control of noise from the operation of stationary systems;* and Information *Paper E13: Control of construction noise and v*ibration.

health outcomes into account within the context of Government policy on sustainable development, which seeks to:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

8.13.11 Government planning guidance on noise is based on the premise that once the level of sound is above a specific threshold, the effect on people in their homes increases as the level of sound increases. The guidance defines two levels of effect: Lowest Observed Adverse Effect Level; and Significant Observed Adverse Effect Level. The explanatory note to Government noise policy considers it likely that these effect thresholds will be different for different sources, different receptors and at different times.

8.13.12 Therefore for the Proposed Scheme, effect thresholds for the onset of both 'adverse' and 'significant adverse' effects on health and quality of life have been defined for noise and vibration, as described in the SMR. For effects on people in their homes these are based on national and international standards and guidance

8.13.13 'Significant adverse' effects of health and quality of life are reported in the assessment as 'likely significant effects'. 'Adverse' effects on health and quality of life on a larger community group may also be identified as an effect likely to be considered significant on a community basis. The criteria for identifying 'likely significant effects' are set out in the SMR.

Assumptions and limitations

Construction assumptions

8.13.14 The assessment includes consideration of noise and vibration on a month-by-month basis, assuming that the mitigation measures defined in the draft CoCP have been implemented. Noise levels will vary day-to-day. The highest daily levels may sometimes be around 5dB higher than the monthly average levels but could also be substantially lower on other days.

8.13.15 It is anticipated that there may be some night-time working during works to cross or tie into existing roads and railways. In these situations, it is expected that the noise effects will be limited in duration and hence are unlikely to be significant. Any noise effects arising from these short-term construction activities will be controlled and reduced by the management processes set out in the draft CoCP.

Operational assumptions

8.13.16 The effects of noise and vibration from the operation of the Proposed Scheme have been assessed based on the likely train flows.

8.13.17 The assessment is based on the expected passenger service frequency when the full Y network is operational, as identified in Section 4.3.

8.13.18 There will be regular line inspections and planned maintenance work at night at some locations along the route. At any one location on the route, maintenance is likely to be very occasional. Given the irregularity of the activity and short duration at any one

location, maintenance work is considered unlikely to give rise to significant noise or vibration effects.

8.13.19 On most nights, a small number of diesel-powered specialist engineering trains will travel from the IMB-R to remote locations on the route to either inspect the line or undertake planned maintenance. These trains will leave the IMB-R as soon as possible after passenger services finish at 00:00 and are likely to return to the IMB-R shortly before passenger services start again at 05:00. It is assumed that the engineering trains will be specified and operated so that any adverse noise effects are no greater than those for the night-time passenger services.

8.13.20 It is assumed that HS2 trains will be quieter than the relevant current European Union specifications, as reported in the Phase One ES[189]. This will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 186mph (300kph) with current pantograph designs, drawing on proven technology in use in East Asia. The track will be specified to reduce noise, as will the maintenance regime. Overall these measures would reduce noise emissions by approximately 3dB at 360kph compared to a current European high speed train operating on the new track.

8.13.21 The assessment has been undertaken on the assumption of slab track as the track form for the Proposed Scheme.

8.13.22 Passenger services have been assumed to operate at up to 225mph (360kph). Services will be timetabled based on a speed of 200mph (330kph) where the maximum operational speed of 225mph (360kph) applies. It is assumed that around 10% of services will operate at the full speed of 225mph (360kph).

8.13.23 In the years before the full Phase Two services commence (i.e. with Phase 2b in operation), the operating speeds are assumed to be the same as those described above although there will be fewer trains per day over the Phase 2a route as described in Section 4.3. At the start of Phase 2a operation the airborne noise and vibration levels at receptors along the route will be around 2-3dB lower than those predicted with full, long-term Phase Two (i.e. with Phase 2b) operation

8.14 Traffic and transport

Scope

8.14.1 The traffic and transport assessment covers all relevant modes of transport, including cars, HGVs, public transport (road and rail), equestrians, walking and cycling, waterways and air. The assessment has included consideration of effects resulting from physical changes to transport networks (including road, bus route and PRoW diversions) and from the additional trips generated by the Proposed Scheme both during construction (including HGV movements and worker trips) and after opening (e.g. trips made as a result of new/reassigned passenger capacity and by employees), causing congestion or other effects on existing road users.

8.14.2 The spatial scope includes direct changes to the highway (road and PRoW) network, together with the extent of the relevant networks likely to be significantly affected.

[189] HS2 Ltd., (2013), London- West Midlands Environmental Statement – Volume 1, Introduction to the Environmental Statement and the Proposed Scheme, November 2013. Available online at: https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-1-introduction-to-the-environmental-statement

This extent is varied according to the magnitude and nature of the impacts, and the characteristics of the network, in each case.

8.14.3 The scope also includes consideration of the impacts at a route-wide and off-route level, presented in Volumes 3 and 4 respectively. The route-wide effects are mainly focussed on the construction impacts on rail passengers and rail freight during rail possessions and, during operation, the potential of the Proposed Scheme to provide improved journey times on HS2 services building on the benefits of Phase One and the impacts on travel patterns.

8.14.4 As there are no HS2 stations within the Proposed Scheme, the off-route impacts are limited to changes in demand at existing railway stations and off-route highway modifications.

Baseline

8.14.5 The assessment takes 2015, 2016 and 2017 baseline conditions and adjusts these for future assessment scenarios in 2023 (for construction) and 2027 and 2041 (for operation).

8.14.6 Current transport conditions were derived from a combination of surveys, modelling and site visits. Future baseline conditions were derived by taking into account both changes in the demand for travel (by applying growth factors to the baseline traffic and incorporating, where relevant, committed and planned developments) and change to the transport supply network (by considering committed and planned transport improvement schemes). Transport modelling was used, where appropriate, to inform the future baseline conditions.

Methodology

8.14.7 The assessment has taken account of best practice guidance published by the DfT. Consideration has been given to the effects on traffic congestion and delay, road safety, parking and loading, public transport, non-motorised users (including cyclists, pedestrians and equestrians) and navigable waterways. The evaluation of significance has taken account of guidance such as DMRB Volume 11, WebTAG and IEMA guidelines and best practice developed by, for example, Crossrail and HS2 Phase One. Key assessment criteria include:

- delays in public transport;
- congestion at stations/interchanges;
- delays, diversions or volumetric changes in traffic flows;
- changes to parking provision or demand;
- traffic related severance impacts on non-motorised modes;
- changes in travel distance, amenity or ambience for vulnerable road and PRoW users (pedestrians, cyclists, equestrians);
- accident and safety risks; and
- obstruction of navigable waterways.

8.14.8 Effects have been assessed by comparing the future baseline[190] with the infrastructure changes and additional traffic generated by the Proposed Scheme.

Assumptions and limitations

8.14.9 The approach for the transport assessment for future year assessments require a number of assumptions to be made relating to:

- committed developments and transport schemes;
- socio-economic forecasts (e.g. population, employment, economic conditions);
- demand forecasts; and
- travel characteristics, including: modal share of trips; traffic flows; public transport passenger flows; traffic speeds and congestion; and journey times.

8.14.10 Surveys or modelled flows have been used or flows have been estimated on the basis of surrounding flows in instances where existing traffic flow information has not been available. Where there is no data for pedestrians and cyclists, flow levels have been considered in the context of the surrounding environment and professional judgement exercised to provide an appropriate assessment.

8.14.11 The assessment of construction traffic has been based on the assumption that construction traffic will use the main road network wherever possible and that there will generally be one primary inbound and one outbound route to and from each compound (and that these routes are often the same route).

8.14.12 Utilities works (including diversions) have been assessed in detail where they involve major works and where there would be potentially significant traffic and transport impacts and effects from the works separately, or in combination with other works. In this context 'major works' have been assumed to include:

- large pipes and sewers;
- high pressure gas pipeline diversions;
- extra high voltage underground cable diversions; and
- overhead pylon diversions.

8.14.13 In general, the key impacts of utilities works are expected to be associated with road closures and/or significant diversions. More minor utilities works are expected to result in only localised traffic and pedestrian diversions that will be of short duration.

8.14.14 There is the potential for construction activity associated with the Proposed Scheme and the Crewe Hub proposal to overlap. At this time, the Crewe Hub proposal is at an early stage of development and there is insufficient information on which to base a robust assessment of in-combination construction effects. Nevertheless, the construction assessment for the Proposed Scheme considers the potential combined

[190] The future baseline includes the traffic from general baseline growth and from committed and planned developments in the area.

construction impacts of the Proposed Scheme and the Crewe Hub proposal, in the event that the latter proceeds at the same time as the Proposed Scheme.

8.15 Waste and material resources

Scope

8.15.1 The assessment identifies the likely significant environmental effects from the off-site disposal to landfill of solid waste that will be generated by the construction and operation of the Proposed Scheme. The quantity of waste requiring off-site disposal to landfill has been forecast and compared to the amount of landfill capacity projected to be available during construction and operation.

8.15.2 The scope includes wastes generated during construction (i.e. from earthworks, construction and demolition activities and from worker accommodation sites) and operation (i.e. from passengers and track and ancillary infrastructure maintenance).

8.15.3 Consideration of material resources in this assessment is limited to the beneficial reuse of excavated material arising from the construction of the Proposed Scheme including the restoration of borrow pits. It does not include material inputs to construction (e.g. aggregates).

8.15.4 Liquid waste (e.g. wastewater from construction site dewatering) is addressed in the water resources and flood risk assessment (Volume 2: Community area reports, Section 15). Other liquid wastes[191], such as waste oil, is not considered as they will be insignificant compared to solid wastes and have, therefore, been scoped out.

8.15.5 The direct and indirect effects of waste-related transport are addressed within Volume 2: Community area reports, Section 5 (Air quality), Section 13 (Sound, noise and vibration) and Section 14 (Traffic and transport).

8.15.6 Issues relating to mineral resources and contaminated land are addressed within Volume 2: Community area reports, Section 10 (Land quality).

8.15.7 The scope includes any contaminated material identified within the land quality assessment that cannot be remediated and is suitable only for off-site disposal to landfill.

8.15.8 The spatial scope (and study area) for the assessment has been defined as the counties (local area) and former regional planning jurisdictions (regional area) through which the route of the Proposed Scheme will pass. This represents the administrative areas for which waste arisings and waste infrastructure data are available and within which the various waste streams are likely to be managed.

Baseline

8.15.9 The baseline describes environmental conditions with respect to the types, quantities and management of waste generated and the availability (capacity) of waste infrastructure within the study area.

[191] Official Journal of the European Union, *Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Article 6)*.

8.15.10 Baseline conditions have been obtained from the latest available published data from the Environment Agency, Defra and waste planning authorities. Future baseline data are based on the extrapolation of this data for the construction and operation phase, and other published forecasts.

Methodology

8.15.11 Forecasts of the quantities of waste that will require off-site disposal to landfill have been based on an integrated earthworks design approach for the Proposed Scheme (for surplus excavated material) and evidence-based landfill diversion rates (i.e. for reuse, recycling and recovery) applicable to waste from construction, demolition, worker accommodation sites and operational activities.

8.15.12 The quantities of surplus excavated material and other wastes requiring off-site disposal to landfill have been compared to the projected landfill capacity that will be available during construction and operation.

8.15.13 Assessment and mitigation have been considered with respect to relevant legislation, policy and guidance applicable to the generation and management of waste in England.

Assumptions and limitations

8.15.14 Consideration of material resources in the assessment is limited to the beneficial reuse of material arising from construction of the Proposed Scheme. In this context material resources includes materials arising from the excavation of borrow pits. Excavated material is only considered to be waste if it is not required or is unsuitable for construction of the Proposed Scheme.

8.15.15 Borrow pits will be restored to original levels using suitable materials derived from the Proposed Scheme in accordance with a Materials Management Plan The excavated material used for the necessary restoration of the borrow pits will therefore not be considered to be waste.

