

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 1: Introduction and methodology

HS2

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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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Contents

Preface	8
The Environmental Statement	8
Consultation on the Environmental Statement	8
Non-technical summary	9
Glossary, abbreviations and references	9
Volume 1: Introduction and methodology	9
Volume 2: Community Area reports and map books	10
Volume 3: Route-wide effects	11
Volume 4: Off-route effects	11
Volume 5: Appendices and map books	11
Background information and data	11
1 Introduction	14
1.1 Overview of High Speed Two	14
1.2 Hybrid Bill procedure	19
1.3 The need for EIA and the role of an ES	22
1.4 Meeting environmental commitments after consent	25
1.5 HS2 and sustainability	26
1.6 The acquisition and use of land	31
2 Background to High Speed Two	32
2.1 The need for high speed rail	32
2.2 Evolution of High Speed Two Phase 2b	32
2.3 The case for 2b Western Leg – transformation of the north – enhancing capacity and connectivity	36
2.4 Managing local impacts and effects	45
3 Stakeholder engagement and consultation	46
3.1 Background	46
3.2 Key stages and mechanisms for engaging with stakeholders	46
3.3 Engagement and consultation with stakeholder groups	52
3.4 Further engagement and consultation	54
4 The Proposed Scheme	56
4.1 Introduction	56
4.2 Description of the Proposed Scheme	56

4.3	Services and operating characteristics	62
5	Permanent features of the Proposed Scheme	69
5.1	Overview	69
5.2	Environmental Design	69
5.3	Rail corridor	71
5.4	Cuttings and embankments	72
5.5	Drainage and watercourse realignments	75
5.6	Highways (roads) and public rights of way	78
5.7	Tunnels	79
5.8	Portals	81
5.9	Ventilation and intervention (vent) shafts	82
5.10	Cross passages	84
5.11	Bridges	84
5.12	Viaducts	86
5.13	Stations	88
5.14	Maintenance facilities for HS2 operational infrastructure	89
5.15	Maintenance of HS2 trains	90
5.16	Noise barriers	91
5.17	Site restoration and landscape treatment	93
5.18	Track	96
5.19	Power supply	96
5.20	Train control and telecommunications	98
6	Construction of the Proposed Scheme	100
6.1	Introduction	100
6.2	Construction land requirements	100
6.3	Environmental controls during construction	101
6.4	Advance works	113
6.5	Overview of the main construction works	116
6.6	Site establishment and temporary fencing/hoardings	118
6.7	Construction compounds	118
6.8	Site clearance, advance works and site mobilisation	120
6.9	Utility diversions	121
6.10	Cuttings and embankments	124
6.11	Sourcing acceptable engineering material	127

Environmental Statement

Volume 1

6.12	Drainage and watercourse realignment and diversion	130
6.13	Highways (roads) and public rights of way	131
6.14	Site haul routes	132
6.15	Piling	133
6.16	Tunnels	136
6.17	Portals	141
6.18	Ventilation and intervention (vent) shafts	142
6.19	Cross passages	142
6.20	Viaducts	143
6.21	Bridges	146
6.22	Stations	150
6.23	Temporary railhead and construction sidings	150
6.24	Infrastructure maintenance bases	150
6.25	Rolling stock maintenance and stabling facilities	151
6.26	Noise barriers and bunds	151
6.27	Site restoration and landscape treatment	151
6.28	Track	152
6.29	Power supply	153
6.30	Water supply	153
6.31	Train control and telecommunications	154
6.32	Interfaces with the conventional rail network during construction	154
6.33	System testing and commissioning	155
7	Environmental impact assessment	157
7.1	Overview	157
7.2	Scope of the assessment	160
7.3	Impacts and effects	162
7.4	Cumulative effects	163
7.5	Over-site development	165
7.6	Assumptions and limitations	165
8	Scope and methodology summary for environmental topics	166
8.1	Introduction	166
8.2	Agriculture, forestry and soils	166
8.3	Air quality	168
8.4	Climate change	170

8.5	Community	175
8.6	Ecology and biodiversity	177
8.7	Electromagnetic Interference	180
8.8	Health	181
8.9	Historic environment	183
8.10	Land quality	186
8.11	Landscape and visual	188
8.12	Major accidents and disasters	192
8.13	Socio-economics	194
8.14	Sound, noise and vibration	197
8.15	Traffic and transport	205
8.16	Waste and material resources	209
8.17	Water resources and flood risk	211
9	Approach to mitigation and monitoring	216
9.1	Overview	216
9.2	Agriculture, forestry and soils	218
9.3	Air quality	220
9.4	Climate change	221
9.5	Community	224
9.6	Ecology and biodiversity	225
9.7	Electromagnetic interference	227
9.8	Health	228
9.9	Historic environment	228
9.10	Land quality	230
9.11	Landscape and visual	232
9.12	Major accidents and disasters	234
9.13	Socio-economics	235
9.14	Sound, noise and vibration	236
9.15	Traffic and transport	240
9.16	Waste and material resources	244
9.17	Water resources and flood risk	245
10	Strategic, route-wide and route corridor alternatives	248
10.1	Introduction	248
10.2	Strategic alternatives to the high speed rail previously studied	249

10.3 Strategic alternatives to Phase 2b	250
10.4 Route-wide rail alternatives	251
10.5 Route corridor alternatives	257
11 Local and regional alternatives Crewe - Manchester	260
11.1 Introduction	260
11.2 Route development – refinement of the 2013 proposed scheme for consultation	260
11.3 Local alternatives considered post 2013/2014 consultation	261
11.4 Local alternatives considered in 2015/2016	264
11.5 Local alternatives considered post 2016/2017 consultation	265

Tables

Table 1: Main milestones in the development of Phase 2b Western Leg	32
Table 2: Touchpoints where the Proposed Scheme interacts with Northern Powerhouse Rail	44
Table 3: Key engagement and consultation activity to-date for HS2 Phase 2b	47
Table 4: Fastest standard journey times between key destinations ‘without’ and ‘with’ HS2 in operation. For journeys to destinations that are not on the core HS2 network, a change on to the conventional rail network will be required	63
Table 5: Construction interfaces with the existing conventional rail network	154
Table 6: Main reasonable local alternatives considered post 2013/2014 consultation for the Phase 2b Western Leg prior to July 2017 preferred route announcement	262
Table 7: Main reasonable local alternatives considered in 2015/2016 for the Phase 2b Western Leg prior to the July 2017 preferred route announcement	264
Table 8: Main reasonable local alternatives considered post 2016/2017 public consultation for the Phase 2b Western Leg	265

Figures

Figure 1: Structure of the Environmental Statement	12
Figure 2: The HS2 Network and Crewe Northern Connection	18
Figure 3: Hybrid Bill procedure	20
Figure 4: Interfaces of the Proposed Scheme with Northern Powerhouse Rail	43
Figure 5: The Proposed Scheme	59

Environmental Statement

Volume 1

Figure 6: Phase One, Phase 2a and the Proposed Scheme (with growth) – peak hour one-way train flow	66
Figure 7: Indicative two-track rail corridor	72
Figure 8: Illustration of a generic cutting and cross-section of cutting	73
Figure 9: Illustration of a generic embankment and environmental mitigation earthworks and cross-section of embankment	74
Figure 10: Illustration of generic retaining walls	74
Figure 11: Cross-section of generic twin-bore tunnel	80
Figure 12: Cross-section of a generic cut-and-cover tunnel or box structure	81
Figure 13: Illustration of a cut-and-cover tunnel portal in a non-urban location	82
Figure 14: Illustration of a generic ventilation shaft and headhouse in an urban location	83
Figure 15: Illustration of a generic ventilation shaft and headhouse in a non-urban location	83
Figure 16: Illustration of a generic single-span bridge	85
Figure 17: Illustration of a generic pedestrian underbridge	86
Figure 18: Illustration of a generic high viaduct	87
Figure 19: Illustration of a generic low viaduct	88
Figure 20: Photograph of a noise fence barrier	92
Figure 21: Cross section of a generic viaduct including parapet noise fence barrier	93
Figure 22: Landscape design solutions	95
Figure 23: Diagram showing the indicative process of supplying power to the trains	98
Figure 24: Stages of main construction activities	117
Figure 25: Simplified sequence of works for the temporary diversion of an overhead power line	122
Figure 26: Illustration of a generic construction sequence for a cutting	125
Figure 27: Illustration of a generic construction sequence for an embankment	126
Figure 28: Indicative material composition of a HS2 zoned embankment	126
Figure 29: General borrow pit excavation and backfilling process	129
Figure 30: Photograph of an example of a piling rig	135
Figure 31: Photograph of a generic tunnel boring machine	136
Figure 32: Cross-section of a slurry shield tunnel boring machine and earth pressure balance machine	137
Figure 33: Cut-and-cover / box structure construction method - option one	140
Figure 34: Cut-and-cover / box structure construction method – option two	141
Figure 35: Generic sequence for constructing a beam and deck viaduct	145
Figure 36: Generic sequence for constructing an overbridge	148
Figure 37: Generic sequence for constructing an underbridge	149

Environmental Statement
Volume 1

Figure 38: Environmental impact assessment process for the Proposed Scheme	157
Figure 39: Peak hourly train flow assumptions for the operational sound, noise and vibration assessment	203
Figure 40: Hierarchy of alternatives considered	249

Preface

The Environmental Statement

This document is Volume 1 of the Environmental Statement (ES) that accompanies the deposit of the hybrid Bill for the High Speed (Crewe – Manchester) Bill (hereafter referred to as the Bill), for the Phase 2b Western Leg. This comprises the section of the proposed High Speed 2 (HS2) rail network from Crewe to Manchester, with connections onto the West Coast Main Line (WCML). In addition, a number of works are required beyond the route, such as to the existing conventional rail network, to enable the operation of the Phase 2b Western Leg. Provision is also made for future Northern Powerhouse Rail (NPR) services to connect with HS2. Collectively, this is referred to in this ES as the ‘Proposed Scheme’. The ES describes the Proposed Scheme and reports its likely significant environmental effects and the measures proposed to mitigate those effects.

The hybrid Bill for Phase One of the HS2 network, between London and the West Midlands, was the subject of an ES deposited in November 2013. The Phase One hybrid Bill received Royal Assent in February 2017. The main works commencing in April 2020.

The hybrid Bill for Phase 2a of the HS2 network, between the West Midlands and Crewe, was the subject of an ES deposited in July 2017. The Phase 2a Bill received Royal Assent in February 2021.

Consultation on the Environmental Statement

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

Structure of the Environmental Statement

This report is part of the suite of documents that make up the ES for 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 comprises the following documents:

Non-technical summary

This provides a summary in non-technical language of the following:

- the Proposed Scheme and the reasonable alternatives studied;
- engagement and consultation carried out with respect to the Proposed Scheme;
- the likely significant beneficial and adverse effects of the Proposed Scheme;
- the means to avoid, reduce or mitigate likely significant adverse 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, abbreviations and references

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

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 used for the environmental topic assessments;
- 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 Government's announcement of the preferred route in July 2017). Local alternatives studied post July 2017 are reported in the Alternatives report (Volume 5: Appendix CT-003-00000).

Volume 2: Community Area reports and map books

These cover the following community areas:

- MA01 Hough to Walley's Green;
- MA02 Wimboldsley to Lostock Gralam;
- MA03 Pickmere to Agden and Hulseheath;
- MA04 Broomedge to Glazebrook;
- MA05 Risley to Bamfurlong;
- MA06 Hulseheath to Manchester Airport;
- MA07 Davenport Green to Ardwick; and
- MA08 Manchester Piccadilly Station.

The reports provide the following information for each area:

- an overview of the area;
- a description of the construction and operation of the Proposed Scheme within the area;
- a description of the environmental baseline;
- a description of the likely significant beneficial and adverse effects of the Proposed Scheme;
- the proposed means of avoiding, reducing or managing the likely significant adverse effects; and
- the proposals for monitoring during construction and operation.

The maps relevant to each community area are provided in a separate Volume 2, Community Area map book. These maps should be read in conjunction with the relevant Community Area report. These maps show the existing environment (Map Series CT-10), proposed construction (Map Series CT-05) and operational stages (Map Series CT-06) of the Proposed Scheme.

There are also specific maps showing viewpoint and photomontage (i.e. multiple photos stitched together to give one seamless image) locations (Map Series LV-03, and LV-04. These should be read in conjunction with Section 11, Landscape and visual of Volume 2, Community Area reports). There are also maps showing the operational noise and vibration impacts and likely significant effects (Map Series SV-05). These should be read in conjunction with Section 13, Sound, noise and vibration of Volume 2, Community Area reports.

Volume 3: Route-wide effects

This describes the likely significant environmental effects at a geographical scale greater than the community areas described in Volume 2, Community Area reports.

Volume 4: Off-route effects

This provides an assessment of the likely significant environmental effects of the Proposed Scheme at locations beyond the Phase 2b Western Leg route corridor and its associated local environment. The maps relevant to the assessment of off-route effects are provided in a separate Volume 4, Off-route effects 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.

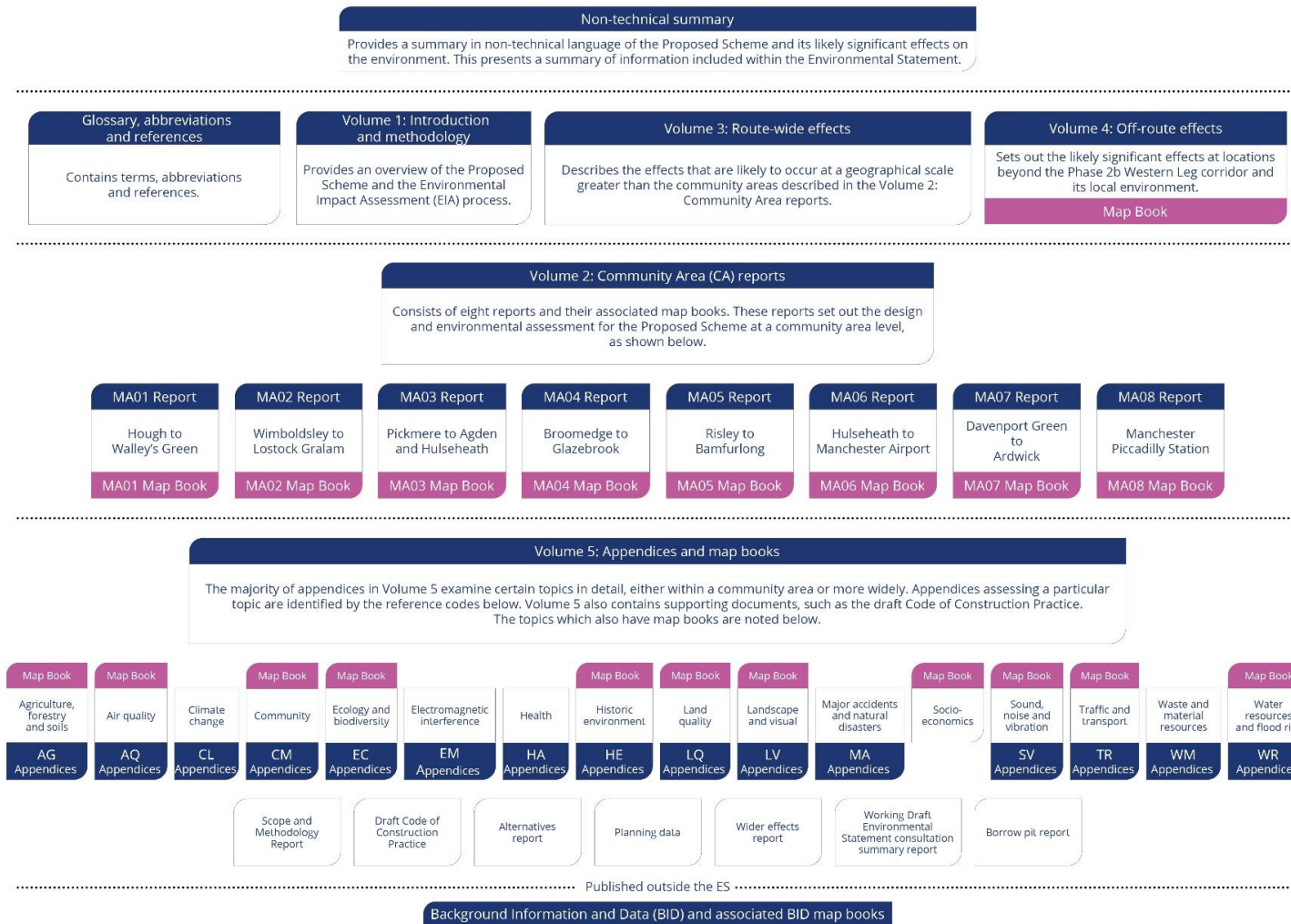
Background information and data

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 and are referenced at various places within the ES.

Environmental Statement

Volume 1

Figure 1: Structure of the Environmental Statement



Structure of this report

Volume 1, this report, comprises the following sections:

- Section 1: Introduction - introduces the Proposed Scheme, the hybrid Bill procedure and the EIA process;
- Section 2: Background to HS2 - explains how the Government's case for the Proposed Scheme has evolved;
- Section 3: Stakeholder engagement and consultation - describes the approach to consultation and engagement in relation to the design and assessment of the Proposed Scheme and the process going forward;
- Section 4: The Proposed Scheme - provides a summary of the Proposed Scheme, the proposed train 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 for environmental topics - provides an outline of the approach adopted for each environmental topic;
- Section 9: Approach to 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 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 the announcement of the full Phase 2b preferred route in July 2017. Reasonable local alternatives studied after July 2017 are reported in the Alternatives report (Volume 5: Appendix CT-003-00000).

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. It will transform intercity and long distance passenger rail travel in the UK, providing the first major increase in intercity rail capacity for over a century and freeing up substantial capacity for rail travel and freight on the conventional rail network. London, Birmingham, Manchester and cities in the Midlands, the North and Scotland will be served by high speed trains running at speeds of up to 360 kilometres per hour (kph) (225 miles per hour (mph)) on HS2 lines and on the existing conventional rail network. As part of the Proposed Scheme, new stations will be built at Manchester Piccadilly and Manchester Airport in addition to the stations in London and the West Midlands included in HS2 Phase One.
- 1.1.2 In January 2012, following a consultation exercise, the Government announced its intention to develop a Y-shaped high speed rail network, which would be brought forward in two 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 with main works commencing in April 2020. Phase One will have a staged opening between 2029 and 2033.
- 1.1.3 In January 2013, the Government announced its initial preferred route for Phase Two between the West Midlands, Leeds and Manchester. Following some minor amendments, the proposed route was subject to a seven-month public consultation from July 2013 until January 2014.
- 1.1.4 In two reports, HS2 Plus¹ and Rebalancing Britain², the then HS2 Ltd Chairman, 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 and the north of England and Scotland sooner. In the November 2015 Command Paper High Speed Two: East and West: The next steps to Crewe and beyond³, the Government announced its

¹ High Speed Two (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](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf).

² High Speed Two (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](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 (2015), *High Speed Two: East and West: The next steps to Crewe and beyond*. Cm 9157. November 2015. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf.

intention to bring forward the route between the West Midlands and Crewe, and set out the preferred line of route for what is known as Phase 2a. Phase 2a comprises the section of the route between the West Midlands and Crewe. The High Speed Rail (West Midlands – Crewe) Bill, together with an ES, was prepared for the Phase 2a proposals and deposited in Parliament in July 2017. The High Speed Rail (West Midlands – Crewe) Bill received Royal Assent in February 2021.

- 1.1.5 On 15 November 2016 the Government set out the majority of its preferred route⁴ between Crewe and Manchester and between the West Midlands and Leeds, referred to as the full Phase 2b scheme and to complete what was referred to as the ‘Y network’. Alongside the preferred route of the full Phase 2b scheme, the Government also announced a consultation on seven route refinement areas.
- 1.1.6 On 17 July 2017, the Government announced a decision on these refinements and confirmed the remainder of the preferred route for the full Phase 2b scheme. The full Phase 2b scheme announced comprised the route from:
- Crewe to Manchester (approximately 85km (52 miles) in length), with a connection onto the WCML (referred to as the ‘Phase 2b Western Leg’); and
 - the West Midlands to Leeds via the East Midlands and South Yorkshire (referred to as the ‘Phase 2b Eastern Leg’). The Phase 2b Eastern Leg is not the subject of this Bill and this ES.
- 1.1.7 On 11 October 2018, HS2 Ltd launched two parallel consultations on the working draft ES and the working draft Equality Impact Assessment (EQIA) Report for the full Phase 2b scheme (including both Eastern Leg and Western Leg).
- 1.1.8 On 6 June 2019, the Government launched a national consultation on 11 proposed design refinements to the full Phase 2b scheme. These refinements included proposed infrastructure for HS2 to accommodate future potential NPR services.
- 1.1.9 In August 2019, the Government announced that Douglas Oakervee would chair an independent review of HS2, referred to as the ‘Oakervee Review’. The review was asked to assemble and test all the existing evidence in order to allow the Government to make properly informed decisions on the future of all phases of the HS2 project.
- 1.1.10 The Oakervee Review, published on 11 February 2020⁵, concluded that the HS2 project should proceed, based on a number of recommendations. These included the need for Phase 2b to be considered as part of an Integrated Rail Plan (IRP) for the North and Midlands and for the full Phase 2b scheme to be split into smaller sections.

⁴ Department for Transport (2016), *High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond. Moving Britain Ahead*. Cm 9355, November 2016. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568208/high-speed-two-crewe-manchester-west-midlands-leeds-web-version.pdf.

⁵ Oakervee, D. (2020), *Oakervee review of HS2*. February 2020. Available online at: <https://www.gov.uk/government/publications/oakervee-review-of-hs2>.

- 1.1.11 In February 2020 the Government recommitted to providing better rail connectivity between London, the Midlands and the North, ensuring all parts of the country benefit from opportunities for economic development and prosperity. The Government committed to preparing an IRP (including consideration of the Eastern and Western Legs), informed by a 'Rail Needs Assessment' undertaken by the National Infrastructure Commission (NIC).
- 1.1.12 At that time the Government also announced⁶ its decision to proceed with the legislation to allow for the development of the Phase 2b Western Leg (the Proposed Scheme) separately and that, subject to the IRP, the full Phase 2b scheme could be legislated for in two or more hybrid Bills. This ensured work on the HS2 project continued whilst the IRP was being developed, to minimise delay. Figure 2 shows the HS2 network and the Crewe Northern Connection.
- 1.1.13 The IRP was published in late 2021⁷. In terms of the Proposed Scheme, the IRP confirmed that the HS2 Crewe – Manchester hybrid Bill should proceed to deposit in Parliament. The outcomes will be taken into account in the on-going development of the Proposed Scheme.
- 1.1.14 The Proposed Scheme comprises:
- the HS2 Western Leg from Crewe to Manchester, including:
 - new stations at Manchester Airport and Manchester Piccadilly;
 - a depot north of Crewe;
 - maintenance facilities north of Crewe and at Ashley; and
 - a connection onto the WCML near Bamfurlong;
 - the Crewe Northern Connection, connecting the route of the Proposed Scheme with the WCML and enabling future NPR services to connect with HS2;
 - provision for the NPR London to Liverpool, Manchester to Liverpool, and Manchester to Leeds junctions, to enable these future NPR routes to connect with HS2; and
 - a number of works at locations beyond the Western Leg route corridor, referred to as 'off-route works' which include:
 - works to enable HS2 trains to call at existing stations further north on the WCML; and
 - construction of depots to provide overnight stabling for HS2 trains serving the north of England and Scotland.
- 1.1.15 On 7 October 2020, the Government provided a Western Leg route-wide update and launched a national consultation on four further proposed design refinements that were

⁶ Department for Transport (2020), *Terms of reference for an integrated rail plan for the north and midlands*. Available online at: <https://www.gov.uk/government/publications/high-speed-north-an-integrated-rail-plan-for-the-north-and-midlands-terms-of-reference/terms-of-reference-for-an-integrated-rail-plan-for-the-north-and-midlands>.

⁷ Department for Transport (2021), *Integrated Rail Plan for the North and Midlands*. Available online at: [Integrated Rail Plan for the North and Midlands - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/publications/integrated-rail-plan-for-the-north-and-midlands/integrated-rail-plan-for-the-north-and-midlands).

relevant to the Phase 2b Western Leg. This included changes to allow the HS2 route to be used by future NPR trains to link cities across the North of England.

- 1.1.16 The NIC published the Rail Needs Assessment for the Midlands and the North in December 2020⁸. The NIC developed a menu of options for a programme of rail investments in the Midlands and the North, using three different illustrative budget options: focussing on upgrades (baseline budget only); prioritising regional rail links; and prioritising long distance links. The Proposed Scheme was included in the scope of all options.
- 1.1.17 In June 2021 HS2 Ltd published a route wide update⁹ of the Proposed Scheme and included the latest design proposals.
- 1.1.18 As announced by Government, the powers for the Proposed Scheme, are being sought through a hybrid Bill named the High Speed Rail (Crewe - Manchester) Bill, with the aim of receiving Royal Assent at the end of 2024, construction assumed to commence in 2025, and operation assumed to start in 2038.

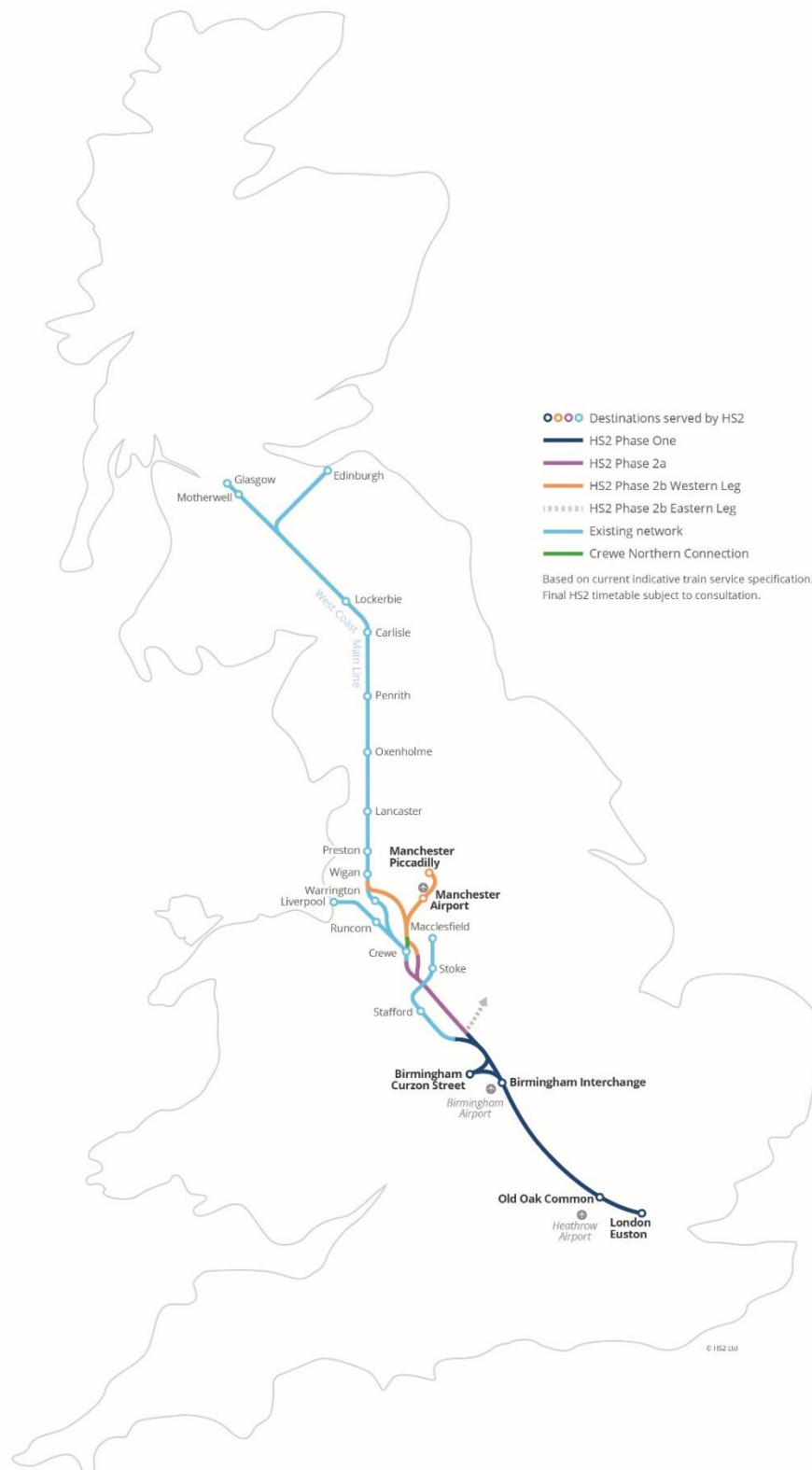
⁸ National Infrastructure Commission December (2020), *Rail Needs Assessment for Midlands and the North: Final Report*. Available online at: [RNA-Final-Report-15122020.pdf \(nic.org.uk\)](https://www.nic.org.uk/publications/rail-needs-assessment-for-midlands-and-the-north-final-report).

⁹ HS2 route wide update (2021). Available online at: <https://www.hs2.org.uk/what-is-hs2/phase-2b/>.

Environmental Statement

Volume 1

Figure 2: The HS2 Network and Crewe Northern Connection



1.2 Hybrid Bill procedure

- 1.2.1 The Government uses hybrid Bills to promote the largest infrastructure projects of national importance. They have been used most recently for Phase 2a¹⁰ and Phase One¹¹ of HS2 and for other rail schemes, such as through the Channel Tunnel Rail Link Act 1996¹² (known as High Speed 1) and the Crossrail Act 2008¹³. Use of primary legislation rather than promoting a development consent order under the Planning Act 2008¹⁴ 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.

¹⁰ *The High Speed Rail (West Midlands – Crewe) Bill*, as introduced to the House of Commons Select Committee, March 2016. Available online at: https://publications.parliament.uk/pa/bills/cbill/2017-2019/0006/cbill_2017-20190006_en_1.htm.

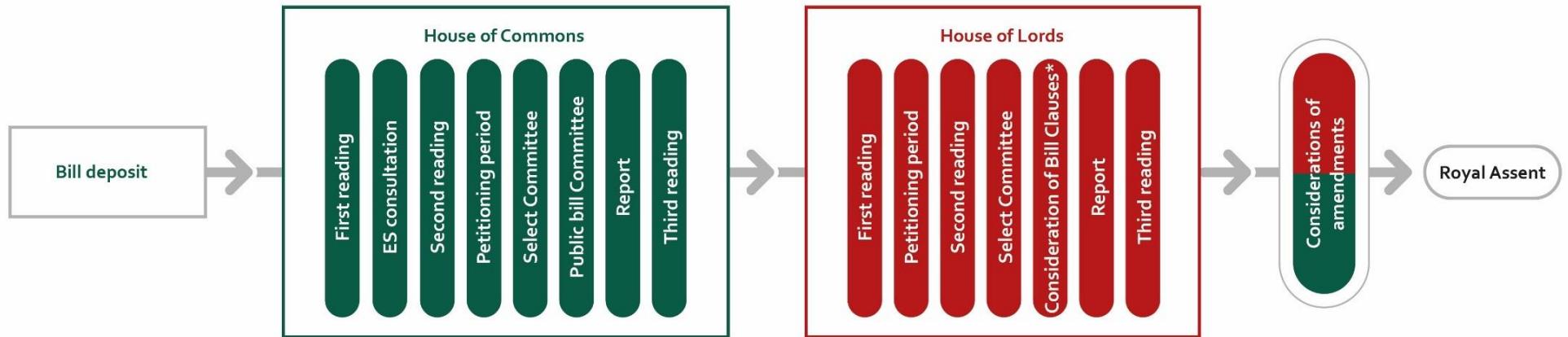
¹¹ *The High Speed Rail (London – West Midlands) Bill* as amended in the House of Commons Select Committee, March 2016. Available online at: http://www.publications.parliament.uk/pa/bills/cbill/2015-2016/0137/cbill_2015-20160137_en_1.htm.

¹² *Channel Tunnel Rail Link Act 1996*. Her Majesty's Stationery Office, London.

¹³ *Crossrail Act 2008*. Her Majesty's Stationery Office, London. Available online at: <https://www.legislation.gov.uk/ukpga/2008/18/contents>.

¹⁴ *Planning Act 2008 (c.29)*. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/ukpga/2008/29/pdfs/ukpga_20080029_en.pdf.

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 for the Proposed Scheme, 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 people and the environment together with a report on the reasonable alternatives studied (which also forms part of the ES).
- 1.2.4 In accordance with Parliamentary Standing Orders following First Reading of the Bill and the deposit of the hybrid Bill and supporting documents, Parliament will undertake a public consultation on the ES. This formal consultation will be held over a period of at least 56 days (eight weeks). Parliamentary officials will appoint an independent assessor. The Secretary of State, as promoter of the Bill, is required to publish any comments made in response to the consultation and to submit them to the independent assessor. The independent assessor will be responsible for submitting a report to Parliament summarising issues raised by stakeholders in response to the consultation before Second Reading of 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 appointed¹⁵ 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. The petitioning period will be determined during the Second Reading. 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. Local authorities situated along the route of the Proposed Scheme will also be able to petition on behalf of their communities as will Members of Parliament on behalf of their constituents. 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 Commons¹⁶. These petitions are then considered by the Select Committee, which may result in amendments to the Bill and can require the Government to change its plans, either by amendments to the Bill or changes to the commitments made by HS2 Ltd.

¹⁵ In the House of Commons, Select Committee members are Members of Parliament who have no constituency interest in the Bill.

¹⁶ More information on who may petition against the Bill, and how to do so, is available on Parliament's website <http://www.parliament.uk>.

- 1.2.7 A Public Bill Committee of MPs then reviews the Public aspects of the Bill, and may make amendments to it. The Bill then progresses to Report and Third Reading stages in the House of Commons, during 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 Parliament¹⁷. Upon enactment, the Act of Parliament will grant deemed planning permission for the works as defined within the Act.
- 1.2.10 The powers within the Bill for the Proposed Scheme will include:
- authority to nominate an undertaker to construct, operate and maintain the railway and associated works as described in the Act (and its accompanying plans and sections) and other ancillary works;
 - powers of compulsory acquisition or temporary possession of land and properties required for the Proposed Scheme;
 - powers to divert or protect gas, water, telecommunications and electricity infrastructure, which might be affected by the Proposed Scheme;
 - powers over rights of way, public highways and waterways;
 - powers to carry out works to listed buildings and buildings in conservation areas; and
 - powers to carry out protective works to buildings and third party infrastructure.
- 1.2.11 The Parliamentary Plans and Sections accompanying the Bill show, amongst other things, the land required, both permanently and temporarily, the 'limits of deviation' (used to show the limits of the scheduled works, as listed in Schedule 1 of the Bill) and 'limits of land to be acquired or used' (used to show additional limits for other works (e.g. construction compounds and ancillary works such as the provision of environmental mitigation))¹⁸ for the construction of the Proposed Scheme, as described in Section 1.3 of this report.

1.3 The need for EIA and the role of an ES

- 1.3.1 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

¹⁷ Parliamentary procedure is determined by Parliament and so is liable to change.

¹⁸ 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).

Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017/571) (the English EIA Regulations) which apply to assessment of the effects of certain public and private projects on the environment.

- 1.3.2 The English EIA Regulations were developed in accordance with European Union (EU) EIA Directive (2014/52/EU)¹⁹, and provide for the assessment of the environmental impacts of public and private projects. The objective of the legislation is to identify and assess the likely significant environmental effects of a project, in order to inform the decision maker as part of the development consent process.
- 1.3.3 For those off-route works falling within Scotland, as there is no substantive difference between the English EIA Regulations and the Town and Country Planning (EIA) (Scotland) Regulations 2017 and since Standing Orders refers to the English EIA Regulations, the 2017 English EIA Regulations will be followed. However, relevant Scottish legislation, policy and guidance and any relevant data provided by Scottish government, local authorities and statutory bodies will be applied to the assessment of works in Scotland and the ES will adopt the relevant terminology (e.g. for listed buildings Category A, B, C; for agricultural land – Prime quality classes etc.).
- 1.3.4 The UK has now left the EU following the end of the transition period on 31 December 2020. The European Union (Withdrawal) Act 2018 converts the body of existing EU law into domestic law and preserves the laws made in the UK to implement EU obligations. This body of retained EU law includes the English EIA Regulations and other relevant domestic environmental legislation, such as the Conservation of Habitats and Species Regulations 2017 (SI 2017/1012) and the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (SI 2017/407) (as amended).
- 1.3.5 This ES may refer to the original EU Directive or to the relevant domestic Regulations and it is to be taken as a reference to the relevant retained EU law in each case.
- 1.3.6 Standing Order 27A^{20,21} requires that the ES should include:
- information set out in regulation 18(3)(a) to (e) and 18(4)(b) of the EIA Regulations;
 - any additional information specified in Schedule 4 to the EIA Regulations which is relevant to the specific characteristics of the works authorised by the Bill and to the environmental features likely to be significantly affected; and

¹⁹ European Commission (2014), *Amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment* (Text with EEA relevance), EC Directive 2014/52/EU. Available online at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex>.

²⁰ House of Commons (2019), *Standing Order 27A relating to private business (environmental assessment)*, House of Commons. Available online at: <https://www.parliament.uk/business/publications/commons/sessional-orders-private1/>.

²¹ House of Lords (2018), *Standing Orders - private Business*, House of Lord. Available online at: <https://www.parliament.uk/documents/publications-records/House-of-Lords-Publications/Standing-Orders-Private/privord02.pdf>.

- a report which identifies, describes and evaluates reasonable alternatives to the works authorised by the Bill, taking into account the objectives and geographical scope of the Bill.

1.3.7 The information required by regulation 18(3)(a) to (e) 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 envisaged in order to avoid, prevent or reduce and if possible, offset 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.

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

- the Proposed Scheme as shown in Map Series CT-06, including the mitigation measures shown therein and as described in Volume 2, Community Area reports Section 2;
- the construction arrangements, including land requirements, shown on Map Series CT-05 and described in Volume 2, Community Area reports, Section 2;
- the land required permanently for the Proposed 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 show 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);
- 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 and in Section 4.3 of this report; and
- the noise fence barriers shown on Map Series CT-06 and as described in Volume 2, Community Area reports, Section 2.

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

1.3.10 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 stations, depots or ventilation (intervention) shafts for which specific limits are shown.

- 1.3.11 Given the powers provided by the Bill to deviate within the statutory limits of deviation, Volume 5: CT-006-00000 (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 also described. Changes that are considered unlikely or impracticable from an engineering perspective 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 (EMR). The nominated undertaker and its contractors will be contractually bound to comply with the EMR 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 EMR; 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 EMR, 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 EMR 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. The 2017 English EIA Regulations makes provision for post-EIA monitoring of significant adverse effects on the environment in appropriate cases. HS2 Ltd will work with the relevant responsible authorities to develop the necessary monitoring in appropriate cases.

- 1.4.5 The EMR 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 EMR 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 and standards to which a developer or contractor must adhere in order to provide effective planning, management and control of potential impacts on individuals, communities and the environment during construction;
 - an Environmental Memorandum, which provides a framework for the nominated undertaker, its contractors and stakeholders, such as the Environment Agency and Natural England, to work together to ensure that the design and construction of the Proposed Scheme is carried out with due regard for environmental considerations;
 - a Planning Memorandum, which will set out the agreements between DfT, the nominated undertaker and the local planning authorities relating to the consideration and processing of detailed planning approvals under the provisions of the hybrid Bill, including attendance at a Planning Forum to discuss technical planning and environmental matters. The detailed planning approvals will relate to, for example, the design and appearance of stations, depots, bridges, viaducts, tunnel portals, noise barriers and earthworks;
 - a Heritage Memorandum which will set out, for the nominated undertaker, its contractors and stakeholders, such as the Historic England and local authorities, how the historic environment (including assets and their setting) will be addressed during the design and construction; and
 - undertakings and assurances given during the passage of the Bill as recorded on the Register of undertakings and assurances.