8.16 Water resources and flood risk

Scope

8.16.1 This assessment includes consideration of all surface water and groundwater bodies, including their associated water resources, water quality, hydromorphology, hydrology and flood risk.

8.16.2 Descriptions of the current baseline for water resources and flood risk, the likely impacts, and significant effects of the route of the Proposed Scheme's construction and operation on surface water and groundwater bodies and their associated water resources are assessed in the Volume 2 community area reports. The likely impacts and significant effects of the Proposed Scheme on flood risk and land drainage are also considered.

8.16.3 Volume 3: Route-wide effects, Section 16, Water resources and flood risk covers the following at a route-wide level:

- the risk to water resources associated with accidents or spillages from trains during operation of the Proposed Scheme;

- a summary of how the Proposed Scheme complies with the statutory requirements of the Water Framework Directive (WFD); and
- route-wide flood risk issues related to application of the Sequential Test and Exception Test in the National Planning Policy Framework (NPPF)[192].

8.16.4 Detailed information on the water resources and flood risk issues specific to each community area are contained in the Volume 5 appendices. These comprise:

- Volume 5: Appendix WR-002-001, 002, 003, 004 and 005 – Water resources assessment reports; and
- Volume 5: Appendix WR-003-001, 002, 003,004 and 005 – Flood risk assessments.

8.16.5 Volume 5 also includes a detailed stand-alone WFD compliance assessment (Appendix WR-001-000) and a draft route-wide water resources operation and maintenance plan (Appendix WR-005-000). Detailed hydraulic modelling reports are included in BID (with the identifier code of each beginning see BID-WR-004[193]).

8.16.6 The spatial scope of the assessment (the study area) is generally based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. However, in some community areas, the study area has been extended, for example where works extend more than 200m from the centre-line, or where very high value receptors are in close proximity, but outside of the 1km zone. These extensions to the study area are defined within the assumptions and limitations section of each Volume 2 community area report.

8.16.7 Impacts to groundwater quality from existing land contamination are presented in Section 8.9 of this report and in the Volume 2: Community area reports, Section 10 Land quality. Impacts on biological receptors and ecology are presented in section 8.7 of this report and in the Volume 2: Community area reports, Section 8 Ecology and biodiversity.

Baseline

8.16.8 Baseline information has included:

- surface water and groundwater hydrology, quality, designations, licensed abstractions, private water supplies; and
- areas at risk of flooding from rivers, surface water, groundwater and reservoir failure inundation.

8.16.9 Information was obtained primarily from secondary/published sources such as the Environment Agency, Lead Local Flood Authorities, British Geological Survey and water companies, supplemented where necessary by targeted survey of surface

[192] Department for Communities and Local Government, (2012), *National Planning Policy Framework*.
[193] HS2 Ltd (2017), High Speed Two (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data. Available online at: www.gov.uk/hs2

waters, as well as hydraulic modelling. Hydrogeological information was obtained from geological maps and borehole logs where available.

8.16.10 Current projections indicate that climate change may affect the future baseline against which the impacts of the Proposed Scheme are being assessed. The projected impacts of climate change on peak river flows and peak rainfall intensities are being considered in the assessment based on the recommended allowances contained in the Environment Agency guidance issued in February 2016[194]. Whilst other changes may occur in the water baseline due to climate change, these are unlikely to change the significance of the effects of the Proposed Scheme reported in the Volume 2: Community area reports.

8.16.11 WFD classification data is taken from the Environment Agency Cycle 2 River Basin Management Plan annexes. These classifications are the formal baseline against which the Environment Agency will assess compliance with the no deterioration objectives. This information was supplemented by specialist surveys.

Methodology

8.16.12 The assessment has taken account of relevant policy and guidance, as set out in the SMR and the SMR Addendum. Effects have been derived from the interaction between the magnitude of impact and the value of the receiving water body or flood receptor. Impact magnitude has been based on quantitative criteria wherever possible. Receptor value reflects its degree of vulnerability or importance, for example vulnerability to flooding, or relative importance for water supply, biodiversity or recreation.

8.16.13 Although there is no published methodology for WFD compliance assessment, the approach adopted is based on guidance from the Environment Agency and professional judgement. It has also been discussed and agreed with Environment Agency specialists.

Assumptions and limitations

8.16.14 The following assumptions have been made for the ES:

- the Environment Agency's Flood Maps provide an indication of areas potentially at risk of flooding from rivers, surface water, groundwater and reservoirs (although this information has been supplemented by modelling work in areas where the potential for impacts to occur has been identified);
- hydraulic modelling has made best use of existing river models, topographic and LiDAR data available. Conservative assumptions have been made about the capacity of the hydraulic structures for which detailed measurements are not yet available. Similarly, conservative assumptions have been made about the potential for new proposed structures, such as viaduct piers, to impact on flood levels. This is to help ensure that locations where there is potential for flood risk impacts to occur have been identified and to inform the additional mitigation required at the detailed design stage;

[194] Environment Agency, (2016), *Adapting to Climate Change. Advice for Flood and Coastal Erosion Risk Management Authorities*.

- all ground and surface water abstractions are assumed to be active and sensitive to disruption, unless site surveys have confirmed otherwise;
- all watercourses, other than minor drainage ditches, have been assumed to be of high or very high value, unless surveys have been completed that confirm otherwise;
- springs, issues or seepages shown on Ordnance Survey maps are conservatively assumed to be surface expressions of groundwater bodies (aquifers), unless surveys have been completed that confirm otherwise;
- in the absence of site specific data, it is assumed that the permeable alluvium and/or river terrace deposits which underlie the River Trent and its tributaries are likely to be in hydraulic connection with these watercourses and provide an element of baseflow, particularly during drier periods;
- railway track drainage will, where reasonably practicable, be kept separate from existing land drainage that crosses the route; and
- where there are limited borehole records available from which to understand the local geological and hydrogeological conditions, it is assumed that topography has some control over groundwater flow directions with groundwater level contours roughly parallel to topographic contours.

8.16.15 The estimated zone of influence, and therefore the assessment of the potential impact of dewatering on receptors, is based on a reasonable worst-case assessment using available literature, values of hydraulic parameters and geological cross sections. Hydraulic conductivity values, obtained from available literature, are being used in conjunction with professional judgment to estimate the maximum extent of the zone of influence that is likely to be produced when dewatering of a cutting or a borrow pit occurs. The hydraulic conductivity values used are generally in the high range of literature values to provide a realistic factor of safety to the estimated zone of influence.

9 Approach to mitigation and monitoring

9.1 Overview

Mitigation

9.1.1 The EIA Regulations require an ES to include a description of the measures proposed in order to avoid, prevent or reduce the likely significant adverse effects on the environment. Such measures are described generally in this ES as mitigation measures. Priority has been given to avoiding or preventing effects; and then (if this was not possible), to reducing or abating them, through restoration and compensation.

9.1.2 This approach is driven by the HS2 Sustainability Policy (see Section 1.5 of this report) and the HS2 Environmental Policy, with the latter stating HS2 Ltd's commitment to "developing an exemplar project, and to limiting negative impacts through design, mitigation and by challenging industry standards whilst seeking environmental enhancements and benefits". Furthermore, the Environmental Minimum Requirements (EMR) (see Section 1.4 of this report) will impose a general requirement on the nominated undertake to use reasonable endeavours to adopt measures to reduce the adverse environmental effects reported in the ES, provided that this does not add unreasonable cost or delay to the construction and operation of the Proposed Scheme. The draft CoCP has been produced in conjunction with the ES so that the ES can take account of the measures that will be imposed during construction to avoid or limit the occurrence of environmental impacts and effects.

9.1.3 Mitigation measures were identified by regularly reviewing the likely significant adverse environmental effects identified during the assessment process and considering these at design workshops within the HS2 project teams. Design modifications were identified to avoid or reduce significant adverse effects.

9.1.4 The ES describes the likely effectiveness of the adopted mitigation and identifies the significant residual effects (i.e. those remaining after mitigation). Not all such effects will be adverse, and significant beneficial effects are also reported.

9.1.5 The mitigation measures and policies considered in the assessment can be divided into three types:

- mitigation that is provided through the planning and design of the Proposed Scheme, which is not shown explicitly as such on the scheme drawings;
- mitigation that requires additional physical features, which is shown on the scheme drawings; and
- mitigation to be delivered through further measures in accordance with HS2 Ltd policies.

9.1.6 Construction impacts will be mitigated through the application of the CoCP in addition to mitigation through design and policy.

9.1.7 Opportunities for mitigation beyond that described in the ES will be considered as part of the detailed design process in accordance with the EMRs.

9.1.8 Mitigation that is being incorporated into the route alignment and design of the Proposed Scheme includes:

- selection of the Proposed Scheme from a range of alternatives taking account of environmental issues;
- alignment of the Proposed Scheme where reasonably practicable to avoid impacts at source, especially on residential properties, community facilities, public open space, business premises, farm buildings, sites of environmental and ecological importance and important heritage features;
- design of the vertical alignment of the Proposed Scheme (i.e. height below/above existing ground level) to achieve, where reasonably practicable:
  - noise mitigation at sensitive locations by placing the route of the Proposed Scheme within cutting; and
  - visual screening using natural landforms.
- provision of bridges or underpasses to avoid the severance of roads, PRoW and private accesses, where reasonably practicable;
- creation of new habitats and other features of ecological value to compensate for losses;
- avoidance or reduction of impacts on floodplains and the provision of replacement flood storage areas;
- provision of retained cuttings (i.e. with vertical or near-vertical retaining walls), in order to reduce the amount of land required;
- provision of noise fence barriers and earth bunds for noise mitigation;
- provision of planting to screen views to assimilate the Proposed Scheme into the local landscape; and
- provision of balancing ponds, in order to control the volume of surface water runoff from the Proposed Scheme in rural areas.

9.1.9 Precautionary mitigation has been identified as part of the assessment where:

- there was insufficient information to confirm the baseline conditions; and
- it was considered that there is a reasonable likelihood of an impact/effect occurring that would require mitigation.

9.1.10 The precautionary approach to mitigation was informed by:

- publicly available information;
- stakeholder information/consultation;
- site knowledge; and
- professional judgement.

9.1.11 The Volume 2 community area reports identify and describe the precautionary mitigation included within the Proposed Scheme. Precautionary mitigation will be validated through future surveys and modified/removed as required.

Monitoring

9.1.12 The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 requires a description, where appropriate of any proposed monitoring arrangements of significant adverse effects on the environment. This monitoring is for significant adverse effects associated with both the construction and operational phases of a scheme.

Monitoring during construction

9.1.13 The draft CoCP includes commitments to monitoring significant effects during construction. Further information on this can be found within Section 6.3 of this report. Monitoring measures during construction for each environmental topic is presented in Sections 9.2 – 9.16 of this report.

Monitoring during operation

9.1.14 HS2 Ltd will carry out appropriate post-construction monitoring during the operational phase for both:

- 'general' monitoring, for example, monitoring of: mitigation provided for protected species; the progress of habitat creation works; the condition of restored agricultural land; and the establishment of landscape planting; and
- 'specific' monitoring agreed for particular significant adverse effects where appropriate – for example, monitoring of a public water supply borehole.

9.1.15 Operational monitoring measures for each environmental topic is presented in Sections 9.2 – 9.16 of this report. Operational monitoring specific to significant effects reported in a community area is presented within the Volume 2 community area reports on a topic basis, where relevant.

9.2 Agriculture, forestry and soils

Mitigation

9.2.1 Impacts on agricultural holdings will vary according to the size of the holding and the nature of its use and business. Work with farmers and landowners is being undertaken to assist in mitigating the effects of the Proposed Scheme on their businesses where reasonably practicable. A guide for farmers and growers affected by the Proposed Scheme, the *Phase 2a Farmers and Growers Guide*, will be published following deposit of the Bill.

9.2.2 Topsoil and subsoil will be stripped prior to construction and stored appropriately to enable agricultural land to be restored. The design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land, through the adoption of good practice techniques in soil handling.

9.2.3 Land drainage schemes and water supplies used for livestock and irrigation may be severed or otherwise affected by the Proposed Scheme. These effects will be

accommodated by suitable works in order to maintain continuity of land drainage and supply of water so far as reasonably practicable during the period of construction of the Proposed Scheme. Where it is not possible to maintain continuity of land drainage or supply of water, the facilities will be reinstated or made good as soon as reasonably practicable.

9.2.4 The Proposed Scheme will inevitably sever some accesses within agricultural holdings and create new field layouts that will require new accesses. Map Series CT-06 in the Volume 2 Map Books included in the ES show the new accesses under or over the railway that are currently proposed to accommodate this severance and so reduce this impact. New accesses will be provided so that they are available as soon as is reasonably practicable in order to reduce the effects of severance. In addition, the contractor will be required to consult with the affected farmers to agree the phasing of the works so as to reduce severance. Where appropriate access arrangements cannot be provided during construction, the severed land will be acquired, subject to agreement between the appropriate parties.

9.2.5 Further details of the approach to compensation for land compulsorily acquired is discussed within Section 1.6.

Monitoring

Construction

9.2.6 Appropriately qualified environmental management staff will be appointed to facilitate compliance with Section 6 of the draft CoCP in relation to soils. Their responsibilities will include the monitoring of topsoil and subsoil stripping, handling, storage and replacement, as appropriate.

9.2.7 As set out in *Information Paper E19 Soil Handling for Land Restoration*[195], during construction, on-site inspections of works will be carried out by the nominated undertaker, to monitor progress and standards of restoration. Completed works will be inspected by a suitably qualified and experienced soil scientist or practitioner to certify that the land has been restored to the specifications as set out in the construction area-wide Soil Resource Plans (and as specified in the individual plans for affected farms). Contractors will also provide an audit of soil resources following a soil survey within six months of completion of the restoration. Information Paper E19 also sets out that the nominated undertaker will put in place agricultural liaison officers who will be available by telephone 24 hours a day, 7 days per week, during the construction of Proposed Scheme works on agricultural land. More information will be available on this after Royal Assent of the Bill.

9.2.8 On completion of construction, soils restored to agricultural, forestry or landscape uses will be monitored to identify any unsatisfactory growing conditions during the five-year aftercare period.

Operation

9.2.9 Given that no significant agriculture, forestry and soils effects are anticipated during operation of the Proposed Scheme, no operational monitoring is required.

[195] HS2 Ltd., (2017), *Phase 2a Information Paper E19: Soil Handling for Land Restora*tion.

9.3 Air quality

Mitigation

9.3.1 The proposed mitigation measures to control and manage the construction effects of the Proposed Scheme in relation to air quality are stated in the draft CoCP and in the transport assessment in relation to road traffic.

9.3.2 These include the following general measures:

- contractors being required to manage dust, air pollution, odour and exhaust emissions during construction works;
- inspection and visual monitoring, undertaken in consultation with the local authorities, to assess the effectiveness of the measures taken to control dust and air pollutant emissions;
- cleaning (including watering) of vehicle routes and designated vehicle waiting areas to suppress dust;
- the use of water spray systems on demolition sites to dampen down fugitive dust;
- keeping soil stockpiles away from sensitive receptors where reasonably practicable, also taking into account the prevailing wind direction relative to sensitive receptors;
- the use of enclosures to contain dust emitted from construction activities; and
- soil spreading, seeding and planting of completed earthworks as soon as reasonably practicable following completion of earthworks.

9.3.3 The draft CoCP includes the requirement for site-specific traffic management measures, such as the use of site haul routes for construction vehicles to minimise the need to use public roads.

9.3.4 Best practice engine emission standards have been set for on and off road construction vehicles.

9.3.5 The use of borrow pits is intended to reduce the need for longer distance transport and import of materials, therefore reducing the volume and impact of road traffic on local roads and communities.

9.3.6 The railway will operate efficient, non-polluting electrically powered passenger trains.

Monitoring

Construction

9.3.7 The nominated undertaker will require its contractors to implement inspection and monitoring procedures to assess the effectiveness of measures to prevent dust and air pollutant emissions. Relevant local authorities will be consulted on the monitoring procedures to be implemented.

9.3.8 Reports of the monitoring will be provided to local authorities. These will include, where appropriate, the interpretation of any continuous automatic monitoring data, any site action level alarms, investigations and remedial actions.

9.3.9 Monitoring of dust and particulate matter during construction of the project will be undertaken following the current best practice guidance (currently IAQM 2012).

9.3.10 Monitoring of significant air quality effects adjacent to highways will be undertaken following current best practice guidance (currently Defra's Local Air Quality Management Technical Guidance 2016).

9.3.11 Further information on general air quality monitoring during construction is set out in Section 7.3 of the CoCP.

Operation

9.3.12 Given that no significant air quality effects are anticipated during operation of the Proposed Scheme, no operational monitoring is required.

9.4 Climate change

Greenhouse gases emissions

Mitigation

9.4.1 Environmental Protection and Management is one of five key themes established in HS2's Sustainability Policy, which is further expanded within HS2's Environmental Policy. The Environmental Policy describes the Proposed Scheme's approach to climate change as being to 'minimise the carbon footprint (of the Proposed Scheme) and deliver low-carbon, long-distance journeys that are supported by low-carbon energy'. Carbon minimisation is further described in the HS2 Ltd Carbon Minimisation Policy[196]. HS2 Ltd has also endorsed[197] the Government's Infrastructure Carbon Review[198], reinforcing its commitment to pursing lower carbon solutions that cost less and also release the value of lower carbon through leadership, innovation and procurement.

9.4.2 Publicly Available Specification (PAS) 2080[199] has been adopted as a best practice framework for managing and minimising HS2's whole lifecycle carbon emissions, the approach will continue to be developed and applied to the Proposed Scheme.

Monitoring

9.4.3 There currently is no specific guidance or GHG emissions threshold which if exceeded is considered significant. Nevertheless carbon emissions from relevant construction and operation activities will be monitored as outlined below.

[196] HS2 Ltd., (2017), *Phase 2a Information Paper E2: Carbon*.
[197] The Green Construction Board, *Statement of Endorsement*. Available online at: http://www.greenconstructionboard.org/index.php/resources/infrastructure/statement-of-endorsement
[198] HM Treasury (2013), *Infrastructure Carbon Review*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/260710/infrastructure_carbon_review_251113.pdf
[199] Construction Leadership Council & the Green Construction Board, (2016), *PAS 2080: 2016: Carbon Management in Infrastructure*, BSI Limited, London, UK.

Construction

9.4.4 The CoCP requires the nominated undertakers lead contractors to produce carbon management plans detailing 'the approach to energy and carbon dioxide (CO_2) monitoring and reporting from relevant site activities'.

Operation

9.4.5 Carbon dioxide emissions will be calculated and monitored during operation.

In-combination climate change impacts

Mitigation

9.4.6 The HS2 Environmental Policy sets out the Proposed Scheme's principles in relation to climate change as seeking to '*minimise the combined effect of the project and climate change on the environment*'.

9.4.7 To address this policy principle the in-combination climate change impacts assessment considered how climate change, in combination with the impacts of the Proposed Scheme, may affect the receiving environment.

9.4.8 The mitigation of potential in-combination climate change effects during construction will be provided by the draft CoCP and existing topic specific mitigation measures. The mitigation of potential in-combination climate change effects during operation will be mitigated by embedded topic specific mitigation measures. Any significant in-combination climate change effects identified during construction or operation will be mitigated by additional mitigation measures address adverse effects on the ability of resources and receptors to adapt to climate change.

9.4.9 The approach to the mitigation of in-combination climate change impacts and effects is further described in the SMR and in Volume 3: Route-wide effects.

Monitoring

Construction

9.4.10 The CoCP includes a requirement for the nominated undertaker's lead contractor to monitor extreme weather events during construction.

9.4.11 Monitoring of any significant adverse in-combination climate change effects arising from construction will form part of the aftercare and monitoring strategies for the relevant topics.

Operation

9.4.12 Monitoring of any significant adverse in-combination climate change effects during operation will form part of the operational monitoring strategies for the relevant topics.

Climate change resilience

Mitigation

9.4.13 The HS2 Sustainability Policy[200] defines the Proposed Scheme's approach to climate change as '*building a network which is resilient to climate change in the long-term and adaptable to future trends and demands…*'.

9.4.14 To address this policy theme the climate change resilience assessment considered how climate change impacts may affect the resilience of infrastructure and assets associated with the Proposed Scheme.

9.4.15 The mitigation of climate change related risks to HS2 assets and infrastructure during construction is provided by the draft CoCP and adherence to relevant health and safety standards. The mitigation of climate change related risks during operation is provided through one or more of the following categories of embedded measures:

- existing resilience measures embedded within the design of the Proposed Scheme;
- measures which will be included in the development of maintenance and monitoring measures for the Proposed Scheme; and/or
- measures which will be considered and developed during appropriate further design stages as not being considered as part of the Proposed Scheme.

9.4.16 The approach to ensuring the resilience of the Proposed Scheme is further described in the SMR and Volume 3: Route-wide effects.

Monitoring

Construction

9.4.17 The CoCP includes a requirement for the nominated undertaker's lead contractor to monitor extreme weather events during construction.

Operation

9.4.18 Requirements for weather and climate change resilience monitoring will be integrated into processes for developing asset management and procurement strategies for the Proposed Scheme.

9.5 Cultural heritage

Mitigation

9.5.1 The design of the Proposed Scheme has sought to avoid direct impacts on all heritage assets. Where this has not been possible, a range of measures will be implemented to mitigate the impact on such assets.

9.5.2 A Heritage Memorandum has been prepared setting out the commitments of the Secretary of State for Transport to the historic environment and heritage assets. The memorandum provides a framework for the nominated undertaker, Historic England,

[200] HS2 Ltd., (2017), Sustainability Policy.

local authorities and other stakeholders to work together to ensure that the Proposed Scheme is designed and constructed with proper regard to the historic environment. The memorandum will form part of the EMRs (as described in Section 1.4 of this report).

9.5.3 Route-wide research approaches have been developed by the nominated undertaker in consultation with Historic England and local authorities for Phase One. A route-wide general written scheme of investigation: historic environment research and delivery strategy (GWSI:HERDS) has also been prepared setting out the research framework and general principles for design, evaluation, investigation, recording, analysis, reporting and archive deposition to be adopted for the design development and construction of the Proposed Scheme. The document will be revised in consultation with Historic England and the Heritage Subgroup for Phase 2a, to reflect the different geographical research objectives. The GWSI:HERDS is supported by strategies, technical standards and procedures that will provide the detailed mechanisms for the delivery of the works. These will be set out as requirements in construction procurement documentation. The process will be carried out and overseen by suitably qualified archaeological and heritage specialists.

9.5.4 The nominated undertaker will record, analyse, report and publish the results of all historic environment investigations, and will archive the resulting records, artefacts and materials in suitable repositories.

9.5.5 The Bill will dis-apply various legislative provisions currently in place for affected nationally designated listed buildings. The Bill will identify the affected assets and will provide an alternative planning mechanism. The nominated undertaker will enter into heritage agreements with local authorities for listed buildings and with Historic England for scheduled monuments. As part of each agreement, a method statement for specified works in relation to these named heritage assets will be submitted to the local authorities and Historic England for agreement within specified timescales.

9.5.6 The Bill will dis-apply the various legislative provisions in instances where construction of the Proposed Scheme will directly affect burial grounds, human remains and monuments. A project-specific regime will be put in place to ensure that all human remains and burial grounds are afforded all due dignity, care and respect. A Burial Grounds, Human Remains and Monuments Procedure will be used to implement these requirements.