1.5 HS2 and sustainability

- 1.5.1 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 Assembly²² defined sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

- 1.5.2 The Government's commitment to sustainable development originates from the Department for Environment, Food and Rural Affairs (Defra) strategy set out in *Securing the Future*²³, 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.
- 1.5.3 This was updated and reinforced by the publication of the Government's 25 Year Environment Plan in January 2018²⁴. The Plan sets out goals for improving the environment within a generation and leaving it in a better state than it is at present. The Plan includes commitments to biodiversity net gain, woodland creation and the creation of a nature recovery network.
- 1.5.4 In June 2021 the Government announced an aim for the Proposed Scheme to deliver net gains in biodiversity. Plans are being developed to support this key policy area.
- 1.5.5 The 25 Year Environment Plan is underpinned by the Environment Act 2021. The Act makes provision for:
- the creation of binding environmental targets, plans and policies to improve the natural environment;
 - a requirement for statements and reports about environmental protection;
 - the creation of the Office for Environmental Protection; and
 - additional controls on waste and resource efficiency, air quality and water; for the protection and enhancement of nature and biodiversity including conservation covenants; and with respect to the regulation of chemicals.
- 1.5.6 The Government has had in place legally binding targets to reduce greenhouse gas emissions since 2008. In 2019 it updated the Climate Change 2008 Act and set a legally binding target of 100% reduction in carbon emissions by 2050 (i.e. net-zero carbon emissions). That Act also established a framework for the UK to achieve its long-term goals of reducing greenhouse gas emissions. The Government has published several strategies

²² UN General Assembly (1989), *Implementation of General Assembly resolutions 42/186 and 42/187: resolution/adopted by the General Assembly*. A/RES/44/227.

²³ Department for Environment, Food and Rural Affairs (2005), *Securing the future – delivering UK sustainable development strategy* (PB10589). Available online at: <https://sustainabledevelopment.un.org/content/documents/1408uk.pdf>.

²⁴ Department for Environment, Food and Rural Affairs (2018), *A Green Future: Our 25 Year Plan to Improve the Environment*. Available online at: <https://www.gov.uk/government/publications/25-year-environment-plan>.

setting out how it aims to decarbonise the economy including the power and transport sectors and industry. This is set out in more detail in Volume 3 Route-wide effects, Section 4.

- 1.5.7 The National Planning Policy Framework (NPPF)²⁵ 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 and fostering well-designed and safe built environments required to meet the needs of present and future generations; and
 - environmental: contributing to protecting and enhancing our natural, built and historic environment, including landscapes and green infrastructure, 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).
- 1.5.8 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 lives of people and communities. Equally investing in nature and the environment can support economic growth. Therefore, to achieve sustainable development, the NPPF requires economic, social and environmental gains to be sought jointly and simultaneously.
- 1.5.9 Green Infrastructure is also an important part of the NPPF and Natural England is working with Defra and other partners and stakeholders to deliver the 25 Year Environment Plan commitment to develop a National Framework of Green Infrastructure Standards.
- 1.5.10 The Government's environmental goals, the principles of the NPPF and HS2 Ltd's Sustainability Policy and Environmental Policy²⁶ have been, and continue to be, an important

²⁵ 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 were followed during the design and assessment process. At the time of assessment, the relevant version of the NPPF was Department for Communities and Local Government (2019). *National Planning Policy Framework*. Available online at: <https://www.gov.uk/government/collections/revised-national-planning-policy-framework>.

In July 2021, an updated version of the NPPF was published: Ministry of Housing, Communities and Local Government (2021). *National Planning Policy Framework*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf.

The key principles of sustainable development set out in NPPF 2019 have been retained in NPPF 2021 and therefore it is considered the NPPF 2019 remains an appropriate basis to influence the assessment and design of the Proposed Scheme for this ES.

²⁶ The assessment has been based on the 2019 versions of HS2 Ltd's Sustainability Policy and Environmental Policy. An updated version of the Environmental Policy is planned for publication imminently and will be available online at: www.hs2.org.uk/environment. The updated policy strengthens the objectives relating to green corridor and climate change whilst remaining broadly consistent with the 2019 policy.

influence on the development of the Proposed Scheme. HS2 Ltd will also publish its Environmental Sustainability Vision²⁷ imminently. This sets out HS2's ambitions for cutting carbon emissions and boosting nature recovery. An appraisal of sustainability (AoS) process has been used to appraise and report on the sustainability performance of the Phase Two (Phase 2a and 2b) proposals throughout their development.

- 1.5.11 In July 2013, the Government published the HS2 Phase Two Sustainability Statement²⁸ 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 the Phase 2b Western Leg) supported objectives for sustainable development, following the AoS. Four sustainable development priorities were used for the appraisal:
- 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.
- 1.5.12 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 for sustainable development priorities, as outlined 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 engineering practicality. This was incorporated into decision-making on the development of the route, which helped refine the number of alternative options down to a single preferred route.
- 1.5.13 Consultation on the route of Phase Two took place between July 2013 and January 2014. Question 7 of the consultation asked for feedback on the AoS of the 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 November 2016 alongside a wider response to the consultation²⁹.

²⁷ High Speed Two Ltd (planned for publication imminently), *Environmental Sustainability Vision*. Will be available online at: www.hs2.org.uk/environment.

²⁸ Temple-ERM (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.

²⁹ High Speed Two (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.

- 1.5.14 An updated Sustainability Statement³⁰ for the full Phase 2b scheme was published in November 2016. As well as outlining the majority of the preferred scheme and the associated sustainability impacts, it also summarised the key changes from the 2013 consultation route. A further consultation was also launched on several changes to the route. This consultation took place between November 2016 and March 2017, with a decision on the Government's preferred route in July 2017.
- 1.5.15 The potential significant effects identified in the 2016 Sustainability Statement have been reviewed during the EIA and assessed in the context of the Proposed Scheme.
- 1.5.16 HS2 Ltd's Sustainability Policy (2019)³¹ sets out its priority for sustainable design, which will help to reduce adverse environmental effects. The Sustainability Policy sets out the following principles:
- 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.
- 1.5.17 Each of the Sustainability Policy principles is further described in the HS2 Sustainability Approach Document (2017)³².
- 1.5.18 Supporting the Sustainability Policy is a commitment to developing an exemplar project through seeking environmental enhancements and benefits whilst limiting negative impacts through design, construction and operation of the railway. This commitment has broad objectives in five environmental sustainability topics areas: climate change; green corridor; being a good neighbour; historic environment; and responsible consumption and production.
- 1.5.19 Building on existing commitments, HS2 Ltd is working to accelerate progress towards a more environmentally sustainable railway as it builds and brings HS2 into operation. From day one HS2 will be capable of delivering carbon free journeys as a significant part of a multimodal zero carbon transport network and, working with the supply chain, is considering how to accelerate the ambition of the construction industry to realise net zero during the construction phase of the Proposed Scheme.
- 1.5.20 To contribute to nature recovery, and recognise aspirations set out in the 25 Year Environment Plan and Environment Act 2021, HS2 Ltd has committed to aiming for

³⁰ Temple-RSK (2016), *High Speed Rail: Phase 2b Preferred Route - Sustainability Statement including Post Consultation Update*. Available online at: <https://www.gov.uk/government/publications/hs2-phase-2b-sustainability-statement-2016>.

³¹ High Speed Two (HS2) Ltd (2019), *Sustainability Policy*. Available online at: <https://www.gov.uk/government/publications/hs2-sustainability-policy>.

³² High Speed Two (HS2) Ltd (2018), *HS2 Supplier Guide*. Available online at: <https://www.gov.uk/government/publications/hs2-supplier-guide>.

biodiversity net gain through working in partnership during construction and operation of the Proposed Scheme.

- 1.5.21 Further information is provided in the HS2 Phase 2b Information Paper E23: Approach to sustainability³³. HS2 Ltd's commitments in relation to sustainability and environmental performance will continue to evolve, as they do for any organisation managing these issues, in order to ensure continuous improvement. As a result, policies and objectives may be amended over time. Up to date information on developments in this area will be provided via updates to the information paper.

1.6 The acquisition and use of land

- 1.6.1 The Bill for the Proposed Scheme includes 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 HS2 Phase 2b Information Paper C8: Compensation code for compulsory purchase³⁴. 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 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.
- 1.6.3 The limits of deviation enable the Proposed Scheme to deviate slightly from the centre line of the works, shown on the Parliamentary Plans as may be required following detailed design, but the Proposed Scheme must remain within the limits 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.

³³ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E23: Approach to sustainability*.

³⁴ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper C8: Compensation code for compulsory purchase*.

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 2 of this report.

2.2 Evolution of High Speed Two Phase 2b

- 2.2.1 A summary of the development of the strategic case for a high speed rail network and for the HS2 Phase One and Phase 2a routes is contained within Volume 1 of the Phase One ES³⁵ and Phase 2a ES³⁶ respectively. The main milestones informing the development of the Proposed Scheme preceding deposit are summarised in Table 1.

Table 1: Main milestones in the development of Phase 2b Western Leg

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 ³⁷ , together with supporting documents. The Command Paper confirmed the Government's intention to develop a Y shaped 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 ³⁸ . The Secretary of State for Transport announced the Government's intention to proceed with the planning and design of Phase Two, and published the initial preferred route to Leeds and Manchester. Published alongside this was a Sustainability Summary and initial preferred route plan and profile maps. Also published was HS2 Ltd's March 2012 advice to Government that helped inform the selection of the initial preferred route. Key documents published included: ³⁹ <ul style="list-style-type: none">Options for Phase Two of the high speed rail network;

³⁵ High Speed Two Ltd (2013), *High Speed Rail (London – West Midlands), Environmental Statement*. Available online at: <https://www.gov.uk/government/collections/hs2-phase-one-environmental-statement-documents>.

³⁶ High Speed Two Ltd (2017), *High Speed Rail (West Midlands – Crewe), Environmental Statement*. Available online at: <https://www.gov.uk/government/collections/hs2-phase-2a-environmental-statement>.

³⁷ Department for Transport (2012), *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3648/hs2-decisions-and-next-steps.pdf.

³⁸ Department for Transport (2013), *High speed rail: investing in Britain's future Phase Two - The route to Leeds, Manchester and beyond*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69738/hs2-phase-two-command-paper.pdf.

³⁹ Department for Transport (2013), *HS2 Phase Two: investing in Britain's future*. 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?dm_i=BLC,18UH6,576H0Q,4813U,1.

Environmental Statement

Volume 1

Date	Activity
	<ul style="list-style-type: none"> Options for Phase Two of the high speed rail 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 HS2 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 from the West Midlands to Manchester, Leeds and beyond. Consultation documents included supporting technical information (including maps), the Sustainability Statement ²⁸ and quick reference factsheets.
October 2013	Publication of the Economic Case for HS2 and Strategic Case for HS2 in support of the Phase One Bill deposit.
November 2013	The Secretary of State for Transport announced that Sir David Higgins (the then Chairman of HS2) had been tasked with reporting on how to reduce the cost of HS2; how its benefits (such as jobs and growth) could be maximised and delivered earlier ⁴⁰ .
March 2014	Publication of HS2 Plus: A report by David Higgins, which recommended the accelerated delivery of the section of Phase Two route to Crewe ⁴¹ .
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. 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.
November 2015	In the November 2015 command paper ⁴² , the Government announced its intention to accelerate the delivery of the section of Phase Two between the West Midlands and Crewe with connections to the conventional rail network (Phase 2a).
November 2016	<p>The Secretary of State for Transport confirmed part of the Phase 2b route. A Sustainability Statement was published. As well as outlining the preferred scheme and the associated sustainability impacts, it also summarised the key changes from the July 2013 consultation route. The Secretary of State also launched a consultation on seven route refinement areas (see Section 3 of Volume 1 (this report)).</p> <p>Publication of the 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 July 2013 Phase Two consultation, regarding the AoS.</p>

⁴⁰ Department for Transport (2013), *News story: 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>.

⁴¹ High Speed Two 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](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374695/HS2_Plus_-_A_report_by_David_Higgins.pdf).

⁴² Department for Transport (2015), *High Speed Two: East and West: The next steps to Crewe and beyond. November 2015*. Cm 9157. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf.

Environmental Statement

Volume 1

Date	Activity
	Publication of the High Speed Two Phase 2b strategic outline business case, including the Strategic Case ⁴³ and Economic Case ⁴⁴ . The Strategic Case set out the Government's strategic case for Phase 2b and the Economic Case set out the economic case for completing the Y shaped network. Launch of the High Speed Rail Phase 2b Property Consultation.
July 2017	<p>The Secretary of State for Transport announced the 2017 Phase 2b preferred route to Manchester and Leeds. Publication of the updated HS2 Strategic Outline Business Case (including the Phase Two commercial case, economic case, financial case, management case and strategic case), economic case advice for the DfT, route refinement advice, Crewe to Manchester 2017 route engineering report, West Midlands to Leeds 2017 route engineering report, and plan and profile maps for the western and eastern legs⁴⁵.</p> <p>Publication of the HS2 Phase 2b Draft EIA Scope and Methodology Report (SMR)⁴⁶, Draft Equality Impact Assessment (EQIA) SMR⁴⁷, Eastern leg rolling stock depot⁴⁸ and Crewe Hub⁴⁹ documents for consultation.</p>
September 2018	The Government instructed HS2 Ltd to accommodate Northern Powerhouse Rail (NPR), including Crewe Northern Connection and Midlands Connect into the full Phase 2b scheme as part of HS2 future proofing.
October 2018	Publication of the working draft ES for HS2 Phase 2b: Crewe to Manchester and West Midlands to Leeds ⁵⁰ and the working draft EQIA ⁵¹ for consultation.

⁴³ Department for Transport (2016), *High Speed Two Phase 2b Strategic Outline Business Case: Strategic Case*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570068/hs2-phase-2b-sobc-strategic-case.pdf.

⁴⁴ Department for Transport (2016), *High Speed Two Phase 2b Strategic Outline Business Case: Economic Case*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/570845/hs2-phase-2b-sobc-economic-case.pdf.

⁴⁵ Updated information on proposals for the HS2 route from Crewe to Manchester and West Midlands to Leeds that supported the announcement of the 2017 Preferred Route to Manchester and Leeds (2b) is available online at: <https://www.gov.uk/government/collections/hs2-phase-2b-crewe-to-manchester-and-the-west-midlands-to-leeds>.

⁴⁶ High Speed Two Ltd (2017), *HS2 Phase 2b draft Environmental Impact Assessment Scope and Methodology Report*. Available online at: <https://www.gov.uk/government/consultations/hs2-phase-2b-draft-environmental-impact-assessment-scope-and-methodology-report>.

⁴⁷ High Speed Two Ltd (2017), *HS2 Phase 2b draft Equality Impact Assessment Scope and Methodology Report*. Available online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/627894/draft_eqia_smr_phase_2b.pdf.

⁴⁸ High Speed Two Ltd (2017), *Eastern leg rolling stock depot consultation*. Available online at:

<https://www.gov.uk/government/consultations/hs2-phase-2b-eastern-leg-rolling-stock-depot>.

⁴⁹ Department for Transport (2017), *Crewe Hub Consultation*. Available online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641267/crewe-hub-consultation-web-version.pdf.

⁵⁰ High Speed Two Ltd (2018), *HS2 Phase 2b working draft Environmental Statement*. Available online at: <https://www.gov.uk/government/consultations/hs2-phase-2b-working-draft-environmental-statement>.

⁵¹ High Speed Two Ltd (2018), *HS2 Phase 2b working draft Equality Impact Assessment report*. Available online at: <https://www.gov.uk/government/consultations/hs2-phase-2b-working-draft-equality-impact-assessment-report>.

Environmental Statement

Volume 1

Date	Activity
	Publication of the revised HS2 Phase 2b: Crewe to Manchester and West Midlands to Leeds EIA SMR ⁵² and EQIA SMR ⁵³ .
June 2019	Launch of the HS2 Phase 2b: Crewe to Manchester and West Midlands to Leeds Design Refinement Consultation ⁵⁴ consulting on 11 proposed design refinements to the full HS2 Phase 2b scheme.
August 2019	An independent review of HS2 chaired by Douglas Oakervee commenced to assemble and test all existing evidence to allow the Government to make a decision on the future of Phases One and Phase Two of the project. In February 2020 the review concluded that the HS2 project should proceed, based on a number of recommendations, and a Y-shaped network was the right strategic answer for the country.
February 2020	The Government committed to preparing an IRP for the North and Midlands, informed by a 'Rail Needs Assessment' undertaken by the NIC considering both the Eastern and Western Legs of the full Phase 2b scheme. The Government also announced its decision to proceed with the legislation to allow for the development of the Phase 2b Western Leg (the Proposed Scheme) separately and that the full Phase 2b scheme could be legislated for in two or more hybrid Bills. This did not prejudice any recommendations or decisions to be taken in the IRP, but ensured work on the HS2 project continued whilst the IRP was being developed, to minimise delay.
October 2020	Publication of the Design Refinement Consultation Response ⁵⁵ to the consultation launched in June 2019. Launch of a second design refinements consultation on proposed changes in four geographical locations along the Phase 2b Western Leg, together with a route-wide update on the Western Leg design proposals, including changes to the existing rail network ⁵⁶ . The consultation closed in December 2020.

⁵² High Speed Two Ltd (2018), *HS2 Phase 2b: Crewe to Manchester and West Midlands to Leeds Environmental Impact Assessment Report Scope and Methodology Report*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/745518/HS2_Phase_2b_Working_Draft_ES_EIA_Scope_and_Methodology_Report.pdf.

⁵³ High Speed Two Ltd (2018), *HS2 Phase 2b: Crewe to Manchester and West Midlands to Leeds Equality Impact Assessment Scope and Methodology Report*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/745313/HS2_Phase_2b_Working_Draft_EQIA_Scope_and_Methodology_Report.pdf.

⁵⁴ Department for Transport (2019), *High Speed Two: Phase 2b Design Refinement Consultation - Moving Britain Ahead*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/807420/hs2-phase-2b-design-refinement-web.pdf.

⁵⁵ Department for Transport (2020), *High Speed Two: Phase 2b Design Refinement Consultation Response. Moving Britain Ahead*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/924646/DRC1_Response_Western_Leg.pdf.

⁵⁶ Department for Transport (2020), *HS2 Phase 2b Western Leg Design Refinement Consultation – Moving Britain Ahead CP 288*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/927058/10961-DfT-HS2_DRC2_Response_Correction_Slip_in.pdf.

Date	Activity
June 2021	Publication of a route-wide update on the Proposed Scheme which included the latest design proposals ⁵⁷ .
November 2021	Publication of the Minister of State's response to the second design refinement consultation.
November 2021	Publication of the Integrated Rail Plan.

2.3 The case for 2b Western Leg – transformation of the north – enhancing capacity and connectivity

- 2.3.1 As noted in Section 2.1 of this report, the Government's case for a new high speed rail network has already been accepted in the High Speed Rail (London-West Midlands) Act 2017.
- 2.3.2 The key objectives of the Proposed Scheme are:
- providing sufficient capacity to meet long-term rail demand and to improve resilience and reliability on the network;
 - improving connectivity by making journeys faster and easier;
 - boost economic growth across the UK; and
 - delivering a vital contribution to the UK's environmental targets.
- 2.3.3 Whilst the response to COVID-19 caused a short term reduction in rail travel during the period of the pandemic, forecasts are for rail demand to recover and continue to grow in the longer term.

Capacity, resilience and reliability

- 2.3.4 Railways in Britain have seen an unprecedented period of growth since the mid-1990s. The 2020 Full Business Case analysis for HS2 Phase One⁵⁸ reported growth at an average of 3.7% per annum across all types of rail journeys. Long distance passenger rail travel, which underpins the market for HS2, saw even greater growth at 4.2% per annum.
- 2.3.5 After the last WCML upgrade was completed between 1998 and 2008, it saw a period of extraordinary growth that continued every year to 2019 – despite the economic downturn from 2008. In total, passenger journeys on the WCML nearly tripled, growing from 13.2m in

⁵⁷ High Speed Two (Ltd), *Phase 2b: Crewe to Manchester, West Midlands to Leeds. Route wide Update 2021*. Available online at: <https://www.hs2.org.uk/what-is-hs2/phase-2b/>.

⁵⁸ Department for Transport (2020), *Full Business Case High Speed 2 Phase One Moving Britain Ahead*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/939905/full-business-case-hs2-phase-one.pdf.

1996/97 to 39.5m in 2018/19; this represents growth of 199% compared to 119% on the wider rail network.

- 2.3.6 Manchester Piccadilly is the busiest railway station in the North of England, and the London to Manchester route is one of the most valuable long-distance markets in the UK. Growth on the key corridors served by the Proposed Scheme has been consistently strong, outstripping industry forecasts.
- 2.3.7 This has created significant pressure on the outdated Victorian railway infrastructure with the network operating, in many places, at its limits. Consequently, punctuality and reliability may be well below the level passengers expect. The Proposed Scheme will provide capacity relief for a key constrained section of the WCML north of Crewe.
- 2.3.8 The WCML is one of the busiest mixed-use railways in Europe, with passenger and freight, fast and slow services sharing the same lines, slowing all traffic and causing congestion. Constructing new lines to remove fast services allows for more frequent, faster and reliable services on dedicated lines. This simultaneously releases capacity on existing lines for commuter, semi-fast services and freight. Constructing new lines can unlock demand and boost growth through new and faster connectivity. The combination of new and released capacity also provides the opportunity to deliver growth through the provision of new and/or different local services.
- 2.3.9 Though the UK has pioneered many types of infrastructure from railways to mobile telecommunications, the quality of UK transport infrastructure has been rated as second lowest among G7 countries, and business highlights it as a key issue. A survey in 2015 by the Confederation of British Industry⁵⁹ found that 90% of businesses were concerned that trains were full.
- 2.3.10 The Proposed Scheme offers the potential for more commuter services to run on some of the key routes into and out of Manchester. The combination of new HS2 services alongside changes to conventional rail services has the potential to more than double evening peak seats on conventional rail services from Manchester Piccadilly on the Stoke and Crewe corridors.

Improve connectivity by making journeys faster and easier

- 2.3.11 Poor rail connectivity, limited infrastructure capacity, passenger crowding and reliability challenges are factors contributing to the North and Midlands having more isolated labour markets and less economic interaction. The practical effect is that fewer passengers make journeys by rail between population centres in the North of England than in the South East,

⁵⁹ Confederation of British Industry (2015), *Turning momentum into delivery – CBI/Aecom Infrastructure Survey 2015*. Available online at: http://www.infrastructure-intelligence.com/sites/default/files/article_uploads/Infrastructure%20survey%202015%20report_FINAL.pdf.

restricting access to labour supply for businesses and fewer businesses trading with each other.

- 2.3.12 In addition, UK productivity lags international competitors (e.g. c.20% below the USA and 13% below France), and few cities outside of London have a higher rate of productivity than the national average.
- 2.3.13 This stands in contrast to countries such as France and Germany where most of the biggest cities out-perform the national average in productivity, innovation and other measures of economic performance.
- 2.3.14 The differences in incomes between different parts of the country can in part be attributed to weaknesses in transport infrastructure and connectivity, which can limit growth in areas with lower productivity.
- 2.3.15 Building on previous phases, the Proposed Scheme will further reduce journey times on key long-distance routes in Britain. London Euston to Manchester Piccadilly will reduce from 2 hours 8 minutes to 90 minutes with Phases One and 2a, and further reduce to 71 minutes with the addition of the Proposed Scheme. Euston to Preston will reduce from 2 hours 7 minutes to 90 minutes with Phases One and 2a, and further reduce to 78 minutes with the addition of the Proposed Scheme. The Proposed Scheme will see the introduction of HS2 services from Birmingham Curzon Street to Manchester reducing journey times between the two biggest English cities outside of London from the current 87 minutes to 41 minutes, and doubling frequency to two trains per hour.
- 2.3.16 The Proposed Scheme will also significantly improve rail connectivity between London and Scotland, and, by splitting services at Carlisle, providing direct HS2 services to Edinburgh and Glasgow.
- 2.3.17 The Proposed Scheme will provide a necessary component of the proposed NPR scheme for the Liverpool – Manchester corridor via Manchester Airport which will improve connectivity across the North.
- 2.3.18 The Proposed Scheme will dramatically improve access to Manchester Airport, the important South Manchester and North Cheshire market, and create major regeneration opportunities through Manchester Airport High Speed station. The station is predicted to be used by around 17,000 HS2 passengers daily. Around a further 16,000 passengers are expected to use NPR services from the station once they are operational.

Boosting economic growth

- 2.3.19 The Government is committed to levelling up the economies of the North and Midlands, increasing productivity and bringing growth and prosperity across the country. Connecting cities and communities through better transport links helps increase the size of labour markets, bringing more employment and trading opportunities to people and businesses.
- 2.3.20 To level up the economy, the Government wants to see more high productivity jobs created outside of the South East, and particularly in the UK's major cities. High productivity jobs

tend to locate in large urban centres, as companies need access to large pools of people. Patterns of location and employment in the UK point to increasing urbanisation, with cities accounting for around 60% of UK economic activity. Rail provides the best transport solution for people getting into city centres. HS2 both provides links between cities and frees up capacity on other rail lines for more commuter services.

- 2.3.21 The Proposed Scheme will enable the realisation of wider socio-economic benefits for businesses, communities and local authorities including generating demand for property development around the Proposed Scheme stations (Manchester Piccadilly and Manchester Airport) which will provide substantial new employment space and new homes. The Strategic Regeneration Framework for Manchester Piccadilly proposes approximately 8 million square feet of development of which around 55% will be for residential use equating to over 5,000 residential units.
- 2.3.22 The Greater Manchester Combined Authority⁶⁰ forecasts that the Proposed Scheme combined with other proposed infrastructure will enable the redevelopment of Manchester Piccadilly, supporting the creation of 40,000 new jobs and 13,000 new homes. Equally, it reports that the Manchester Airport High Speed station is critical for redevelopment plans around Manchester Airport that could support further business and employment growth in the area leading to the creation of over 20,000 new jobs. The Proposed Scheme will also form a key component of the proposed NPR scheme which will support economic growth across the North.
- 2.3.23 HS2 Ltd is also building a skills legacy through the way the construction programme is delivered which will benefit both individuals and companies. At its peak, the construction of the Proposed Scheme is expected to support over 17,500 jobs in 2029/30 and at least 1,000 apprenticeships will be created on the full Phase 2b scheme⁶¹. Overall, it is estimated that the construction phase will generate 87,800 person years of construction employment opportunities⁶² (equivalent to 8,800 full time construction jobs⁶³). The supply chain has committed 6,000 volunteer days to supporting school engagement to inspire the next generation to pursue careers in science, technology, engineering and mathematics (STEM) subjects. A similar approach will be adopted for construction of the Proposed Scheme.
- 2.3.24 HS2 Ltd is working to make contract opportunities available to the broadest range of possible suppliers. Over 2,000 businesses have delivered work on HS2 and three quarters of

⁶⁰ Greater Manchester Combined Authority (2018), *HS2 and Northern Powerhouse Rail Growth Strategy – the stops are just the start*. Available online at: https://assets.ctfassets.net/nv7y93idf4jq/4sSHKQVxGMQuM488IMsWqG/cdc77581d9f6ce8d407b07976a2417e0/17-1060_HS2_Growth_Strategy.pdf.

⁶¹ High Speed Two Ltd (2021), *HS2 labour and skills demand and supply forecasting and analysis July 2021*. Available online at: https://assets.hs2.org.uk/wp-content/uploads/2021/08/HS2_LSF-report_clean_V2-0508.pdf.

⁶² Construction labour is reported in construction person years, where one construction person year represents the work done by one person in a year composed of a standard number of working days.

⁶³ Based on the total construction person years generated by the Proposed Scheme and a ratio of 10 construction person years to one full time permanent job.

these (over 1,500) were small to medium sized enterprises. Ninety seven per cent of HS2 Ltd contracts have been awarded to UK-based businesses.

Climate change and the transport network

- 2.3.25 The Proposed Scheme has been developed against a background of concern and strengthening Government 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.
- 2.3.26 Policy background and developments in these areas is set out in detail in Volume 3, Route-wide effects. Further information is provided in Section 8 and Section 9 of this report and in Volume 5.

Decarbonisation

- 2.3.27 HS2 will be vital to decarbonising the transport network and the wider Government commitment to bring all greenhouse gas emissions to net zero by 2050. Electric rail remains the most efficient means of mass transportation.
- 2.3.28 Transport emissions accounted for 27 per cent of Britain's greenhouse gas emissions in 2019 and Government acknowledges that decarbonising transport will be essential to achieving the ambitious target. HS2 is expected to play a vital role in achieving the transition to net zero. The Proposed Scheme encourages people to choose to travel by rail and will be influential in moving business passengers from domestic aviation to rail.
- 2.3.29 The Government's Transport Decarbonisation Plan (TDP) was published in July 2021 and amongst other measures sets out commitments to build extra capacity on the rail network to meet growing passenger and freight demand. It recognises high speed rail is the most effective way to increase the capacity, connectivity and sustainability of intercity travel. HS2 will operate as a high capacity, high-frequency inter-city service on dedicated lines. By building HS2 and running intercity train services on the new line, the Proposed Scheme will free up train paths and platforms across the heavily congested WCML.
- 2.3.30 High speed rail is considered to draw an optimum balance between carbon reduction and economic benefits. The base case for this assessment has assumed that travel on high speed rail will become progressively lower carbon 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 would be further carbon benefits associated with the operation of Phase Two including the Proposed Scheme.
- 2.3.31 Encouraging a shift to lower-carbon modes of transport was one of the considerations in rejecting 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. Modal shift benefits would also be realised from releasing capacity on the conventional rail network.

- 2.3.32 HS2 Ltd's Net Zero Carbon Plan⁶⁴ seeks to accelerate the ambition of the construction industry to realise net zero during the construction phase of the Proposed Scheme and also to procure zero carbon electricity from day one of operation. These aspirations have not driven the main results of this assessment but have been considered as part of the sensitivity analysis.

Climate resilience

- 2.3.33 The Government has put in place a framework for building the UK's ability to adapt to climate change through risk assessment and adaptation, planning in a five year cycle.
- 2.3.34 The design and EIA processes for major infrastructure projects are required to incorporate consideration of climate change implications. More specifically, the first National Adaption Programme states that "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".
- 2.3.35 DfT's development agreement with HS2 Ltd states "the railway shall be capable of operating high levels of train service, performance, reliability and resilience, including during degraded conditions... and shall be insofar as practicable, resilient to any periods of poor performance on the wider network". There is a resilience objective within HS2 Ltd's Sustainability Policy. Environment Agency guidance on climate change allowances to be used in flood risk assessments as set out in the NPPF has informed the assessment.
- 2.3.36 HS2 will play an important role in climate change resilience. With extreme weather events becoming more frequent, existing transport networks are less resilient to events such as high winds, intense rainfall and increased frequency of major storms. HS2 has been designed with these extreme weather events in mind, and can be expected to maintain performance under more extreme weather conditions.

Enabling connections between the Proposed Scheme and Northern Powerhouse Rail

- 2.3.37 The Government is working in partnership with Transport for the North (TfN) on the NPR programme. TfN is the first statutory sub-national transport body bringing together 20 local transport authorities to enable the north of England to speak with one voice on the transport infrastructure investment needed to drive transformational growth and rebalance the UK. The NPR programme aims to offer faster, more frequent and reliable rail links across the North and open up new opportunities for communities and businesses.

⁶⁴ High Speed Two Ltd (planned for publication imminently), *Net Zero Carbon Plan*. Available online at: www.hs2.org.uk/environment.

- 2.3.38 TfN's vision for the NPR network is outlined in the TfN's Strategic Transport Plan, which was consulted on in 2018 and published in February 2019⁶⁵.
- 2.3.39 Working together TfN, HS2 Ltd, Network Rail and DfT have identified touchpoints where the Proposed Scheme and NPR proposals directly intersect. It has been necessary to make changes to the design of the Proposed Scheme to avoid precluding, or making it very expensive to provide, inter-connectivity between NPR routes and HS2 in the future at 'touchpoints'. Touchpoints enable future connections between NPR and HS2 to future-proof the Proposed Scheme. The designs for these 'touchpoints' are intended to allow subsequent choices on the NPR network. HS2 Ltd has been working with the Government and TfN to integrate the designs for this series of touchpoints.
- 2.3.40 See Volume 2 Community Area reports: Hough to Walley's Green (MA01); Pickmere to Agden and Hulseheath (MA03); Hulseheath to Manchester Airport (MA06); Davenport Green to Ardwick (MA07) and Manchester Piccadilly Station (MA08) for further details on the NPR related infrastructure that will be provided as part of the Proposed Scheme.
- 2.3.41 The Secretary of State for Transport consulted on the provision of two touchpoints for NPR in June 2019⁶⁶. These will facilitate future services between Liverpool and Manchester.
- 2.3.42 Figure 4 shows where the Proposed Scheme interacts with NPR. Table 2 describes those interfaces.

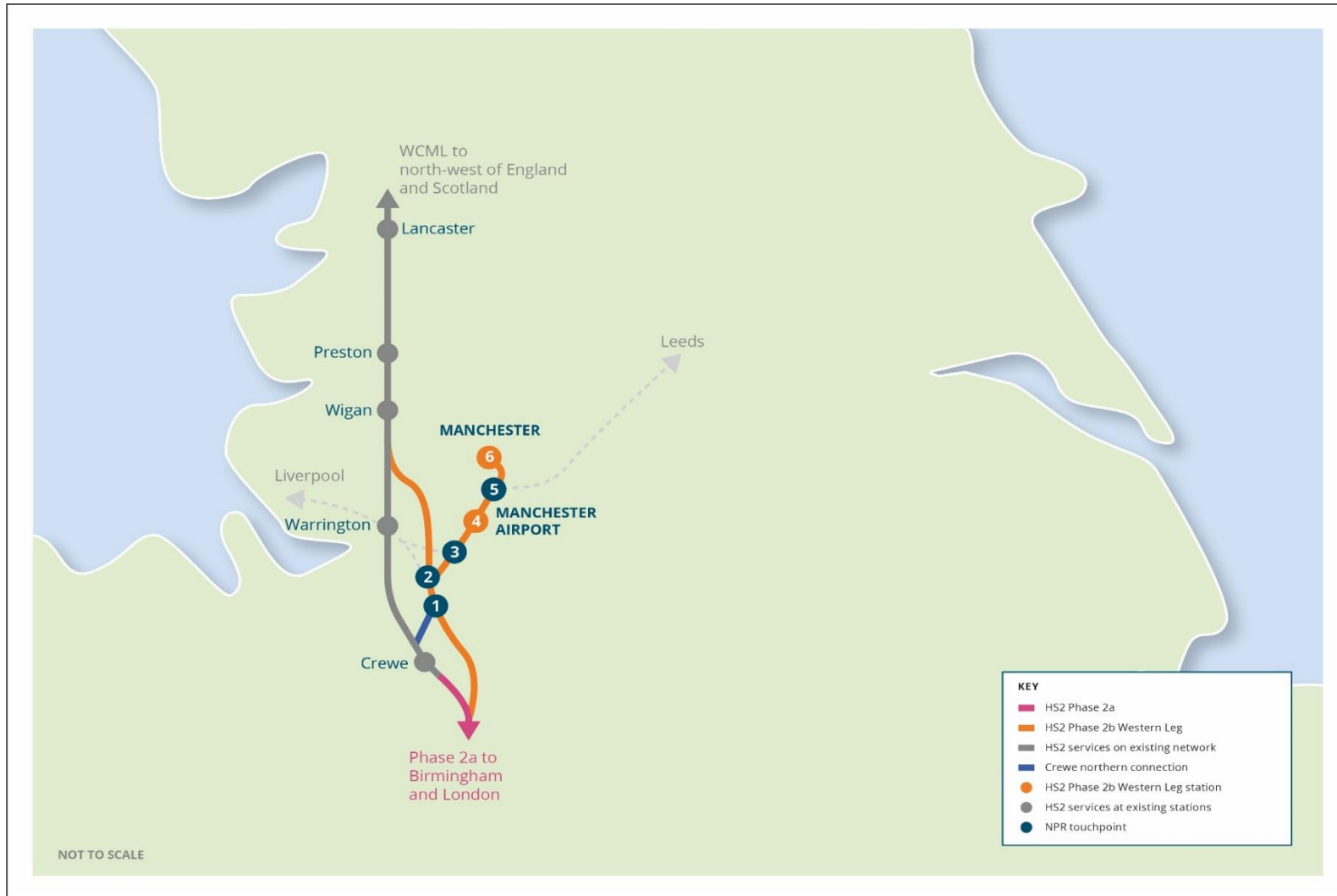
⁶⁵ Transport for the North (2019), *Strategic Transport Plan*. Available online at:

<https://transportforthenorth.com/wp-content/uploads/TfN-final-strategic-transport-plan-2019.pdf>.

⁶⁶ High Speed Two Ltd (2019), *High Speed Two: Phase 2b, Design Refinement Consultation - Moving Britain Ahead*. Available online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/807420/hs2-phase-2b-design-refinement-web.pdf.

Figure 4: Interfaces of the Proposed Scheme with Northern Powerhouse Rail



Environmental Statement
Volume 1

Table 2: Touchpoints where the Proposed Scheme interacts with Northern Powerhouse Rail

Figure reference	HS2 Phase 2b touchpoint with regional rail schemes	Description of works
1	Crewe Northern Connection	<p>The Proposed Scheme will include a connection to the WMCL which will enable high speed services to call at Crewe Station, and future NPR services to connect with HS2.</p> <p>See Volume 2, Community Area reports: Hough to Walley's Green (MA01) and Wimboldsley to Lostock Gralam (MA03) for further details.</p>
2	Passive provision to enable a future London to Liverpool chord (passive provision refers to the minimum level of additional works required to avoid disruption to the operation of HS2 when the junction is fully built after HS2 is operational)	<p>The Proposed Scheme will provide features, including earthworks and civil engineering structures, to enable the future construction of a London to Liverpool chord so that a future NPR route will connect to HS2 and thereby facilitate improved connectivity and capacity between Liverpool, Warrington and London.</p> <p>See Volume 2, Community Area report: Pickmere to Agden and Hulseheath (MA03) for further details.</p>
3	Passive provision to enable a future NPR connection between Manchester and Liverpool	<p>The Proposed Scheme will include earthworks and civil engineering structures to enable the future construction of a NPR connection between Manchester and Liverpool so that a future NPR route between Manchester and Liverpool will connect to HS2, thereby facilitating improved connectivity and capacity between Liverpool, Manchester Airport and Manchester Piccadilly.</p> <p>See Volume 2, Community Area report: Hulseheath to Manchester Airport (MA06) for further details.</p> <p>Civil engineering structures and earthworks will also be provided on both sides of the HS2 route, to enable provision for the future NPR connection between Manchester and Liverpool.</p> <p>See Volume 2, Community Area report: Pickmere to Agden and Hulseheath area (MA03) for further details.</p>
4	Manchester Airport High Speed station	<p>The Proposed Scheme will make provision for both HS2 and NPR services whilst also allowing for passengers to interchange onto conventional rail services and Metrolink. It will include two additional island platforms which will provide four platform faces to accommodate HS2 and NPR services. This will enable services to stop at the Airport before serving Manchester Piccadilly High Speed station. The Proposed Scheme will also make passive provision for an interchange with the Metrolink network.</p> <p>See Volume 2, Community Area report: Hulseheath to Manchester Airport (MA06) for further details.</p>
5	Manchester to Leeds junction	<p>The Proposed Scheme will include a junction to enable connectivity for future NPR services between Manchester and Leeds to connect to HS2.</p> <p>See Volume 2, Community Area reports: Davenport Green to Ardwick (MA07) and Manchester Piccadilly Station (MA08) for further details.</p>
6	Manchester Piccadilly High Speed station	<p>The proposed six-platform high speed station will make provision for both HS2 and NPR services, while also allowing for</p>

Figure reference	HS2 Phase 2b touchpoint with regional rail schemes	Description of works
		passengers to interchange onto conventional rail services and Metrolink. See Volume 2, Community Area report: Manchester Piccadilly Station (MA08) for further details.

2.4 Managing local impacts and effects

- 2.4.1 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 Proposed Scheme, impacts have been reduced so far as reasonably practicable. Environmental appraisal and assessment has been integral to route development and design, initially by way of the AoS process (as reported in the Sustainability Statement) and subsequently through the EIA process and preparation of the ES.
- 2.4.2 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 insofar as reasonably practicable or compensatory environmental measures provided. The approach to mitigation is described further in Section 9 of this report.
- 2.4.3 Local impacts were also identified through the engagement and consultation process. Options for addressing these issues were considered as the alignment and design of the Proposed Scheme evolved. Further details of the engagement and consultation process are set out in Section 3 of this report.

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 full Phase 2b scheme and latterly the Proposed Scheme from its inception. It has enabled the general public, businesses, local authorities, statutory bodies, and expert, technical and specialist stakeholders to respond to, and inform:

- the development of the design, including the consideration of alternatives;
- 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 Proposed Scheme;
- the measures identified to avoid or mitigate significant adverse effects; and
- monitoring arrangements.

3.1.2 This section sets out:

- how and when engagement and consultation has been undertaken;
- the range of stakeholders involved; and
- future opportunities for stakeholder engagement and consultation on the ES and through petitioning the Bill.

3.1.3 In Section 3 of Volume 2, a detailed community area specific summary is provided on which stakeholders have been engaged and how their feedback has been considered in the development of the design and assessment of the Proposed Scheme.

3.2 Key stages and mechanisms for engaging with stakeholders

Introduction

3.2.1 The Government recognises that the Proposed Scheme will have significant effects on those who live close to the route and upon the local environment through which it will pass. Engagement on Phase Two started in 2013 with the announcement of the initial preferred route. Since then HS2 Ltd has engaged with local communities and landowners along the route of the Proposed Scheme and with other stakeholders to identify and seek to resolve issues of concern.

3.2.2 Community engagement has continued to evolve and mature. Early lessons learnt from Phase One led to changes in the approach on Phase Two. For example, this included a

coherent and organised programme of engagement with individual stakeholders throughout the design and assessment process. These changes were adopted to help identify and resolve, where reasonably practical, issues of concern for local communities and stakeholders at the earliest possible opportunity.

- 3.2.3 The HS2 Community Engagement Strategy published in 2017 (revised 2018) provides the overall framework for HS2 Ltd 's engagement activities for both its staff and contractors. This includes a Residents' Charter which lists 10 commitments that are used to measure how successfully HS2 Ltd is delivering engagement. The Strategy will continue to evolve as the HS2 project progresses to meet the changing needs of the communities and stakeholders affected by the Proposed Scheme
- 3.2.4 Key engagement and consultation activities undertaken during the development of the full Phase 2b Proposed Scheme are described in Table 3. This includes formal public consultations such as those on the Phase 2b draft EIA and EQIA SMRs, the working draft ES and working draft EQIA, design refinement consultations and property compensation consultation. This formal consultation is described, as well as engagement through meetings, working groups and correspondence with national and local environmental stakeholders, local authorities, parish councils, individual landowners and organisations.

Table 3: Key engagement and consultation activity to-date for HS2 Phase 2b

Date	Engagement and consultation activity	Stakeholders engaged/consulted
2012 – Ongoing	HS2 National Environment Forum	Engagement with key statutory and non-governmental organisations to represent the interests of local people and wider society in respect to specific environmental issues. This includes bilateral meetings on specific issues on a case by case basis and regular engagement with organisations including Natural England, Historic England and the Environment Agency.
2012 – 2019	HS2 Ministerial Environmental Roundtable	Secretary of State for Transport led engagement with key statutory and non-governmental organisations and local authority representatives to provide opportunities for organisations with appropriate expertise and knowledge to discuss national level environmental issues related to HS2. Attendees have included the Campaign to Protect Rural England, the Campaign for Better Transport, the National Trust, the Woodland Trust, the Wildlife Trusts, the Royal Society of Wildlife Trusts, Ramblers, the National Farmers Union and the Local Government Association.
2012	Secretary of State led engagement with key city/regional stakeholders	Engagement led by the Secretary of State for Transport with potential station cities to help inform initial preferences for Phase Two, including consideration of relevant environmental information.
28 January 2013	Post announcement of the Phase Two initial preferred route	Following announcement, engagement with key stakeholders on emerging key issues and concerns about the route and its impacts ahead of consultation.
January 2013 – May 2013	Consultation on a Proposed Exceptional Hardship	Property compensation consultation on proposed EHS for Phase Two. Information was sent to key stakeholders, including local authority chief executives, national charities

Environmental Statement

Volume 1

Date	Engagement and consultation activity	Stakeholders engaged/consulted
	Scheme (EHS) for Phase Two	and relevant organisations, professional associations, local chambers of commerce, Local Enterprise Partnerships (LEP) and transport groups.
17 July 2013 – 31 January 2014	Consultation on the Proposed Phase Two route. High Speed Rail: investing in Britain's Future, the route from the West Midlands to Manchester, Leeds and beyond	Consultation on the proposed route, stations and depots, supported by various documentation, including a Sustainability Statement describing the sustainability performance of the scheme. Consultation providing all stakeholders with the opportunity to participate. Information was published on the gov.uk website, sent to stakeholders and directly affected communities and released through local and social media advertising. Information events were held in 31 locations along the Phase Two route.
7 July 2016 – 11 August 2016	Engagement following publication of HS2 Phase 2b: Sheffield and South Yorkshire Report 2016	Information events were held to engage with local communities and members of the public following publication of the recommended M18/Eastern route alignment along the Phase 2b Leeds Leg.
15 November 2016	Phase 2b preferred route announcement	Engagement with key stakeholders on emerging key issues and concerns about the preferred route and its impacts concurrent to route refinement consultation.
15 November 2016 – 9 March 2017	HS2 Phase 2b: Crewe to Manchester, West Midlands to Leeds route refinement consultation 2016	Consultation on proposed route refinements, providing all stakeholders the opportunity to participate. Information was published on the gov.uk website, sent to stakeholders and directly affected communities and released through local and social media advertising. Direct engagement with communities and their representatives through information events with documents being made available at a range of community locations along the route.
15 November 2016 – 9 March 2017	HS2 Phase 2b Property Consultation 2016	Consultation on the property compensation and assistance schemes the government proposed for people affected by the plans for the full Phase 2b scheme. Direct engagement with communities and their representatives through information events with documents being made available at a range of community locations along the route.
17 July 2017	Confirmation of full Phase 2b scheme, Crewe Hub and the proposed relocation of the eastern leg rolling stock depot. Start date of detailed engagement with local communities and stakeholders on the confirmed Phase 2b route	Confirmation of full Phase 2b scheme, Crewe Hub and the proposed relocation of the eastern leg rolling stock depot. Start date of detailed engagement with local communities and stakeholders on the confirmed Phase 2b route
17 July 2017 – 29 September 2017	Consultation on the proposed relocation of the eastern leg rolling stock depot. Consultation on the draft Scope and Methodology Reports for the EIA and EQIA. Consultation on proposals	Consultation on the proposed relocation of the eastern leg rolling stock depot. Consultation on the draft Scope and Methodology Reports for the EIA and EQIA. Consultation on proposals for an enhanced Crewe hub station

Environmental Statement

Volume 1

Date	Engagement and consultation activity	Stakeholders engaged/consulted
	for an enhanced Crewe hub station	
4 June – 14 July 2018	Phase 2b information events to provide an update on design development	Ongoing engagement with communities and their representatives through information events with documents being made available at a range of community locations along the route. Those directly affected by the proposals were written to and offered one-to-one meetings.
11 October 2018 – 21 December 2018	Consultation on the Phase 2b working draft ES and working draft EQIA report.	Consultation with information published on the gov.uk website, sent to stakeholders and directly affected communities and released through local and social media advertising. Engagement with local authorities, expert, technical and specialist stakeholders. Engagement with communities and their representatives through information events with documents being made available at a range of community locations along the route. Those directly affected by the proposals were written to and offered one-to-one meetings.
6 June – 6 September 2019	Phase 2b consultation on design refinements	Consultation on 11 proposed refinements to the full Phase 2b scheme. Publicised via mailout to communities close to the full Phase 2b scheme, advertised in local media and emails sent to key stakeholders including local and statutory authorities, parish councils and political representatives. Those directly affected by the proposals were written to and offered one-to-one meetings. Information events were held in communities where design refinements were proposed, providing local authorities, parish councils, community organisations, farmers and growers and members of the public opportunities to attend, view the information and ask questions.
7 October 2020 – 11 December 2020	Phase 2b Western Leg design refinement consultation	Consultation on proposed refinements in four geographical locations on the Phase 2b Western Leg, alongside a full update on the Phase 2b Western Leg design proposals, including changes to the existing rail network. Publicised via mailout to communities close to the Phase 2b Western Leg scheme, advertising in local media, social media and emails sent to key stakeholders including local and statutory authorities, parish councils and political representatives. Information was also made available on the hs2.org.uk webpage, where an interactive map and a virtual exhibition room provided alternative ways for people to access the information. Thirteen live webinars were held and the proposals were shared in a virtual exhibition room and via an online “Navigator” tool. Those directly affected by the proposals were written to and offered virtual one-to-one meetings.
16 June – September 2021	Phase 2b Western Leg Crewe to Manchester Route-wide update	Launched on June 16 th , HS2 Ltd published a route-wide update on the Phase 2b Western Leg Scheme. To support this, information events were held using a combination of in-person information events and online webinars to provide local communities and members of the public an update on the scheme design in readiness for the government

Date	Engagement and consultation activity	Stakeholders engaged/consulted
		depositing a hybrid Bill for the Phase 2b Western Leg. Online webinars also provided an update on ground investigations and utilities works. Those directly affected by the proposals were written to and offered one-to-one meetings.

- 3.2.5 The remainder of this section sets out further detail on key engagement and consultation activities undertaken to inform the design and assessment of the full Phase 2b scheme and the Proposed Scheme since confirmation of the Phase 2b route in July 2017.

Consultation on the Draft EIA Scope and Methodology Report

- 3.2.6 The draft EIA SMR (the 2017 SMR) was formally consulted on between July and September 2017. It was issued to statutory bodies, non-government organisations and local authorities. It was made available on the [gov.uk](https://www.gov.uk) website, allowing comment by local interest groups and the public. A total of 107 responses were received, as a result of which changes to the draft 2017 SMR were made. A revised EIA SMR was published in October 2018 (the 2018 SMR) as part of the working draft ES (described in the following sections).
- 3.2.7 The changes between the 2017 SMR and the publication of the 2018 SMR were set out in the EIA SMR Consultation Summary Report⁶⁷, published in October 2018.
- 3.2.8 The assessment reported in this ES follows the scope and methodology in the EIA SMR⁶⁸.

Consultation on the working draft ES

- 3.2.9 Consultation on the working draft ES took place from October to December 2018. A parallel consultation on the working draft EQIA was also undertaken during this period. These consultations related to the full Phase 2b scheme (including both Eastern Leg and Western Leg). As part of the process of consultation, stakeholders were invited to comment on the full Phase 2b scheme, the working draft ES and working draft EQIA Report. Documents were made available on the [gov.uk](https://www.gov.uk) website.
- 3.2.10 Information events were held in communities along the full Phase 2b scheme as part of the consultation and directly affected stakeholders were invited to participate.
- 3.2.11 Feedback from consultation was considered in the further development of the full Phase 2b scheme and the Proposed Scheme and taken into account in preparation of this ES that

⁶⁷ High Speed Two Ltd (2018), *HS2 Phase 2b: Crewe to Manchester and West Midlands to Leeds, Environmental Impact Assessment Scope and Methodology Report, Consultation Summary Report*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/745512/HS2_Phase_2b_EIA_Scope_and_Methodology_Report_Consultation_Summary_Report.pdf.

⁶⁸ Volume 5: Appendix CT-001-00001, *Environmental Impact Assessment Scope and Methodology Report*.

accompanies the Bill. A summary of these changes is provided in the Working Draft Environmental Statement Consultation Summary Report (CSR)⁶⁹.

Consultations on design refinements

2019 Design Refinement Consultation

- 3.2.12 Consultation on 11 proposed key design refinements to the full Phase 2b scheme took place from June to September 2019. Details of the proposed design refinements, along with supporting information such as visualisations and plan and profile maps, were made available in public locations and online at the [gov.uk](https://www.gov.uk) website.
- 3.2.13 As part of this process, stakeholders were invited to comment on these design refinements proposed to the full Phase 2b scheme since the working draft ES consultation. Information events were held in communities where the design refinements were proposed and directly affected stakeholders were invited to participate. Those directly affected by the proposals were written to and offered one-to-one meetings.
- 3.2.14 Feedback from the 2019 design refinement consultation was considered in the further development of the full Phase 2b scheme and feedback relevant to the Proposed Scheme taken into account in the preparation of this ES. The Secretary of State for Transport produced a formal response to the consultation in October 2020 which is available on the [gov.uk](https://www.gov.uk) website.

2020 Western Leg Design Refinement Consultation

- 3.2.15 Consultation on further proposed key design refinements, in four geographical locations, to the Proposed Scheme took place between October 2020 and December 2020. Details of the proposed design refinements, along with supporting information such as visualisations and construction and operational plans, were made available on the [gov.uk](https://www.gov.uk) website. The proposals were also made available at the hs2.org.uk website, where an interactive map and a virtual exhibition room provided alternative ways for people to access the information. Printed copies of the materials were sent free of charge following requests to the HS2 Helpdesk.
- 3.2.16 A series of 13 live webinars were held for people to view the proposals and ask questions about them. Those directly affected by the proposals were written to and offered virtual one-to-one meetings. Feedback from the design refinement consultation was considered in the further development of the Proposed Scheme and taken into account in the preparation of this ES.
- 3.2.17 A summary of the consultation was produced by DfT and is available at the [gov.uk](https://www.gov.uk) website.

⁶⁹ Volume 5: Appendix CT-007-00001, *working draft Environmental Statement consultation summary report*.

3.3 Engagement and consultation with stakeholder groups

Communities

- 3.3.1 Communities were engaged and formally consulted during the route design and assessment process to ensure they had the opportunity to input to and inform the development of the Proposed Scheme.
- 3.3.2 Communities that had the potential to be affected by the Proposed Scheme were identified and were a key focus of engagement and formal consultation. The purpose of this engagement has been to provide affected communities with information on the development of the Proposed Scheme and to give the opportunity to raise issues in relation to the design and assessment of the Proposed Scheme. Engagement was undertaken with these communities in a number of different ways, including through information events that were held in local community facilities and online. Engagement was also held with key community representatives and with a broad range of interest groups within the respective areas.
- 3.3.3 Programmes of public information events were held to share new information with communities and to engage them on it. HS2 Ltd notified people of events by sending leaflets to addresses along the route, advertising in local media and via social media. Public information events were held in September 2017, between June and July 2018, October and December 2018 and June and July 2019. In October and November 2020, information events were held using online channels including webinars and a virtual exhibition room. Information events held in June, July and September 2021 used a combination of in-person interaction and online webinars. Members of local communities and other interested parties were invited to engage on issues pertinent to the development of the Proposed Scheme design and its assessment.
- 3.3.4 Engagement has been, and will continue to be, undertaken with community stakeholders, particularly those close to the Proposed Scheme. These stakeholders include educational establishments, organisations with specialist interests or those catering to the needs of vulnerable people within the community. This has informed the assessment of community and health impacts in this ES, whilst also informing the concurrent EQIA.

MPs, local authorities and parish councils

- 3.3.5 Engagement with MPs, metropolitan, city, county, borough, district and parish councils was undertaken throughout the design and assessment of the Proposed Scheme. The aim was to maximise the opportunity for local authorities and parish councils to engage and inform the development of the Proposed Scheme.
- 3.3.6 The local authorities and parish councils were able to provide technical information to support development of the Proposed Scheme and the environmental assessment process.

They also provided information on communities and other stakeholders within their area, which helped aid understanding of local issues and concerns, provided access to wider stakeholders and communities and provided a mechanism for ongoing dialogue and discussion on the assessment and design development.

Expert, technical and specialist groups

- 3.3.7 This stakeholder group comprises those with specific technical knowledge or particular interest in the Proposed Scheme. This includes national representatives of environmental statutory authorities and government departments, as well as non-statutory technical/specialist organisations.
- 3.3.8 Designated statutory consultees in both England and Scotland, were engaged throughout the assessment. Engagement with statutory environmental stakeholders assisted to inform the design and assessment of the Proposed Scheme (including the Environment Agency, Scottish Environment Protection Agency (SEPA), Natural England, NatureScot, Historic England and Highways England⁷⁰). Specific, dedicated engagement on health was also undertaken, including with health and joint wellbeing boards, Directors of Public Health and Public Health England.
- 3.3.9 Engagement is also continuing with utility companies and statutory stakeholders, such as Network Rail, National Grid and the Oil and Pipelines Agency, to establish how the Proposed Scheme may affect utility company infrastructure and the existing conventional rail network.
- 3.3.10 Engagement to date with these stakeholders has informed the design and environmental assessment process. Engagement with these stakeholders will continue as the project develops.

Directly affected individuals, farmers and growers

- 3.3.11 This group includes those with land and property potentially affected either permanently or temporarily by the Proposed Scheme, including individuals, farmers and growers.
- 3.3.12 Engagement has been offered directly to potentially affected individuals via a variety of mechanisms including by letter and through known land agents.
- 3.3.13 Information events also provided affected individuals, farmers and growers with the opportunity to gain an understanding of compensation and assistance available for property owners. As part of information events held in October 2018, June 2019 and virtual information events held between October and November 2020, targeted engagement was also offered to those stakeholders who have land or property directly affected by the construction and/or operation of the Proposed Scheme. Facilities were available at the events to have private meetings with HS2 Ltd staff. These appointments provided an opportunity to meet with technical experts, to gain a better understanding of the emerging

⁷⁰ Highways England was renamed National Highways in August 2021.

design and share their thoughts on how this might affect them. Whilst these opportunities did not replace their right to respond formally to consultation, feedback received has been considered during design development and the assessment process.

- 3.3.14 Engagement has been offered to all farmers and growers directly affected by the Proposed Scheme whether permanently or temporarily. Where offers have been accepted and it has been possible, visits have been made to the land and property affected although some interviews have needed to be undertaken virtually. The purpose of this engagement has been to obtain baseline information and provide the opportunity to raise issues and discuss mitigation in relation to the Proposed Scheme.
- 3.3.15 Engagement with directly affected individuals will continue as the project develops and opportunities for engagement will continue to be offered throughout the parliamentary process.
- 3.3.16 Engagement is also continuing with key representatives of the farmers and growers industry, in particular with the National Farmers Union and Country Land and Business Association.

Major asset owners and businesses

- 3.3.17 This group includes those with property potentially affected by the Proposed Scheme, including major asset holders and businesses.
- 3.3.18 As part of the information events held in October 2018, June 2019 and virtual information events held between October and November 2020, targeted engagement was also offered to those stakeholders who have land, property or business operations directly affected by the construction and/or operation of the Proposed Scheme. These appointments provided an opportunity for these stakeholders to meet with technical experts, to gain a better understanding of the emerging design and share their thoughts on how this might affect them. Whilst these opportunities did not replace their right to respond formally to consultation, the feedback received has been considered during design development.
- 3.3.19 Engagement with these stakeholders will continue as the project develops.

3.4 Further engagement and consultation

Phase 2b Planning Forum

- 3.4.1 The Phase 2b Planning Forum will be the main mechanism for discussion on planning matters between HS2 Ltd and the local planning authorities affected by the Proposed Scheme. It will focus on matters of route-wide interest.
- 3.4.2 The Phase 2b Planning Forum and its sub-groups commenced in summer 2021, prior to the Bill submission and will continue during the passage of the Bill through Parliament and beyond. It focusses on matters associated with powers contained in the Bill.

Parliamentary consultation and petitioning

- 3.4.3 In accordance with Parliamentary Standing Orders, Parliament will undertake a public consultation on the ES following deposit of the hybrid Bill. Consultees will have at least 56 days (eight weeks) to respond to the consultation following the deposit of the hybrid Bill documents in Parliament and the first publication of the necessary newspaper notices. The Secretary of State will publish all comments received on the ES and submit them to an independent assessor to be appointed by Parliament. The independent assessor is required to provide a summary to Parliament of the issues raised by stakeholders in response to the consultation before Second Reading of the Bill.
- 3.4.4 There will also be a petitioning period. This petitioning period will provide an opportunity for individuals or organisations specially and directly affected by the Proposed Scheme to petition against the Bill. More information on who may petition against the Bill, and how to do so, is available on Parliament's website (<http://www.parliament.uk>).

National Environment Forum

- 3.4.5 The National Environment Forum is attended by members of key statutory organisations to represent the interests of local people and 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.
- 3.4.6 The forum meets approximately quarterly and provides the opportunity for HS2 Ltd to give updates to forum members and for forum members to provide 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.

4 The Proposed Scheme

4.1 Introduction

- 4.1.1 This section provides a summary description of the Proposed Scheme. Detailed descriptions of the Proposed Scheme are contained in the Volume 2, Community Area reports, Section 2 and Volume 4, Off-route effects. The route of the Proposed Scheme has been divided into the community areas shown in Figure 5 for environmental assessment and community engagement.
- 4.1.2 This section also provides a description of:
- the interfaces between the Proposed Scheme and HS2 Phase 2a;
 - the interfaces with the conventional rail network and other transport services; and
 - the anticipated services, operating characteristics and maintenance requirements of the Proposed Scheme.

4.2 Description of the Proposed Scheme

Overview

- 4.2.1 The Proposed Scheme comprises:
- the route from Crewe to Manchester with connections onto the WCML;
 - a number of works beyond the route corridor, to allow HS2 trains to call at existing stations further north on the WCML and provide depots for HS2 trains; and
 - provisions for efficient future integration between NPR services to and HS2.
- 4.2.2 The route of the Proposed Scheme is summarised in the text and figures that follow. Each of the distances provided in this section are approximate.

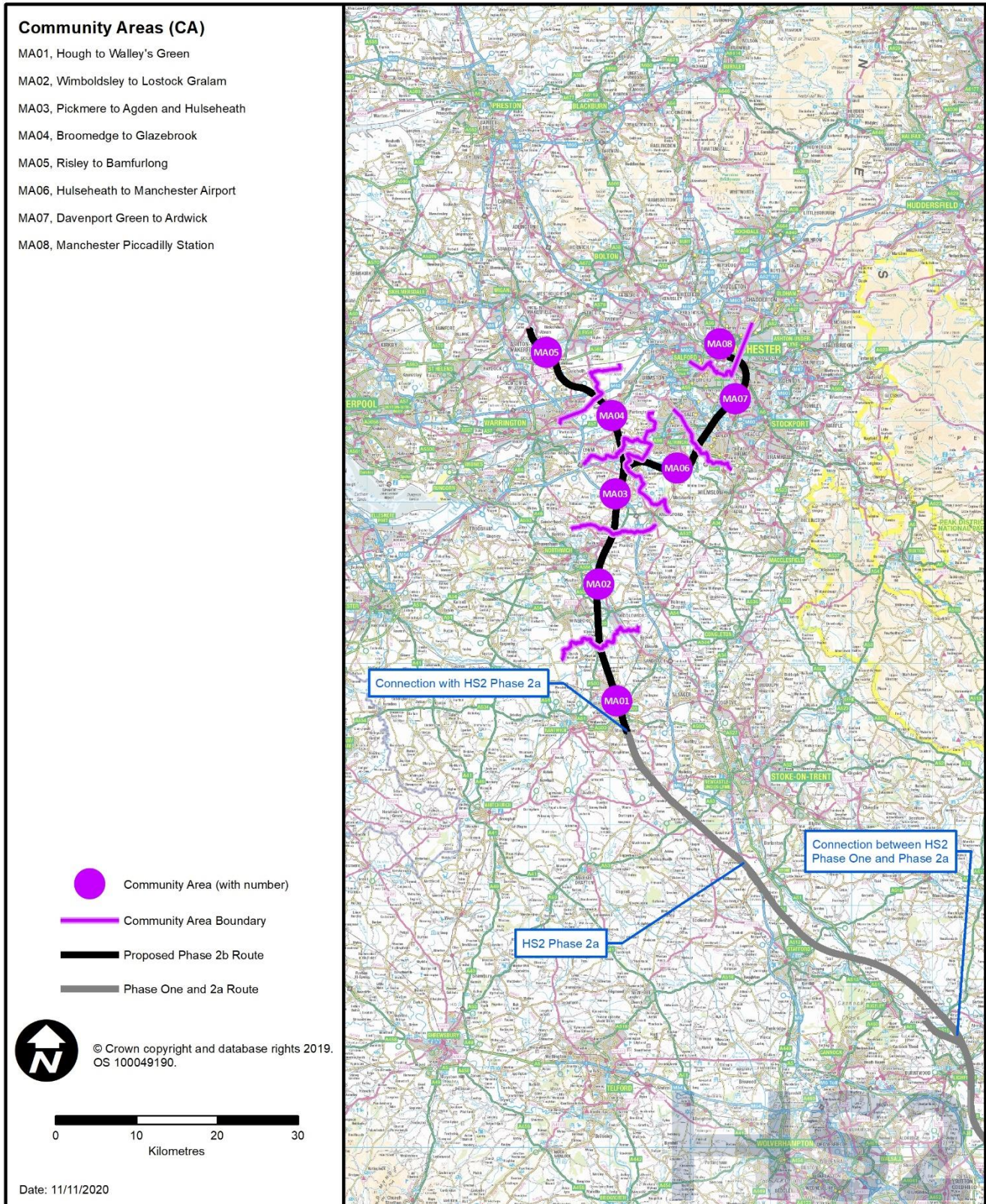
The route of the Proposed Scheme

- 4.2.3 The route of the Proposed Scheme will run from Crewe to Manchester and to the WCML near Bamfurlong, as shown in Figure 5. The total length of the route is 85km (52 miles). The route will begin to the south of the existing Crewe Station, south of the A500 Shavington Bypass, where it will connect to HS2 Phase 2a. It will then enter the Crewe tunnel, which will include two vent shafts: at Cowley Way and Middlewich Street. The route will re-emerge to the north of the B5076 Bradfield Road. The Crewe Northern Connection will be provided to the north of Crewe tunnel to connect the route of the Proposed Scheme to the WCML and enable future NPR services to connect with HS2. The HS2 Phase 2a route will also connect to the WCML to the south of Crewe Station and so integrates the existing station into the HS2 route.

- 4.2.4 Crewe North rolling stock depot (RSD) and Crewe North infrastructure maintenance base – rail (IMB-R) will be located between the route of the Proposed Scheme and the WCML where they diverge to the east of Walley’s Green. The RSD will serve as an operational and maintenance hub for HS2 rolling stock. The IMB-R will be an infrastructure maintenance facility and storage area for the Proposed Scheme. Reception tracks will connect the RSD with the WCML, the route of the Proposed Scheme and the IMB-R.
- 4.2.5 The route of the Proposed Scheme will continue north passing between the towns of Winsford and Middlewich on a series of embankments and viaducts to the west of Lostock Green and east of Higher Shadrach, Rudheath, Lostock Gralam and Higher Wincham. The route will then cross the M6 on a viaduct. The HS2 WCML connection will then diverge from the HS2 spur to Manchester. The Proposed Scheme also includes the NPR London to Liverpool junction at this location. This junction will be provided to enable future NPR services between London and Liverpool to connect to HS2.
- 4.2.6 The HS2 WCML connection will continue north towards the M56. The NPR Manchester to Liverpool junction overbridge will span the route to the south of the M56. This will enable a future NPR route between Manchester and Liverpool to cross over the route of the Proposed Scheme. The HS2 WCML connection will pass beneath the M56, which will be carried on an overbridge, before crossing the Manchester Ship Canal on a viaduct to the east of Hollins Green. It will then continue north to cross the M62 on viaduct and pass to the west of Culcheth, before continuing through Lowton and connecting with the WCML south of Bamfurlong.
- 4.2.7 The HS2 Manchester spur will continue in a north-easterly direction towards Manchester. After crossing under the A556 Chester Road, it will run in an easterly direction, broadly parallel with the M56, passing to the north of Rostherne Mere. The Proposed Scheme includes the NPR Manchester to Liverpool junction at this location. This junction will enable a future NPR route between Manchester and Liverpool to connect to HS2. Ashley IMB-R will also be located adjacent to the route in this area. Ashley IMB-R will be a maintenance facility and storage area for the Proposed Scheme.
- 4.2.8 Continuing in an easterly direction, the HS2 Manchester spur will cross the Mid-Cheshire Line on a viaduct. It will then turn northwards before passing beneath the M56 in a box structure to the east of Warburton Green.
- 4.2.9 The HS2 Manchester spur will then continue to Manchester Airport High Speed station. The station will be located adjacent to the M56 and north-west of Manchester Airport. It will include four platforms, two of which will be for future NPR services. A section of viaduct will be constructed across the station to enable future provision of a Metrolink (a light rail network operated by Transport for Greater Manchester) stop at the station. Two Metrolink platforms will be provided on the viaduct.
- 4.2.10 The HS2 Manchester spur will enter the Manchester tunnel to the north of Manchester Airport High Speed station, near Davenport Green. The tunnel will pass beneath south Manchester in a northerly direction, and will include four vent shafts: at Altrincham Road, Palatine Road, Wilmslow Road and Birchfields Road.

- 4.2.11 The northern portal of the tunnel will be located in the Ardwick area, with the route re-emerging into a box structure and cutting. The Proposed Scheme also includes the NPR Manchester to Leeds junction at this location. This junction will enable a future NPR route between Manchester and Leeds to connect to HS2.
- 4.2.12 The HS2 Manchester spur will then rise onto embankment and continue on viaduct before terminating at the proposed Manchester Piccadilly High Speed station, a six-platform station for HS2 and future NPR services, with its southern edge adjoining the existing Manchester Piccadilly Station. The Proposed Scheme in the area will include:
- the relocation of the existing Piccadilly Metrolink stop, which will be located beneath Manchester Piccadilly High Speed station;
 - the realignment of existing Metrolink tracks;
 - provision for a new Metrolink stop, called Piccadilly Central; and
 - a new Metrolink turnback facility located immediately east of the existing New Islington Metrolink stop, to replace the existing turnback facility on Sheffield Street. The turnback is a terminating section of track enabling trains to reverse.

Figure 5: The Proposed Scheme



Off-route works

4.2.13 The off-route works include:

- works to accommodate HS2 services at Preston and Carlisle stations;
- construction of stabling facilities for HS2 trains serving the north of England and Scotland at Annandale depot (near Gretna in southern Scotland); and
- minor enhancement to existing facilities at Polmadie depot (Glasgow) to provide overnight stabling for HS2 trains serving the north of England and Scotland.

Interfaces between the Proposed Scheme and Phase 2a

4.2.14 The route of Phase 2a will include and terminate at the end of the retained cutting leading to Crewe tunnel southern porous portal⁷¹, which will be constructed as part of the Proposed Scheme. The Proposed Scheme will continue in that tunnel underneath Crewe towards Manchester. Phase 2a also includes spurs connecting to the WCML south of Crewe and into Crewe Station.

Interfaces with the conventional rail network and future rail schemes

Interface with Crewe Hub

4.2.15 Network Rail, working closely with the DfT, Cheshire East Council (CEC) and other stakeholders, are in the process of developing proposals for 'Crewe Hub', an enhanced transport hub at the existing Crewe Station. A consultation on Crewe Hub was launched at the same time as the Phase 2a Bill deposit, in July 2017. The outcome of the consultation was published in March 2018 and confirmed the Government's support for the Crewe Hub vision. The scope of the Phase 2a Bill was subsequently modified to support the proposals⁷². The design changes included:

- reconfiguration of the existing WCML tracks to the south of Crewe Station; and
- the alteration of Platforms 5 and 6 at Crewe Station to enable splitting and joining of HS2 trains.

⁷¹ 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.

⁷² High Speed Two Ltd (2019), High Speed Rail (West Midlands – Crewe), *Supplementary Environmental Statement 2 and Additional Provision 2 Environmental Statement*. Available online at: <https://www.gov.uk/government/collections/hs2-phase-2a-supplementary-environmental-statement-2-and-additional-provision-2-environmental-statement-february-2019>.

- 4.2.16 The consultation response also indicated that a junction between the WCML and HS2 would be required north of Crewe Station to facilitate Crewe Hub. This junction is included in the Proposed Scheme as the Crewe Northern Connection.
- 4.2.17 Crewe Hub itself 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 environmental effects arising from Crewe Hub.
- 4.2.18 As the proposal for Crewe Hub has some status in local policy, the assessment presented in Volume 2, Community Area report: Hough to Walley's Green (MA01) treats it as a "committed development" for the purposes of considering cumulative effects. However, at the time of assessment, 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.

West Coast Main Line

- 4.2.19 The Crewe North RSD will connect directly with the WCML. Further connections to the WCML will be provided near Bamfurlong in the Risley to Bamfurlong area (MA05) and as part of the Crewe Northern Connection in the Hough to Walley's Green and Wimboldsley to Lostock Gralam areas (MA01 and MA02).

Future NPR interfaces

- 4.2.20 The Proposed Scheme will also include the following provisions to enable connections to future NPR services:
- the Crewe Northern Connection will be provided in the Hough to Walley's Green and Wimboldsley to Lostock Gralam areas (MA01 and MA02). It will connect the route of the Proposed Scheme to the WMCL. This connection will enable high speed services to call at Crewe Station, and future NPR services to connect with HS2;
 - the NPR London to Liverpool junction in the Pickmere to Agden and Hulseheath area (MA03) will provide features to enable a future NPR route to connect to HS2 and thereby facilitate improved connectivity and capacity between Liverpool, Warrington and London;
 - civil engineering structures and earthworks will also be provided in the Pickmere to Agden and Hulseheath area (MA03), to enable provision for the future NPR connection between Manchester and Liverpool;
 - the NPR Manchester to Liverpool junction in the Hulseheath to Manchester Airport area (MA06) will enable a future NPR route between Manchester and Liverpool to connect to HS2, thereby facilitating improved connectivity and capacity between Liverpool, Manchester Airport and Manchester Piccadilly;
 - the new Manchester Airport High Speed station will include two island platforms which will provide four platform faces to accommodate HS2 and NPR services in the Hulseheath to Manchester Airport area (MA06);

- the NPR Manchester to Leeds junction in the Davenport Green to Ardwick area (MA07) and the Manchester Piccadilly Station area (MA08) will enable connectivity for future NPR services between Manchester and Leeds; and
- the new six-platform Manchester Piccadilly High Speed station will include provision for NPR services in the Manchester Piccadilly Station area (MA08).

4.2.21 Further details can be found in Section 2.3 of this report and the relevant Volume 2, Community Area reports.

4.2.22 There will be a number of other interfaces between HS2 infrastructure and the conventional rail network at locations beyond the HS2 route corridor. Further details can be found in Volume 4, Off-route effects.

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 Business Case and to provide assumptions for an operational specification for the EIA of the Proposed Scheme.
- 4.3.2 It is envisaged that passenger services will operate from 05:00 up to midnight from Monday to Saturday and from 08:00 up to midnight on a Sunday. Maintenance and engineering works will occur outside these hours, unless required as a result of exceptional circumstances and 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 route of the Proposed Scheme as shown in Figure 6 and as detailed within the Volume 2, Community Area reports. It is assumed that this number of services will operate every hour from 07:00 to 21:00. The number of passenger services will progressively decrease after approximately 21:00 and the last service is generally expected to arrive at terminal stations and/or depots by midnight.

Journey times

- 4.3.3 The expected fastest standard journey times are set out in Table 4. Note that for journeys to destinations that are not on the core HS2 network, parts of the conventional rail network have been used.

Table 4: Fastest standard journey times between key destinations ‘without’ and ‘with’ HS2 in operation. For journeys to destinations that are not on the core HS2 network, a change on to the conventional rail network will be required

Train origin/destination	Train destination/origin	Current fastest standard hour journey time by conventional rail (hours:minutes)	Fastest standard hour journey time with the Proposed Scheme (including Phase One and Phase 2a) (hours:minutes)
London Euston	Carlisle	3:16	2.:23
	Crewe	1:30	0:56 (requires Phase One and Phase 2a only)
	Manchester Airport	2:24 (to existing conventional rail station)	1:03 (to high speed station)
	Manchester Piccadilly	2:07	1:11
	Preston	2:08	1:18
	Liverpool Lime Street	2:14	1:34
	Glasgow (Central)	4:30	3:46
	Edinburgh (Waverley)	4:22	3:42
Birmingham Curzon Street	Manchester Piccadilly	1:28	0:41
	Glasgow (Central)	4:02	3:23
	Edinburgh (Waverley)	4:07	3:20

Form of trains

- 4.3.4 Following completion of construction of the Proposed Scheme the high speed railway could be used by two types of train:
- specially designed high speed trains that are capable of running on high speed and existing rail infrastructure where 25kv electrification is provided (referred to as ‘conventional compatible’ trains); and
 - standard European-sized high speed trains capable of operating on high speed infrastructure only (referred to as ‘captive’ trains).
- 4.3.5 To enable conventional compatible trains to operate on the conventional network, they will be equipped with suitable train control and power systems and will be of a reduced width and height compared to captive trains.
- 4.3.6 It is anticipated that conventional compatible and captive high speed trains will be 200m-long and that, when required, could be coupled together to form 400m-long trains. A greater number of HS2 trains are expected to be 400m long during peak hours, with 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, and therefore, up to approximately 1,100 passengers for each 400m-long train.

Maintenance of HS2 operational infrastructure

- 4.3.7 The maintenance regime will include inspection and monitoring to predict and prevent changes to the condition and performance of HS2 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 physical interaction between train and rail system assets;
 - the frequent operation of infrastructure measurement trains which record the condition of infrastructure assets and carry out:
 - track inspections;
 - rail grinding;
 - track maintenance and renewal;
 - overhead line maintenance and renewal;
 - inspection of structures and earthworks; and
 - visual inspection and measurement by maintenance staff.
- 4.3.8 Viaducts, tunnels and civil engineering assets will be examined using a combination of vehicles equipped with appropriate lifts and access platforms, high-definition video and laser scan, and drone/unmanned aerial vehicle technologies.
- 4.3.9 Other elements of the maintenance regime will include:
- inspection and maintenance of electrical and mechanical equipment including the overhead line equipment and lineside locations such as auto-transformers;
 - preventative maintenance of the track systems including the use of dedicated works trains for infrastructure maintenance, rail re-profiling and other heavy-duty operations;
 - preventative maintenance for other equipment including ‘maintenance by replacement’ whereby components are exchanged, to be serviced offline in a suitable facility;
 - during the life of the railway, elements of the railway system will need to be refurbished or 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.
- 4.3.10 The assumptions underpinning the HS2 maintenance regime include:
- maintenance within the operational rail corridor will take place between the hours of midnight and 04:59 on Monday to Saturday and midnight to 07:59 on Sunday, outside passenger train operating hours unless required under exceptional circumstances and the works can be safely undertaken with trains operating 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, equipment will be located to allow daytime inspection and maintenance from a safe and secure location and without affecting operations;
- maintenance affecting services, such as servicing mechanical and electrical equipment in tunnels, will be largely mechanised and undertaken from rail-based vehicles, including the use of mobile factory trains⁷³; and
- maintenance trains will be of an electric and diesel hybrid type.

4.3.11 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.

4.3.12 Network Rail assets will be maintained separately by Network Rail.

Infrastructure maintenance facilities

4.3.13 Infrastructure maintenance operations, including routine line checks and replacement of track and overhead line equipment, will be managed and resourced from a series of infrastructure maintenance facilities (see Section 5.14).

Train flows and speeds

4.3.14 Figure 6 shows the peak hour train flow in each direction across the Proposed Scheme that has been assumed in the ES, with the exception of the sound, noise and vibration assessment as discussed in Section 8.14 which shows the peak hour one-way train flow by route section with Phases One, 2a and the Proposed Scheme of HS2 operating. These flows account for an element of growth from the year of opening.