9.5.7 Mitigation measures have been developed in consultation with other disciplines, notably landscape, to ensure that heritage assets have been incorporated into mitigation works such as sympathetic design to the local historic landscape or townscape. Further discussion with other disciplines will be undertaken during detailed design to identify any further measures that can be incorporated to avoid or reduce impacts on cultural heritage assets.

9.5.8 The assessment does not predict that any heritage asset is likely to be rendered unviable as a result of the construction and operation of the Proposed Scheme. In the event that such an effect were to occur, potentially leading to dereliction or changes in management affecting heritage significance, mitigation will be addressed on a case by case basis with relevant stakeholders. Mitigation measures will take account of the range of effects that have been identified.

Monitoring

Construction

9.5.9 The nominated undertaker will require its lead contractors to implement appropriate monitoring of the consequences of construction work, as required, on all cultural heritage assets (designated and non-designated) to ensure the effectiveness of management measures and compliance with agreed approaches to construction activities and cultural heritage assets.

9.5.10 Risk assessments identifying appropriate surveys, for example, structural or condition surveys and vibration monitoring will be undertaken at locations of archaeological or built heritage interest adjacent to the construction site prior to, during and following construction works. The risk assessments will include, but not be limited to, specific buildings identified in the hybrid Bill and the ES.

Operation

9.5.11 There are no specific monitoring requirements during operation of the Proposed Scheme. It is assumed that all heritage assets within the land required for construction will be removed unless expressly excluded as a result of the mitigation process. Noise effects can contribute to setting effects on heritage assets (for example where a quiet rural setting contributes to the significance of the asset). The heritage assessment has drawn on noise modelling to identify where this may be relevant. It is not however at present proposed to monitor noise at any heritage assets simply because they are heritage assets either during operation or construction.

9.6 Community

Mitigation

9.6.1 Significant effects on a community resulting from the loss of public open space or of a community facility can be mitigated, where reasonably practicable, in a number of ways. One of the mitigation measures that has been considered for the temporary loss of open space or community facilities for the Proposed Scheme is to provide alternative open space or community facilities for the period where the land is not available for community use. When the land is no longer required for the Proposed Scheme it will be restored to its former use, in agreement with the original owners or users of the land.

9.6.2 The draft CoCP includes provisions to mitigate community effects during construction, including:

- appointment of community relations personnel;
- a community helpline to handle enquiries from the public;
- sensitive layout of construction sites to reduce nuisance; and
- maintenance of public roads, cycleways and PRoW around construction sites, where reasonably practicable, to avoid their deterioration due to construction traffic.

9.6.3 The specific measures within the draft CoCP for the mitigation of individual noise, air quality, visual and construction traffic effects will also serve to reduce in-combination

effects [201] and isolation effects on community facilities, residential properties and open space.

9.6.4 Where there are community effects that cannot currently be mitigated, HS2 Ltd will continue to engage with owners and operators of these facilities to identify reasonably practicable measures to help mitigate the residual significant effects identified in the assessment.

Monitoring

9.6.5 Any construction and operational monitoring requirements in relation to in-combination effects arising from noise, air quality, visual and construction traffic effects have been described in the relevant sound, noise and vibration, air quality, landscape and visual, and traffic and transport topic chapters.

9.7 Ecology and biodiversity

Mitigation

9.7.1 The Proposed Scheme has been designed to avoid or reduce impacts on habitats, species and other features of ecological value where reasonably practicable.

9.7.2 Efforts have been made to reduce the duration, scale and extent of the anticipated effects in instances where avoidance has not been practicable. Appropriate compensation or enhancements have been identified for effects that are still anticipated following mitigation.

9.7.3 Areas are included within the identified extent of the Proposed Scheme where mitigation and/or compensation is required. These areas include:

- receptor sites for habitats and species that will be translocated prior to construction and thus require land that will not be subject to any construction works; and
- areas where habitats of ecological value will be created following the completion of construction.

9.7.4 In accordance with the Ecological principles of mitigation set out in the SMR addendum, a route-wide, integrated strategic approach has been developed to compensate for loss of widely distributed habitats, especially woodland and grassland. The habitat creation is required to fulfil the objective of no net loss in biodiversity as far as practicable in the local area, as well as to ensure that the populations of protected and notable species are maintained. With these objectives in mind, where reasonably practicable, the locations of habitat creation areas have been selected so as to increase the size of existing higher quality habitat and to increase connectivity.

9.7.5 The Environmental Memorandum (which forms part of the EMRs) includes a commitment to provide long-term management of habitat creation to ensure that the

[201] Significant in-combination effects are the result of cumulative residual effects associated with noise and vibration, air quality, landscape and visual and HGV construction traffic impacts on residential and community resources. The in-combination effect of two or more residual significant effects arising from these other topic assessments results in a significant in-combination effect.

target value of these habitats is achieved. This may be achieved through a variety of potential mechanisms, including the following:

- retention and management of the land by the nominated undertaker;
- returning the land to the original landowner, with an agreement to manage it within the required parameters;
- transferring the land for management by a third party, such as a Wildlife Trust; or
- developing a bespoke management arrangement on a case-by-case basis.

9.7.6 Mitigation and compensation to address effects on legally protected species will, where appropriate, include translocation or relocation of species, the provision of replacement habitat and provision of special measures such as underpasses and green bridges to facilitate the movement of species across the route.

9.7.7 Formal applications for derogation licences for protected species will be made after Royal Assent.

Monitoring

Construction

9.7.8 The nominated undertaker will define a programme for undertaking ecological surveys prior to and during construction. The surveys will be used to verify the baseline ecological conditions described in the ES, to refine the mitigation and control measures required during construction as appropriate, and to provide appropriate monitoring during construction.

9.7.9 The nominated undertaker will require its contractors to undertake appropriate monitoring of the consequences of construction works on ecological resources and of the effectiveness of the management measures designed to control ecological effects, associated with works that may affect protected or notable species, statutory designated or non-statutory sites of ecological interest. *Information Paper E2: Ecology* [202]specifies that monitoring will be put in place throughout the habitat establishment period to measure its success, and that this may need to continue beyond the establishment period.

9.7.10 HS2 Ltd is committed to monitoring the effectiveness of ecological mitigation and compensation measures for a sufficient period to ensure the objectives of the proposals for nature conservation are achieved, as set out in the Environmental Memorandum. As identified in *Information Paper E2: Ecology*, an Ecology Review Group will review the outputs of monitoring for habitat creation sites and make recommendations for remedial action where appropriate.

[202] HS2 Ltd., (2017), *Phase 2a Information Paper E2: Ecology*.

Operation

9.7.11 The nominated undertaker will be required to monitor the effective management and performance of ecological mitigation and compensation measures. Arrangements will be made to obtain the advice of the Ecology Review Group.

9.8 Health

Mitigation

9.8.1 Design-based interventions to reduce health effects have been incorporated through the scheme design and wider EIA process – for example, route design to avoid (where reasonably practicable) residential properties and other sensitive receptors, vertical alignment, incorporation of bunds and other measures to reduce noise and visual effects. This incorporated mitigation is part of the Proposed Scheme assessed in the EIA. Other, non-design related mitigation measures may be made with regard to the construction process and ongoing management and delivery of the Proposed Scheme. These have been incorporated into the CoCP and other HS2 strategies and policies as appropriate.

Monitoring

9.8.2 Any construction and operational monitoring requirements in relation to impacts generated from air quality, noise and vibration, traffic and visual effects that have the potential to influence health have been described in the relevant topic sections in Volume 2 and Volume 3.

9.9 Land quality

Mitigation

9.9.1 Mitigation of the effects of pre-existing contaminated soils or groundwater will mainly take place as close to the point of excavation/deposition as possible and take the form of various established methodologies for soil and groundwater remediation, such as:

- soil washing;
- soil stabilisation;
- bio-remediation; and
- in-situ or ex-situ groundwater treatment.

9.9.2 Soils that are not responsive to in-situ or ex-situ treatment will be deposited within a suitably licensed landfill, in the expected small number of cases where this occurs.

9.9.3 Appropriate remediation methods will be used to prevent contamination mobilisation, such as vertical and horizontal barriers (for ground gases and leachates within old landfills), and soil cover systems. Where piling through contaminated soils is required, appropriate piling techniques and preventative measures will be adopted to mitigate the potential for contaminant migration.

9.9.4 Methods to mitigate temporary effects during the process of remediation, within the construction period, are described in the draft CoCP.

9.9.5 Mitigation measures for mining/mineral resources may include prior extraction of the resources for use within the Proposed Scheme or elsewhere. A plan will be discussed and agreed in advance with relevant mineral/landowners, mineral planning authorities and other stakeholders to help manage affected minerals, where this is reasonably practicable.

Monitoring

Construction

9.9.6 The nominated undertaker will require gas, groundwater and/or leachate monitoring procedures to be implemented, as appropriate, in of contaminated land, which may comprise landfill, made ground, former and existing industry sites, quarries and naturally occurring gassing strata.

9.9.7 Groundwater and surface water monitoring plans will be prepared, as appropriate, by the lead contractors as part of their EMS, in the vicinity of contamination remediation works, or where piling risk assessment has indicated a potential effect on below-ground contamination.

9.9.8 Monitoring of any works that have the potential to impact identified geological resources will be carried out. Such procedures will be agreed in consultation with stakeholders for any works which may affect geological SSSI or LGS, including inspections, the appropriate recording of geological information, and mapping of soil and rock exposures.

9.9.9 Appropriate health, safety and environmental monitoring will be set out to support adherence to the procedures relating to working on or adjacent to land affected by contamination.

Operation

9.9.10 During the operational phase, monitoring works (such as for groundwater and landfill gas) will continue, where required, in order to demonstrate the effectiveness of any remedial works, or as part of a strategy of any agreed Monitored Natural Attenuation (MNA) programme.

9.10 Landscape and visual

Mitigation

9.10.1 Measures to mitigate landscape and visual impacts are part of an integrated design approach that includes consideration of engineering requirements, environmental considerations and best practice design. The landscape proposals incorporate mitigation measures for landscape, noise, ecology, agriculture, cultural heritage and open space.

9.10.2 Mitigation measures have been developed to:

- avoid or reduce effects on the character and setting of the landscape, including valued, designated and historic landscape features;
- seek to enhance such resources where appropriate; and
- avoid or reduce effects on the visual amenity of residential communities,

receptors and users of the landscape due to potential intrusion into, obstruction of, or loss of existing views.

9.10.3 Landscape design and mitigation has been considered at a strategic scale to integrate the Proposed Scheme into the surroundings. Specific measures include:

- design of earthworks to achieve visual screening, integration of the route by reflecting the character of local topography, and to facilitate the restoration of agricultural land;
- provision of new planting to connect with existing planting areas, reinstate lost historic planting, reconnect locally fragmented planting areas, as well as habitat creation;
- design of earthworks and large scale planting to integrate new structures such as bridges, viaducts and buildings;
- design of new, diverted or realigned roads and PRoW to reconnect lost routes, integrate into wider access networks and promote walking and cycling initiatives;
- design of noise mitigation, including earthworks and noise fence barriers to ensure good fit with the local landscape and townscape;
- design and appearance of fencing, including boundary and security fencing to reflect landscape character; and
- design of diverted watercourses, balancing ponds and ecological ponds to ensure integration with the local landscape and the promotion of green infrastructure.

9.10.4 The design or external appearance of new structures will be subject to the approval of the relevant local authority.

9.10.5 Mitigation will also reduce the effects of construction through, for example, advance planting, temporary screening or earthworks. Temporary or permanent mitigation will be installed at the earliest opportunity, where appropriate. Planting away from the route will also be established to reduce adverse landscape and visual effects.

9.10.6 The nominated undertaker will maintain landscaped areas within the rail corridor to an appropriate standard, and will ensure that the maintenance of other landscaped areas is secured through agreement. The aim is to ensure that planting successfully establishes and develops, so that it achieves and maintains its mitigation objective. *Information Paper E20: Maintenance of Landscaped Areas*[203], outlines how the new areas of woodland, grassland and wetland planting created along the line of route for of the Proposed Scheme will be maintained.