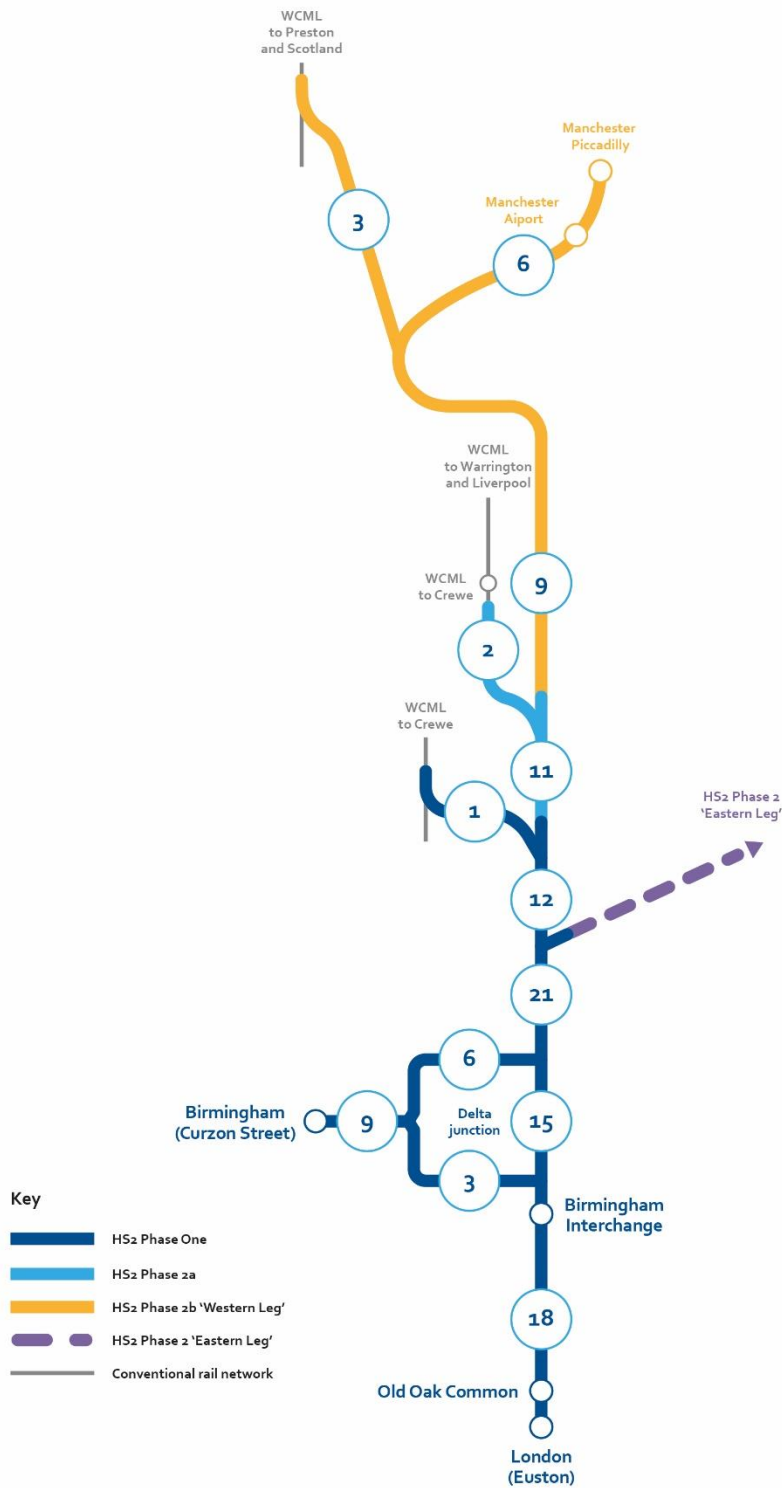
4.3.15 HS2 conventional compatible trains will transfer between the Proposed Scheme and the conventional rail network via the WCML. This will provide HS2 conventional compatible services to destinations such as Liverpool, Preston and Glasgow as well as a number of other intermediate stations. The number of HS2 trains transferring between the Proposed Scheme and the conventional rail network is shown in Figure 6. The resulting change in rail services on the conventional rail network and any associated likely significant environmental effects is reported in the ES.

⁷³ A train that carries all necessary equipment and supplies to carry out the required maintenance activities of the track and rail corridor. The trains may be stationed at infrastructure maintenance facilities (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 Heavy Good Vehicles (HGVs).

Environmental Statement

Volume 1

Figure 6: Phase One, Phase 2a and the Proposed Scheme (with growth) – peak hour one-way train flow



- 4.3.16 High speed trains will generally operate at up to 360kph (225mph), where the alignment allows. However, where possible, the route of the Proposed Scheme has been designed to allow for train speeds of up to 400kph (248mph) in the future where there is a commercial justification for doing so. Operation at up to 400kph will require demonstration that train design and infrastructure enables services to operate at that higher speed without giving rise to new or different likely significant environmental effects.
- 4.3.17 Sections of the route are designed to maximum operational speeds as follows:
- up to 360kph (225mph) on the route of the Proposed Scheme between the interface with Phase 2a and the connection to the WCML south of Bamfurlong; and
 - up to 230kph (145mph) on the Manchester spur.
- 4.3.18 The technical and operational specification for the Proposed Scheme is derived from the National Technical Specification Notices (NTSN)⁷⁴, which defines the requirements for all new high speed railways and their connections to the conventional rail network.
- 4.3.19 It is assumed that conventional compatible trains will operate over the conventional rail network at speeds no greater than existing highest line speed and will use the existing traction power electrification.
- 4.3.20 A number of modifications to the conventional rail network are required as part of the Proposed Scheme. Those outside the HS2 route corridor are outlined within Volume 4, Off-route effects. There may be further works required to the conventional rail network in future to accommodate growing demand for passenger and freight services, together with HS2 services. Should those works give rise to significant adverse environmental effects likely to require further application for consents or approval, they would require assessment at that stage.

Maintenance of HS2 trains

- 4.3.21 Passenger rolling stock maintenance planning and delivery will be conducted from the Crewe North RSD (included in the Proposed Scheme) and at the Washwood Heath RSD, which was included in the Phase One Scheme (as described in the Phase One ES³⁵).
- 4.3.22 The operation of the Proposed Scheme also requires two off-route depots/stabling facilities, which will be provided in the following locations as part of the Proposed Scheme as set out in Volume 4, Off-route effects:
- a new facility at Annandale (between Gretna Green and Kirkpatrick Fleming in southern Scotland); and
 - an existing depot at Polmadie in Glasgow where some minor works to accommodate HS2 trains are expected.

⁷⁴ Department for Transport (2020), *Railway interoperability: National Technical Specification Notices*. Available online at: <https://www.gov.uk/government/publications/railway-interoperability-national-technical-specification-notices-ntsns>.

- Train stabling and service preparation will be required to take place at Crewe North RSD, Annandale and Polmadie depots in order to reduce the number of empty train movements at the beginning and end of service, and to provide a timely start of service.

4.3.23 Light maintenance of trains, such as cleaning will also take place in sidings and at stations (see Section 5.15).

5 Permanent features of the Proposed Scheme

5.1 Overview

5.1.1 This section describes each of the features of the new high speed railway.

5.2 Environmental Design

Design principles

5.2.1 The design of the Proposed Scheme has been developed over a period of time and in line with the principles of the HS2 Design Vision⁷⁵. The Design Vision sets out nine principles grouped around the following three themes:

- people – design for everyone to benefit and enjoy;
 - design for the needs of our diverse audiences;
 - engage with communities over the life of the project;
 - inspire excellence through creative talent;
- place – design for a sense of place;
 - design places and spaces that support quality of life;
 - celebrate the local within a coherent national narrative;
 - demonstrate commitment to the natural world;
- time – design to stand the test of time;
 - design to adapt for future generations;
 - place a premium on the personal time of customers; and
 - make the most of the time to design.

5.2.2 In addition to HS2's design approach, the Secretary of State for Transport has established an Independent Design Panel (IDP). The IDP has its own terms of reference and governance structure, to ensure that designs of high speed stations, structures and other related aspects of the new railway will complement local aspirations and contribute to the natural and built environment. The IDP provides professional expertise and independent advice to help HS2 Ltd achieve a high standard of design that is also cost-effective and sustainable.

5.2.3 Good design requires a collaborative approach, where all the design elements of the project can be successfully brought together whilst also respecting the operational and maintenance requirements of a high speed railway.

⁷⁵ High Speed Two Ltd (2017), *HS2 Design Vision*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/607020/HS2_Design_Vision_Booklet.pdf.

Landscape and urban design

- 5.2.4 Landscape and urban design helps integrate and consolidate the work of other design areas, including civil engineering and railway systems, the architecture of high speed stations and structures and associated public realm walking and cycling routes and the related environmental topics.
- 5.2.5 The scope of landscape and urban design is wide. Along with new landscapes and public places, it will deliver environmental requirements such as landscape and urban integration, visual screening and appropriate settings for engineering design and architectural elements. It will also provide the opportunity to restore agricultural land, build in noise mitigation, create new ecological habitats, improve water quality, provide opportunities for green and blue infrastructure⁷⁶, build in climate resilience, absorb greenhouse gas emissions, provide settings for heritage features and historic landscapes and promote the integration of footpaths, bridleways and cycle paths.
- 5.2.6 Building on the Design Vision, HS2 Ltd has produced the Landscape Design Approach⁷⁷ and other guidance, including that listed in the Design Handbook 2017, to guide the appointed designers to achieve a high quality design which is functional, effective and responds sensitively to the local context along the route of the Proposed Scheme. The Design Vision will be underpinned by a Design Strategy specific to Phase 2b to support an integrated design approach to asset delivery. It is also intended that the landscape design will deliver a strong place identity and integrated natural and urban systems that support the environmental, social and economic objectives of HS2 including the creation of new landscapes, transformational public spaces, networks and connections.

The Green Corridor

- 5.2.7 One of HS2's key aims is to create a 'green corridor' alongside the railway that will enhance the environment for the benefit of people and nature. It is an aim that aligns with the Government's 25 Year Environment Plan to be the first generation to leave the environment in a better state than we found it. The green corridor comprises two elements, firstly the environmental mitigation needed to reduce and compensate for the impacts of constructing the railway; including the creation of wildlife habitats, green spaces, footpaths and bridleways that reconnect and integrate into the surrounding landscape. Secondly, through the provision of additional funds to help stakeholders adjacent to the route of the Proposed Scheme to realise their own green infrastructure projects, that have benefit for nature and

⁷⁶ Green and blue infrastructure refers to a network of natural and semi-natural areas of both land and water designed and managed to deliver a wide range of environmental and quality of life benefits for local communities.

⁷⁷ High Speed Two Ltd (2016), *HS2 Landscape Design Approach*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/550791/HS2_Landscape_Design_Approach_July_2016.pdf.

communities. The goal is to create an environment that, when combined, is greater than the sum of its parts; an environment that is healthier, bigger, better and more joined up.

- 5.2.8 In December 2020, the Green Corridor Prospectus⁷⁸ was published. This outlines the principles of the green corridor, provides details about how HS2 Ltd is already delivering projects up and down the route of Phase One and how communities can benefit further by getting involved. The Green Corridor Prospectus is complimented by an online mapping tool⁷⁹, which spatially tracks the development of the HS2 Ltd mitigation design and shows the progress of community projects. Further information on this is set out in HS2 Phase 2b Information Paper E28: Green infrastructure and the green corridor⁸⁰.

Low carbon resilient design

- 5.2.9 In order to manage and reduce the carbon footprint of the Proposed Scheme, HS2 Ltd is implementing the global standard for carbon management in infrastructure: PAS 2080⁸¹. The PAS 2080 framework aims to reduce whole life carbon and cost through intelligent design, construction and use, this is set out in more detail in Section 9.
- 5.2.10 Climate change resilience is built into HS2 Ltd's standards for design, construction and operation of the Proposed Scheme. Climate change resilience assessments will continue to take place throughout the design, construction and operation stages of the Proposed Scheme. Work during further design stages of the project will assess the impacts of climate change on interdependencies between the Proposed Scheme and other organisations such as rail, road, power and telecoms infrastructure operators.
- 5.2.11 Ground stability and the potential for managing subsidence as a result of mine workings, for example for the extraction of salt, brine, coal and limestone has been considered in the development of the design.

Design standards

- 5.2.12 Relevant design standards and guidance will be considered during the detailed design stages.

5.3 Rail corridor

- 5.3.1 In most locations the Proposed Scheme will comprise two railway tracks, one for northbound and one for southbound services. The width of the rail corridor will vary along

⁷⁸ High Speed Two Ltd (2020), *Green Corridor Prospectus*, December 2020. Available online at: https://assets.hs2.org.uk/wp-content/uploads/2020/12/11152821/24136_HS2_GreenCorridor_v43_CS1469_Interactive.pdf.

⁷⁹ High Speed Two Ltd (2020), *Green corridor mapping tool*. December 2020. Available online at: <https://www.hs2.org.uk/building-hs2/hs2-green-corridor/>.

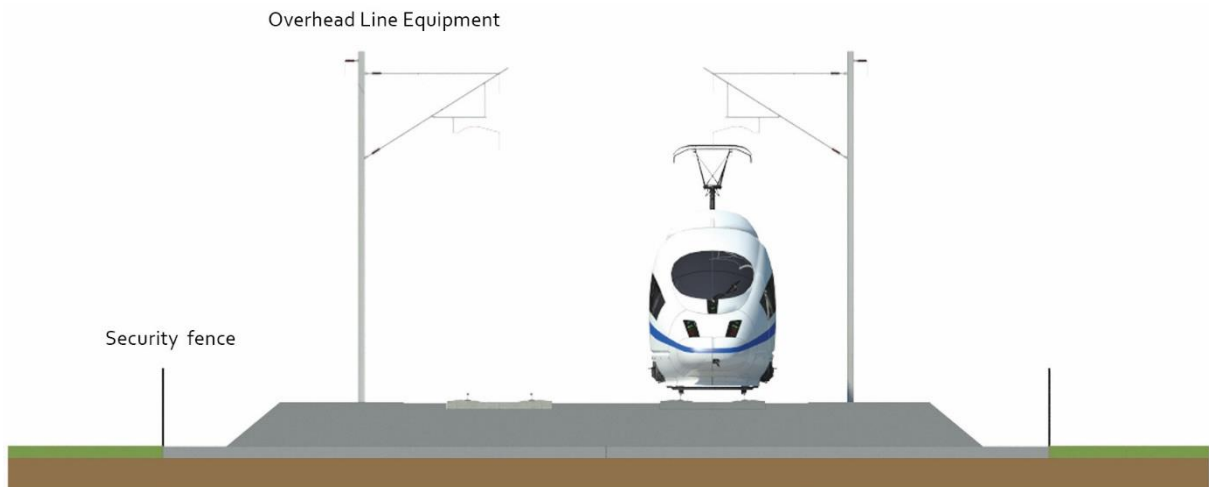
⁸⁰ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E28: The green corridor*.

⁸¹ British Standards Institute (2016), *PAS 2080: 2016, Carbon Management in Infrastructure. PAS 2080:2016*.

its length in response to the topography. The rail corridor will, in general, encompass the two tracks, associated overhead line equipment, track drainage, electricity cables, cable troughing, line-side walkways, access and noise fence barriers, where required. Power supply (see Section 5.19) and train control and telecommunications (see Section 5.20) infrastructure will be required at certain locations along the Proposed Scheme. The rail corridor will be continuously fenced.

- 5.3.2 An indicative cross section through a two-track rail corridor at ground level is shown in Figure 7.

Figure 7: Indicative two-track rail corridor



- 5.3.3 In some locations the rail corridor will be wider to accommodate more than two tracks. This will be necessary:
- where the rail corridor approaches a station;
 - where trains need to slow down and access a station, without impeding through trains;
 - for sections of the route of the Proposed Scheme where different lines converge or diverge; and
 - on the approach to an infrastructure maintenance facility or a RSD, where additional track work will be provided for trains to enter/exit the depot facilities and for sidings.

5.4 Cuttings and embankments

- 5.4.1 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 of the Proposed Scheme will cross valleys and is not otherwise on bridges or viaducts.
- 5.4.2 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.

5.4.3 Throughout the ES, cuttings and embankments are measured as follows:

- the depths of cuttings are measured from existing ground level down to the top of the rail of the Proposed Scheme; and
- the heights of embankments are measured from existing ground level up to the top of the rail of the Proposed Scheme.

5.4.4 An illustration of a cutting is shown in Figure 8 and an illustration of an embankment is shown in Figure 9.

Figure 8: Illustration of a generic cutting and cross-section of cutting

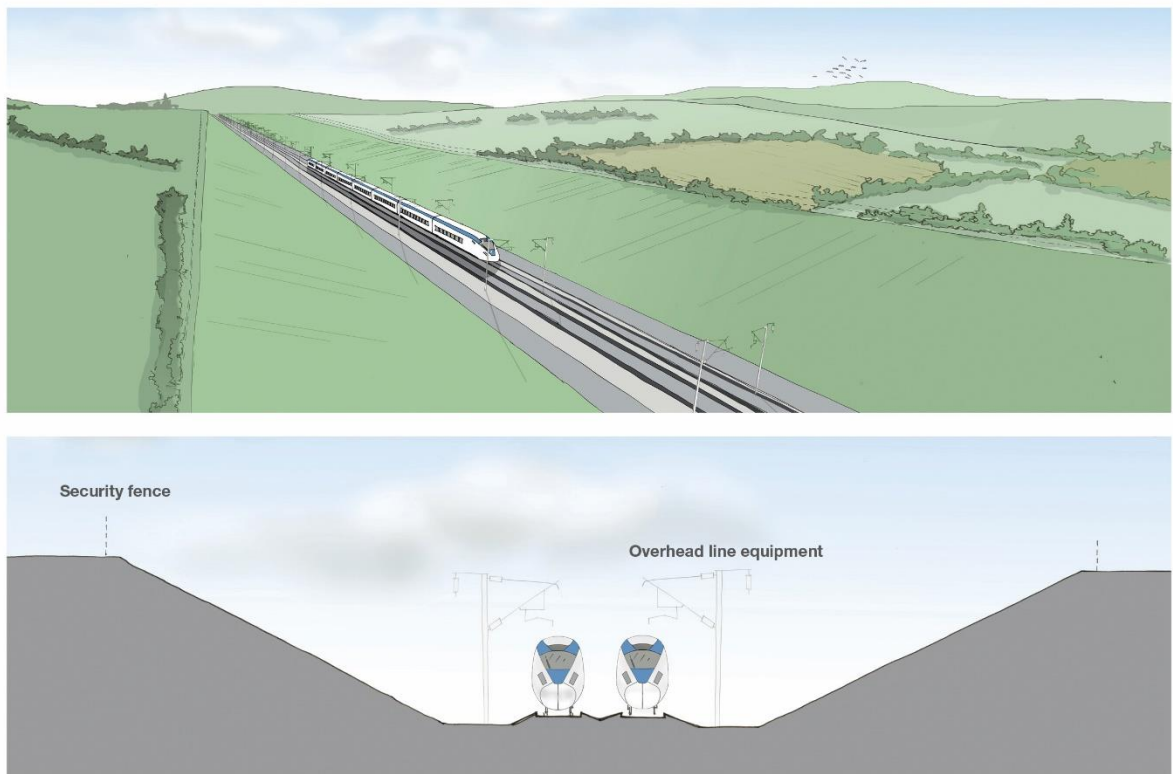
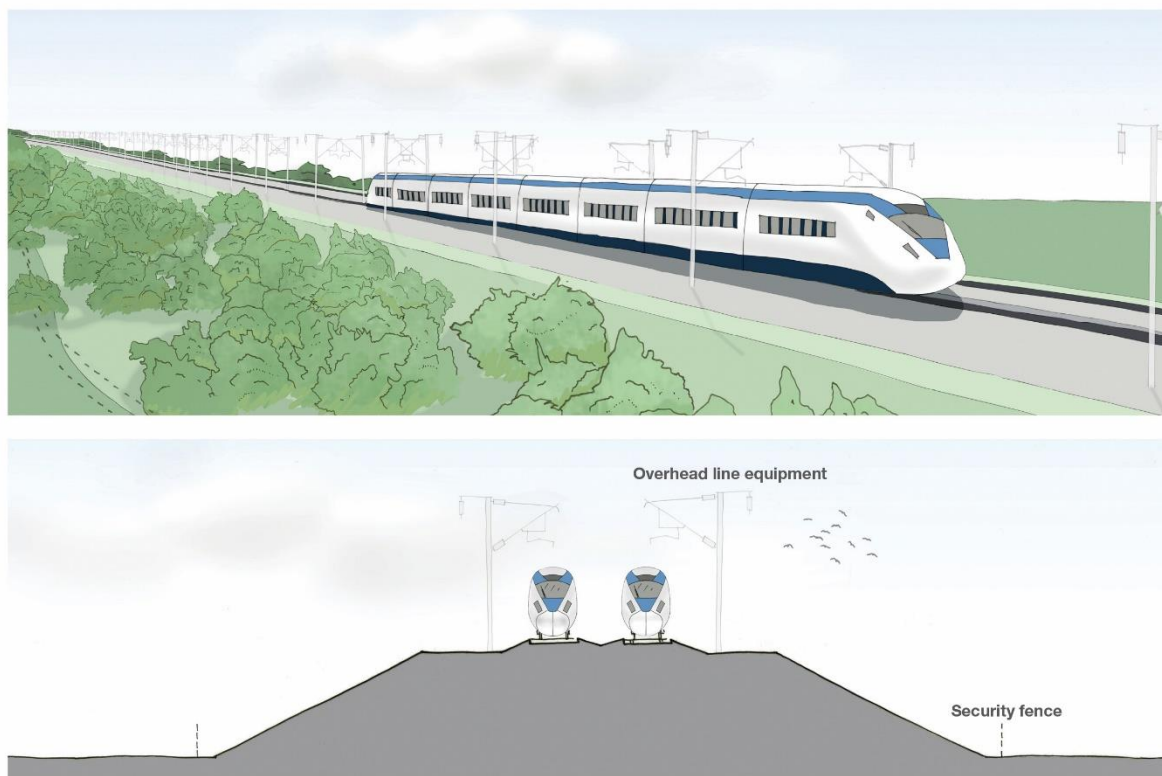
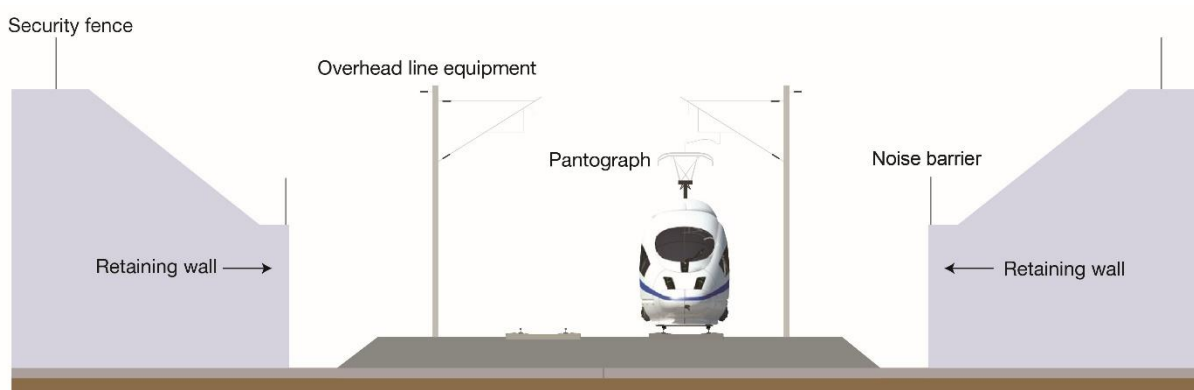


Figure 9: Illustration of a generic embankment and environmental mitigation earthworks and cross-section of embankment



- 5.4.5 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. In general, cutting slopes will be 1:3, that is for each metre of depth or height, the width of each slope will be three 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 10.

Figure 10: Illustration of generic retaining walls



- 5.4.6 Cutting and embankment slopes will generally be top-soiled and seeded to a specification suitable for the proposed final land use. 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.
- 5.4.7 Construction of the Proposed Scheme will generate significant quantities of excavated material. HS2 Ltd has developed an integrated approach to earthworks design to form embankments and environmental mitigation earthworks reusing excavated material where appropriate in order to reduce the quantity of imported material used and surplus excavated material generated. This will reduce the need for imported materials and the off-site disposal of surplus excavated material which both have associated environmental effects.
- 5.4.8 Surplus excavated materials are materials which have become surplus if their irrecoverable physical, chemical or bio-chemical quality precludes their use in the project, if there is more material available than fulfils the requirements of the project, or if the requirement for a type of material is too far away from the point of arising to make its use practicable. Surplus excavated material will be managed as described in Section 6.3 of this report.

5.5 Drainage and watercourse realignments

Railway drainage

- 5.5.1 Several drainage solutions will be used for railway drainage, based on four typical cross-sections of the railway alignment:
- on embankment, the typical drainage solution will be 'over-the-edge'⁸², where track cross-sections will be profiled to direct the rainwater flows to open ditches on each side;
 - where mitigation earthworks are adjacent to embankments and prevent direct run-off, track drainage will be collected in channels. The channels will outfall to carrier drains running through the mitigation earthworks at regular intervals, connecting to the track drainage ditch proposed at the outside toe of the mitigation earthworks;
 - in cuttings, the track will be drained by filter drains typically on both sides of the track; and
 - on viaduct, drainage will be by carrier drains which form part of the viaduct structure.
- 5.5.2 All railway drainage will be attenuated prior to discharge where required. Attenuation has been designed for a 1 in 100 year annual rainfall probability event, with an additional 40% allowance for climate change resilience.

⁸² Over-the-edge drainage is where surface water is allowed to drain from the railway track or highway carriageway, over the edge and down an embankment slope directly into open ditches.

- 5.5.3 Through the rural section of the route of the Proposed Scheme, attenuation will typically be provided by balancing ponds. These balancing ponds will be of three types: attenuation ponds, infiltration ponds and hybrid ponds. Attenuation ponds will attenuate peak flows so that runoff generated from the railway track discharges at the 'greenfield runoff rate' to a nearby watercourse. This is equivalent to the runoff rate prior to any development (i.e. a green field), thereby reducing the risk of localised flooding. Infiltration ponds will allow runoff to be absorbed into the ground where conditions are suitable. Hybrid ponds combine features of both attenuation and infiltration ponds.
- 5.5.4 Balancing ponds may be unlined or lined in concrete depending on the requirements of local geology. 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.
- 5.5.5 At some locations where the alignment is in cutting, a gravity drainage solution (using downhill flows only) would not be possible. In these locations the railway surface water drainage will be pumped up to a balancing pond or tank, for storage prior discharge.
- 5.5.6 Surface water runoff within urban areas will typically be stored within an attenuation tank due to spatial constraints. The tank will discharge to surface water or to a combined sewer, at a controlled rate to be agreed with the utility owner.

Highways Drainage

- 5.5.7 Highway drainage system will typically be based on the category of the highway. A kerb and gully system will typically be used for urban and major roads, while rural roads will be drained by a filter drain and/or ditch.
- 5.5.8 For highway diversions, surface water will be attenuated prior to discharge. Attenuation has been designed for the 1 in 100 year annual rainfall probability event, with an additional 40% allowance for climate change resilience. Similar to the railway drainage, attenuation will typically be provided in balancing ponds in rural areas, and in attenuation tanks in urban areas. Pumping will be provided for some highway alignments in cutting that cannot discharge using gravity.
- 5.5.9 In rural areas, discharge will be to watercourses at 'greenfield runoff rate'. In urban areas, discharge will be to surface water or combined sewer at a controlled rate to be agreed with the utility owner.
- 5.5.10 For minor highway realignments, like-for-like drainage will be provided, and the discharge rate will match the existing discharge rate.
- 5.5.11 Accommodation accesses, HS2 accesses, and PRow will be drained by over-the-edge drainage without any formal provision (e.g. drainage ditches).

Buildings and facilities drainage

- 5.5.12 Sewage from the infrastructure maintenance facilities and RSDs and other manned facilities will be discharged into adjacent sewers, where appropriate capacity is available. On-site treatment or collection of foul effluent may be necessary in specific cases.
- 5.5.13 Surface water runoff from stations, 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 runoff and improve discharge water quality. The drainage system will also incorporate pollution control devices such as oil and silt traps where necessary.

Land drainage

- 5.5.14 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 runoff 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.

Replacement floodplain storage areas

- 5.5.15 Watercourse crossings will be designed to reduce losses of flood storage areas. Wherever losses of such of flood storage areas are anticipated provision will be made on a precautionary basis in the design to replace this storage at the affected location on and 'volume for volume' and where reasonably practicable a 'level for level' basis.

Watercourse crossings

- 5.5.16 New structures will be required to carry the railway over existing watercourses, ranging from box culverts (a tunnel which is pipe or box shaped, that carries a stream or open drain under a road or railway) to underbridges (a bridge carrying the Proposed Scheme over other features). 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 and freeboard. Bridge soffits (the underside of a bridge) will be raised above the one in 100 year annual rainfall probability event, including allowances for climate change and freeboard. The freeboard is 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 reduce as far as reasonably practicable the risk of blockage by floating debris.

Watercourse realignments and diversions

- 5.5.17 Watercourses will need to be realigned or diverted in some cases. Where watercourses will be diverted, this may result in changes in flow regime within discrete sections of channel. Channel flows will be designed and maintained in consultation with the relevant drainage authority. The methods to realign or divert watercourses are described in more detail in Section 6.12 of this report.
- 5.5.18 Rivers and streams will be reinstated, where reasonably practicable, with a natural-looking appearance, including appropriate planting, taking account of the requirements of the Water Framework Directive (WFD). Appropriate access will be provided to watercourses to allow for maintenance.

5.6 Highways (roads) and public rights of way

- 5.6.1 New, diverted or realigned roads and public rights of way (PRoW), such as footpaths, bridleways, cycleways and byways, will be constructed to the appropriate standard for each location. Alterations to major roads will be designed using the UK's national standards given in the Design Manual for Roads and Bridges (DMRB)⁸³. However, country lanes are very different to the main road network, and it is important to retain the existing character of minor rural routes where reasonably practicable. Since most published standards do not cater adequately for this type of road, HS2 Ltd has developed a set of design criteria which is based on experience from High Speed 1 (HS1) and industry good practice. These will be applied where new, realigned or diverted routes are required, helping them to retain a similar 'feel' to other roads in the locality. Local authority design standards will also be used, where appropriate, together with national guidance. The shortest practicable route for realignment consistent with design and safety requirements will normally be used. PRoW realignment and replacement will be designed into their surroundings as far as reasonably practicable, and to retain the existing character of the route.
- 5.6.2 In certain cases where the Proposed Scheme crosses major trunk roads with the potential for predicted road widening, HS2 Ltd has worked with Highways England to allow future road widening works to continue without impacting on the operation and maintenance of HS2 services. This includes, but is not limited to, underbridges, overbridges, and temporary realignments. Further detail is provided in the Volume 2, Community Area reports and Volume 4, Off-route effects where appropriate.
- 5.6.3 New or enhanced vehicular access will be required at various points to allow access to the Proposed Scheme. Facilities such as the stations, RSD and infrastructure maintenance facilities will require access at all times. Emergency access will be required to tunnel portals

⁸³ Department for Transport (2012), *Design Manual for Roads and Bridges*. Available online at: <http://www.standardsforhighways.co.uk/ha/standards/dmrbr/index.htm>.

and vent shafts, whilst occasional access will be required for maintenance purposes to features such as balancing ponds, structures, landscaped areas and line-side equipment.

5.7 Tunnels

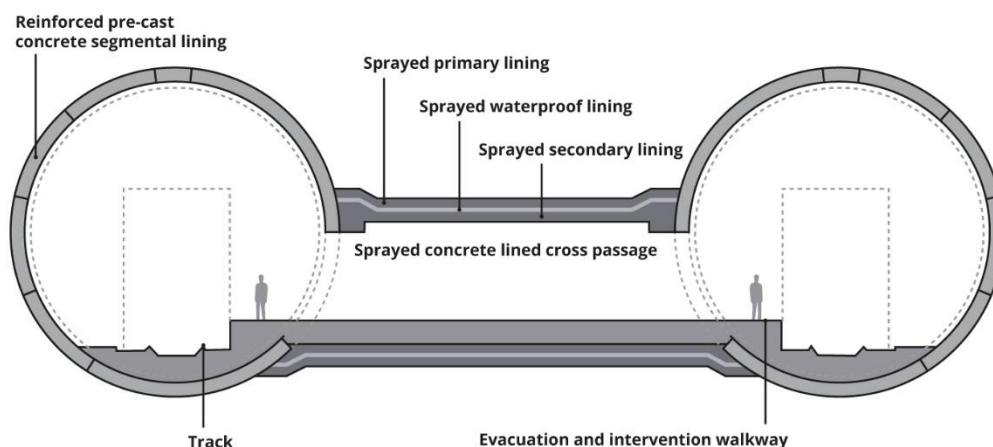
Introduction

- 5.7.1 Tunnels will be constructed at a number of locations along the route of the Proposed Scheme. Box structures will be used where rail lines (conventional, NPR or HS2) need to be carried across skewed crossings and a conventional overbridge or viaduct is not possible.
- 5.7.2 Two methods of construction will be used:
- bored, 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. Construction of a box structure is similar to construction of a cut-and-cover tunnel.
- 5.7.3 All tunnels will have portals (exit/entrance structures) whilst longer tunnels will require cross passages, vent shafts, mechanical ventilation and other services. 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. There will be buildings sited at tunnel portals and these sites may include radio masts for train control to provide continuous communication to trains, traction power equipment and distribution network operator connections. The different tunnel types and features are described in the following sections.

Bored tunnels

- 5.7.4 Bored tunnels will generally be constructed where the depth between the railway and existing ground level, or surface constraints, mean that open excavation is not practicable, and where the tunnel length is sufficient to make the use of tunnel boring machine (TBM) equipment viable (further detail about the nature and operation of TBM is provided in Section 6.16 of this report). Bored tunnels are proposed to pass underneath Crewe in the Hough to Walley's Green area (MA01) and under south Manchester in the Davenport Green to Ardwick (MA07) area as detailed within the Volume 2, Community Area reports.
- 5.7.5 Tunnel bores will usually have an external diameter of between approximately 8m and 10m and an internal lined diameter of between approximately 7m and 9m. Twin-bore tunnels will comprise two parallel bores, each containing a single rail track. They will be approximately one tunnel diameter apart, except where they approach the portals, and will be connected by cross passages at intervals.
- 5.7.6 A cross-section of a generic twin-bore tunnel is shown in Figure 11.

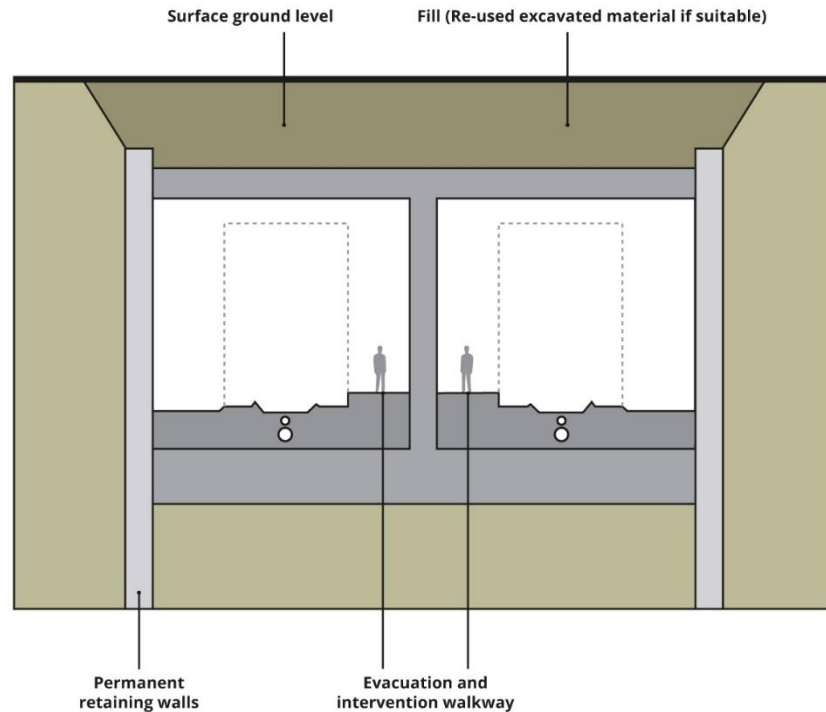
Figure 11: Cross-section of generic twin-bore tunnel



Cut-and-cover tunnels and box structures

- 5.7.7 Cut-and-cover tunnels are built by excavating the ground, building a tunnel structure, and then restoring the land above. A box structure is a linear reinforced concrete structure with a solid roof. Box structures will carry rail lines (conventional, NPR or HS2) across skewed crossings where a conventional overbridge or viaduct is not possible.
- 5.7.8 The Proposed Scheme includes both cut-and-cover tunnels and box structures as detailed within the Volume 2, Community Area reports.
- 5.7.9 Figure 12 shows a cross section of a generic cut-and-cover tunnel or box structure.

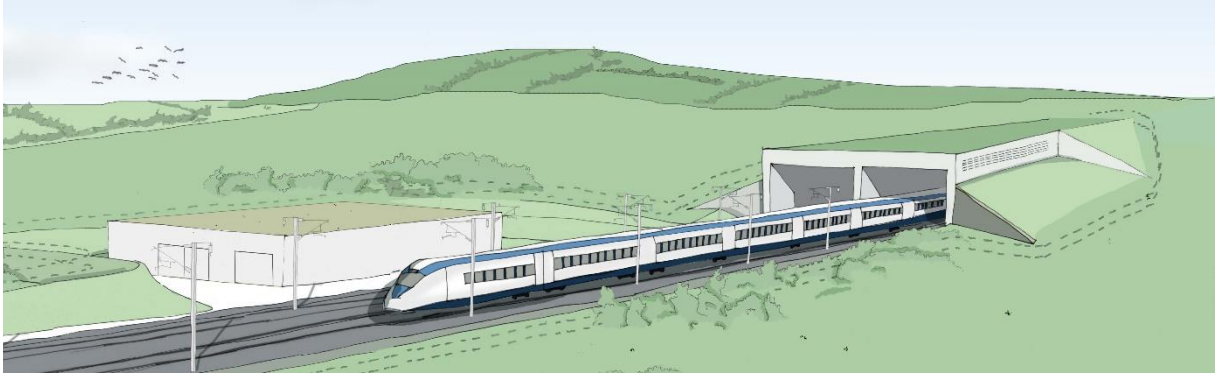
Figure 12: Cross-section of a generic cut-and-cover tunnel or box structure



5.8 Portals

- 5.8.1 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.
- 5.8.2 Tunnel portals may incorporate some or all of the following features:
- porous portal (a tapered, perforated structure usually formed of reinforced concrete at a tunnel entrance), 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;
 - surface buildings housing services such as power, telecommunications, radio control, water supply, drainage and ventilation equipment;
 - storage tanks;
 - road access for maintenance and emergency services;
 - escape routes; and
 - a minimum 550m² rescue area for parking and hardstanding for service vehicles (which will also be used in the event of an emergency).
- 5.8.3 An illustration of a cut-and-cover tunnel portal in a non-urban location is shown in Figure 13.

Figure 13: Illustration of a cut-and-cover tunnel portal in a non-urban location



5.9 Ventilation and intervention (vent) shafts

- 5.9.1 Some tunnels will require vent shafts to the surface, which will be spaced approximately every 2-3km. The vent shafts will provide access for maintenance, pressure relief from the rail tunnels and emergency intervention, and will allow for mechanical ventilation for smoke control purposes in the event of a train fire in the tunnel. They will incorporate both lifts and stairs, terminating at ground level in headhouses, which will accommodate ventilation fans, lift winding gear and other plant, together with emergency access doors. The design and external appearance of headhouses will be approved by relevant local authorities in order to fit into the local surroundings.
- 5.9.2 An illustration of a generic vent shaft and headhouse in an urban location is shown in Figure 14 and in a non-urban location in Figure 15.

Figure 14: Illustration of a generic ventilation shaft and headhouse in an urban location

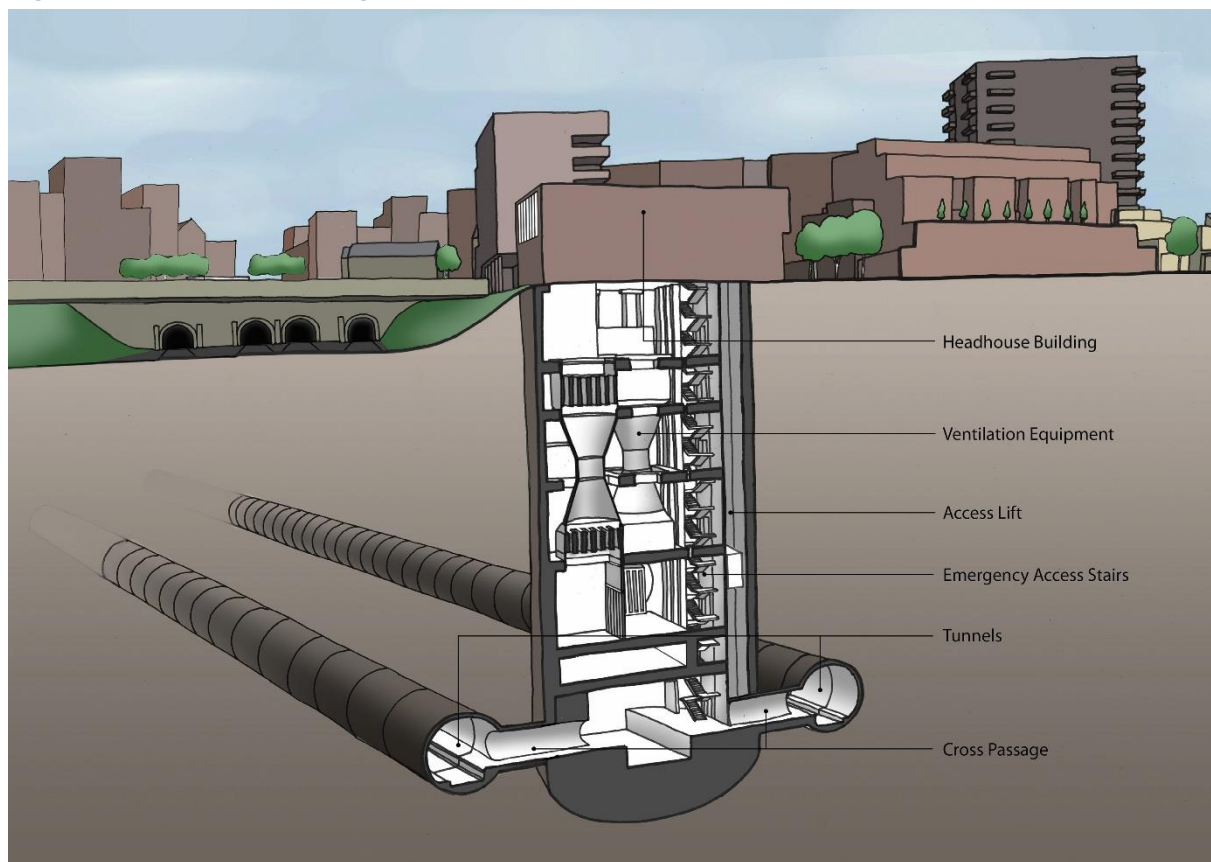


Figure 15: Illustration of a generic ventilation shaft and headhouse in a non-urban location



- 5.9.3 Ventilation equipment and control cabinets will be required within some of the tunnels. For tunnels with shafts, axial fans (a fan consisting of a rotating arrangement of vanes or blades which act on the air) will normally be installed into the shafts. These will supply or extract air to/from the tunnels either via dampers (a framed opening in a wall fitted with moveable horizontal slats for admitting air and or light) at the headhouses or, where required to control noise, through the roof of the headhouse. Piston effect pressure relief may also be

provided via these shafts, or, again where required to control noise, through the roof of the headhouse.

- 5.9.4 Under normal operating conditions, air will be pushed out of the vent shafts as each train approaches and will be drawn in after each train has passed. If a train stalls in the tunnel, the fans will be used to eject warm air at some shafts or portals, whilst drawing in ambient air at others. In the event of a fire, the fans will be used in a similar way to eject smoke and supply fresh air.
- 5.9.5 For tunnels without ventilation shafts, and in some tunnels in addition to shafts, ventilation will be provided by jet fans (axial fans with a free standing inlet and outlet, mounted on the walls of a tunnel and used to control the movement of air in the tunnel) located within the tunnel, providing ventilation from one portal to the other. These fans will be switched off under normal conditions, but will be activated in the event of an emergency and for periodic testing. Shorter tunnels can usually be naturally ventilated.

5.10 Cross passages

- 5.10.1 For safety reasons, longer tunnels will have cross passage evacuation escape routes, spaced at a maximum every 500m, between individual twin-bore tunnels and access routes from the surface. Cross passages will be located at least 350m from a vent shaft. These will be used for rescue, maintenance and evacuation purposes. The cross passages will be a minimum of 1.5m wide and 2.25m high. Additional cross passages for the sole use of emergency services will be provided at each vent shaft. These will be a minimum of 2.3m wide and 2.3m high.

5.11 Bridges

- 5.11.1 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.
- 5.11.2 Throughout the ES, the heights of overbridges (bridges over the Proposed Scheme) are measured from the top of the rail of the Proposed Scheme to surface level on the bridge above. For underbridges (bridges carrying the Proposed Scheme over other features) heights are measured from ground level to the underside of the bridge.
- 5.11.3 Overbridges will typically be constructed of concrete or weathering steel. Intermediate piers are likely to be of reinforced concrete construction on pad (a foundation structure that spreads the imposed loads over a sufficient area to reduce stress on foundation material, often described as shallow foundations) or piled foundations (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), subject to ground conditions. Typical height clearances will be 7.15m (from rail level to the underside of the bridge). Generally, bridge parapets (low walls along the edges of the bridge, to protect people from falling) will be 1.8m in height where above the railway lines.

- 5.11.4 Underbridges 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 year annual rainfall probability event, including allowances for climate change and freeboard. Throughout the ES, the heights of underbridges are measured from ground level to the underside of the bridge. Figure 16 is an example drawing of a single-span overbridge. Figure 17 is an illustrative example of a pedestrian underbridge.

Figure 16: Illustration of a generic single-span bridge

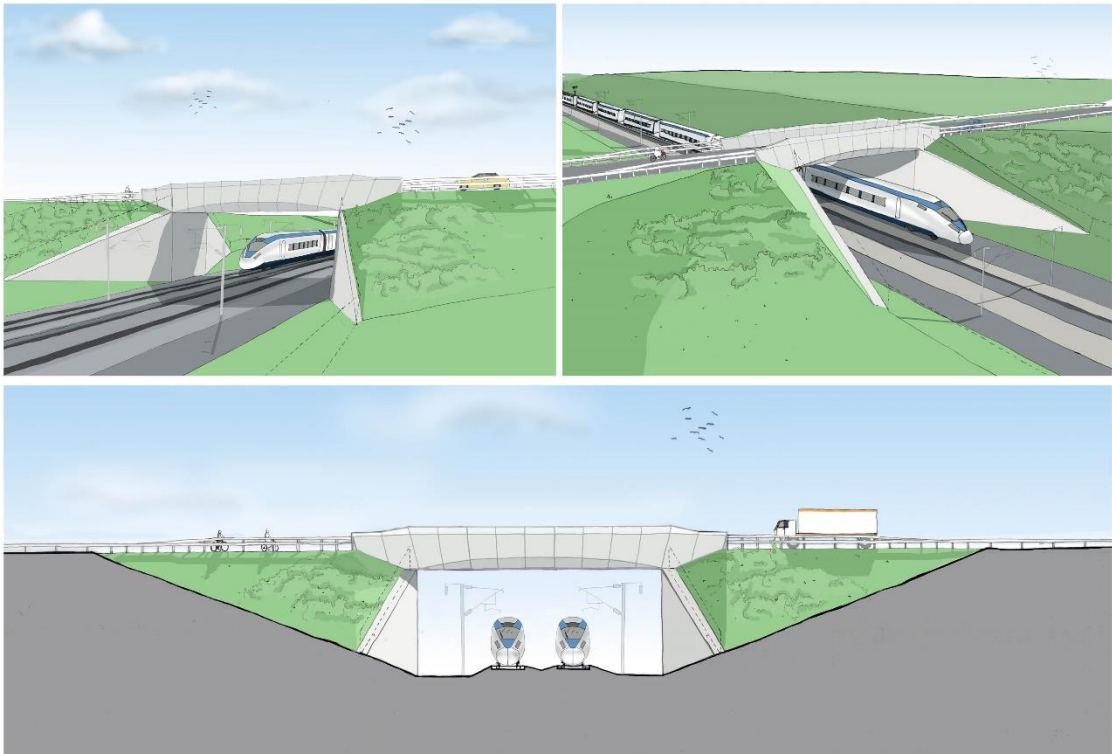
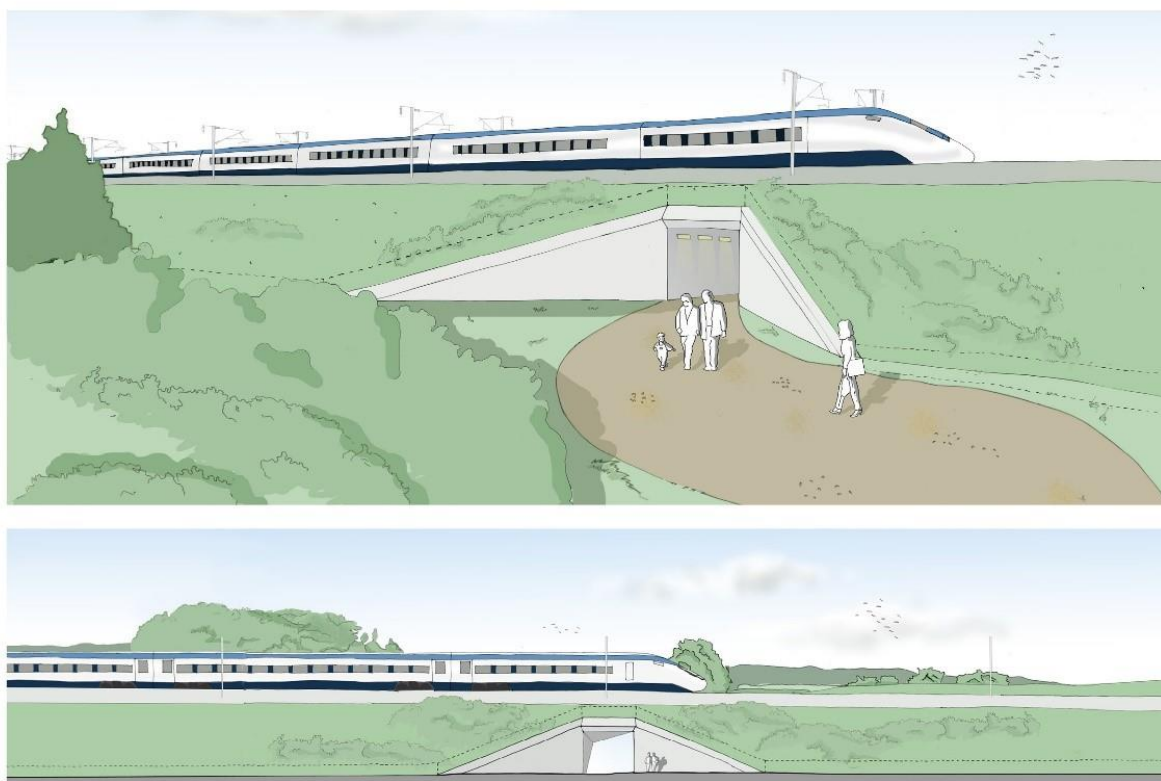


Figure 17: Illustration of a generic pedestrian underbridge



5.12 Viaducts

- 5.12.1 Viaducts are constructed where embankments will 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.
- 5.12.2 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 year annual rainfall probability event, including allowances for climate change and freeboard.
- 5.12.3 Throughout the ES, the heights of viaducts are measured from ground level to the top of the rail of the Proposed Scheme.
- 5.12.4 The standard viaduct design is proposed to have a solid wall on the viaduct edge (the parapet) approximately 1m above track level. This will provide edge protection and a degree of incorporated noise mitigation. Where further noise mitigation is required, additional noise barrier elements will be mounted on top of this parapet wall. In addition, train derailment

protection will also be provided on viaducts. Figure 18 and Figure 19 are illustrative examples of high and low-level viaducts.

Figure 18: Illustration of a generic high viaduct

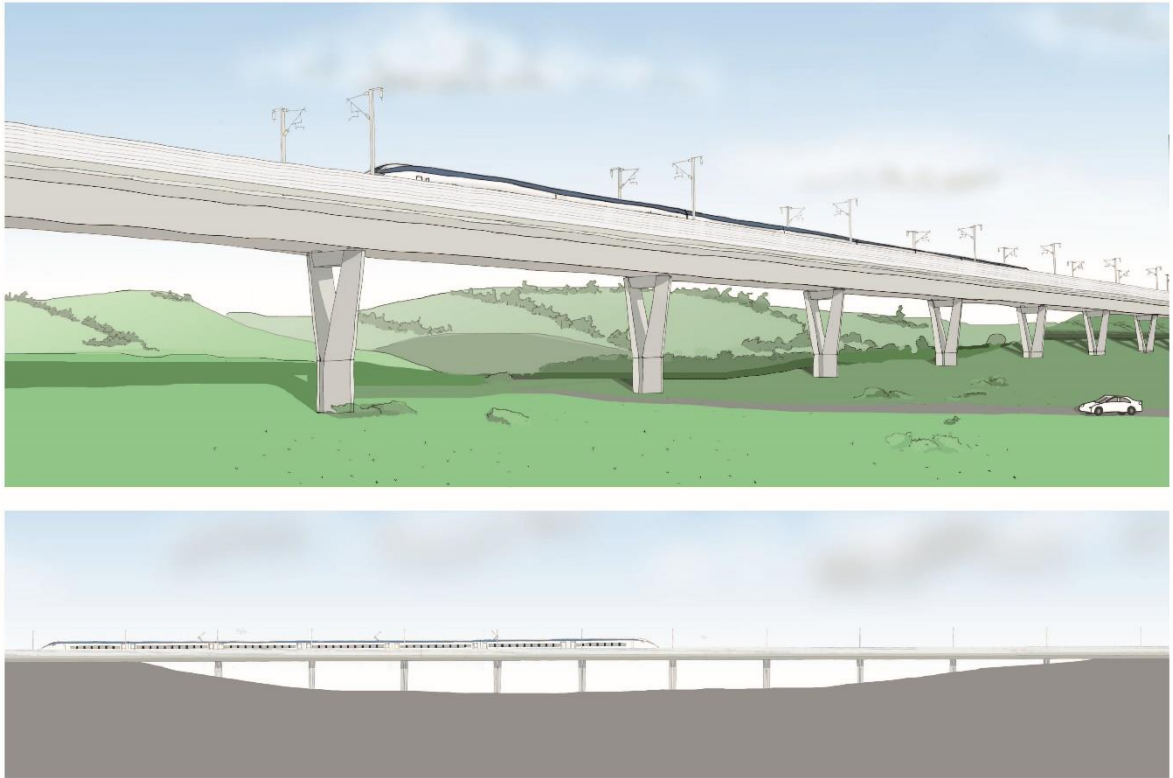
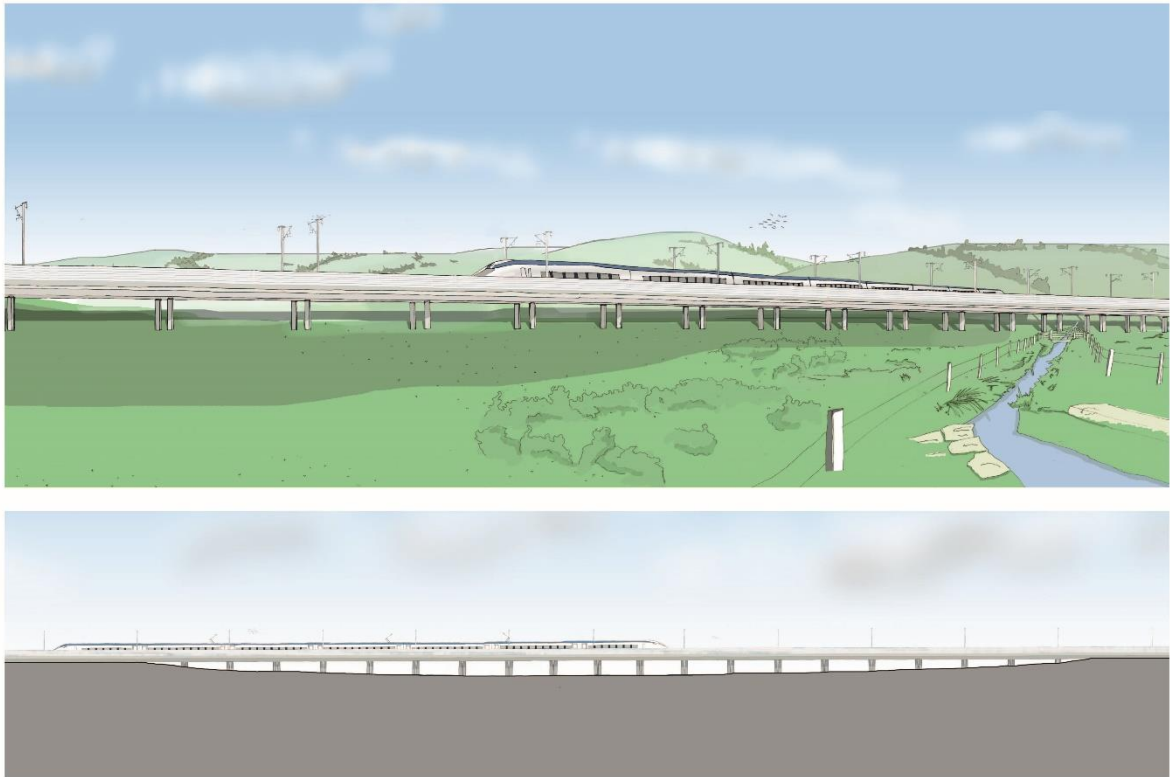


Figure 19: Illustration of a generic low viaduct



5.13 Stations

- 5.13.1 The Proposed Scheme will include two new high speed stations:
- Manchester Piccadilly High Speed station, a terminus station, located adjacent to the existing Manchester Piccadilly Station; and
 - Manchester Airport High Speed station, an intermediate station, located to the west of both the M56 and Manchester Airport.
- 5.13.2 The two proposed stations have individual design requirements. However, they share a number of functional characteristics. Their typical layout will consist of a platform level, providing access to/from the proposed high speed trains and NPR services, and a concourse level, providing the main circulation space and including a ticket hall, retail and refreshment facilities. Connections will be provided to other transport modes as necessary via escalators, lifts and walkways.
- 5.13.3 The design of these stations will offer opportunities to help integrate with local development plans and strategies.
- 5.13.4 Further information on the emerging station designs and layout is provided in the Volume 2, Community Area reports: Hulseheath to Manchester Airport (MA06) and Manchester Piccadilly Station (MA08).

5.13.5 In addition to the new high speed stations, works will be required to a number of existing stations on the conventional rail network in order to facilitate the operation of HS2 services. These comprise:

- Preston Station (see Volume 4, Off-route effects, Section 4); and
- Carlisle Station (see Volume 4, Off-route effects, Section 5).

5.14 Maintenance facilities for HS2 operational infrastructure

5.14.1 Infrastructure maintenance operations will be managed and resourced from a series of infrastructure maintenance facilities. These will include:

- an infrastructure maintenance depot (IMD) which will be the main depot from which infrastructure maintenance will be managed. This will be located at Calvert, Buckinghamshire which is included in the Phase One scheme (as described in Volume 1 of the Phase One ES³⁵);
- a centralised infrastructure maintenance base – rail (IMB-R) which will be a facility with rail access, to both the Proposed Scheme and the conventional rail network, to manage and resource infrastructure maintenance activities. An IMB-R is required to provide on track maintenance machine stabling along the route. This will be located at Stone, Staffordshire and is included in the Phase 2a scheme (as described in Volume 1 of the Phase 2a ES³⁶);
- two satellite IMB-R, which will supplement the centralised IMB-R. These will be facilities with rail access to the Proposed Scheme and, some cases, the conventional rail network, and variable levels of additional functional requirements based on the local infrastructure and adjacent maintenance facilities. The satellite IMB-R will enable temporary satellite stabling of railway maintenance vehicles to help optimise the works during periods of maintenance and avoid railway maintenance vehicles having to depart from and return to the Stone IMB-R within the maintenance period. One will be located at the Crewe North RSD in the Wimboldsley to Lostock Gralam area (MA02); and one at Ashley in the Hulseheath to Manchester Airport area (MA06). Further information is provided in the relevant Volume 2, Community Area report; and
- maintenance facilities based at each HS2 station, which will provide the minimum level of functional requirements to support a maintenance team including a rapid response service to attend to service affecting faults.

5.14.2 Maintenance facility locations have been selected, so far as reasonably practicable, so as to:

- be of sufficient size to accommodate engineering trains;
- limit the land to be acquired;
- combine more than one type of facility at the same location, including sharing a site with an operational facility such as a station or RSD; and
- facilitate use of resources, such as maintenance staff, from the local community.

5.14.3 IMB-R will be required to provide:

- stabling (the parking of the infrastructure maintenance trains whilst out of service);
- light maintenance of the infrastructure maintenance trains;
- storage areas for materials, spare parts and plant; and
- servicing and replenishing of the infrastructure maintenance trains, including refuelling, cleaning, refilling water tanks and emptying toilet tanks.

5.14.4 The Calvert IMD and Stone IMB-R may be operational 24 hours a day, seven days a week. Maintenance works and stabling at the satellite IMB-R will only be during periods of planned or unplanned maintenance, as required. Maintenance activities at the satellite IMB-R will generally be undertaken during the night-time and temporary stabling will generally be during the day.

5.15 Maintenance of HS2 trains

Rolling stock depots and train stabling

5.15.1 Passenger rolling stock maintenance planning and delivery will be conducted from the Crewe North RSD and at the Washwood Heath RSD. They will provide facilities for:

- train servicing (interior and exterior cleaning, refilling water tanks and emptying of toilet tanks);
- light and heavy maintenance; and
- stabling.

5.15.2 Both RSD will be operational 24 hours a day, seven days a week.

5.15.3 Crewe North RSD will be located to the north of Crewe in the Wimboldsley to Lostock Gralam area (MA02), occupying land between the existing WCML and the route of the Proposed Scheme south of Winsford. Further information is contained in the relevant Volume 2, Community Area report.

5.15.4 The Washwood Health RSD will be located in Birmingham and was included in the Phase One scheme (as described in Volume 1 of the Phase One ES³⁵).

5.15.5 The operation of the Proposed Scheme also requires two off-route depots/stabling facilities, which will be provided in the following locations as part of the Proposed Scheme as set out in Volume 4, Off-route effects:

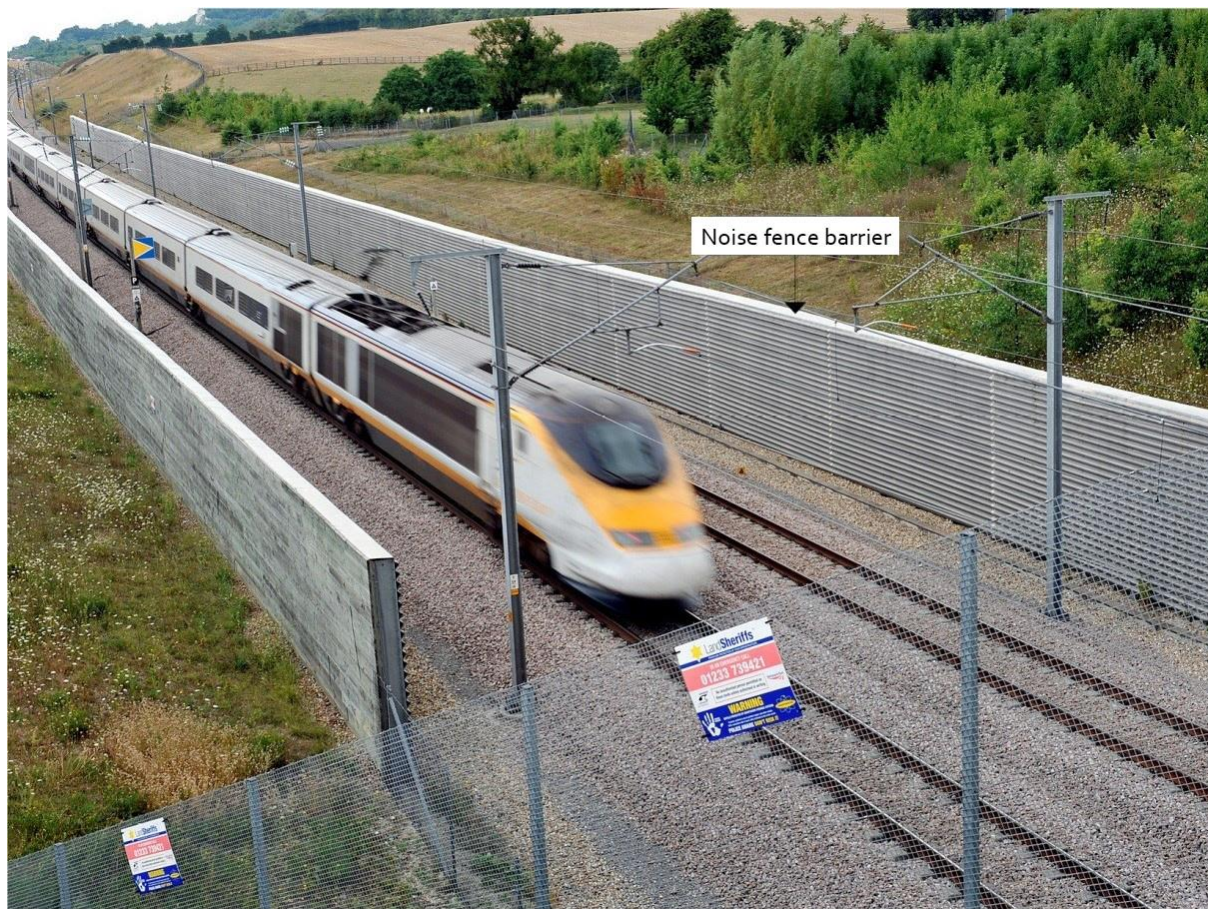
- a new facility at Annandale (between Gretna Green and Kirkpatrick Fleming in southern Scotland); and
- an existing depot at Polmadie in Glasgow where some minor works to accommodate HS2 trains are expected.

- 5.15.6 Train stabling and service preparation will be required to take place at Crewe North RSD, Annandale and Polmadie depots in order to reduce the number of empty train movements at the beginning and end of service, and to provide a timely start of service.

5.16 Noise barriers

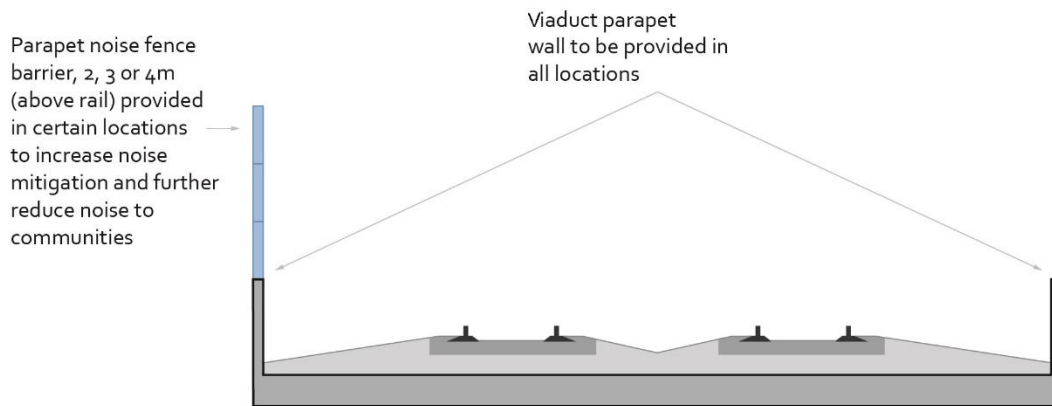
- 5.16.1 The Proposed Scheme will include noise barriers where needed to avoid or reduce significant airborne noise effects. The barriers will generally take the form of landscape earthworks or noise fence barriers. The locations of noise barriers are shown in the Volume 2, Community Area map books and Volume 4, Off-route effects map book.
- 5.16.2 The extents and heights of noise barriers are designed to reduce 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.
- 5.16.3 Noise effects will be reduced at many locations along the route of the Proposed Scheme by engineering structures, such as cuttings, and by landscape earthworks provided to avoid or reduce significant visual effects. Noise fence barriers will also be used at locations along the route of the Proposed Scheme to reduce noise effects. An example of a noise fence barrier is shown in Figure 20.
- 5.16.4 Throughout this ES, the heights of noise fence barriers and landscape earthworks are measured as follows:
- where located at grade or on embankment, the heights of noise fence barriers are measured from the top of the rail of the Proposed Scheme; and
 - where located at the top of cuttings, the heights of noise fence barriers are measured from the ground level.

Figure 20: Photograph of a noise fence barrier



- 5.16.5 On viaducts, where further noise mitigation in addition to the standard 1m parapet wall described above may be required to avoid or reduce significant noise effects, the parapet wall will be enhanced to provide an acoustically absorptive noise barrier of a total height of 2m, 3m or 4m above rail level in certain locations. Throughout this ES, the heights of parapet noise fence barriers are measured from the top of the rail of the Proposed Scheme.
- 5.16.6 A cross section of a generic viaduct showing the provision of increasing heights of parapet noise fence barrier is shown in Figure 21.

Figure 21: Cross section of a generic viaduct including parapet noise fence barrier



5.17 Site restoration and landscape treatment

- 5.17.1 All temporary plant, materials, equipment, buildings, access roads and vehicles will be removed from the site when construction is complete.
- 5.17.2 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 on that land are complete. Where this is agricultural land it will be returned to farming and restored to an Agricultural Land Classification (ALC) grade equivalent to its original or as otherwise agreed.
- 5.17.3 Mitigation design will be developed to respond to the appropriate landscape strategies and design objectives set out in HS2 Ltd's Landscape Design Approach⁸⁴ (e.g. to conserve, enhance, restore or transform landscapes in response to landscape character and context, and associated landscape integration requirements in relation to the Proposed Scheme). The following may be provided (among others) within restored areas to compensate for, replace, or enhance resources adversely affected during construction:
- habitat for wildlife species; and
 - compensatory planting and restoration of landscape features and elements, to enhance connectivity and integration.
- 5.17.4 Any areas of replacement habitat will be established and appropriately monitored to maintain the long-term conservation status of the species/habitat.

⁸⁴ 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.

5.17.5 Landscape design solutions, as set out in the Landscape Design Approach, can provide multiple benefits, including landscape integration, visual screening, noise mitigation, habitat creation, and the protection and enhancement of heritage assets, as indicated in Figure 22. 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 and landscape character connectivity).

Figure 22: Landscape design solutions

Support local economies

Woodland planting to integrate railway could also be locally managed as coppice woodland, which respects historic landscape character and traditional woodland management.

Positive use of excavated materials

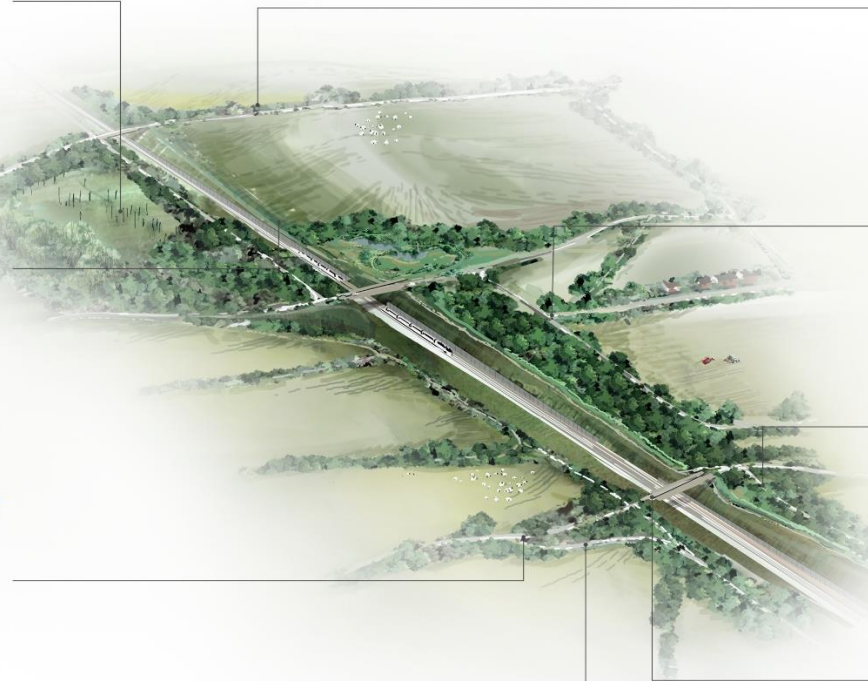
Excavated material carefully designed to screen views of HS2 from local receptors, and returned to agriculture. Contouring to be natural and reflect the character of local topography.

Community and visitor features

Earthwork and planting features that can provide landscape enhancement and HS2 observation areas for the community and visitors.

Promote local walking & cycling network

Provide opportunities for enhancing health and wellbeing in publicly accessible areas. Look to recreate local landscape features.



Conserve or enhance local landscape character

Hedgerows with tree species reinstated and enhanced to reflect landscape character and reconnect locally fragmented planting areas.

Access

Severed routes will be reconnected and integrated into wider access networks.

Planting character

Planting area to be shaped to respond to the scale and character of local planting and earthwork patterns.

Positive integration of structures

Earthworks and large scale planting used to integrate realigned bridge structure with the local landscape.

- 5.17.6 Landscape design can facilitate biodiversity enhancement by linking existing features such as ponds, streams or waterways with woodlands, copses or hedgerows.
- 5.17.7 Trees and shrubs planted within restored areas will be a species of local provenance. Section 9 of this report provides further information on the approach to mitigation and monitoring.

5.18 Track

- 5.18.1 The track for the Proposed Scheme will either be laid on crushed stone (ballasted track) or on concrete slabs supported on a continuous structural layer (slab track).
- 5.18.2 The EIA has been undertaken on the assumption that the type of track laid produces the reasonable worst case scenario for each relevant environmental topic assessment. The assessments that include construction vehicle movements (e.g. traffic and transport and related topics such as air quality) have included the number of heavy goods vehicles (HGV) movements associated with ballasted track as this is associated with larger numbers of HGV movements. 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 of the Proposed Scheme.

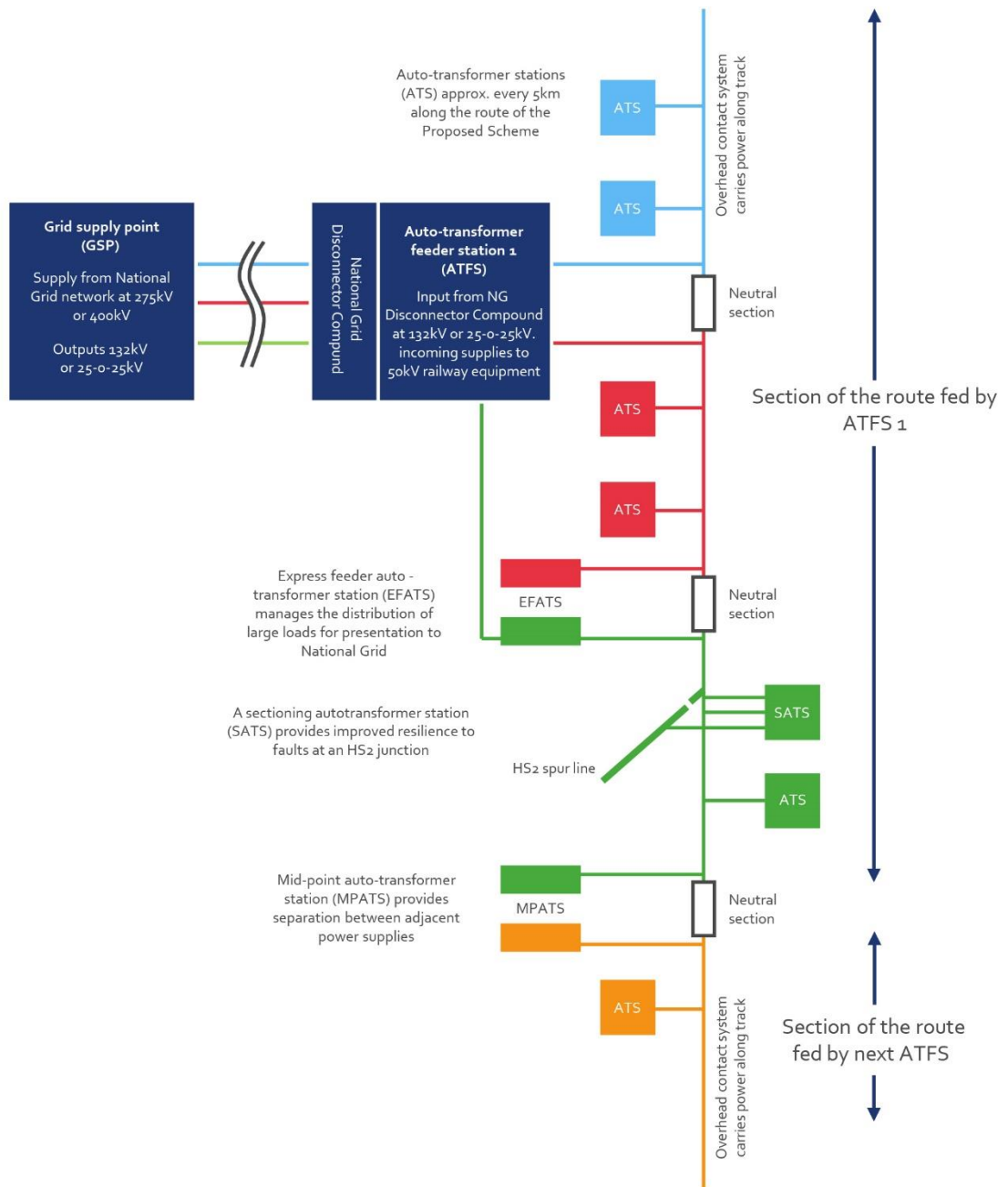
5.19 Power supply

- 5.19.1 Figure 23 shows the HS2 system for providing power to high speed trains. Power supply infrastructure will be provided within the high speed rail corridor. This system will be a continuation of the system proposed across all phases of HS2 to enable operation of trains throughout the network.
- 5.19.2 Power will be provided from National Grid 400kV or 275kV grid supply points (GSP) to auto-transformer feeder stations (ATFS) via a National Grid disconnector compound. The ATFS will be located adjacent to the route of the Proposed Scheme. Underground cables or overhead power lines will be provided from the GSP to the National Grid disconnector compound directly adjacent to the ATFS. The connection will operate at either 132kV or 50kV. If the connections are required to transition from overhead power lines to underground cables, or vice versa, compounds of approximately 0.5ha that are accessible by road will be provided.
- 5.19.3 Each National Grid GSP will contain switchgear, power transformers and ancillary equipment to step down the electrical power from 400kV or 275kV.
- 5.19.4 The ATFS sites will contain 25kV switchgear, traction transformers, and ancillary equipment. In some cases they will also include termination of 132kV overhead power lines, 132kV switchgear, and provision for electrical phase balancing equipment. Each ATFS will be located adjacent to the route of the Proposed Scheme, generally occupying an area of approximately 2.75ha and will require road access.
- 5.19.5 Auto-transformer stations (ATS) will be provided along the route of the Proposed Scheme at approximately 5km intervals. They will require road access and each will occupy an area of

approximately 0.2ha. Where larger sectioning equipment is required at an ATS, in order to enable electrical sectioning of the railway overhead catenary system (OCS), the site is called a sectioning auto-transformer station (SATS). SATS compounds will occupy between 0.3 and 0.5ha of land.

- 5.19.6 Mid-point auto-transformer stations (MPATS) will allow the overhead line to be sectioned at the boundary between two electrical sections fed by different ATFS. MPATS will require an area of approximately 0.2ha and will require road access.
- 5.19.7 Express feeder auto-transformer stations (EFATS) manage the distribution of large electrical loads and transfer them to an adjacent National Grid incoming connection at the same ATFS. EFATS will require approximately 0.5ha of land and will require road access.
- 5.19.8 In many cases traction power sites will also accommodate non-traction power switchgear, transformers, and telecommunications and signalling equipment. Section 5.20 of this report provides further detail on train control and telecommunications.
- 5.19.9 Traction power will be distributed to trains through overhead line equipment. This will comprise steel masts and cantilever supports, contact wires to carry the current to train pantographs, catenary wires, auto-transformer feeder wires and earth wires. The masts and frames will be approximately 8.5m high and will typically be spaced at approximately 45-65m intervals along the track.
- 5.19.10 The overhead line equipment will be divided into major electrical sections, which will be fed by separate supplies from the National Grid. Each major section is shown as a different colour in Figure 23. A neutral section is a section of overhead line that provides safe separation of two different power supplies while allowing the passage of train pantographs.
- 5.19.11 Electrical power will be required for other purposes in addition to the traction power supply, including points heating, junction lighting, for rail systems (e.g. train control and telecommunications equipment), lighting and the operation of equipment in tunnels and on viaducts. Arrangements will be made with the local Distribution Network Operator for auxiliary power supplies at each location where they are required. These locations will also be provided with suitably sized compounds and access roads which is likely to be approximately 0.3ha.