9.10.7 Areas of mitigation provided outside the rail corridor will, where reasonably practicable, be transferred to third parties, subject to agreements to ensure that the necessary management objectives are met.

[203] HS2 Ltd., (2017), Phase 2a Information Paper E20: Maintenance of *Landscaped Areas*.

9.10.8 Landscape maintenance will incorporate a risk assessment for vegetation in landscape areas. Visual inspections of mitigation planting (and/or existing planting in the vicinity of the Proposed Scheme) will be carried out on a regular basis to determine whether it poses a risk to the safe operation of the railway. Maintenance operations will ensure that trees within all operational land (and adjoining land if applicable) cannot fall onto the track, overhead lines or other line-side equipment.

Monitoring

Construction

9.10.9 The nominated undertaker will require its contractors to implement appropriate monitoring of any new advanced permanent or temporary planting to ensure they become established and are properly maintained throughout the construction period.

9.10.10 The nominated undertaker will supply its contractors with information prior to construction to verify the landscape planting design and requirements as set out in the ES, on drawings and in the specification. This will allow the contractor(s) to fully understand the required landscape mitigation measures.

9.10.11 Further information on inspection, monitoring and maintenance requirements of planting and seeding works throughout the construction period can be found in Section 12.4 of the draft CoCP.

Operation

9.10.12 The nominated undertaker will monitor all landscaped areas to ensure that all planting (woodlands, grasslands, wetlands and hedgerows) successfully establishes and develops, so that it achieves its wide range of functions and remains effective thereafter.

9.10.13 Any third parties undertaking the maintenance of landscape areas outside the rail corridor will also be required to undertake monitoring to ensure that the necessary management objectives are met.

9.10.14 Further detail on the successful establishment and maintenance of all planting (advanced permanent or temporary and planting in operation) is described in the *HS2 Landscape Design Approach*, (which guides and directs the development of integrated and multifunctional landscape design solutions along the route of the Proposed Scheme), and *Information Paper E20: Maintenance of Landscaped Areas*, (which outlines how the new landscaped areas will be maintained).

9.11 Major accidents and natural disasters

Mitigation

9.11.1 Management and mitigation of safety risks is a fundamental concept of the Proposed Scheme, embedded in HS2 Ltd's legal and contractual obligations as well as its management frameworks. The guiding principle is to manage all risks to be as low as reasonably practicable. A number of UK legislative requirements and EU regulations must be complied with, to demonstrate the management of safety risks throughout the design, management, operation and maintenance of the Proposed Scheme.

9.11.2 Measures to mitigate health, safety and environmental risks related to the potential for major accidents and natural disasters during construction and operation of the Proposed Scheme are embedded through technical standards and specifications for the Proposed Scheme.

Monitoring

Construction

9.11.3 The draft CoCP includes a requirement to monitor weather events and make due consideration of the potential impacts of extreme weather events and related conditions.

9.11.4 Specific monitoring solutions, for example during tunnelling activities will be developed as part of detailed design.

Operation

9.11.5 A rigorous safety management system (SMS) will be established and adhered to as part of the Proposed Scheme. This is a requirement of the Railways and Other Guided Transport Systems (Safety) Regulations 2006. The SMS will record adverse incidents and monitor these in order to take appropriate action where appropriate.

9.12 Socio-economics

Mitigation

9.12.1 Businesses displaced by the Proposed Scheme will be compensated within the provisions of the Compensation Code[204]. This recognises that businesses displaced from their existing premises by compulsory purchase will usually seek to relocate to another site. The code provides for the cost of such relocation to be taken into account under the heading of disturbance compensation.

9.12.2 The Compensation Code is considered a fair basis for compensation in respect of such costs. HS2 Ltd recognises the importance of displaced businesses being able to relocate to new premises and will offer appropriate support to facilitate this process.

9.12.3 All reasonably practicable steps will be undertaken to limit the impact of the Proposed Scheme on existing businesses.

9.12.4 The construction of the Proposed Scheme offers considerable opportunities to businesses and residents along the line of the route in terms of supplying goods and services and accessing employment opportunities. There is a commitment to work with suppliers to build a skilled workforce that fuels further economic growth across the UK.

9.12.5 No further mitigation of significant temporary in-combination effects is proposed at this stage. However, the measures set out in the draft CoCP will provide further mitigation for individual significant effects (noise, vibration, air quality, visual, construction HGV traffic) on a case-by-case basis.

[204] The collective term for the principles derived from both statute and case law, relating to compensation for compulsory acquisition.

Monitoring

9.12.6 Where there are likely residual significant effects at existing businesses, the specific operational monitoring requirements in relation to noise, vibration, construction HGV traffic, air quality and visual effects are described in the relevant air quality, sound, noise and vibration, landscape and visual, and traffic and transport topic sections in Volume 2 and Volume 3.

9.13 Sound, noise and vibration

Mitigation

Introduction

9.13.1 The development of a new high speed railway requires that provision be made for mitigation measures to protect the environment from intrusive noise and vibration.

9.13.2 The Proposed Scheme has been designed to manage and control the impact of railway noise and vibration, in so far as is reasonably practicable:

- by avoiding or reducing significant noise effects; and
- where there are opportunities to do so, by reducing existing exposure to noise or vibration through the provision of mitigation.

9.13.3 Mitigation of likely significant adverse noise or vibration effects has, where practicable, been incorporated into the Proposed Scheme in the following order:

- through alignment design: that is, keeping the railway as far from as many sensitive receptors as possible (whilst taking into account other environmental impacts and engineering considerations);
- at source: the project has the opportunity to design and specify a complete railway system including quieter trains, track and their maintenance to reduce noise emission;
- by noise barriers: delivered, for example, as fence barriers or constructed cuttings using landscape earthworks or as a combination of both; and
- by reducing noise entering property.

9.13.4 Priority has been given to mitigation at source, for example through train or alignment design. Consideration is then given to the provision of noise barriers. These types of measures are prioritised since they will reduce effects on the environment as a whole, and on amenity, as well as inside properties.

9.13.5 Preference has been given to the most sustainable means of providing the necessary noise mitigation. For example, providing a noise barrier in a rural location by a landscape earthwork is, where reasonably practicable, preferred to a noise fence barrier. This is because the landscape earthwork can be shaped to follow the grain of the landscape, it can be used to return as much land as possible to agricultural or community use.

Construction

9.13.6 Construction noise and vibration will be controlled and managed in accordance with the draft CoCP as described in Section 6.3 of this report.

Operation

9.13.7 The development of the Proposed Scheme has sought to keep the route alignment as low as reasonably practicable and away from main communities. These avoidance measures have protected many communities from likely significant noise or vibration effects.

Airborne noise

9.13.8 HS2 trains will be quieter than the relevant current European Union specifications. This will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 186mph (300kph) with current pantograph designs, drawing on proven technology in use in East Asia, such as the Shinkansen N700 trains in Japan. The track will be specified to reduce noise, as will the maintenance regime. Overall these measures will reduce noise emissions by approximately 3dB at 225mph compared to a current European high speed train operating on the new track.

9.13.9 Noise effects will be reduced in other locations along the line by landscape earthworks provided to avoid or reduce significant visual effects and engineering structures such as cuttings.

9.13.10 The Proposed Scheme will include noise barriers in the form of landscape earthworks, noise fence barriers and/or parapet barriers on viaducts to avoid or reduce significant airborne noise effects. Such mitigation will be identified taking account of:

- environmental and health benefit;
- cost;
- engineering practicability;
- other environmental effects caused by the further noise mitigation; and
- response from consultation and stakeholder engagement (such as a stated preference for a noise barrier in the form of landscape earthworks rather than a fence).

9.13.11 Tunnel portals will be designed to avoid significant airborne noise effects caused by the trains entering the tunnel.

9.13.12 Significant noise effects from the operational static sources such as line-side equipment will be avoided through their design and the specification of noise emission requirements.

9.13.13 Noise insulation measures will be offered for qualifying buildings as defined in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996[205] (the Regulations). The assessment provides an estimate of the buildings that are likely

[205] The Noise Insulation (Railways and Other Guided Transport Systems) Regulations, (1996). London, Her Majesty's Stationery Office.

to qualify under the Regulations. Qualification for noise insulation under the Regulations is identified and noise insulation offered in time to enable it to be installed when the Proposed Scheme becomes operational.

9.13.14 Where required, as well as improvements to the noise insulation of windows facing the railway, ventilation will be provided so that windows can be kept closed to protect internal sound levels.

9.13.15 Following Government's National Planning Practice guidance, where the noise from the use of new or additional railways authorised by the Bill measured outside a dwelling exceeds the Interim Target defined by the World Health Organisation (WHO) Night Noise Guidelines for Europe[206], residents are considered to be significantly affected by the resulting noise inside their dwelling. The effect on people at night due to the maximum sound level as each train passes has also been assessed[207]. The WHO Interim Target is set at a lower level of noise exposure than the Regulations trigger threshold for night noise. In these particular circumstances, following the methodology set out in the Regulations (i.e. pertaining to new or additional railways) where night-time noise levels are predicted to exceed 55dB[208], or the maximum noise level (dependent on the number of train passes) as a train passes exceeds the criterion, noise insulation will be offered for these additional buildings.

Ground-borne noise and vibration

9.13.16 Significant ground-borne noise or vibration effects will be avoided or reduced through the design and maintenance of the track and track-bed.

Monitoring

Construction

9.13.17 The nominated undertaker will require its contractors to undertake and report such monitoring, including real-time noise and vibration monitoring, as is necessary to ensure and demonstrate compliance with all noise and vibration commitments and the requirements of the CoCP. The monitoring and compliance assurance process will be set out in each of the lead contractors' noise and vibration management plans. Proposals for monitoring locations will be set out in each LEMP. The Section 61 applications will include a detailed description of the monitoring and monitoring locations proposed for the particular works covered by the consent application. Monitoring data will be provided regularly to and reviewed by the nominated undertaker and will be made available to the local authorities.

Operation

9.13.18 The noise and vibration monitoring strategy and commitments are set out in full in HS2's *Information Paper E12: Operational Noise and Vibration Monitoring Framework*[209].

[206] World Health Organization, (2010), *Night Noise Guidelines for Europe*.
[207] During the night (2300-0700) a significant effect is also identified where the Proposed Scheme results in a maximum sound level at the façade of a building at or above: 85 dB LpAFmax (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB LpAFmax (where the number of train pass-bys exceeding this value is greater than 20).
[208] Equivalent continuous level, LpAeq,23:00-07:00 measured without reflection from the front of buildings
[209] HS2 Ltd., (2017), *Phase 2a Information Paper E12: Operational Noise and Vibration Monitoring Framework.*

9.13.19 Information Paper E12 sets out that noise and vibration monitoring will be carried out at different times during the lifetime of the Proposed Scheme at a combination of appropriate monitoring locations including: adjacent or attached to moving vehicles, at fixed positions or in the vicinity of individual assets; and locations within the surrounding areas and communities alongside the railway corridor. These data, together with noise and vibration measurements will be used to monitor the operational noise and vibration performance of the Proposed Scheme.

9.13.20 Where noise and vibration performance deviates from expected conditions, either this information will be used to inform possible improvements (where measurements indicate better-than-expected performance), or investigations will be undertaken to inform reasonable remedial measures (where measurements indicate worse-than-expected performance).

9.13.21 The expected noise and vibration performance of the Proposed Scheme, operational noise and vibration measurement data, associated asset information, description of corrective actions, results of measured performance compared to expected conditions, and monitoring reports will be shared with the relevant local authorities at appropriate intervals.