Figure 23: Diagram showing the indicative process of supplying power to the trains



5.20 Train control and telecommunications

- 5.20.1 The train control system will be a computer-based interlocking system, controlled from a route-wide Network Integrated Control Centre (NICC) at the Washwood Heath RSD in Birmingham (as described in Volume 1 of the Phase One ES³⁵).
- 5.20.2 The Proposed Scheme will not require traditional trackside signals for its operation. However, a number of conventional railway signals and associated equipment will be required on HS2 infrastructure where HS2 trains transition onto the conventional railway.

- 5.20.3 The associated line-side equipment on the route of the Proposed Scheme will include cable troughs, axle counter equipment, switches and crossings control equipment, marker boards and location cabinets, generally no more than 1-3m high.
- 5.20.4 HS2 will use radio communications as part of its railway operations and train control systems. Telecommunications sites will be located approximately every 2-3km along the route of the Proposed Scheme to provide transmission network capability for all the railway systems including for train safety-critical communications applications. In some instances, additional sites have been included in areas with a high density of traffic for example at RSD. Telecommunications sites will often be located within the traction power sites (as described in Section 5.19 of this report) where it is practicable to do so.
- 5.20.5 Each telecommunications site will include a railway telecommunications mast and associated radio transmission equipment, control equipment and/or cabinets. Non-traction power switchgear and transformers will also be included and road access will be provided. The railway telecommunications masts will typically be at a height of 15-20m above track level but, in limited circumstances, depending on what is required to achieve reliable and adequate radio coverage, may extend up to a maximum 30m above track level. The associated radio transmission equipment will be mounted at the base of the transmission masts. A network of optical fibre cables will be laid in troughs beside the track to connect all line-side equipment, including the extended communications equipment within the footprints of the traction power sites, to the NICC.

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 of the Proposed Scheme, which is assumed to commence in 2025, with operation planned to start in 2038. An indicative construction programme for each community area is included within the Volume 2, Community Area reports. An indicative construction programme for the off-route works is included within Volume 4, Off-route effects.

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;
 - temporary site haul routes;
 - the diversion, realignment and widening of roads and junctions, and/or the provision of temporary alternative routes;
 - the diversion or realignment of PRow and private accesses, and/or the provision of temporary alternative routes;
 - the diversion and realignment of sections of existing railways, watercourses and utilities;
 - borrow pits, to provide acceptable material for construction of the Proposed Scheme; and
 - transfer nodes (a location where bulk deliveries or excavated materials leave or enter the construction worksites from public roads) and railheads, which will be used for the movement of excavated material and delivery of construction materials and plant.
- 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 will arise, such as tunnel portals and deep excavations. Temporary material stockpiles will be required to limit the distances over which such materials need to be transported. Land used only for construction purposes will be restored as agreed with the owner of the land and the relevant planning authority once construction works on that land are complete.
- 6.2.3 In most cases the reasonable worst-case assumption, at the design and assessment stage, is that all structures on property falling within the land required for the Proposed Scheme will be demolished to enable construction and operation. However, as the detailed design develops it is likely that not all the properties identified for demolition would need to be demolished, for example where not all of the land is required for permanent works.

- 6.2.4 For the purposes of assessment, where land required for the construction of the Proposed Scheme is for utility works only, it is assumed that some but not all property or existing land uses (e.g. woodland or open space) within that land will be lost. Where specific assumptions on demolitions or loss of existing land use within these areas are identified, these are reported within the relevant environmental topic sections of the Volume 2 Community Area reports and Volume 4, Off-route effects.

6.3 Environmental controls during construction

Overview

- 6.3.1 The nominated undertaker, its contractors 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 of this report, environmental controls and processes contained in the EMR will provide the mechanisms for meeting environmental commitments once Royal Assent has been received. The nominated undertaker and all construction contractors will be required to comply with the CoCP, which forms part of the EMR, and a series of local environmental management plans (LEMP) which will be mandated in the CoCP and their contracts.
- 6.3.2 Site-specific control measures at a local level will be included within the LEMP, which will be developed during the Parliamentary process and detailed design stage in consultation with the relevant stakeholders. The Proposed Scheme extends across eight local authorities, necessitating engagement with a wide range of stakeholders. The draft CoCP is, therefore, intended to provide a framework to ensure a consistent approach.
- 6.3.3 The draft CoCP is presented in Volume 5: Appendix CT-002-00000. This section summarises its key elements. The CoCP will be in draft form until it is finalised when the Bill receives Royal Assent.

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 and all construction 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 aspects, such as soil handling and dust management, will be considered from industry best practice documents as set out in the draft CoCP.

Environmental management system

- 6.3.6 As part of its implementation of Phase One of HS2, HS2 Ltd (as nominated undertaker) has developed and implemented an environmental management system (EMS) in accordance with BS EN ISO 14001⁸⁵. The scope of the EMS covers all phases of HS2 during construction and operation.
- 6.3.7 The EMS for the Proposed Scheme 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;
 - 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

- 6.3.8 The nominated undertaker will require each of its lead contractors (a construction company that is directly contracted for the works by the nominated undertaker) to have an EMS certified to BS EN ISO 14001. Their EMS 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.
- 6.3.9 Lead contractors will be required, as part of their EMS, 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

⁸⁵ British Standards Institution (2004), *BS EN ISO 14001:2004 Environmental management systems*.

by the nominated undertaker (e.g. suitability of construction phase plans) and by any statutory consents required.

- 6.3.10 The lead contractors' EMS 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 EMS, as appropriate.
- 6.3.11 The lead contractors' EMS 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' EMS will be subject to review and acceptance as being suitable by the nominated undertaker.

Enforcement and local environmental management plans

- 6.3.12 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.
- 6.3.13 The LEMP 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 (including, for example, air quality and noise monitoring reports) that reflect the general requirements of the CoCP.

Monitoring

- 6.3.14 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 EMS. Aspects to be monitored will include the impact of the works and the effectiveness of mitigation measures. Any actions that may be necessary for compliance will be identified.

Considerate Constructors Scheme

- 6.3.15 Lead contractors will be required to sign up and adhere to the Considerate Constructors Scheme⁸⁶. 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.

⁸⁶ Considerate Constructors Scheme. Available online at: www.ccscheme.org.uk.

Community relations

- 6.3.16 HS2 Ltd has produced a Community Engagement Framework⁸⁷ for Phase One of HS2, which sets out how HS2 Ltd and its contractors, as well as their sub-contractors, will undertake community engagement during the construction of the HS2 project. The framework is being implemented on Phase One of HS2 and is applicable to all phases of HS2 (and is therefore expected to be applied during construction of the Proposed Scheme).
- 6.3.17 The objectives of the framework include:
- to set out how HS2 Ltd and its contractors will undertake community engagement during the construction of the project;
 - to provide clarity and reassurance to HS2 Ltd's stakeholders about how community engagement activity will be managed; and
 - to help HS2 Ltd be a good neighbour to local communities, including by providing accurate and timely information about construction works and offering opportunities to influence them, where appropriate.
- 6.3.18 The nominated undertaker and its contractors will provide appropriately experienced community relations personnel to implement the Community Engagement Framework. 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, particularly focusing on:
- those who may be affected by construction impacts, including local residents, businesses, landowners and community resources;
 - the specific needs of protected groups (as defined in the Equality Act 2010)⁸⁸; and
 - its approach to handling agricultural property matters as set out in the relevant farmers and growers guide⁸⁹.
- 6.3.19 Regular meetings will be held between the lead contractor, the nominated undertaker, the local authority and representatives of the local community or other stakeholders to discuss construction issues and the forthcoming programme of works.

Advance notice of works

- 6.3.20 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

⁸⁷ High Speed Two Ltd (2017), *Community Engagement Framework*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/625971/hs2_community_engagement_framework.pdf.

⁸⁸ *Equality Act 2010*. Her Majesty's Stationery Office, London.

⁸⁹ High Speed Two Ltd (2019), *Guide for Farmers and Growers*. Available online at: <https://www.gov.uk/government/publications/hs2-guide-for-farmers-and-growers>.

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. In addition, information on the works will also be available on the HS2 website and at appropriate locations along the route of the Proposed Scheme.

Core working hours

- 6.3.21 The contractors will apply for consents for the proposed works from the relevant local authority under Section 61 of the Control of Pollution Act 1974⁹⁰. Applications will include details on proposed working hours.
- 6.3.22 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 insofar as reasonably practicable, unless otherwise permitted by the relevant local authority under Section 61 of the Control of Pollution Act.
- 6.3.23 Guidance on site-specific variations to core hours and/or additional hours likely to be required will be included within the LEMP following consultation with the relevant local authority.
- 6.3.24 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

- 6.3.25 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

- 6.3.26 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

⁹⁰ *Control of Pollution Act 1974*. Her Majesty's Stationery Office, London. Available online at: <https://www.legislation.gov.uk/ukpga/1974/40/contents>.

hour a day, seven days a week basis to maximise the use of the specialised equipment. Where reasonably practicable, material will be stockpiled within the site boundary for removal during normal working hours.

- 6.3.27 Works within existing lines, stations and at railheads, track laying activities and work requiring the closure, or limiting the use of, major transport infrastructure will be required during construction. These works will be managed through possessions and blockades. Possessions limit the use of the railway for trains or access to stations for passengers and blockades are used where works require the total closure of a line or station. These activities are normally undertaken during night-time, Saturday afternoons, Sundays and/or bank holidays, for reasons of safety or operational necessity so that there is less disruption to services and passenger access/movements. Such activities may often involve consecutive nights of work over weekend possessions, and on occasion may involve longer duration. Activities outside core working hours that could give rise to disturbance will be kept to a reasonably practicable minimum.
- 6.3.28 Where HS2 works affect highways, these will be planned to minimise, where practicable, the impact on users. Where there is a requirement for partial or full closures, the timing of closures, scope of traffic management and diversion routes will be discussed with the relevant highway authorities prior to submission, as appropriate. The project will aim to avoid conflicting requirements in any one area through early planning of highway works, depending on the scale and scope of the likely disruption.
- 6.3.29 Certain operations such as earthworks are season- and weather-dependent. In these instances, the nominated undertaker's contractors may 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.
- 6.3.30 Certain other specific construction activities may 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 of core working hours.
- 6.3.31 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, will be unsafe or harmful to 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

- 6.3.32 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

- 6.3.33 Vehicles accessing the construction compounds can be divided into three broad categories:
- HGV: articulated lorries for plant and materials, concrete trucks, bulk tipper trucks, abnormal/oversize loads;
 - light goods vehicles (LGV): 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.
- 6.3.34 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 associated working areas will be on designated site haul routes within the construction area, often along the line of the new railway or parallel to it.
- 6.3.35 The traffic and transport assessment considers 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;
 - the delivery mechanisms for temporary and permanent closures, diversions or realignments of highways (roads and PRoW); and
 - the proposed traffic management and logistics strategies.
- 6.3.36 Contractors will be required to ensure that impacts on the local community from all types of 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 and vehicle sharing.
- 6.3.37 The measures in the draft CoCP include clear controls on vehicle types, hours of site operation and routes for HGV, to reduce the impact of road based construction traffic. These include the use of low emission vehicles during construction of the Proposed Scheme, i.e. Euro VI HGV, Euro 4 petrol and Euro 6 diesel cars and LGV. 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 excavated material

- 6.3.38 Reasonable precautions will be taken in relation to the handling and storage of agricultural and forestry soils as set out in the draft CoCP. This will include separate handling of different types of soils, ensuring soils are in a suitable condition to be handled, covering stockpiles, prevention of soil contamination and controls of weeds.
- 6.3.39 Dust and air quality management measures will be implemented to limit pollution arising from the transportation and storage of materials as set out in the draft CoCP. This will include measures such as covering materials, handling them in enclosed or shielded areas, careful siting of stockpiles and mounds and covering, watering or stabilising them.
- 6.3.40 Likewise, dust pollution associated with processing and crushing rock, for use as aggregate or other materials within the works, and for conveying material, processing, crushing, cutting and grinding and liming will be limited through measures set out in the draft CoCP. This will include the use of conveyors, enclosures and water sprays.
- 6.3.41 As set out in the draft CoCP all reasonably practicable measures will be put in place to avoid/limit and mitigate the deposition of mud and other debris on the highway.
- 6.3.42 Excavated material that is uncontaminated (or can be remediated to a suitable standard and can be used for site engineering and restoration purposes) will be managed in accordance with the controls specified by industry codes of practice or in accordance with appropriate environmental permit or exemption from permitting as set out in the draft CoCP.
- 6.3.43 If excavated material is not required or is unsuitable for the construction of the Proposed Scheme or in restoring borrow pits it will be considered waste.

Waste management

- 6.3.44 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.
- 6.3.45 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 resort⁹¹.

- 6.3.46 HS2 Ltd has adopted circular economy principles for the specification, design, procurement, construction, and operation and maintenance and end of life phases of the project⁹². The circular economy is an alternative approach to the typical 'linear' way of using resources. By finding opportunities of remanufacturing, reusing or recycling materials and keeping them in use for longer, both resource use and waste generation can be reduced. HS2 Ltd's circular economy principles are to keep resources in use for as long as possible, recover and regenerate resources at the end of each use and keep resources at their highest quality and value at all times.
- 6.3.47 HS2 Ltd's approach to the circular economy is complemented by its overarching principles 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 for materials efficiency' 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.
- 6.3.48 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.
- 6.3.49 Further information regarding waste management is given in the draft CoCP.

Management of surplus excavated material

- 6.3.50 Where material cannot be used in features of the Proposed Scheme, such as embankments and landscape earthworks, it becomes surplus excavated material. The disposal of surplus excavated materials, either off or on site (under licence) is the last resort and so HS2 Ltd has, within financially acceptable limits, sought beneficial uses for this material. HS2 Ltd has considered the following potential routes for disposal of the material:
- re-use opportunities off-site;
 - treatment off-site;
 - disposal in existing landfills;
 - restoration of mineral sites; and

⁹¹ Unacceptable material Class U2 material will be disposed of directly to hazardous landfill. Class U2 'hazardous waste', is described in the *Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clause 3(i)*. Availability online at: <http://www.standardsforhighways.co.uk/ha/standards/mchw/vol1/>.

⁹² High Speed Two Ltd (2017), *HS2 Circular Economy Principles*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657833/hs2_circular_economy_principles.pdf.

- local placement - deposit on land within or adjacent to the Proposed Scheme (including land raising).

6.3.51 Surplus excavated material that displays hazardous properties will be unsuitable for use within the design of the Proposed Scheme and will be disposed to landfill as hazardous waste.

Re-use opportunities off-site

6.3.52 There is potential for surplus excavated material to be used beneficially at sites not connected with the Proposed Scheme. There may also be manufacturing processes, such as the use of clay for landfill capping, and restoration of mineral sites which could use some of the materials generated within the Proposed Scheme. However, developments likely to occur during the construction period of the Proposed Scheme are unlikely to have planning permissions at this stage and the demand from manufacturing cannot be foreseen at present. As a result, it is not possible to forecast the potential schemes which might use surplus excavated material from the Proposed Scheme and this option cannot therefore be assessed further as a viable solution for the purposes of this ES. During the final design process, however, further consideration will be given to development opportunities and other infrastructure projects with a materials deficit.

Treatment off-site

6.3.53 Consideration has been given to the potential for the use of off-site treatment centres for the management of contaminated soils and for the selective separation of materials such as concrete and brick. It is anticipated that this will only apply to a small proportion of the total surplus excavated materials.

Existing landfill sites

6.3.54 The viable landfill sites which could accept surplus excavated material and are likely to still be in operation at the time the Proposed Scheme is under construction have been considered taking into account the distance of the site from the Proposed Scheme and the mode of transport which would be used (road, rail or barge). It is anticipated that this will only apply to a small proportion of the total surplus excavated materials.

Mineral sites

6.3.55 A review of potential third party mineral extraction sites which may require material for restoration has been carried out. It is anticipated that this will only apply to a small proportion of the total surplus excavated materials.

Local placement

6.3.56 Disposal of surplus excavated material on land already required for the Proposed Scheme, referred to as local placement, was a further option considered. Local placement can reduce

the need for off-site road transport and disposal of surplus excavated materials and can reduce the associated environmental impacts arising from HGV movements on the public road network.

6.3.57 Local placement has been considered but does not form a feature of the Proposed Scheme.

Noise and vibration strategy

6.3.58 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 1990⁹³, 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 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; and
- 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.

6.3.59 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.

⁹³ *Environmental Protection Act 1990*. Her Majesty's Stationery Office, London. Available online at: <https://www.legislation.gov.uk/ukpga/1990/43/contents>.

- 6.3.60 Noise insulation or ultimately temporary rehousing will enable residents to avoid being significantly affected⁹⁴ by levels of construction noise inside their dwellings. Alternatively, a resident or tenant may wish to seek compensation under the HS2 Prolonged Disruption Compensation Scheme⁹⁵ and as outlined in HS2 Phase 2b Information Paper E13: Control of construction noise and vibration⁹⁶.
- 6.3.61 Buildings qualifying for noise insulation or residents qualifying for temporary rehousing 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.
- 6.3.62 Contractors will seek to minimise disturbance to livestock from noise and vibration through liaison with the occupiers of affected farms.

Ground settlement

- 6.3.63 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, insofar as reasonably practicable, the effects of settlement.
- 6.3.64 The nominated undertaker will assess potential settlement along the route of the Proposed Scheme 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.
- 6.3.65 Measures to reduce settlement will form part of the EMR, as will survey and monitoring requirements.

⁹⁴ Information is provided in Department for Communities and Local Government (2019), *Planning Practice Guidance – Noise*. Available online at: <https://www.gov.uk/guidance/noise--2> (for example, the table summarising the noise exposure hierarchy).

⁹⁵ Prolonged disruption compensation scheme. Available online: <https://www.gov.uk/government/publications/hs2-prolonged-disruption-compensation-scheme/prolonged-disruption-compensation-scheme>.

⁹⁶ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E13: Control of construction noise and vibration*.

Extreme weather events

- 6.3.66 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 Warnings Direct service or SEPA's Floodline as appropriate in areas of flood risk.
- 6.3.67 The lead contractors will ensure that appropriate measures within the draft CoCP are implemented, and as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.
- 6.3.68 The lead contractors' EMS 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, historic environment investigations, the translocation of species and/or habitats, creation of habitats and visual screening planting.

Ground investigation and topographical 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;
 - topographical surveys to map ground contours and existing surface features;
 - soil surveys to record the soil profile characteristics; and
 - ALC to provide benchmark data for land restoration.

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 or where surveys have expired, and to inform licence applications and proposed works to translocate habitat/species;
 - historic building, non-intrusive 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 monitor conditions during main works; 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 soil 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;
 - 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 have been identified for the provision of ecological mitigation and 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 (the winter den of a hibernating animal or insect) or basking features⁹⁷; 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 will otherwise be lost will be translocated to identify appropriate receptor sites.

Archaeological and built heritage works

- 6.4.9 A programme will be developed to deliver the heritage investigation and recording works outlined in the ES and as progressed during the detailed design process. All archaeological and built heritage works will be managed in accordance with the Heritage Memorandum, which presents the commitments of the Secretary of State to heritage assets and addresses the elements of the works authorised by the Bill that have a direct impact on them. The programme will set out the key stages of investigation and recording, for example:
- detailed desk-based assessment;
 - field evaluation (to inform location-specific investigation and recording);
 - location-specific investigation and recording; and
 - archaeological and built heritage post excavation (assessment, analysis, reporting and archiving).
- 6.4.10 The provisions for the management of heritage assets during construction are set out in the draft CoCP.

Planting and other landscape measures

- 6.4.11 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

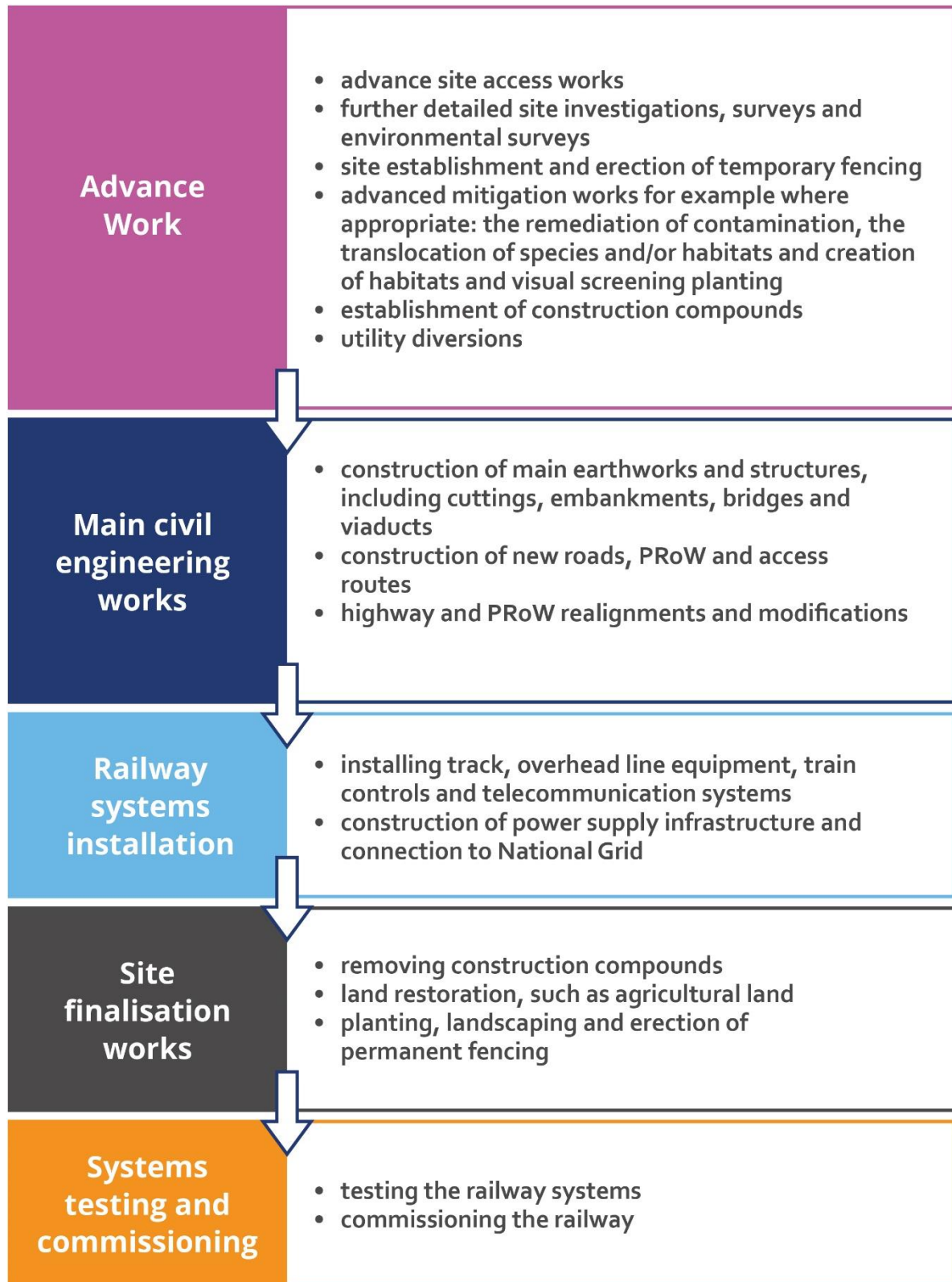
⁹⁷ Many species habitually seek out external sources of heat or shelter from heat. For example, many reptiles regulate their body temperature by basking in the sun, or seeking shade when necessary.

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 main construction works

- 6.5.1 Following the advance construction works, the main construction works along and adjoining the route of the Proposed Scheme will generally be of two broad types: civil engineering and railway systems installation. Figure 24 shows these works, alongside the advance works, site finalisation works and the systems testing and commissioning prior to commencement of operation of the railway (see Section 6.33 of this report). Some planting and habitat creation activities will be completed at the end of the main construction works.

Figure 24: Stages of main construction activities



- 6.5.2 Rail systems modification works will be required at a number of locations on the conventional railway network, including the WCML, as a result of the Proposed Scheme. This will involve a combination of civil engineering and/or railway installation works. An overview of the works required outside of the Phase 2b Western Leg route corridor is included in Volume 4, Off-route effects.

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 advance works and construction, including at construction compounds. 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 of this report.

6.7 Construction compounds

- 6.7.1 Construction compounds will be required in various locations along the route of the Proposed Scheme, and will generally be sited alongside or adjacent to the relevant works. The location and use of each compound for advance works, construction works and railway installation activities is detailed in the relevant Volume 2, Community Area reports and Volume 4, Off-route effects.
- 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 (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 3ha of land (although this may vary depending on site conditions) and will typically support up to 400 construction personnel at peak times.
- 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 typically require between approximately 0.5 and 3ha of land and will typically support up to 150 construction personnel at peak times.
- 6.7.4 Compounds used for railway installation works in most cases will be based at some of the main and satellite construction compounds which will continue to be used for this following the completion of civil engineering works. A small number of satellite compounds will be established for railway work specifically. The railway installation compounds will facilitate

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

- 6.7.5 During construction a temporary railhead will be used to receive (by rail) and stockpile materials required for the construction of the railway tracks, signals, and electrification systems. For the Proposed Scheme this will be located at Ashley in the Hulseheath to Manchester Airport area (MA06).
- 6.7.6 Some construction compounds may act as points of entry to the worksites from the public highway. Some will also act as an interface with the existing rail network for receipt and/or disposal of materials by rail.
- 6.7.7 Construction 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.
- 6.7.8 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 where there is limited space, it may be necessary to stack these units.
- 6.7.9 The total number of compounds per community area and the total number of construction personnel supported at each is provided within the Volume 2, Community Area reports, Section 2.
- 6.7.10 Overnight accommodation for construction staff will be provided at a limited number of compounds (as indicated in the relevant Volume 2, Community Area reports and Volume 4, Off-route effects). This accommodation will help to reduce daily travel for those not normally based locally. Impact on communities from construction workers has been assessed at a route-wide level, and is detailed in Section 8 of the relevant Volume 2, Community Area reports and Volume 3, Route-wide effects.
- 6.7.11 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.

- 6.7.12 Construction compounds will where reasonably practicable be connected to existing local utility services (electricity, water, data, foul sewers and surface water drainage), in order to reduce the need for generators, storage tanks and associated traffic movements. In some compounds temporary water treatment plant will be installed in accordance with measures set out in the draft CoCP.
- 6.7.13 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 in agreement with the landowner and local authority.
- 6.7.14 Some of the construction compounds will be used to manage demobilisation, testing and commissioning of the railway.

6.8 Site clearance, advance works and site mobilisation

- 6.8.1 Areas of land required permanently and temporarily for the works will be cleared, where appropriate.
- 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 typically be stripped down to the top of the subsoil layer and formation respectively, and stored in accordance with best practice as set out in the draft CoCP. 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, insofar 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 breakers⁹⁸ 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

⁹⁸ Demolition hammers or shears fitted to hydraulic excavator plant. The hammers/shears are often on long-reach booms to increase the demolition reach.

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 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

Overview

- 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 supply infrastructure, and fuel pipelines.
- 6.9.2 Discussions with utility providers have been undertaken to confirm whether utility infrastructure will need to be: positioned away from the area of work; protected from the works by means such as a concrete slab or similar; or have sufficient clearance from the works that they will not be affected.
- 6.9.3 This section provides a summary description of the working methods for the key utility diversions. It should be noted that these are standard construction methods, which are used by utilities providers on a regular basis to undertake works of this nature.
- 6.9.4 A methodology or approach will be approved by the relevant statutory undertaker (the utility company) where excavation or piling is required within the vicinity of 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 Some utilities 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 of this report.

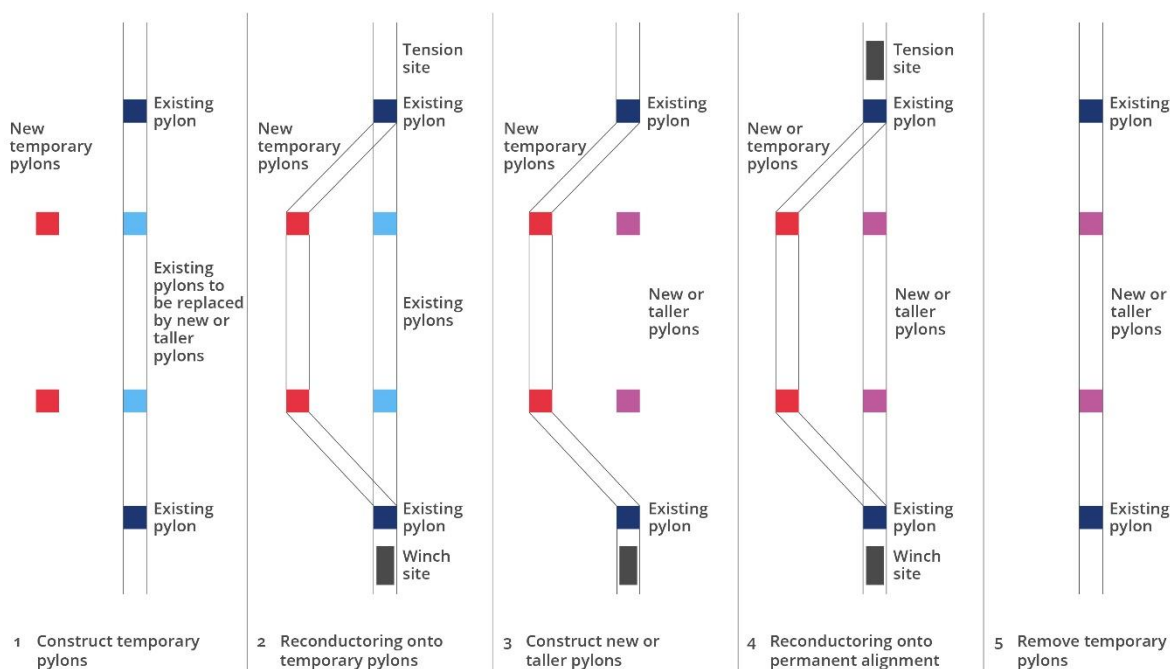
Diversion of overhead power lines

- 6.9.6 When diverting an overhead power line, the electricity supply to premises and facilities must be maintained at all times. Where it is deemed that both circuits being diverted cannot be temporarily disconnected from the transmission system at the same time a temporary diversion may need to be constructed first. Temporary pylons will be erected on-site and temporary conductors (electricity wires) strung along the route. Once the temporary diversion is in place, and live, work will start on the main diversion.
- 6.9.7 The process of removing and reinstalling the main conductors is referred to as reconductoring. In order to carry out reconductoring, a winch will be installed at one end of the main diversion site and a tension point installed at the other. Once the old conductors have been removed the existing pylons will be dismantled and removed from site and new pylons erected. Depending on the specific diversion these could be positioned in the same

location as previously (but with the conductors raised, for example, to travel safely over the route) or in a new location.

- 6.9.8 Once the new pylons have been constructed, new conductors will be winched into place. The temporary diversion will be removed once the new route has been tested and made live. During the diversion works additional earthing will be required at some of the existing pylons. This will be carried out at the next three pylons at either end of the main diversion site. The earth points will be checked regularly throughout the diversion works to ensure the safety of the operators. Figure 25 shows a simplified sequence of overhead power line diversion works.

Figure 25: Simplified sequence of works for the temporary diversion of an overhead power line



Diversions of fibre optic cables

- 6.9.9 Fibre optic telecommunication cables suspended from pylon routes will need to be temporarily diverted whilst pylons are being replaced. This is likely to be carried out in advance of reconductoring works (subject to programme). For these works, it is assumed that the diverted cables will be laid in a shallow trench in ducting (tubing or piping). Cables will be installed by pulling through ducts, following installation of the ducting. Temporary traffic management may be necessary when crossing roads or other infrastructure.

Relocation of telecommunications masts

- 6.9.10 Some telecommunications/mobile masts will need to be moved to accommodate the Proposed Scheme and replaced at alternative locations. Indicative locations for the purposes

of assessment have been identified. These locations will be agreed with the relevant utility providers and may be subject to further refinement.

Diversions and upgrades of gas and fuel pipelines

- 6.9.11 A number of high pressure gas mains will need to be diverted, upgraded or protected to ensure their ongoing safe operation and maintenance through the construction and operational phases of the Proposed Scheme.
- 6.9.12 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).
- 6.9.13 The typical procedure for installation of a gas pipeline comprises the following stages:
- works are planned and designed, including design, logistics and highways or PRow diversions;
 - temporary access tracks are constructed from crushed stone, if necessary;
 - the construction area is marked out and suitable fences are installed;
 - topsoil is stripped in line with the measures set out in the draft CoCP along the route of the proposed pipeline;
 - sections of pipe are delivered to site by HGV and are laid out along the route;
 - a trench is excavated by machine, to a specified depth for pipe placement;
 - the pipe sections are welded together, manually or by machine into one continuous pipeline; angle bends are used to change the line of direction and depth of the pipe to match the contours of the ground;
 - the welded pipe sections are lowered into the trench by sideboom tractors using belts or cradles in a carefully coordinated action;
 - the trench is then backfilled, with a layer of fine fill material around the pipe, normally using material excavated from the trench; and
 - the construction material is removed from the site, topsoil is replaced and the area is restored as closely as possible to its original pre-construction condition.

Decommissioning gas pipework

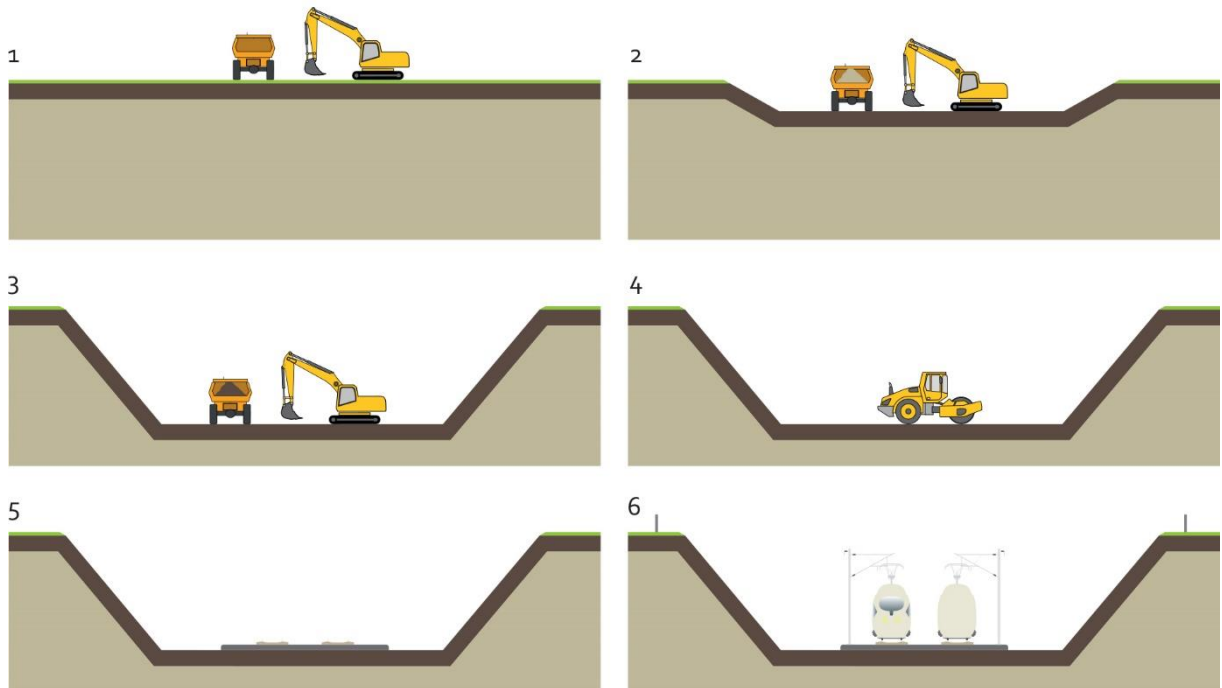
- 6.9.14 The land required for construction of the Proposed Scheme will include sections of underground pipework that are no longer in use by utility providers. Where possible, such pipework will not be disturbed and will remain in situ. However, where the pipework will need to be disturbed by construction of the Proposed Scheme it will be decommissioned and removed. Decommissioning will be done in conjunction with the relevant utility owner and using industry best practice. Any redundant pipework outside this area will be grouted, capped and left in place in accordance with standard industry procedures.

6.10 Cuttings and embankments

Cuttings

- 6.10.1 Cuttings will be excavated using excavators, graders and scrapers.
- 6.10.2 Material excavated from cuttings will be used, where reasonably practicable, to construct embankments, noise bunds and landscape earthworks including false cuttings (a means of screening a linear feature (e.g. a railway) by forming embankments on both sides of the feature). The construction of cuttings and embankments will, therefore, be interdependent, in most cases.
- 6.10.3 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 runoff 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. Figure 26 shows a generic construction sequence for a cutting.

Figure 26: Illustration of a generic construction sequence for a cutting



- 6.10.4 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.

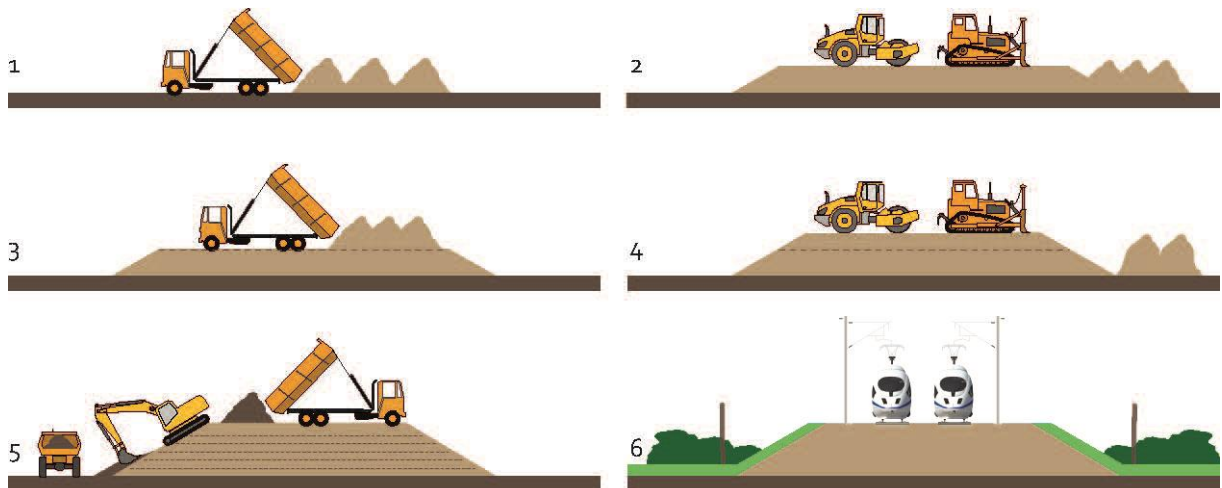
Embankments

- 6.10.5 Earthworks will include the bulk excavation of material and placing of that material to create the route of the Proposed Scheme. Embankments may be built in stages, commencing early in the construction programme, to allow uniform settlement and compaction to occur.
- 6.10.6 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 in line with the measures set out in the draft CoCP, with temporary material stockpiles being appropriately located and sloped to enable surface water runoff 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 surface water runoff 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 in line with the measures set out in the draft CoCP to the required depth, which will be determined by the proposed use (e.g. as grassland).

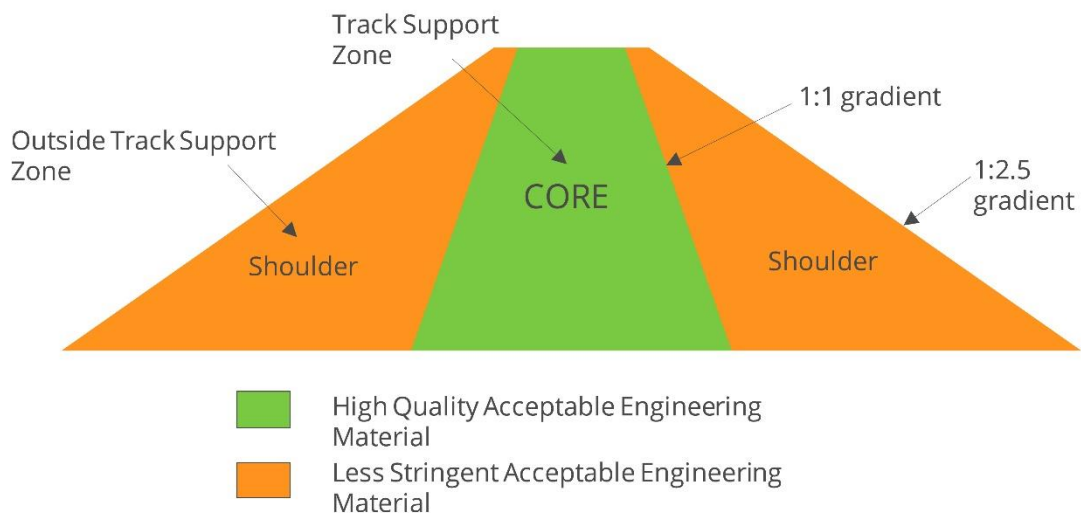
6.10.7 Figure 27 shows a generic construction sequence for an embankment.

Figure 27: Illustration of a generic construction sequence for an embankment



6.10.8 To maximise the reuse of site-won materials and reduce the quantity of high quality engineering material needed for construction, zoned embankments have been introduced into the design of the Proposed Scheme where reasonably practicable, see Figure 28. Zoned embankments only require high quality acceptable granular or stabilised cohesive materials within the track support zone (the core). In the shoulders (outside the track support zone) acceptable materials, with less stringent structural requirements can be used.

Figure 28: Indicative material composition of a HS2 zoned embankment



6.11 Sourcing acceptable engineering material

- 6.11.1 Embankments and cuttings, and any associated improvement of the existing supporting ground, are referred to as earthworks, because they are constructed from geological materials. These features must be constructed of acceptable engineering material. Acceptable engineering materials are materials whose properties are acceptable for the purpose of constructing earthworks for both the route of the Proposed Scheme and associated highway crossings.
- 6.11.2 The primary source of acceptable engineering material needed to construct the Proposed Scheme will be site-won material generated from construction operations. HS2 Ltd aims to maximise the reuse of excavated materials, limit the import of materials from other sources and reduce the export of surplus materials. Maximising the reuse of site-won materials will ensure that the need for disposal of materials off-site is reduced.
- 6.11.3 Where there is a deficit of acceptable engineering materials once the site-won material has been taken into account, other potential sources have been considered for use in the construction of the Proposed Scheme. These other sources of materials comprise:
- recycled aggregates;
 - dredged materials;
 - commercial quarries; and
 - borrow pits.
- 6.11.4 A borrow pit is an area where acceptable engineering material is extracted for use in the construction of infrastructure projects. Unlike commercial quarries, a borrow pit is dedicated to supply material to one particular project only.
- 6.11.5 The presence of natural halite (salt) deposits within the geological bedrock crossed by the Proposed Scheme between Warmingham and Hoo Green has informed a design decision to minimise the number of cuttings within this area. This has resulted in a significant deficit of acceptable engineering material in the Wimboldsley to Lostock Gralam area (MA02) and to an overall deficit throughout the Proposed Scheme.
- 6.11.6 HS2 Ltd has assessed the options to address this deficit including the engineering acceptability of alternatives and the capacity, location and likely transport routes from commercial quarries and potential borrow pits. This assessment has concluded that a limited number of borrow pits within the Wimboldsley to Lostock Gralam area (MA02) will be needed to provide the acceptable materials required to support the construction of the Proposed Scheme.
- 6.11.7 The Proposed Scheme will use four borrow pits to meet the demand for material for construction. Three of these borrow pits will be located within the land required for construction of the Proposed Scheme adjacent to the route of the Proposed Scheme in the Wimboldsley to Gralam area (MA02). This will enable the materials to be extracted and reused with no further transport impacts to the local highway network. The fourth borrow

pit will be located 4.5km (2.8 miles) east of the route of the Proposed Scheme and was selected due to the favourable geological conditions.

- 6.11.8 HS2 Ltd has considered the engineering advantages and disadvantages and potential environmental impacts of the use of borrow pits and has also reviewed the feasibility of using other alternative sources of supply for the required construction materials. Details of the volume and potential sources of materials required, an explanation of the selection of the borrow pits intended to support the construction of the Proposed Scheme and the consideration of reasonable alternatives are presented in the Borrow pit report (Appendix CT-008-00000).
- 6.11.9 Details of stakeholder engagement with a number of statutory stakeholders as well as those parties that will be directly impacted by the borrow pits, including local authorities, landowners and local residents and the environmental assessment of the borrow pits is reported in the Volume 2, Community Area report, Wimboldsley to Lostock Gralam (MA02) and Volume 3, Route-wide effects.
- 6.11.10 As further information becomes available through the design process the earthworks strategy will develop and the volume of acceptable engineering material may change, within the constraints set out within the hybrid Bill.

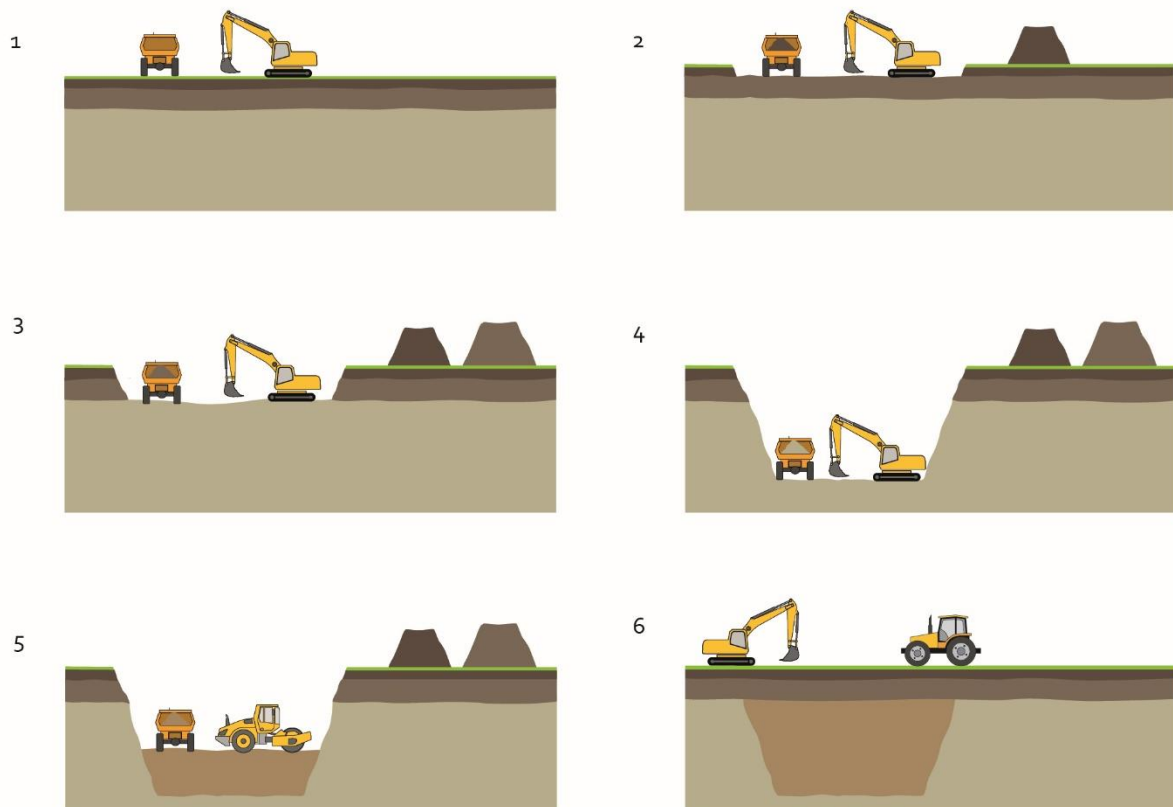
Operation of borrow pits

- 6.11.11 The construction, operation and restoration of borrow pits will be bound by the commitments of the EMR and carried out pursuant to of the discharge of deemed planning conditions in the hybrid Bill and the draft CoCP (see Volume 5: Appendix CT-002-00000), which sets out the measures required to mitigate noise, dust, traffic movements and other possible impacts on the surrounding land and communities (including working hours).
- 6.11.12 Prior to excavation and to inform site-specific restoration plans, detailed studies and, where appropriate, surveys will be undertaken. These surveys will include: topography; ground conditions; archaeology; contamination; hydrology; agriculture; soils; ecology; and landscape.
- 6.11.13 Borrow pit operation will be site specific, but, in general, site set up and operation will comprise the following:
- set up with security fences, office compound and designated processing area;
 - establishment of site haul routes to the land required for the construction of the Proposed Scheme;
 - phased removal of topsoil, subsoil (where present) and storage in bunds around the perimeter of the site in order to provide screening from nearby residential properties or roads;
 - phased extraction of useable mineral using plant and transfer to a processing area;
 - the hydrogeological regimes at the selected borrow pit sites are uncertain at this stage but the need for groundwater control during borrow pit excavation has been assumed;

- screening and/or processing of extracted material to separate the fraction of material that meets the specification for acceptable engineering materials;
- transfer of acceptable engineering mineral to the area of need on the Proposed Scheme; and
- reuse non-conforming material from screening as backfill to worked-out areas.

6.11.14 An outline programme for the operation and restoration of the borrow pits is included in the Volume 2, Community Area report: Wimboldsley to Lostock Gralam area (MA02), Section 2.

Figure 29: General borrow pit excavation and backfilling process



Restoration of borrow pits

- 6.11.15 All of the borrow pits used to support the construction of the Proposed Scheme will be restored. Restoration comprises the works delivered following completion of excavation, including backfilling, regrading of excavations, the placement and preparation of soils, and landscape treatment.
- 6.11.16 The standards that will be applied to the excavation, restoration and aftercare of borrow pits are comparable to those which the regulatory bodies would expect to apply to a commercial mineral operation. Further details concerning the planning and implementation of restoration and aftercare will be developed during detailed design. Site specific restoration plans will be developed in accordance with the principles set out in the Borrow pit report.

- 6.11.17 It is proposed that the four selected borrow pits will be made available to be returned to their original land use, which is agricultural. Other engineering uses, such as balancing ponds or access tracks, as necessary, may be required for the selected borrow pits.
- 6.11.18 Subject to agreement with landowners and the local planning authority, the restoration will, as a minimum, include:
- backfilling with clean naturally occurring fill from excavated material arising from Proposed Scheme earthworks (e.g. cuttings), and compaction in accordance with the required earthworks specification for restoration;
 - reinstatement with subsoil and topsoil (stored on site at commencement of works) to the same levels as prior to commencement, unless otherwise agreed;
 - provision of drainage within and surrounding the borrow pits, as needed;
 - reinstatement of hedgerows and PRow removed during excavation; and
 - restoration to its former use as agriculture, unless otherwise agreed.
- 6.11.19 An aftercare plan will be set out in the site-specific restoration plan for each borrow pit and agreed with relevant statutory bodies. An extended period may apply where ecological mitigation has been provided, or for land restored to agriculture where is agreed with landowners or occupiers.

6.12 Drainage and watercourse realignment and diversion

- 6.12.1 Construction will require both temporary and permanent drainage works, including track drainage, culverts, balancing ponds in drainage ditches 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 (the walls around the mouth of the culvert) may be constructed in-situ from reinforced concrete. Larger culverts may be constructed in-situ from reinforced concrete or prefabricated units.
- 6.12.3 Where watercourse realignments or diversions 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 or diverted to avoid impacts from the Proposed Scheme. A single realigned channel will represent a more sustainable solution where the route will 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 or diversion will generally be constructed by:
- temporarily fencing around the route of the realignment or diversion;
 - excavating the realigned or diverted channel to the required level, leaving existing ground at each end (a 'plug'), or installing sheet pile walling (embedded retaining wall utilising standard steel profiles, used in temporary or permanent conditions and installed by vibration, impact or push/jack techniques), 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 or diverted 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 or diversion 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 culverts⁹⁹ or inverted siphons¹⁰⁰. 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 surface water runoff 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 will be crossed by the route of the Proposed Scheme, or land required for construction, will either be closed and the traffic diverted onto other existing highways, or new crossings will be built. New crossings, utilising under or overbridges, will either be built:

⁹⁹ 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.

¹⁰⁰ 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.

- on the line of the existing road or PRoW (termed 'online'), thereby requiring its closure or temporary realignment during construction; or
 - along or nearby existing routes which will remain open during construction (termed 'offline'), allowing the road to remain open for the majority of construction.
- 6.13.2 The choice between whether new crossings will be constructed online or offline will depend on factors such as safety, traffic flows, physical or environmental constraints, adjacent development and the presence (or otherwise) of public utilities.
- 6.13.3 Online crossings will usually be constructed by:
- constructing the temporary layout of the crossing, 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 closure of the existing route.
- 6.13.5 Works to existing roads, including temporary diversions and junction improvements, 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.
- 6.13.7 Smaller-scale works to existing PRoW will also be carried out in consultation with the relevant highway authority.

6.14 Site 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 will 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 site 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 Site haul routes will generally be up to 10m (including land for any associated infrastructure, such as signalling). Where a site 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 Site haul routes will be surfaced at the connection point between a site haul route and public highway. This will help to maintain the cleanliness of the public highway.
- 6.14.4 Following construction, site haul routes will be appropriately restored (see Section 6.27 of this report).

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 infrastructure maintenance buildings.
- 6.15.2 Piles and diaphragm walls¹⁰¹ 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 membrane¹⁰². 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 Centre¹⁰³.
- 6.15.5 Diaphragm walling involves the construction of reinforced concrete walls within the ground using bentonite slurry as a temporary support medium.

¹⁰¹ A rectangular (in plan) foundation structure used to carry horizontal and vertical loads. Can be installed by excavation using a grab or hydromill (a type of construction equipment using two cutting wheels with a powerful pump to extract the loose material mixed with slurry). The excavated trench is supported using a bentonite support fluid.

¹⁰² Synthetic (generally) fabric used in conjunction with earthworks. Can be used to provide filter or reinforcement properties.

¹⁰³ 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. Available online at: <http://webarchive.nationalarchives.gov.uk/20140329082415/http://cdn.environment-agency.gov.uk/scho0501bitt-e-e.pdf>.

- 6.15.6 Vibratory or silent piling systems will be preferred where displacement piles are used (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.

Figure 30: 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 31 shows a generic TBM.

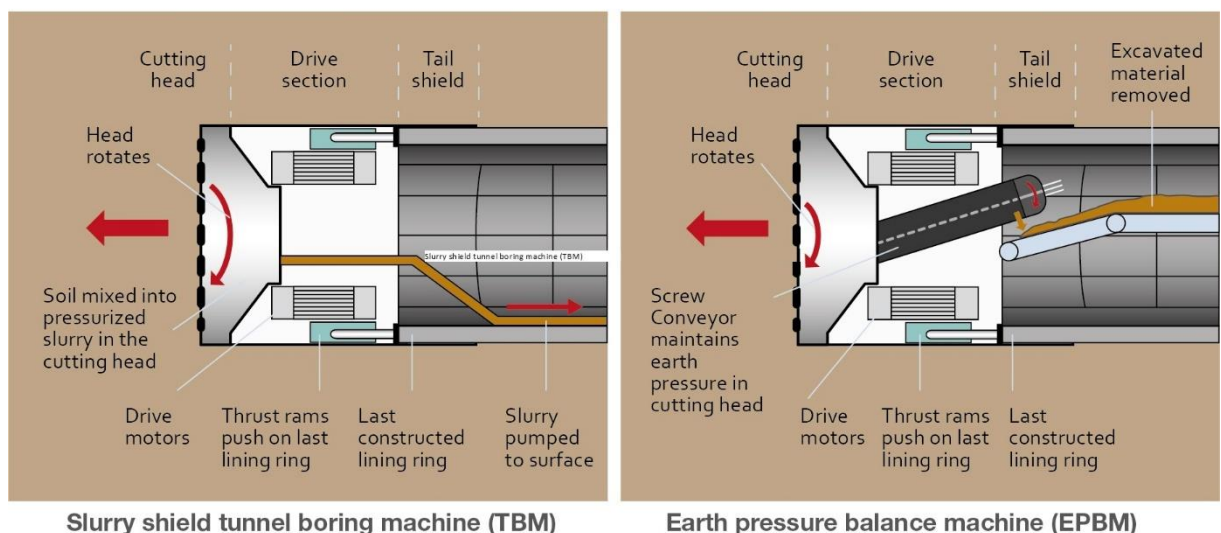
Figure 31: Photograph of a generic tunnel boring machine



6.16.2 The TBM used to construct the Proposed Scheme will be purpose-built machines, using proven state-of-the-art technology and will operate 24 hours a day, seven days a week. They will be electrically powered and will be designed specifically for the project to ensure their reliability of performance, settlement control and to cope with the range of ground conditions expected along the Proposed Scheme.

- 6.16.3 A 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:
- slurry shield;
 - earth pressure balance machine (EPBM); or
 - open face.
- 6.16.4 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.
- 6.16.5 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.
- 6.16.6 The TBM will require a dedicated water supply (see Section 6.30).
- 6.16.7 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.
- 6.16.8 Figure 32 shows a cross-section of a slurry shield and EPBM TBM.

Figure 32: Cross-section of a slurry shield tunnel boring machine and earth pressure balance machine



Bored tunnels

- 6.16.9 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.
- 6.16.10 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.
- 6.16.11 The sequence of a twin-bored tunnel constructed using a TBM, including the construction of tunnel portals, will be as follows:
- site clearance, advance works and compound establishment;
 - excavation of drive shaft (providing an opening for the lowering of the TBM) or portal with retained cutting, commencing with stripping of topsoil in line with the measures set out in the draft CoCP, 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, or alternatively may be assembled in the retained cutting;
 - after assembly, 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 (ground-borne noise and vibration will be controlled by the design and maintenance);
 - 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;
 - this process will be repeated for the second tunnel, following a short delay, after the first;
 - as the second drive progresses, cross passages between the bores will be constructed;
 - once the tunnel drives are completed, the TBM, tunnelling train and other associated plant will be dismantled, lifted out of the reception portal or a vent shaft, loaded onto HGVs and removed from site;

- tunnels will either be constructed using two TBM in sequence driving through from one end of the tunnel to the other and lifted from a reception portal, or constructed using four TBM in sequence, two at each end, and driving towards the middle to be lifted from a vent shaft; 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.

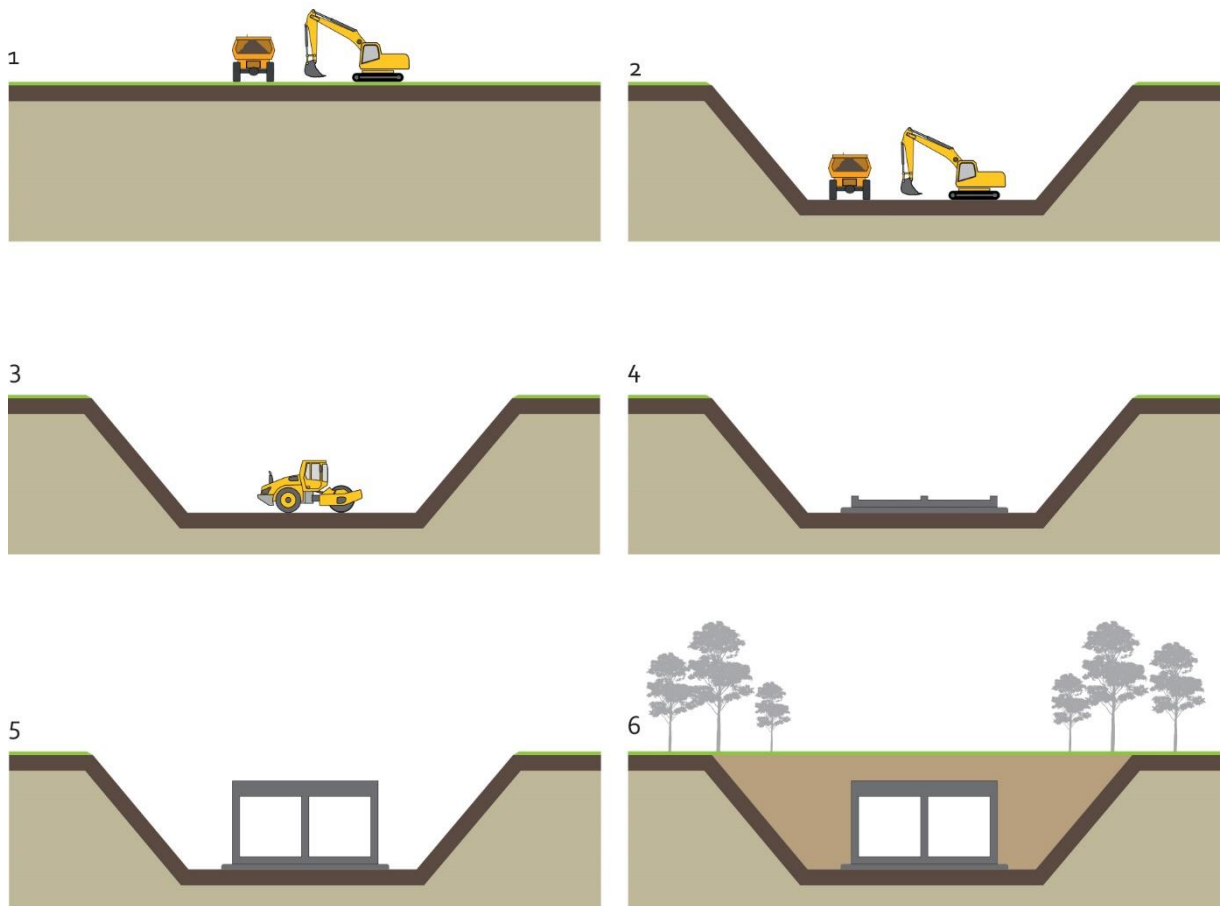
Cut-and-cover tunnels and box structures

- 6.16.12 Construction of cut-and-cover tunnels and box structures will involve excavation and /or construction of a box structure, where required, and backfilling with fill material and soil. Where impacted the land surface above a cut-and-cover tunnel will be established in line with the draft CoCP and 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.
- 6.16.13 Two main cut-and-cover 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.
- 6.16.14 The sequence of construction for option one will be:
- site clearance, advance works and compound establishment;
 - excavation to the required depth;
 - construction of a 'box' structure from reinforced concrete;
 - backfilling around the sides and across the top of the structure, to suit the intended land use, and completion of the landscaping works;
 - diversion and installation of utilities and laying road surfaces, as required; and
 - removal of temporary works, including any diversion/realignment of roads and PRoW.
- 6.16.15 The construction of box structures, which do not require excavation, will follow a similar sequence to the above without the requirement for excavation and backfilling above the structure.
- 6.16.16 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 (temporary structures such as scaffolding used to support the permanent works), formwork (temporary or permanent moulds into which concrete or similar materials are poured), steel reinforcement and other 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.

6.16.17 An illustration of this construction sequence is shown in Figure 33.

Figure 33: Cut-and-cover / box structure construction method - option one



6.16.18 For the second option, the walls will be constructed first using diaphragm walling (embedded walls inserted into the ground) which can be used as foundation walls, groundwater barriers or to isolate portions of contaminated ground 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.

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

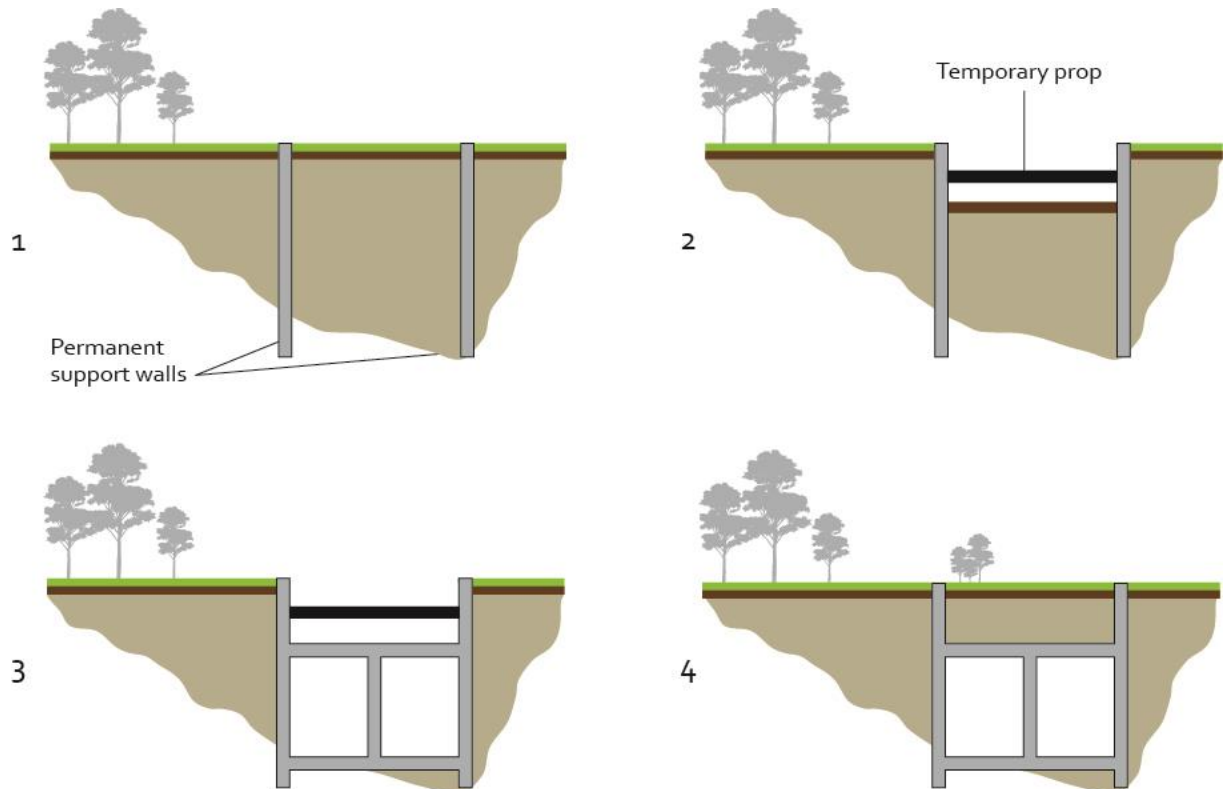
6.16.20 The sequence of construction for option two will be:

- constructing the walls, with vertical retaining panels (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 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.

6.16.21 The excavation beneath the roof slab will be executed in stages if temporary props are required, with these being installed progressively. An illustration of this construction sequence is shown in Figure 34.

Figure 34: Cut-and-cover / box structure construction method – option two



6.17 Portals

6.17.1 In rural locations, portals will typically be constructed by open excavation, with soil and rock slopes benched (cut in steps) and reinforced as necessary. Reinforced concrete headwalls and wing walls (a smaller wall attached or next to a larger wall or structure) will be formed around the tunnel entrances. In urban locations, and where space is restricted, portals will utilise embedded retaining wall structures.

- 6.17.2 Portals will be constructed by open cut where the excavation is relatively shallow. Diaphragm wall or contiguous bored pile¹⁰⁴ 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 Ventilation and intervention (vent) shafts

- 6.18.1 Vent shaft construction will be undertaken during tunnelling. The methods for constructing vent shafts will depend on local ground and groundwater conditions, the depth of shaft and whether there is any need to access the TBM during construction.
- 6.18.2 Possible techniques include:
- diaphragm walling or bored piling;
 - caisson construction (using a watertight retaining structure or enclosure from which groundwater can be pumped out to maintain dry working conditions), with a pre-cast concrete segmental lining; or
 - open excavation with pre-cast concrete segmental or sprayed concrete lining (or a mix of both).
- 6.18.3 Vent shafts will generally be constructed in the following sequence:
- site clearance, advance works and worksite establishment;
 - construction of the vent shafts;
 - construction of the remaining shaft internal works and installation of mechanical and electrical machinery;
 - if the shaft is offline (not directly over the tunnel), it will be connected to the main tunnel by constructing short connecting tunnels using sprayed concrete lining techniques or similar; and
 - following installation of the ventilation equipment and construction of the headhouse over the shaft, the site will be landscaped.

6.19 Cross passages

- 6.19.1 Cross passages will be constructed once both tunnel drives have passed the location of the cross passage. The method of constructing the cross passages will comprise reinforcement and treatment of the ground, if required, followed by excavation, application of sprayed concrete, installation of waterproof lining and then a secondary layer of concrete either sprayed or cast in-situ, and installation of base slabs. Depending on ground and

¹⁰⁴ Closely spaced, bored piles used to form an underground wall, for the construction of a deep basement or cut-and-cover tunnel.

groundwater conditions, cross passages may require some form of treatment (e.g. injection of grout) to exclude groundwater and aid support during excavation.

6.19.2 Cross passages will typically be constructed in the following sequence:

- installation of special hybrid concrete/spheroidal graphite iron segments in each tunnel where cross passages are to be located, during the tunnel driving;
- ground improvement and/or de-watering to prevent groundwater ingress;
- installation of spiles (e.g. steel pipes) at the crown of each cross passage, if required, to provide physical support and removal of specified segments of tunnel;
- construction of concrete collars connected to the lining of segmented sections;
- excavation of earth at pre-defined stages and application of sprayed concrete to provide temporary support;
- on completion of excavation works, application of sprayed waterproof lining and permanent sprayed concrete lining or cast in-situ concrete; and
- casting and installation of base slabs.

6.20 Viaducts

6.20.1 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.

6.20.2 The beam and deck construction method uses either structural steel beams/girders or pre-stressed concrete beams, with a concrete deck acting compositely with the primary beams to enhance structural efficiency.

6.20.3 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.

6.20.4 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).

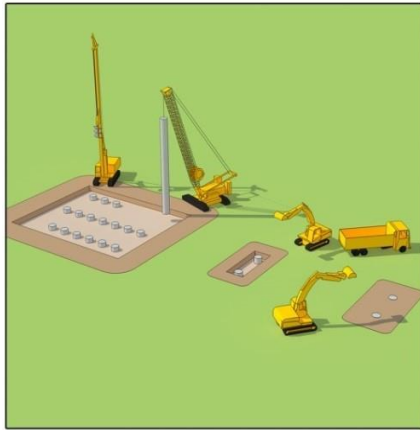
6.20.5 In-situ construction is more economic for low, bespoke, shorter span structures with high degrees of geometric complexity. The beam and deck solution is convenient for bridging over obstructions, for example railways or rivers, especially where construction headroom is restricted.

6.20.6 Viaducts will generally be constructed by:

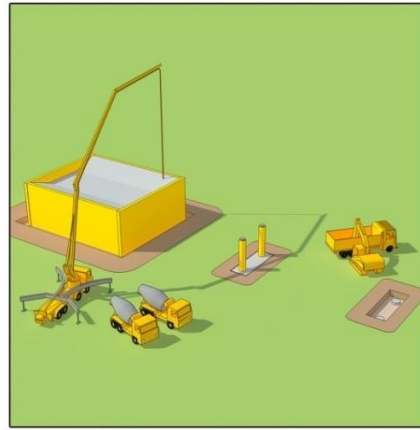
- installing the construction access and working platform;
- constructing foundations and piers from the platform, installing concrete piles, excavating pile caps and constructing pile caps and support piers, followed by backfilling of excavations;
- constructing abutments, including excavating and constructing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

6.20.7 An illustration of this construction sequence is shown in Figure 35.

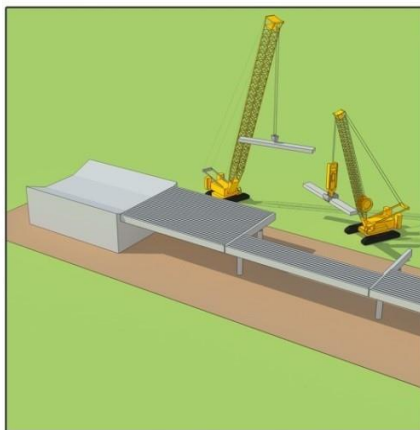
Figure 35: Generic sequence for constructing a beam and deck viaduct



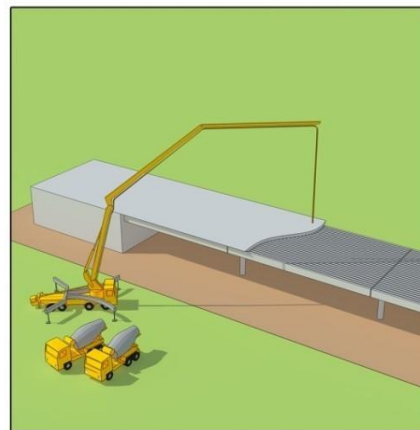
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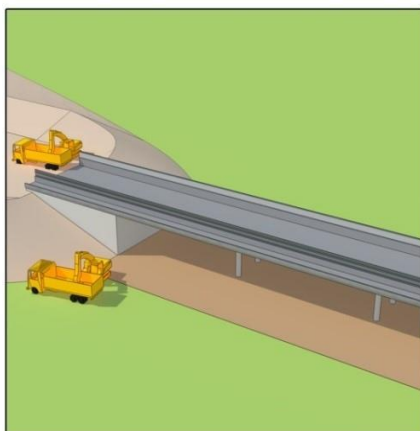
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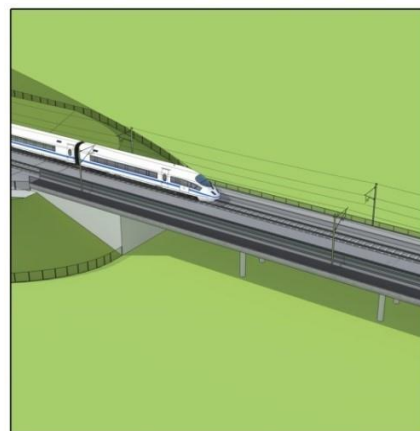
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- 6.20.8 The following sequence will be repeated, for in-situ construction, until the viaduct deck is completed:
- installing falsework and formwork, reinforcement and stressing tendons¹⁰⁵;
 - casting the concrete deck;
 - post-tensioning the structure; and
 - removing formwork and falsework.
- 6.20.9 The temporary mould 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.
- 6.20.10 Final post-tensioning will be installed to the deck on completion of deck launching, and the temporary supports removed.
- 6.20.11 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.

6.21 Bridges

- 6.21.1 Bridges to carry the route of the Proposed Scheme over rivers or other features (underbridges), or to carry those features over the route of the Proposed Scheme (overbridges), will generally be constructed in advance of the main earthworks.

¹⁰⁵ 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.

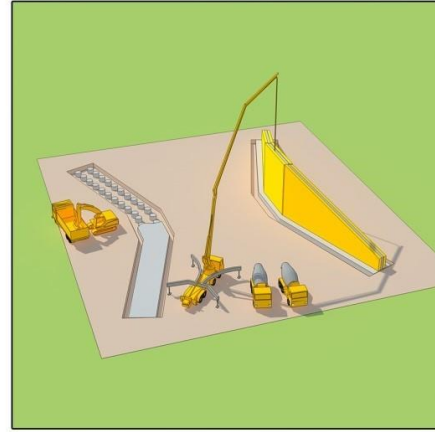
- 6.21.2 The construction sequence for overbridges and underbridges is generally the same. It consists of the following steps:
- excavating and installing foundations;
 - constructing piers, abutments and wing walls;
 - backfilling of abutments and wing walls;
 - installing bearings and deck beams;
 - casting of the deck slab; and
 - installing parapets, expansion joints and finishes.
- 6.21.3 The backfilling operation for integral bridges¹⁰⁶ will generally take place after the deck is constructed.
- 6.21.4 Figure 36 shows a generic sequence for construction an overbridge. Figure 37 shows a generic sequence for construction an underbridge.

¹⁰⁶ 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.

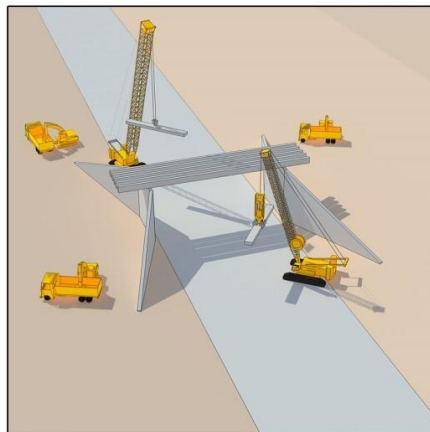
Figure 36: Generic sequence for constructing an overbridge



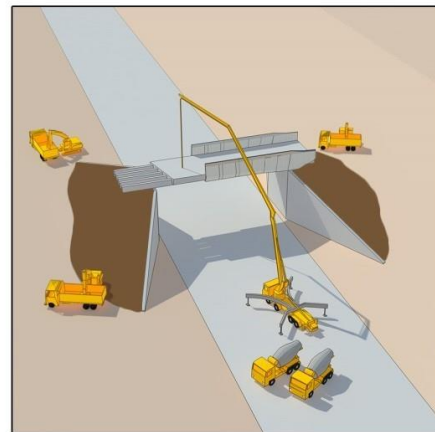
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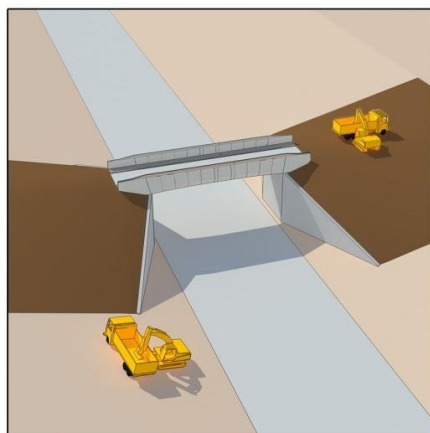
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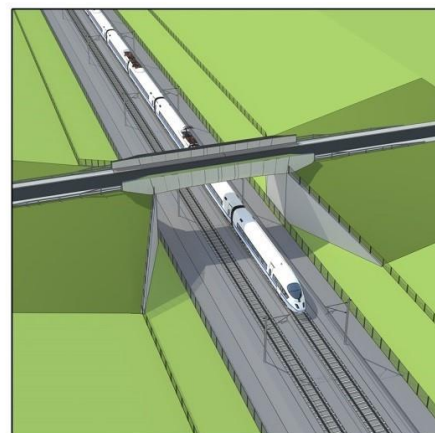
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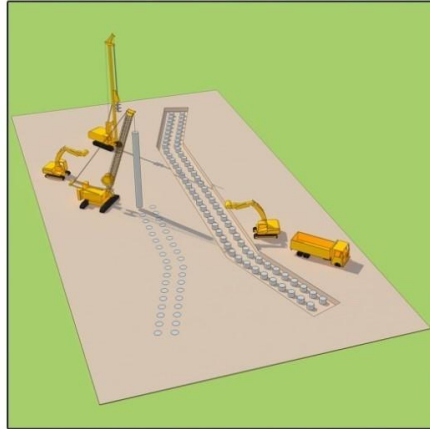


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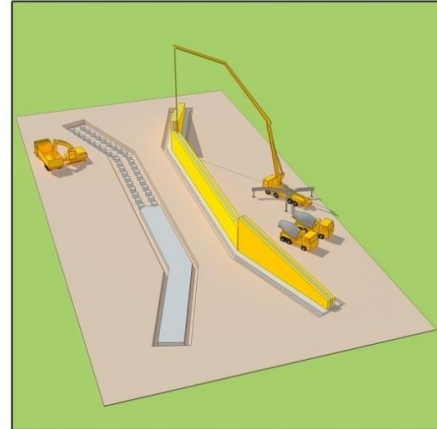


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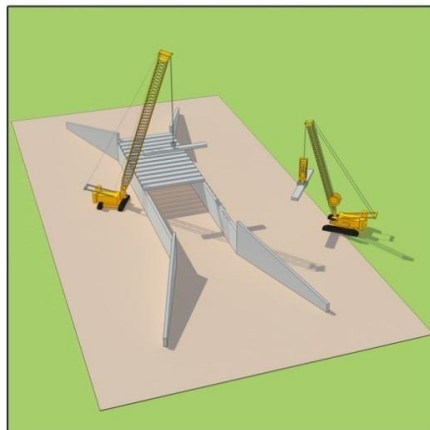
Figure 37: Generic sequence for constructing an underbridge



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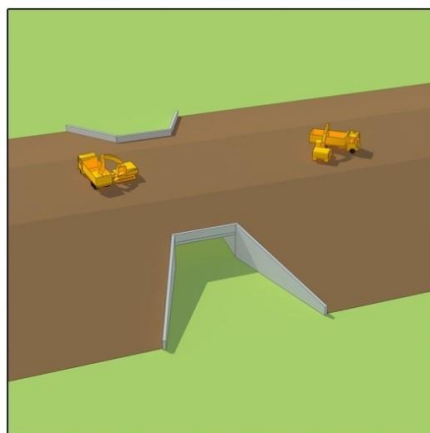
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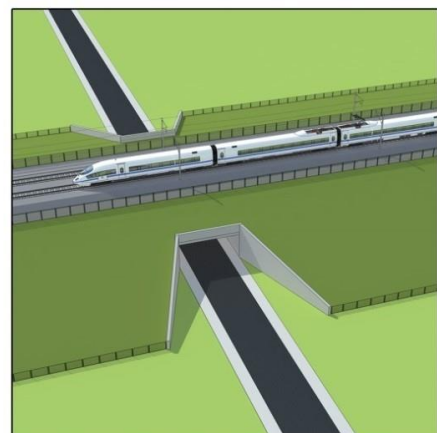
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6.22 Stations

- 6.22.1 The construction methods to be used for stations and related built facilities will vary according to their specific purpose and location. Construction of stations is described in the following Volume 2, Community Area reports:
- Manchester Airport High Speed station: Hulseheath to Manchester Airport (MA06); and
 - Manchester Piccadilly High Speed station: Manchester Piccadilly Station (MA08).
- 6.22.2 Works to existing off-route stations is described in Volume 4, Off-route effects.