9.14 Traffic and transport

Mitigation

Construction

9.14.1 The draft CoCP sets out various mitigation measures to reduce the impact of construction traffic. These include:

- traffic management measures and plans, which will be prepared in consultation with the highway and transport authorities and emergency services;
- an approach to reduce the impacts of temporary road and PRoW closures or disruption to railways or navigable waterways;
- use of internal haul routes for construction vehicles within the construction sites to reduce the need to use public roads;
- management procedures to reduce the impact of construction traffic such as: agreed routes for construction (HGV) vehicles; and keeping to the main road network (e.g. motorways and strategic trunk roads and other primary 'A' roads); and
- workplace travel plans to reduce employee movements to/from construction sites and compounds.

9.14.2 Traffic management mitigation to be used during construction and utility works may include temporary lane closures, junction signal retiming, temporary traffic signals, tidal flow workings, reduced lane widths and overnight/weekend (instead of daytime/weekday) road closures. Traffic diversions will be provided where temporary road closures are required.

9.14.3 New highway crossings of the Proposed Scheme will be built offline, where reasonably practicable, so that they can be completed prior to closure of the existing road. This will avoid or substantially reduce disruption to road users. A diversionary route and temporary bus stops (where necessary) will be identified for bus routes affected by temporary road closures.

9.14.4 During the construction phase, PRoW routes will be maintained operational where reasonably practicable. Where routes cross the Proposed Scheme and are required to be diverted, generally the alternative PRoW crossing of the Proposed Scheme will be constructed prior to any closure of existing routes. Where routes cross the Proposed Scheme in proximity to the existing route, a temporary alternative alignment may be required before the new crossing on the existing alignment is available. In some instances, PRoW routes may need to pass through construction compounds and interface with the haul route. Where this is necessary, the movement through the compounds and across haul route will be managed to minimise any conflict with construction vehicles and to provide safe routes for users.

9.14.5 It will be necessary to close, realign or divert certain local roads and PRoW along the Proposed Scheme, both during construction and, in some cases, permanently. In all such cases, alternative routes will be available either through the use of temporary alternative routes or the existing wider network.

9.14.6 Temporary highway measures including junction improvements, passing places and carriageway widening to manage the safe passing of construction vehicles have been included to avoid impacts that could otherwise occur. Further information is provided in the Volume 2: Community area reports and, where these are off-route, in the Volume 4: Off-route effects.

9.14.7 Construction vehicles will be routed, along the strategic and/or primary road network and insofar as reasonably practicable, the use of the local road network will be limited to use for site set-up, access for surveys and on-going servicing (including refuse collection and general deliveries to compounds) during construction. The use of roads as main construction routes will be subject to approval processes through local planning authorities.

9.14.8 Temporary workers accommodation will be provided at the Trent south embankment main compound (CA2), Yarnfield north embankment satellite compound (CA3) and Basford cutting main compound (CA5). These will reduce the level of construction employee traffic travelling to and from compounds during the week and will encourage off-peak travel.

9.14.9 Where reasonably practicable, movement of construction material, machinery and/or construction workers between the construction compounds and work sites will be via haul routes. These will reduce the need for construction vehicles to use the public road network, therefore helping to reduce traffic related impacts.

9.14.10 Excavating borrow pits will enable high quality material for use in construction of the Proposed Scheme to be extracted locally and transported largely within the construction area of the Proposed Scheme. This will generate considerably lower HGV movements than importing the material from commercial quarries, reducing impacts. Using borrow pits will considerably reduce the number of HGV movements on the highway network.

9.14.11 The need for mitigation has been considered for adverse impacts that could occur at some distance from the Proposed Scheme. Where appropriate, these are reported in the ES.

Framework travel plan

9.14.12 There will be an over-arching framework travel plan (Volume 5: Appendix TR-001-000, Annex A). This will be based on the framework travel plan for HS2 Phase One and amended where relevant for the Proposed Scheme. It will require travel plans to be used along with a range of potential measures to mitigate the impact of transport and movement associated with construction, maintenance and operation of the Proposed Scheme. The scope of this will include:

- a construction workforce travel plan – the framework will:
  - inform site-specific plans that the lead contractors will be required to produce;
  - aim to reduce workforce commuting by private car, especially sole occupancy; and
  - encourage the use of sustainable modes of transport, where practicable.
- consideration of the travel movements arising from operation of the IMB-R – the framework will provide guidance on the expected contents of a depot-specific travel plan, which will be the responsibility of the depot operator; and
- consideration of how operational, delivery and servicing and car parking management plans will be included in travel plans.

Monitoring

Construction

9.14.13 The nominated undertaker will require its contractors to undertake the necessary monitoring to ensure compliance with the requirements of the CoCP, associated Local Traffic Management Plans (LTMPs) and construction travel plans. Details of any monitoring programme, the approach to regular consultation with relevant highway authorities and emergency services and the control processes will be set out in any LTMPs and construction travel plans by the lead contractors' EMSs.

Operation

9.14.14 There are no HS2 stations on the route of the Proposed Scheme and operational and maintenance traffic will be very limited. The workforce travel plan will detail monitoring associated with the operation of the proposed IMB-R.

9.15 Waste and material resources

Mitigation

9.15.1 Sustainable materials will be sourced and made efficient use of for construction of the Proposed Scheme. The aim is to minimise waste and maximise the proportion of material diverted from landfill.

9.15.2 The principles of the waste hierarchy will be followed, with priority given to the prevention of waste generation, followed (where this is not possible) by reuse,

recycling and recovery of waste respectively, with disposal to landfill adopted only as a last resort.

9.15.3 The majority of excavated material that will be generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme, either with or without treatment.

9.15.4 The nominated undertaker will seek to provide any surplus excavated material that arises and which is not required for reuse within the Proposed Scheme:

- for use in other construction projects, where opportunities arise at the time of construction; and/or
- for use for restoration of mineral sites, where the transportation of that material does not result in significant environmental effects (in which case sustainable placement will be used).

9.15.5 Further opportunities will be investigated during detailed design for the prevention, management and treatment of waste during the operational phase of the Proposed Scheme.

Monitoring

Construction

9.15.6 Monitoring of waste management activities will be undertaken by lead contractors in accordance with Section 15.3 of the draft CoCP.

Operation

9.15.7 Monitoring of waste management activities will be undertaken by train operating companies and other users of the Proposed Scheme in accordance with statutory requirements.

9.16 Water resources and flood risk

Mitigation

9.16.1 The principal strategy adopted to limit the temporary and permanent effects associated with the Proposed Scheme is through avoidance of sensitive surface water and groundwater resources and flood risk receptors wherever reasonably practicable. Where receptors could not be avoided, mitigation measures have been incorporated, where necessary, to limit the potential effects. The draft CoCP includes a range of mitigation measures that are suitable to reduce construction impacts as far as is reasonably practicable. The measures that are particularly relevant to each community area are described within the Volume 2 Community area reports.

9.16.2 Where the Proposed Scheme has the potential to increase flood risk, its design will reflect the approach required by the NPPF and the supporting practice guidance. The aim is for there to be no increased risk of flooding for vulnerable receptors during the lifetime of the Proposed Scheme, taking projected climate change impacts into account. If required, the design will mitigate any loss of floodplain by creating replacement flood storage areas for the one in 100 (1%) annual probability flood, with an allowance for climate change.

9.16.3 The design of the Proposed Scheme will seek to ensure that controlled waters - rivers, streams, canals, lakes, ponds, ditches and groundwater - are protected from pollution and that appropriate water quality standards are met.

9.16.4 Sustainable drainage systems will be used to control the rate, volume and quality of runoff from the rail corridor and other infrastructure, taking projected climate change impacts into account. These systems will encourage storm water to soak into the ground or, where that is not reasonably practicable, discharge it into the wider water environment at a rate that matches existing runoff rates.

9.16.5 The detailed design of watercourse diversions, watercourse realignments and of culverts will be developed in general accordance with CIRIA and Environment Agency guidance and in consultation with the relevant consenting authority.

9.16.6 Engagement has been, and will continue to be, undertaken with the Environment Agency, Lead Local Flood Authorities, water companies and the Canal & River Trust, to ensure that likely residual significant adverse effects are managed and mitigated appropriately.

Monitoring

Construction

9.16.7 The nominated undertaker will require its lead contractors to implement appropriate surface water and groundwater inspection and monitoring procedures as part of their EMS. This will include, but will not be limited to, procedures to monitor the effectiveness of the mitigation measures associated with potentially significant effects outlined in the water resources and flood risk sections for each community area in Volume 2 of this ES.

9.16.8 Requirements will cover monitoring of potentially adverse impacts on WFD water bodies identified in the latest version of the WFD compliance assessment, including:

- quantitative or chemical impacts on groundwater bodies;
- water quality (physico-chemical) and quantitative (flow/level) impacts on surface water bodies; and
- hydromorphological impacts on surface water bodies.

9.16.9 Ecological monitoring requirements for WFD water bodies are also outlined in the WFD compliance assessment (Volume 5: Appendix WR-001-000).

9.16.10 The nominated undertaker will require its contractors to consult the Environment Agency regarding water quality, flow and level monitoring to be undertaken for watercourses and groundwater that will be affected by construction works or discharge of surface water run-off, which will include the following, as appropriate:

- pre-construction monitoring to establish baseline water quality conditions for watercourses and groundwater;
- monitoring during construction works to enable the effectiveness of mitigation measures to limit pollution risk to be monitored and any pollution incidents to be identified; and

- monitoring of watercourses or groundwater receiving surface water runoff during construction to enable the effectiveness of treatment and other sustainable drainage systems measures to be determined and to ensure that an unacceptable rise in groundwater levels does not occur.

9.16.11 The nominated undertaker will require its contractors to undertake monitoring to identify:

- pollution risks that are unacceptably high;
- spillages and leakages;
- non-compliance with the CoCP; and
- suspected pollution incidences.

9.16.12 Appropriate actions will be taken where pollution risks are unacceptably high, where there is non-compliance with the CoCP, where spillages and leakages are unacceptable or where there are any suspected pollution incidents.

9.16.13 Groundwater monitoring will be undertaken at any groundwater sensitive areas, as required, to inform the detailed design of the Proposed Scheme and the development of construction methods to mitigate potential impacts.

9.16.14 The contractors will also consult with the relevant regulatory body regarding the pollution incident control plan which will set out the measures to be implemented to address any adverse findings from the monitoring procedures during and following completion of construction works.

Operation

9.16.15 The nominated undertaker will be responsible for ensuring that monitoring is undertaken for agreed periods to confirm the efficacy of implemented mitigation. This will include monitoring of potentially adverse impacts on WFD water bodies identified in the latest version of the WFD compliance assessment, including:

- quantitative or chemical impacts on groundwater bodies;
- water quality (physico-chemical) and quantitative (flow/level) impacts on surface water bodies; and
- hydromorphological impacts on surface water bodies.

9.16.16 Ecological monitoring requirements for WFD water bodies are also outlined in the WFD compliance assessment (Volume 5 Appendix WR-001-000).

9.16.17 The duration of this monitoring will be agreed with the Environment Agency and will depend on the nature of the potential impact concerned.

Provided the construction phase mitigation proves effective, as demonstrated through post-construction monitoring, the remaining measures comprise procedures for inspection, operation and maintenance of the Proposed Scheme as set out in draft operation and maintenance plan (Volume 5: Appendix WR-005-000).

10 Strategic, route-wide and route corridor alternatives

10.1 Introduction

Background

10.1.1 This section sets out the background to the alternatives studied by HS2 Ltd and DfT during development of the Proposed Scheme, and describes the strategic, route-wide and route corridor alternatives. A more detailed account of these alternatives, how they were studied and the reasons for the choices made can be found in the Alternatives report (Volume 5: Appendix CT-002-000).

10.1.2 Local alternatives studied prior to November 2015 are addressed in Section 11. Local alternatives studied since November 2015 are addressed in the Volume 2: Community area reports. Further details on local alternatives studied both prior to and since November 2015 can also be found in the Alternatives report.

10.1.3 This ES does not set out the alternatives to the proposed Y network, as they were presented in Volume 1 and the Alternatives report for the Phase One ES published in November 2013. A summary of the strategic alternatives to the proposed Y-network is set out in the following section.

Regulatory requirements

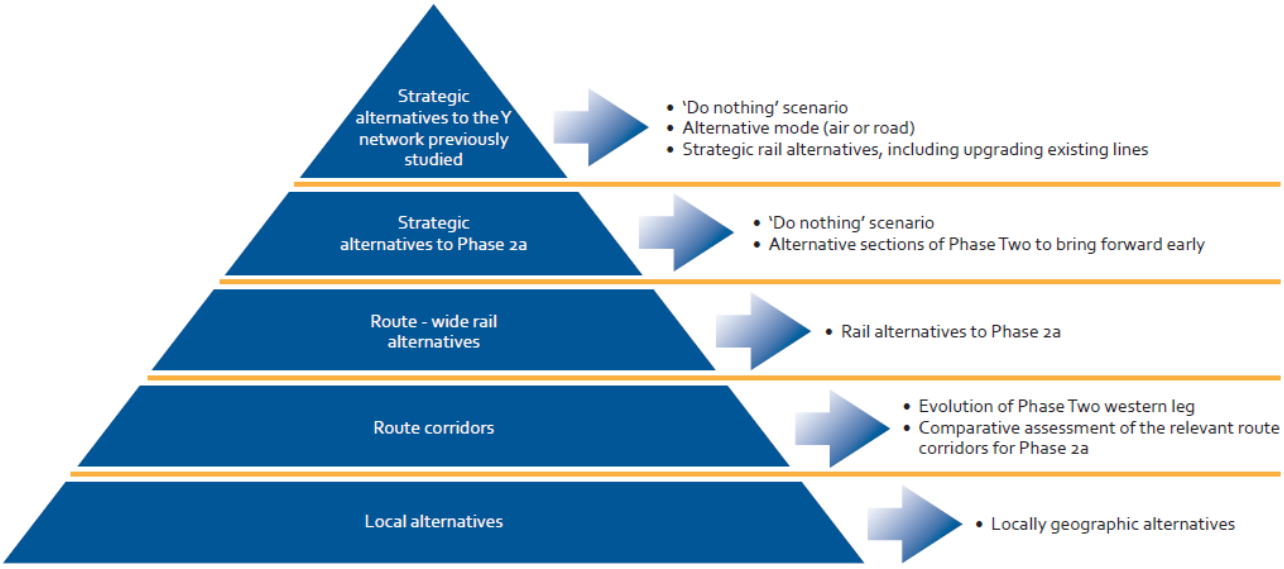
10.1.4 The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 require an ES to include:

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

Definition of alternatives

10.1.5 The alternatives reported here are grouped into five categories, as shown in Figure 35.

Figure 35: Hierarchy of alternatives studied



10.2 Strategic alternatives to the Y network previously studied

10.2.1 The Government has concluded that action is needed to meet the future travel needs of Britain and 'doing nothing' is not an option.

10.2.2 Before deciding to proceed with HS2, a wide range of options to address Britain's inter-urban transport challenges were reviewed. These included domestic aviation, new motorways, a new conventional speed rail line as well as upgrades to existing roads and railways.

10.2.3 The potential for capacity upgrades to the existing main rail network has been explored. The Government rejected this option as further upgrades will not provide the scale of capacity increase and connectivity benefits needed to fulfil the Government's objectives. This would also fail to meet Government objectives for future performance of the rail network and would cause considerable disruption to existing train services during construction.

10.2.4 Carbon emissions from air travel are significantly greater than from high speed rail. The capacity of London's airports is limited and providing for future growth in international travel will be a significant challenge without also serving additional demand from domestic air services. The Government's policy therefore is to enable and encourage more people to take the train instead of air for domestic and short-haul journeys, to achieve environmental benefits and to release capacity at airports for longer journeys.

10.2.5 The Government also decided not to give further consideration to major new motorways as an alternative to HS2, as high speed rail is preferable in terms of both capacity and journey times and has lower carbon emissions and environmental effects.

10.2.6 The cost of a new conventional speed railway would be almost as high as those of high speed rail without delivering the reduced journey times and would have only marginal environmental benefits. For these reasons, a new conventional rail line option was rejected. Prior to the introduction of the Phase One Bill into Parliament in November 2013, the Government considered and reported on alternative configurations of its

proposed high speed rail Y network. The Government's conclusions and its reasons for promoting the Y network were reported both in the Command Paper *High Speed Rail: Investing in Britain's Future* and in the ES deposited in Parliament alongside the Phase One Bill in accordance with standing orders. The Phase One Bill was enacted in February 2017.

10.3 Strategic alternatives to the Proposed Scheme

Do nothing

10.3.1 The 'do nothing' scenario implies not accelerating delivery of Phase 2a and instead delivering Phase One in 2027 and all of Phase Two in 2033. Delivering to this scenario would still help the Government deliver a range of benefits (as outlined in Section 1 of this report), building a stronger, more balanced economy that delivers lasting growth better connects northern cities with faster journeys between London, bringing about widely shared prosperity. However, the Government highlighted in the *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*[210], that doing nothing would mean that we would:

"miss the opportunity of realising some of these benefits six years earlier than the opening of the full Phase Two route in 2033. Doing nothing would mean that we did not accelerate delivery of this section of Phase Two, even though it is well developed, could be delivered early, and the costs of acceleration are outweighed by savings and additional revenue. Government believes that if there is a financially positive and affordable option to bring forward a tranche of benefits by six years, that would help rebalance the economy and unlock the growth and regeneration the country badly needs, then it would be perverse not to take it."

Alternatives to bringing forward the section of Phase Two between the West Midlands and Crewe (the Proposed Scheme)

10.3.2 The Government considered whether there were alternative sections of Phase Two that could be brought forward to become operational in 2027. Alternative sections to the Proposed Scheme that were studied are as follows:

- between Sheffield and Leeds;
- the Western Leg between the West Midlands and Manchester; and
- between Birmingham and the East Midlands.

10.3.3 The following criteria was used to determine which alternative sections of Phase Two could be brought forward:

- connectivity to Phase One;
- delivery of clear connectivity and journey time benefits;
- readiness of the design; and

[210] Department for Transport (DfT), (2015), *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570472/hs2-phase-2a-strategic-case.pdf

- ability to accelerate delivery to complete by 2027.

10.3.4 The Proposed Scheme has a number of advantages over other sections of Phase Two as a standalone scheme. It connects directly with Phase One allowing high speed trains to run on to Crewe from London on a dedicated high speed network. Additional rolling stock (over that used for Phase One) is not required. It improves journey times between London and the key markets of Manchester and the North West and has the potential to relieve some pressure on bottlenecks of the WCML, and to improve reliability and performance. By connecting to the conventional rail network at Crewe, the Proposed Scheme can also benefit from the existing rail connectivity at Crewe. It does not pass through any major urban areas, nor require the delivery of new stations, meaning that it can be developed and built relatively quickly.

10.3.5 The main reasons for not proceeding with the three alternatives are as follows:

- section of Phase Two between Sheffield and Leeds: this section of the route is more complex than the Proposed Scheme as it involves the construction of new stations. Work was also underway to establish an appropriate solution to connect Sheffield and Leeds with plans for enhanced rail infrastructure in the North as part of the Northern Powerhouse Strategy and Northern Powerhouse Rail. Given the complexities of this section of route and the ongoing work required, the Government were not confident that this could be delivered to the required standards as quickly as the route between the West Midlands and Crewe which is more straightforward in engineering terms as it does not include any new stations;

- the western leg all the way to Manchester and the WCML link at Golborne: the section of route north of Crewe to Manchester is more complex than the Proposed Scheme. It travels through an area of complex geology; potentially included new stations and junctions[211]; and would have required further consideration regarding links with Northern Powerhouse Rail. Further work was also required to develop a scheme that best complements the growth and development plans of Manchester. Work was also required on the Golborne link to the WCML and the proposed depot at Golborne[212]. Therefore, it was decided that these route sections could not be designed and built in time to open by 2027, unlike the section of the route between the West Midlands and Crewe;

- between Birmingham and the East Midlands: construction of this part of Phase Two is not as straightforward as the Proposed Scheme. The location and design of the route and a hub station have also been subject to a further work in order to ensure that HS2 delivers the greatest benefits possible to the East Midlands. This included exploring alternative sites for an East Midlands hub station. Although all this further work outlined in this bullet has concluded, options which may have enabled delivery of the route by 2027 could not have been developed in the time available. In addition, it would be easier to achieve

[211] Since consideration of these alternatives, it has now been concluded that new stations and junctions will be required on this section of the Phase Two route.
[212] Since consideration of these alternatives, a depot at Golborne no longer forms part of the Phase Two route.

good connectivity at Crewe, than it would be for an East Midlands hub, as Crewe is already well connected to the conventional rail network. Accelerating delivery of the section of route to the East Midlands would also require additional rolling stock and more trains to be run out of Euston. This could be difficult to achieve in 2027 with the proposed phased development of Euston Station.

10.3.6 As the complexities of these options would not allow for delivery of the route by 2027, they were not considered reasonable alternatives or taken any further. Consequently the section of Phase Two route between West Midlands and Crewe was taken forward.

10.4 Route-wide rail alternatives

Rail alternatives to the Proposed Scheme

Background

10.4.1 The DfT commissioned studies to assess the alternatives to accelerating the delivery of a new high speed line between West Midlands and Crewe (i.e. Phase 2a) in May 2015[213].

10.4.2 A number of potential alternatives to Phase 2a were developed. These options were then sifted down to three options which were taken forward for detailed analysis. The criteria used for this sift was that the options needed to:

- enable delivery of the Phase 2a train service;
- deliver a similar level of capacity as Phase 2a; and
- deliver an environmental impact that is no worse than Phase 2a.

10.4.3 Options taken forward were then assessed against the Phase 2a objectives. Two of these options (the low and medium cost options) focused on enhancing the conventional rail network to improve connectivity and capacity by bypassing some of the current capacity constraints on the WCML, and so delivering some improvements to journey time and performance. The third (high cost) option looked at a different way of delivering Phase 2a so that it connects with the WCML further south of Crewe at Baldwin's Gate. These options are outlined in the following paragraphs.

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

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

[213] Atkins, (2015), *Rail Alternatives to HS2 Phase 2a. A report for the Department for Transport*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480645/rail-alternatives-to-hs2-phase-2a.pdf

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

- 42.5km of HS2 Phase 2a alignment (from Streethay Junction to near Baldwin's Gate);
- 1.4km of new alignment to WCML, including one small bridge crossing a minor brook;
- new flat junction onto WCML fast lines near Baldwin's Gate, which would also need to facilitate parallel movements from the fast to the slow lines on the WCML; and
- 18.3km running on existing WCML from Baldwin's Gate to Crewe – this section has the potential to allow 125mph (201kph) running, and under normal operation, to allocate HS2 services exclusively to the fast lines.

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

10.4.6 The low cost option was originally developed by the WCRM (West Coast Route Modernisation) Team for inclusion in the WCRM programme delivered between 2000 and 2009. This option deliberately limited the design of the new alignment to 140mph (225kph) in order to provide a relatively low cost option that operates at conventional line speeds.

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

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

- 6.8km of new 140mph (225kph) alignment from Rugeley to Hixon;
- upgrade of 6.5km of existing WCML line between Hixon and Sandon to 140mph (225kph);
- 10.8km of new 140mph (225kph) alignment from Sandon to WCML near Norton Bridge. Key features would include:
  - crossing of the Trent and Mersey Canal and the River Trent;
  - three major bridges crossing the A34 dual carriageway, the M6 and the existing railway line between Norton Bridge and Stone; and
  - four small bridges crossing minor roads.
- a total of three new flat junctions at Hixon, Sandon and Norton Bridge, and one new grade separated junction at Colwich; and
- 26.1km running on existing WCML from Norton Bridge to Crewe – this section has the potential to allow 125mph (201kph) running and, under normal operation, to allocate HS2 services exclusively to the fast lines.

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

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

10.4.10 From this point north the design is the same as the low cost option. The Stone line would be upgraded to 140mph (225kph), and a new conventional 140mph (225kph) line built to link the Stone line to the WCML Crewe route just north of Norton Bridge.

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

- 15.2km of Phase 2a alignment from Streethay Junction to Great Haywood;
- 4.8km of high speed alignment from Great Haywood to existing Stone line at Hixon, including three small bridges crossing minor roads and tracks;
- upgrade of 6.5km section of Stone line between Hixon and Sandon to 140mph (225kph);
- 10.8km of new 140mph (225kph) alignment to WCML near Norton Bridge, including:
  - a major crossing of the Trent and Mersey Canal and the River Trent;
  - three major bridges crossing the A34 dual carriageway, M6 and the existing railway line between Norton Bridge and Stone; and
  - four small bridges crossing minor roads.
- 26.1km running on existing WCML from Norton Bridge to Crewe – this section has the potential to allow 125mph (201kph) running, and under normal operation, to allocate HS2 services exclusively to the fast lines; and
- Requires three flat junctions.

Appraisal of alternatives

10.4.12 The findings of this appraisal are outlined in the following sections, assuming the full Y network is constructed.

Low cost and medium cost options

10.4.13 The Atkins report concluded that when considered as part of the full Y network the low and medium cost options do not provide the journey time improvements of the Proposed Scheme and therefore fail to deliver the same level of wider economic benefit. Both options have marginally lower BCRs compared to the Proposed Scheme.

10.4.14 Both these options use sections of the existing WCML. Given this, these options would have reduced spare capacity on the conventional rail network which would result from the Proposed Scheme and this will also potentially constrain future growth on the

WCML and would also offer less network resilience in times of major disruption by reducing the number of alternative routes. Some conventional rail services could impact HS2 services and vice versa.

10.4.15 In addition, the low cost option could also cause visual and noise impacts associated with the grade separated junction near Rugeley and Colton, would bring the route close to Cannock Chase, and would possibly requirement overhead power lines to the north of Colwich to be realigned.

10.4.16 The proposed alignments of the low and medium cost options would run approximately 1km to the north of the Pasturefields Salt Marsh SAC and SSSI. Although these alignments were considered some time ago as part of the WCRM programme, more recent work by HS2 Ltd with the Environment Agency and Natural England showed that effects on the Pasturefields SAC and SSSI could not be ruled out due to complex hydrological issues. This is because research suggested that there was a possibility that the salt marsh could be fed by brine flows located to the north of the site. There was therefore a risk that construction works associated with proposed routes to the north of Pasturefields SAC and SSSI could have interfered with groundwater flows that feed the salt marsh, which could have caused adverse effects on the site. This led HS2 Ltd to reject potential routes to the north of Pasturefields SAC and SSSI in advice to Government because of the high risk associated with ensuring compliance with the Habitats Directive[214]. HS2 Ltd, the Environment Agency and Natural England are in agreement with this approach.

10.4.17 Given the factors outlined above, the low and medium cost options do not meet the strategic objectives of HS2. Therefore, they were not taken any further.

High cost option

10.4.18 The high cost option fails to deliver the same wider economic benefits and has lower journey time improvements compared to the Proposed Scheme, although it has a similar BCR.

10.4.19 If HS2 services are able to operate on straight sections of the WCML between Baldwin's Gate and Crewe at enhanced permissible speed of 125mph (201kph), then there is the potential for this journey time differential to the Proposed Scheme to reduce to approximately two minutes. This would increase the benefits and revenues of this option. Increasing the line speeds to 140mph (225kph) is likely to require much greater level of investment and additional costs but would also offer time savings and benefits.

10.4.20 If the objective was solely to provide improved journey times to Crewe, the high cost option could have been worth further consideration. However, there are other strategic objectives that need to be met by the route between Handsacre and Crewe, including economic objectives.

10.4.21 This option fails to deliver the same performance and resilience benefits of the Proposed Scheme, putting further pressure on the already unreliable WCML. Although the performance of high speed services under this option would be very similar to the Proposed Scheme, the remaining conventional line residual services

[214] Official Journal of the European Union, *Directive 92/43/EEC of 21 May 1992 on the Conservation of natural habitats and of wild fauna and flora*.

operating on the slow lines are likely to be worse than under the Proposed Scheme. The reliability of residual passenger and freight services operating on the slow lines is likely to be lower than under the Proposed Scheme due to the higher utilisation of these lines. Compared to the Proposed Scheme, the option also offers less overall network resilience during periods of major disruptions or maintenance, as there are fewer alternative routes to divert services onto. The Proposed Scheme also provides more capacity than the high cost option, allowing more easily for future growth.

10.4.22 A high level assessment of the environmental impact suggests that the high cost option is likely to have a lower environmental impact than the Proposed Scheme. However, taking account of the considerations above, it has been determined that the high cost option does not meet the strategic objectives of HS2. Therefore, this option has not been taken any further.

Conclusions

10.4.23 All three of the shortlisted alternative options provide an operable alternative to Phase 2a, either as a standalone scheme or as part of the Y network. However, the Government concluded[215] that the alternative options:

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

10.4.24 As these alternatives did not meet the strategic objectives of HS2, they were not taken forward. Consequently Phase 2a emerged as the preferred scheme, which best meets the objectives of HS2.

10.5 Route corridor alternatives

10.5.1 An HS2 route corridor via Crewe was established as the proposed western leg of Phase Two in 2013, and was subject to consultation between July 2013 and January 2014. Alternatives to this, including other routes via Crewe, as well as routes via Stoke-on-Trent and to the east of Stoke-on-Trent ('the easterly corridors'), were studied during

[215] Department for Transport (DfT), (2015), *HS2 Phase 2a Strategic Outline Business Case: Strategic Case*. pP36. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570472/hs2-phase-2a-strategic-case.pdf

earlier scheme development and were consulted upon as part of the 2013/14 consultation.

10.5.2 The easterly corridors were discounted due to various sustainability, engineering and cost considerations, which are described in the Alternatives report (Volume 5: Appendix CT-002-000). Some of the key sustainability constraints included the Peak District National Park, South Pennine Moors SAC, Churnet Valley Site SSSI and other community and heritage impacts around Stoke-on-Trent and Mobberley.

10.5.3 Of the preferred corridor via Crewe, a variant that passed to the south of Pasturefields SAC and SSSI was adopted as the preferred route. This route was assessed as having a negligible risk of impact on the European designated habitat, as well as having other engineering and environmental advantages (including reduced community impacts).

10.5.4 Following consultation on the proposed route via Crewe in 2013/14, another alternative corridor via Stoke-on-Trent was studied in response to representations by Stoke-on-Trent City Council. This alternative was studied against the post-consultation refined route (which later became the preferred route) via Crewe. This concluded that the route via Crewe generally performed better in a number of aspects because it would:

- require fewer property demolitions;
- affect fewer people in terms of potential annoyance from noise;
- have less impact on cultural heritage assets (e.g. listed features and buildings);
- affect fewer areas designated for biodiversity and wildlife protection;
- affect fewer watercourses (but more groundwater resources);
- impact on fewer active and disused landfills;
- have journey time savings; and
- improve regional connectivity.

10.5.5 Further information on route corridor alternatives is provided in the Alternatives report (Volume 5: Appendix CT-002-000).

11 Local alternatives

11.1 Introduction

11.1.1 This section describes the main local alternatives that were studied during development of the Proposed Scheme prior to November 2015.

11.1.2 The main local alternatives were addressed in 2014, in response to feedback following publication of the preferred route for consultation purposes in July 2013 (the consultation route). They comprised alternatives raised during the course of consultation, and as a result of revised engineering standards and general improvements in cost and ease of construction. Local alternatives studied since November 2015 are reported in the Volume 2: Community area reports. Details on local alternatives studied both prior to and since November 2015 can be found in the Alternatives report (Volume 5: Appendix CT-002-000).

11.2 Local alternatives considered prior to November 2015

11.2.1 Most of the alternatives studied took the form of different alignments, and were intended to address the environmental impacts at specific locations. The alternatives were assessed against their cost, engineering feasibility, impact on journey time.

11.2.2 In some locations it was concluded that the alternatives proposed did not offer any net benefit and the alignment used for the consultation scheme was retained. In others the route was amended. The revised scheme formed the basis of the route that was the subject of the Government's announcement in November 2015.

11.2.3 The local route alternatives studied during this process are set out in Table 7. In each case, the issue raised by the consultation scheme is given and the design response (i.e. to amend the scheme or not) is explained. The technical reports supporting this process were published by HS2 Ltd in November 2015[216] as part of the Government's announcement. Alternatives that have been the subject of detailed design work since that time are reported in Volume 2: Community area reports and the Alternatives report (Volume 5: Appendix CT-002-000).

Table 7: Main reasonable local alternatives studied following consultation prior to November 2015 preferred route announcement

Location	Concern or proposal raised during consultation	Project response (November 2015)
Pipe Ridware	The location and height of the railway past the village of Stockwell Heath; landscape impacts around Pipe Ridware; and the location of the maintenance loops.	An option was adopted that includes provision for maintenance loops[217] and requires slightly shallower cuttings to the south of Stockwell Heath, although with similar horizontal alignment to the consultation route.
Great Haywood to Yarlet	The location of the railway past Staffordshire County Showground and through Hopton; the location and height of the railway past Marston and Yarlet; and the	This was not adopted in November 2015. None of the options studied at the time would

[216] Department for Transport (DfT), (2015), *Detailed information for Phase Two of HS2 from the West Midlands to Leeds and Manchester*. Available online at: https://www.gov.uk/government/collections/hs2-phase-two-from-the-west-midlands-to-leeds-and-manchester#department-for-transport-phase-2a-publications

[217] Following further design these maintenance loops are no longer required.

Location	Concern or proposal raised during consultation	Project response (November 2015)
	impacts to Great Haywood Marina, Ingestre Conservation Area and other scattered settlements.	deliver sufficient sustainability benefits to outweigh the additional anticipated costs.
Hopton	The clearance of the existing alignment over the Kingston Brook south of Hopton; and the landscaping and mitigation associated with the green tunnel at Hopton.	A route slightly higher than the consultation route was adopted. This replaces the green tunnel with a 5m-high landscaped retaining wall. This option provides the most viable solution to the Kingston Brook watercourse crossing, with the 5m high retaining wall providing a comparable level of noise and visual mitigation associated with the green tunnel.
M6 crossing and Swynnerton	The height of the route over the M6 and past the village of Swynnerton (Conservation Area) and potential impact on Swynnerton boreholes adjacent to the M6.	The consultation route was retained as the preferred option. Other alternatives studied would have increased impacts on the local environment and would have incurred additional cost without resolving the concerns highlighted following consultation.
Whitmore Heath	The tunnel portal locations and the impacts of the route on Whitmore Wood ancient woodland.	The length of cut-and-cover tunnel was reduced in the design. The length was reduced by 150m south of Whitmore Heath approaching the bored tunnel. This was on the basis of the reduced environmental impact through Whitmore Wood (narrower footprint, including a partially retained cut on the northern side of the route) and slightly reduced noise and visual impacts as a result of an additional section of cut-and-cover tunnel to the south of Whitmore Heath.
Madeley tunnel	Location of the southern tunnel portal and the proposed realignment of the A525 Bar Hill Road at Madeley; and impacts on properties, Barhill Wood Ancient Woodland and highways at Bar Hill.	Options to extend the tunnel to the south of the A525 Bar Hill Road were not adopted in November 2015. The land required for the consultation route at Bar Hill was amended to avoid direct impact on Barhill Wood Ancient Woodland.
Crewe junction	The height of the viaducts at Chorlton; and the layout of the junction to the south of Crewe and interaction with the proposed IMB-R.	An option was adopted that would follow a similar alignment to the consultation route but which would stagger the connections with the WCML, thereby reducing the maximum height of the railway.

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