6.23 Temporary railhead and construction sidings

- 6.23.1 A temporary railhead will be required for construction of the Proposed Scheme. The railhead will provide connections between the existing conventional rail network and the Proposed Scheme. It will be used as the delivery location for bulk rail-borne materials such as fill material, concrete elements, ballast, pre-cast slab track, rails, sleepers and switches and crossings units. It could also be used for the removal of excavated material. Facilities at the railhead will include offices, welfare facilities, storage areas, workshops, a rail marshalling yard and pre-assembly area, car parking areas and rail reception loops. The railhead will operate 24 hours a day, seven days a week during the construction period.
- 6.23.2 The railhead will be located in proximity to the existing conventional railway and strategic road network to facilitate the movement of material. There will be a railhead at Ashley in the Hulseheath to Manchester Airport area (MA06). Further details are provided in the relevant Volume 2, Community Area report.
- 6.23.3 Temporary construction sidings will be required to handle material from the construction of the Proposed Scheme. Sidings will be connected to the National Rail network to allow excavated materials to either join the rail network from the Proposed Scheme construction areas, or to leave the rail network to enter the construction areas. Facilities at construction sidings will include offices and rail sidings to provide for the loading or unloading of construction material from rail wagons. There will be construction sidings located in the Wimboldsley to Lostock Gralam area (MA02) and the Davenport Green to Ardwick area (MA07). Further details are provided in the relevant Volume 2, Community Area report.

6.24 Infrastructure maintenance bases

- 6.24.1 Construction details for each of the satellite IMB-R can be found in Section 2 of the Volume 2 Community Area reports:
- Crewe North RSD: Wimboldsley to Lostock Gralam area (MA02); and
 - Ashley: Hulseheath to Manchester Airport area (MA06).

- 6.24.2 Construction information relating to the centralised IMB-R at Stone can be found in the Phase 2a ES³⁶.

6.25 Rolling stock maintenance and stabling facilities

- 6.25.1 Construction details for the Crewe North RSD are described in Volume 2, Community Area report Wimboldsley to Lostock Gralam (MA02).
- 6.25.2 The enhancements to the existing facilities at Polmadie depot (Glasgow) and construction of Annandale depot (between Gretna Green and Kirkpatrick Fleming in southern Scotland) are set out in Volume 4, Off-route effects.

6.26 Noise barriers and bunds

- 6.26.1 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 in line with the measures set out in the draft CoCP.
- 6.26.2 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.

6.27 Site restoration and landscape treatment

- 6.27.1 Landscape mitigation such as planting will be established at the earliest reasonably practicable opportunity during construction. Planting away from the route of the Proposed Scheme will be undertaken to reduce adverse landscape and visual effects, and to increase habitat and biodiversity value.
- 6.27.2 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 help integrate the Proposed Scheme sympathetically into the character of the surrounding landscape.
- 6.27.3 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 of this report.

6.28 Track

- 6.28.1 The track for the Proposed Scheme will either be ballasted track or slab track (see Section 5.18). A final decision on the track form will be made during the detailed design of the Proposed Scheme.
- 6.28.2 Ballasted track will generally be constructed in the following sequence:
- laying and compaction of the sub-ballast layer;
 - laying and compaction of the ballast layer;
 - placement of sleepers at regular intervals on top of the sub-ballast layer;
 - installation of rails on top of the sleepers;
 - addition of top ballast and tamping (a process to pack the ballast beneath the rails and sleepers to make the track more durable) and alignment of the track to its final position; and
 - stressing the rails and welding of the joints between rails.
- 6.28.3 Slab track construction will use either pre-cast (track in the open) or cast-in-situ (track in tunnels) concrete elements to support the track, instead of ballast.
- 6.28.4 Slab track in the open will usually be constructed by:
- constructing the hydraulically bound layer¹⁰⁷;
 - placing the track slab on top of the hydraulically bound layer;
 - installing the rails;
 - adjusting the track to final position, and fixing into place with grout; and
 - stressing the rails and welding the joints between the rails.
- 6.28.5 Slab track in tunnels will usually be constructed by:
- laying concrete foundation;
 - installation of sleepers on top concrete foundation;
 - installing the rails;
 - track adjustments to its final position and fixing into place with concrete; and
 - stressing the rails and welding the joints between the rails.
- 6.28.6 For both types of track, it is expected that the completed sections of line will be used for delivery of materials, such as ballast, long welded rails, sleepers, catenary wire, cables and granular fill, to the point of installation.

¹⁰⁷ Aggregate mixture incorporating cement, lime based or other binders, which harden in-situ by a chemical/hydraulic reaction.

6.29 Power supply

- 6.29.1 Access for construction of the traction power supply system will be via the local road network, although some elements may be delivered from the Proposed Scheme rail corridor.
- 6.29.2 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.
- 6.29.3 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.
- 6.29.4 Secondary fit-out for traction power and associated switch rooms will then take place.
- 6.29.5 Switch rooms and external transformers will be off-loaded by crane or with hydraulic jacks from large vehicles.
- 6.29.6 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 monopiles¹⁰⁸, pre-cast piles¹⁰⁹ or steel screw piles¹¹⁰ with reinforced concrete pile caps¹¹¹. The masts will be lifted into place and bolted to the foundations using specialised plant, followed by installation of the overhead line equipment.
- 6.29.7 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.

6.30 Water supply

- 6.30.1 Water supply will be required for each construction compound. The quantities of water required will depend on the design components type of construction activities, with tunnel boring and concrete batching (for structures and for ground stabilisation) being particularly water intensive. Further detail is provided in the Volume 2, Community Area reports.
- 6.30.2 The primary source of water for construction will be from water utilities suppliers. There is an opportunity for reusing and recycling water from construction dewatering.
- 6.30.3 Additional supplies may need to be sourced from surface water and groundwater resources that may require approval through the protective provisions in the Bill.

¹⁰⁸ A single large diameter pile with significant vertical and lateral load carrying capacity. It is used as an alternative to a pile group.

¹⁰⁹ A driven pile produced from pre-cast concrete.

¹¹⁰ A displacement pile screwed into the ground in order to transfer vertical load into the ground.

¹¹¹ 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.

6.31 Train control and telecommunications

- 6.31.1 Train control and telecommunications 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 of the Proposed Scheme, and the installation of line-side cabinets and signage.
- 6.31.2 The line-side telecommunications equipment will be constructed from within the rail corridor and access points along the route of the Proposed Scheme.
- 6.31.3 The radio masts, antennae and other heavy assets e.g. Relocatable Equipment Building (REB) will be installed from within the rail corridor where suitable for construction or from the area available within the telecommunications compound accessible via dedicated vehicle access road. The equipment will be delivered to site and lifted into place onto the foundations and cranes may be required for lifting of telecommunications masts and REB.
- 6.31.4 The workforce will access the equipment from the permanent points of maintenance access for the rail corridor, where further fit-out is required.
- 6.31.5 Final Site Acceptance Testing (SAT) activities of telecommunications systems will occur during the testing and commissioning phase.

6.32 Interfaces with the conventional rail network during construction

- 6.32.1 The construction of the Proposed Scheme will involve physical interfaces with the conventional rail network (the existing UK rail network excluding HS1 and HS2). The main points of interface are identified in Table 5.

Table 5: Construction interfaces with the existing conventional rail network

Location	Summary of work
North of Crewe: WCML	Heading north from the Crewe tunnel, the route of the Proposed Scheme will run parallel to the WCML. A RSD will be provided on land between the route of the Proposed Scheme and the WCML, where they diverge to the east of Walley's Green. Modifications will be required on/over the WCML to accommodate the Crewe Northern Connection and connections between the WCML and the RSD. There will be temporary construction sidings to allow movement of material during the construction of the Proposed Scheme. The construction sidings will be accessed via a reception track off the existing WCML.
Whatcroft: Sandbach to Northwich Line	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Sandbach to Northwich Line.
Lostock Gralam: Northwich to Knutsford Railway (Mid-Cheshire Line)	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Northwich to Knutsford Railway.
Glazebrook: Liverpool to Manchester Line (via Warrington Central)	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Liverpool to Manchester Line (via Warrington Central).

Environmental Statement

Volume 1

Location	Summary of work
Culcheth: Liverpool to Manchester Line (Chat Moss)	Construction of a viaduct to carry the route of the Proposed Scheme over the existing Liverpool to Manchester Line (Chat Moss).
Ashley: Mid-Cheshire Line	Construction of a viaduct to carry the route of the Proposed Scheme (Manchester spur) over the existing Mid-Cheshire Line. Modification of existing Mid-Cheshire Line to facilitate the connection of Network Rail to the temporary Ashley railhead.
Ardwick: Ashburys Line	Modification of existing Ashburys Line to facilitate the connection of Network Rail to the temporary HS2 construction sidings.
Manchester Piccadilly	Reconstruction and extension of the existing Manchester Piccadilly station concourse, replacement of a service basement and loading bay underneath the existing station, and alterations to accesses for the Metrolink tram services.
Bamfurlong/Golborne: WCML	Realignment of, and modifications to, the existing WCML to connect with the Proposed Scheme. Construction of a box structure for the northbound line of the Proposed Scheme to cross over the existing WCML.
Preston Station: WCML	Works to accommodate HS2 services at Preston including the extension of two existing platforms, reinstatement of a platform that is not currently used for passenger trains and modifications to the track layout, signalling, overhead line equipment and other railway systems within the Preston Station area.
Carlisle Station: WCML	Works to accommodate HS2 services at Carlisle including extension of two existing platforms and construction of a new platform, a new passenger subway, a new footbridge, modifications to the track layout, signalling, overhead line equipment and other railway systems within the Carlisle Station area.
Annandale (between Gretna Green and Kirkpatrick Fleming in southern Scotland): WCML	Construction of stabling facilities for HS2 trains serving the north of England and Scotland at Annandale depot, including a new access to the depot, remodelling and realignment of the existing track layout, a power traction station and diversion of overhead line equipment.

6.33 System testing and commissioning

- 6.33.1 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 for the Proposed Scheme as a whole is expected to extend over approximately one and a half to two years, commencing by 2036 and completing in 2038.
- 6.33.2 Testing and commissioning will start on the section of route of the Proposed Scheme closest to the connection with Phase 2a in line with the availability of the installed infrastructure.
- 6.33.3 The programme of testing and commissioning will be divided into a number of phases:
- phase 1: off-site testing – factory acceptance tests;
 - phase 2: on-site testing – static tests;
 - phase 3: on-site testing – site acceptance testing;

- phase 4: on-site testing – dynamic testing; and
- phase 5: trial running.

- 6.33.4 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.
- 6.33.5 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 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.
- 6.33.6 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.
- 6.33.7 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

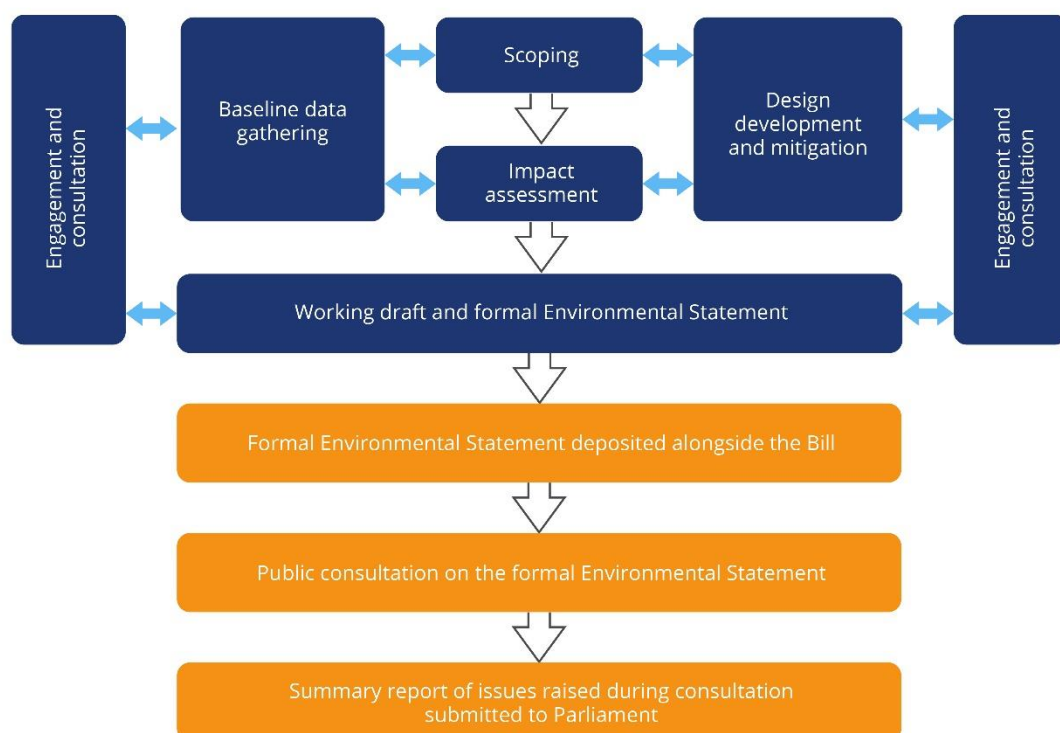
Introduction

- 7.1.1 The purpose of EIA is to identify the likely significant effects of a proposed development on people and the environment. In simple terms, it does this by identifying the current (baseline) conditions, anticipating how these may change in the future when the development is assumed to begin construction, and predicting the potential impacts of constructing and operating the development across a range of environmental 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 environmental topic is summarised in Section 8 of this report.

Preparation of the Environmental Statement and deposit to Parliament

- 7.1.2 The main steps in the EIA process, preparation of the ES and deposit to Parliament are shown in Figure 38 and detailed in the following section.

Figure 38: Environmental impact assessment process for the Proposed Scheme



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 EIA SMR (Volume 5: Appendix CT-001-00001 a supporting document to this ES), which was finalised through engagement and consultation with local authorities, a wide range of environmental organisations and the general public. Since publication of the working draft ES, there have been further refinements to scope and methodology. These are set out in the EIA SMR (Volume 5: Appendix CT-001-00001), which forms part of this ES.

Collection and presentation of baseline data

- 7.1.4 Baseline studies established the current environmental conditions that exist in the vicinity of the route of the Proposed Scheme for each environmental topic study area. These studies comprised desk-top research to gather and evaluate previous environmental work and publicly available information, together with environmental surveys and feedback from stakeholder engagement and consultation. Relevant policies, guidelines and legislation, together with industry-accepted practice, were also identified as part of this stage.
- 7.1.5 The current baseline has been 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 UKCP18 projections¹¹²), policy, legislation, advances in technology and future developments. This is referred to 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. Due to the uncertainty of predicting effects based on future baseline conditions and/or where there is limited data, a reasonable worst-case approach has been adopted.
- 7.1.6 Future developments have been identified where they may introduce new environmental receptors that could be significantly affected by, and/or interact with and create cumulative impacts with, the Proposed Scheme. Receptors are defined as a component of the natural or built environment (such as human beings, water, air, a building, animal 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. 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.
- 7.1.7 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

¹¹² UKCP18 (2018), *UKCP18 Climate Change Projections Report*. Available online at: <https://www.metoffice.gov.uk/research/collaboration/ukcp?mediaid=87894&filetype=pdf>.

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.

Impact assessment

- 7.1.8 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 EIA SMR. 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.
- 7.1.9 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

- 7.1.10 Mitigation measures and procedures for monitoring (including measures to manage the effects of construction, the effectiveness of mitigation post construction, and 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 of this report.

Consultation and engagement

- 7.1.11 Stakeholder engagement has taken place throughout the design process and preparation of the ES, as described in Section 3 of this report.

Consideration of reasonable alternatives

- 7.1.12 A number of reasonable alternatives have been studied in the development of the Proposed Scheme. The strategic, route-wide and route corridor alternatives are described in Section 10 of this report. Local alternatives studied prior to July 2017 and regional alternatives are outlined in Section 11 of this report. 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 ES Alternatives report (Volume 5: Appendix CT-003-00000), including local alternatives studied since July 2017.

Deposit to Parliament and subsequent steps

- 7.1.13 In accordance with House of Commons Standing Order 27A, the ES is to be deposited in Parliament and will include the information set out in Section 1.2 of this report. Copies of the deposited ES (containing the non-technical summary) will be made available for inspection, and for sale at a reasonable price, in accordance with the Standing Order.

- 7.1.14 Also, in accordance with Standing Order 224A, 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. The Secretary of State is required to publish any comments made in response to the consultation and to submit them to an independent assessor. An independent assessor appointed by Parliament will prepare a report summarising the issues raised during that period for parliament. 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:
- years and time periods – ‘the temporal scope’;
 - areas – ‘the geographic scope’; and
 - environmental topics – ‘the technical scope’.

Temporal scope

- 7.2.2 The main construction works are expected to take place between 2025 and 2038 (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 2038. The environmental topics have generally assessed the period of maximum intensity over the construction period and compared it to a defined baseline year. Some topics also include an assessment of future operational years. For example, the transport assessment includes an assessment for a future year when the Proposed Scheme will be at operational maximum, while the landscape and visual assessment includes an assessment of effects once any vegetation planted as part of the Proposed Scheme has matured further or has achieved its design intention.
- 7.2.3 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’. The do minimum case refers to the future that will exist if the Proposed Scheme were not developed.

Geographic scope

- 7.2.4 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 likely to be propagated. It takes account of both the land required permanently for rail infrastructure and the additional land required temporarily for construction.

- 7.2.5 Each of the environmental topics identifies the area within which impacts and effects have been assessed (a study area). This is summarised in Section 8 of this report and further explained within the EIA SMR.
- 7.2.6 The reporting of likely significant effects of the Proposed Scheme is presented in the Volume 2, Community Area reports. Volume 2 is split into community area reports, each of which is based on a distinct geographical area.
- 7.2.7 The assessment of environmental impacts and effects that cover a wider geographical area is reported in Volume 3, Route-wide effects. The effects reported in Volume 3, Route-wide effects are those considered to be appropriately assessed at a geographical scale greater than that presented within the Volume 2, Community Area reports.
- 7.2.8 The assessment of environmental impacts and effects that may occur beyond the route corridor is reported in Volume 4, Off-route effects.
- 7.2.9 Transboundary effects are significant environmental effects caused in other countries (i.e. other than the UK). There are no direct connections between HS2 and other countries. Therefore, it is considered unlikely that the Proposed Scheme will result in any significant effects on the environment of another country and thus transboundary effects will not be considered further unless individual environmental topic areas identify any such significant effects.

Technical scope

- 7.2.10 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;
 - ecology and biodiversity;
 - electromagnetic interference;
 - health;
 - historic environment;
 - land quality;
 - landscape and visual;
 - major accidents and disasters;
 - socio-economics;
 - sound, noise and vibration;
 - traffic and transport;
 - waste and material resources; and
 - water resources and flood risk.

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 and explains how adverse impacts will be mitigated.
- 7.3.2 The predicted impacts have generally been classified according to whether they are considered to be major, moderate or minor; and beneficial or adverse. Whilst the definition of each category varies by topic, as shown in the EIA SMR, 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;
 - minor: slight, very short-term and/or highly localised impact;
 - moderate: limited impact (by extent, duration and/or magnitude); and
 - 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).
- 7.3.4 Impacts have been assessed qualitatively, based on professional judgement, in instances where quantification was not possible. Section 8 of this report indicates where uncertainty exists, and the route-wide assumptions that have been made. The Volume 2, Community Area reports and Volume 4, Off-route effects indicate where local assumptions 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.

7.3.6 Where effects are considered to be significant, the ES shows the geographic (or spatial) level at which they are viewed as significant (for example, at a community level or a regional or national level).

7.3.7 The EIA has been undertaken by independent qualified and competent experts from a number of consultancies with sufficient expertise to ensure the completeness and quality of the assessment. The qualifications of the teams responsible for producing the ES are set out in the High Speed Rail (Crewe-Manchester) Competency Statement (at www.gov.uk/hs2). The leads for each environmental topic, from the appointed consultancies, have met regularly to discuss the methodology being applied, the issues, impacts and effects arising, and the solutions available. National representatives of environmental statutory authorities and government departments have also been involved in these discussions. This approach has enabled experienced EIA practitioners to apply expert professional judgement where appropriate on a consistent basis.

7.4 Cumulative effects

Introduction

7.4.1 Cumulative effects can be either temporary or permanent and 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. This includes the accumulation 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); or
- from an interaction between the effects of the Proposed Scheme with the effects of other projects 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 or Phase 2a may give rise to inter-project effects at the interfaces between the schemes. Existing and/or approved projects in the vicinity of the Proposed Scheme are referred to as committed developments.

7.4.2 Committed developments are defined as developments with planning permission and sites allocated for development, or safeguarded for minerals in adopted development plans, on

or close to the land required for the Proposed Scheme. Consideration has been given to potential cumulative effects of the Proposed Scheme and other committed developments.

- 7.4.3 Developments expected to be completed between 2025 and 2038 (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 2025 are included as receptors of construction of the Proposed Scheme and those in developments to be completed before 2038 are included as receptors of the operational effects of the Proposed Scheme.
- 7.4.5 Developments likely to take place after 2038 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 Local plan allocations which do not provide sufficient information to make reasonable assumptions to inform the future baseline or have potential to result in likely significant cumulative effects have been identified as committed developments but have not been included in the assessment.
- 7.4.7 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 until Royal Assent.
- 7.4.8 A list of committed and proposed developments is contained within Volume 5: Appendix CT-004-00000 and Appendix CT-004-OR000. Committed developments are also shown on Map Series CT-13. Volume 2, Community Area reports and Volume 4, Off-route effects 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 2a and Phase 2b

- 7.4.9 The route of the Proposed Scheme will connect to HS2 Phase 2a at Hough. HS2 Phase 2a received Royal Assent in February 2021 with construction assumed for purposes of this assessment to commence in 2024. It is therefore considered to be a committed development in the context of this assessment.
- 7.4.10 The interface between the Phase 2a and Phase 2b Western Leg are reported in Volume 2, Community Area report Hough to Walley's Green (MA01).

7.5 Over-site development

- 7.5.1 Over-site development (OSD) is development that can be built over and around the permanent operational structures of the Proposed Scheme. The assumption is that any such development will be applied for and determined through the normal planning process if it is brought forward, rather than through the hybrid Bill.
- 7.5.2 This ES only assesses the environmental effects of the works that will be authorised by the Bill; it does not assess the effects of any future OSD.

7.6 Assumptions and limitations

- 7.6.1 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 that affect the assessment of significant environmental effects of the Proposed Scheme are described in the EIA SMR, relevant environmental topic sections within this Volume of the ES, Volume 2, Community Area reports or Volume 4, Off-route effects.
- 7.6.2 In some instances surveys have not been carried out or data obtained in sufficient time to be used as part of this assessment. In these circumstances the precautionary approach has been applied, whereby the assessment has been undertaken using alternative, appropriate sources of information and professional judgement. This constitutes a 'reasonable worst case' basis for the subsequent assessment so that an assessment as to the likely significant effects of the works on the environment could be included in this ES, which accompanies the Bill as deposited.
- 7.6.3 The assessment of individual topics has assumed implementation of the measures set out in the draft CoCP.
- 7.6.4 The peak level of construction traffic activity is expected to be 2030 and the opening year to be 2038. The forecasts used in the assessment have been produced prior to the development of a full understanding of the likely impact of COVID-19 on economic growth and travel behaviour. The full impact of COVID-19 is not yet known but is considered likely to result in lower travel demand in the medium term than the forecasts used in the assessment for background traffic and rail, including HS2.
- 7.6.5 Consequently, the assessment is considered to overstate travel demand for both construction and operation scenarios and therefore to present a robust case for traffic and transport. This also means that the operational assessment for 2046 is likely to include a level of growth more representative of 2048 or later, representing likely impacts at least 10 years post-opening of the Proposed Scheme.
- 7.6.6 Other topics in the ES, including air quality, community and sound noise and vibration, use the outcomes of the transport modelling and traffic and transport assessment which are based on the assumptions above.

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 EIA SMR (Volume 5: Appendix CT-001-00001).

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 of agricultural land quality, soil resources, and of impacts on local rural businesses and on farm enterprises. 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 are identified for all agricultural and commercial forestry land that will be required for the construction and operation of the Proposed Scheme, and for all holdings that include such land. 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 agriculture utilising 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 will 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.
- 8.2.3 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 housed livestock and the ongoing management of operational railway land.

Baseline

- 8.2.4 Information on current agricultural land quality is derived from an interpretation of geological, topographical, soil, agro-climatic and existing detailed and predictive ALC information. This ALC information has been 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 forested areas/woodlands. Details of land used for commercial forestry and farming practices have been obtained from face-to-face interviews wherever possible; elsewhere, information has been obtained from publicly available sources. Land use data have been collected since 2017 for the purposes of the assessment.

Methodology

- 8.2.5 The level of significance of effects has been based on the magnitude of change due to the Proposed Scheme, the sensitivity of the affected receptor/receiving environment to change, and the relative scarcity or abundance of resource in the locality, as well as in the wider context.
- 8.2.6 The nature of impacts on agricultural land has been assessed according to the proportion of best and most versatile agricultural (BMV) land required by the Proposed Scheme. The main issue in the assessment is the amount of BMV agricultural quality land temporarily or permanently required for the construction of the Proposed Scheme.
- 8.2.7 Forestry has been considered as a commercial land use feature providing resources such as timber or fuel. The permanent impact on commercial forestry due to the construction of the Proposed Scheme has been determined within the context of the abundance of forestry land in the locality, as measured within a 4km-wide corridor.
- 8.2.8 The primary functions provided by soils, other than for food and biomass production, such as flood water attenuation, carbon storage or the support of ecological habitats, are identified in this topic and the ability of soils to fulfil their primary functions after construction has been assessed.
- 8.2.9 The main issue for farm holdings is disruption by the Proposed Scheme of the physical structure of agricultural holdings and the operations taking place upon them, during both construction and operational phases.
- 8.2.10 The areas of land required to construct and operate the Proposed Scheme have been calculated on the basis of the maximum extent of the permanent infrastructure and temporary works (including soil storage areas).

Assumptions and limitations

8.2.11 It is 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 temporarily for construction will be restored to the agreed end use;
- all agricultural soil resources generated by the Proposed Scheme will be used appropriately to fulfil one or more of the recognised functions of soil;
- 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;
- where possible, the details of land use have been obtained from face-to-face interviews. Where this has not been possible, holding data have been obtained from publicly available sources;
- capital items demolished will not be replaced as replacement assets are not included in the Proposed Scheme and will ultimately be at the discretion of the landowner; and
- measures will be put in place to maintain access for land management and, where appropriate access arrangements cannot be provided during construction, consideration will be given to the acquisition of severed land.

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, associated traffic movements and highway interventions. Operational effects on air quality will occur as a result of changes to road layouts and traffic flows, and from emissions from new buildings (mainly from heating plant).
- 8.3.2 The key pollutants considered are: dust, oxides of nitrogen (NO_x), including nitrogen dioxide (NO₂), and particulate matter (PM₁₀ and PM_{2.5}). Traffic effects are 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 relating to changes in traffic flows 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);
 - monitoring surveys undertaken for the Proposed Scheme;
 - the Defra Air Information Resource website; and
 - the UK Air Pollution Information System.
- 8.3.5 Where detailed information is available regarding Clean Air Zones (CAZ) within the study area, this has been considered in the assessment.

Methodology

- 8.3.6 The effects from dust emissions during construction are assessed using an approach developed from the guidance produced by the Institute of Air Quality Management (IAQM)¹¹³. 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 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).
- 8.3.7 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, 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.
- 8.3.8 The effects from dust and particulates from mineral extraction from borrow pit operations during construction were assessed using an approach developed from the guidance produced by the IAQM¹¹⁴. This guidance uses a source-pathway-receptor approach to derive the likely magnitude of the effect that will be experienced at a sensitive receptor. The assessment assumes that dust control measures will be applied to the borrow pit operations through the CoCP, so that dust levels at sensitive receptors are kept as low as reasonably practicable.
- 8.3.9 Effects relating to emissions from diesel locomotives (mainly during construction) have been assessed in accordance with Defra guidance.

¹¹³ Institute of Air Quality Management (2016), *Guidance on the assessment of dust from demolition and construction, v1.1*. Available online at: <https://iaqm.co.uk/guidance/>.

¹¹⁴ Institute of Air Quality Management (2016), *Guidance on the assessment of mineral dust impacts for planning, v1.1*. Available online at: <https://iaqm.co.uk/guidance/>.

- 8.3.10 Changes to traffic flows and road alignments have been obtained from the traffic modelling and screened using the criteria in the EIA SMR. Where the changes exceeded the thresholds, traffic related effects on sensitive receptors (e.g. residential properties, educational or healthcare facilities) have been predicted using dispersion modelling. The level of effects from traffic emissions on individual receptors has been identified on the basis of air quality standards (EU air quality limit values and UK objectives), in accordance with the descriptors used in the IAQM/Environmental Protection UK (EPUK) guidance¹¹⁵.
- 8.3.11 The likelihood of increased nitrogen deposition on ecologically sensitive sites (e.g. protected habitats) has been assessed through dispersion modelling and the predicted changes in nitrogen deposition compared against the critical load for each site.
- 8.3.12 Dispersion modelling of point sources (e.g. combustion emissions from energy centres) has also been undertaken where appropriate.
- 8.3.13 A route-wide air quality assessment has also been undertaken for changes brought about by passenger modal shift from the operation of the Proposed Scheme.

Assumptions and limitations

- 8.3.14 Assumptions necessary to undertake the air quality assessment are set out in the EIA SMR and in individual sections in Volume 2, Community Area reports, Volume 3, Route-wide effects and Volume 4, Off-route effects.
- 8.3.15 The air quality assessment has incorporated HS2 Ltd's policies on vehicle emissions¹¹⁶. These include the use of Euro VI HGV, Euro 4 petrol and Euro 6 diesel cars and LGV during construction of the Proposed Scheme.

8.4 Climate change

Introduction

- 8.4.1 Climate change has been assessed in three ways as part of the EIA:
- a greenhouse gas (GHG) assessment;
 - an in-combination climate change impacts (ICCI) assessment; and
 - a climate change resilience (CCR) assessment.

¹¹⁵ Moorcroft and Barrowcliffe (2017), *Land-Use Planning & Development Control: Planning for Air Quality*, v1.2. London, Environmental Protection UK & Institute of Air Quality Management.

¹¹⁶ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E14: Air quality*.

GHG assessment

Scope

8.4.2 The scope of the GHG assessment includes the following stages:

- before use (also referred to as construction emissions or Stage A);
- use (also referred to as operational emissions, including carbon sequestration from tree planting and other land uses, or Stage B);
- end-of-life (or Stage C – not a significant factor for HS2); and
- carbon benefits and loads beyond the system boundary (e.g. from modal shift, such as shifting from cars to trains and road freight able to move to rail due to released capacity).

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 15978¹¹⁷, BS EN 15804¹¹⁸ and PAS 2080¹¹⁹ standards, which is detailed in the EIA SMR.

8.4.5 The GHG emissions associated with the construction and operation of the Proposed Scheme have been reported in the ES in the form of the 'carbon footprint' - reported in tonnes of carbon dioxide equivalent (tCO₂e). The results are also presented in the context of the UK carbon targets and budgets and as comparisons with other modes within the transport sector.

8.4.6 The carbon footprint is based on a 'reasonable worst-case scenario', also referred to as the base case assessment. For example, it is assumed that there will be no carbon emissions reduction improvements within the cement and steel industries between the time of this assessment and the construction of the Proposed Scheme, and that the carbon intensity of UK grid electricity will reduce in accordance with HM Treasury's Green Book Guidance.

8.4.7 The GHG assessment covers a long timescale (i.e. 120-year design life) and as such requires a number of assumptions to be made. The calculated carbon footprint is sensitive to these

¹¹⁷ British Standards Institution (2011), *BS EN 15978:2011. Sustainability of Construction Works – Assessment of environmental performance of buildings – Calculation method*. BS EN 15978:2011.

¹¹⁸ British Standards Institution (2012), *Sustainability of Construction Works – Environmental Products Declarations. Core Rules for the product category of construction products*, BSI Limited, London, UK.

¹¹⁹ Construction Leadership Council & the Green Construction Board (2016), *PAS 2080: 2016: Carbon Management in Infrastructure*, BSI Limited, London, UK.

assumptions and there is a level of uncertainty around the assessment of GHG emissions when projecting into the future. A sensitivity analysis has been undertaken looking at different scenarios and assumptions that would affect the Proposed Scheme's GHG emissions in the future. This analysis examined:

- the decarbonisation of the construction sector;
- the decarbonisation of grid electricity (this uses the profile for two scenarios; the base case scenario using the forecast grid decarbonisation as described above using HM Treasury's Green Book Guidance; and in comparison, the scenario using the recommended grid decarbonisation pathway described by the Climate Change Committee. In addition, the implications if the Proposed Scheme were to be powered with zero carbon energy from its opening year (2038), for example by actively procuring 100% renewable electricity, are explained); and
- the degree of modal shift (with two scenarios, the base case in line with Government projections and the second assuming more rapid decarbonisation of the transport sector where uptake of electric vehicles is consistent with the Ten Point Plan published by the Department for Business, Energy and Industrial Strategy (BEIS)).

8.4.8 The outcome of the sensitivity analysis is presented in Volume 3, Route-wide effect: Climate Change.

Assumptions and limitations

8.4.9 There is a level of uncertainty behind the GHG assessment, as described above, in particular in relation to the carbon intensity of the UK grid electricity generation, the embodied carbon of materials such as concrete and steel, and the fuel type used by road vehicles. These limitations have been addressed by analysing the sensitivity of the Proposed Scheme's carbon footprint as described above.

8.4.10 All the assumptions and limitations behind the GHG assessment are presented in Volume 5: Appendix CL-004-00000, Greenhouse gas calculation methodology,

In-combination climate change impacts assessment

Scope

8.4.11 The ICCI assessment explores the combined effect of the Proposed Scheme and potential climate change impacts on the receiving environment during construction and operation.

8.4.12 The ICCI assessment is route-wide level and covers all environmental topics assessed as part of the EIA. Potential ICCI impacts are based on the study areas within which other topics have undertaken their own assessment of effects.

8.4.13 The temporal scope includes construction plus the 120-year operational period.

Baseline

- 8.4.14 The Climate data and information report (Appendix CL-001-00000) presents an overview of the current climate conditions, projected climate change trends and related information. The document is based on the UK Climate Projections 2018 (UKCP18), which is the latest set of climate projections for the UK.
- 8.4.15 These climate change projections have been used to inform the climate change trends used in the ICCI assessment for the Proposed Scheme.

Methodology

- 8.4.16 The approach to the ICCI assessment is informed by good practice and guidance including that from the European Commission and the Institute of Environmental Management and Assessment (IEMA)¹²⁰.
- 8.4.17 The aim of the ICCI assessment is to identify potential significant ICCI effects which require additional appropriate mitigation measures are developed and, where practicable, incorporated into the Proposed Scheme design. The conclusions of this assessment are summarised in Volume 3, Route-wide effects.

Assumptions and limitations

- 8.4.18 The assumptions which have informed the assessment are as follows:
- the assessment has assumed that embedded mitigation measures included in the design, construction and maintenance of the Proposed Scheme are sufficient to address the effects of the Proposed Scheme under current climatic conditions. The assessment focuses on whether changes in climate will exacerbate the effects of the Proposed Scheme, thereby requiring additional mitigation measures; and
 - the assessment has assumed a trend of increased global carbon emissions in the atmosphere in the coming decades, in line with Representative Concentration Pathways (RCP) used in UKCP18. Increased global carbon emissions will lead to increased global temperatures. In turn this is a general assumption used in the climate models which are the basis of the climate trends used to inform the assessment. To present a range of plausible future climate scenarios, that take the uncertainty in future mitigation action into consideration, the data used in the ICCI assessment for future climate projections covers RCP 4.5 and 8.5, which are considered to represent a broad range of possible outcomes. It is recognised that other outcomes are possible.
- 8.4.19 The limitations of the ICCI assessment are as follows:

¹²⁰ Institute of Environmental Management and Assessment (2020), *IEMA Environmental Impact Assessment Guide To Climate Change Resilience And Adaptation*. Available online at: <https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020>.

- the assessment relies on trends identified from current model projections of climate change. Although the ability to model climate change is constantly evolving, limitations remain in the ability of modelling to simulate the real world; and
- climate projections used in the assessments/baseline only extend to 2099 and some aspects of the projections only extend to 2079. Thus, projections do not cover the full lifetime of the Proposed Scheme.

Climate change resilience assessment

Scope

- 8.4.20 The CCR assessment is a risk-based assessment that considers the potential impact of climate change on HS2 assets within the Proposed Scheme.
- 8.4.21 The spatial scope of the assessment is route-wide and it covers all assets within the Proposed Scheme, which will be owned by HS2 Ltd. The temporal scope includes construction, plus the 120-year operational period.

Baseline

- 8.4.22 The CCR assessment uses the same baseline as the ICCI assessment.

Methodology

- 8.4.23 The approach to the CCR assessment is informed by good practice and guidance including that from the European Commission¹²¹ and IEMA. Additionally, the assessment considered relevant literature, including relevant reports submitted under the UK Adaptation Reporting Power in the first and second rounds of reporting¹²², as well as reports by RSSB¹²³, amongst others.
- 8.4.24 The CCR assessment is undertaken at a route-wide level and includes relevant assets within the Proposed Scheme. It is based on a high-level climate change risk assessment, which uses projections of changes in climate averages and extreme weather events to qualitatively assess the impacts of climate change on the Proposed Scheme using professional expertise

¹²¹ European Commission (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*. European Union Publications Office. Available online at: <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf>.

¹²² Department for Environment, Food and Rural Affairs (2017), *Climate change adaptation reporting: second round reports*. Available online at: <https://www.gov.uk/government/collections/climate-change-adaptation-reporting-second-round-reports>.

¹²³ Rail Safety and Standards Board (2016), *Tomorrow's Railway and Climate Change Adaptation: Phase 1 Summary Report (T1009)*. Available online at: <https://climate-adapt.eea.europa.eu/metadata/projects/tomorrow2019s-railway-and-climate-change-adaptation/11252200.pdf>.

and judgement. The conclusions of this assessment are summarised in Volume 3, Route-wide effects.

Assumptions and limitations

- 8.4.25 The CCR assessment has assumed that embedded mitigation measures included in the design, construction and maintenance of the Proposed Scheme are sufficient to address the effects of the Proposed Scheme under current climatic conditions. The assessment focuses on the resilience of the Proposed Scheme to changes in climate.
- 8.4.26 The assessment has assumed a trend of increased global carbon emissions in the atmosphere in the coming decades, in line with RCP used in UKCP18 as set out above for the ICCI assessment, including the associated assumptions and limitations.
- 8.4.27 The limitations of the CCR assessment are as follows:
- the assessment relies on current model projections of climate change. Although the ability to model climate change is constantly evolving, limitations remain in the ability of modelling to simulate the real world and inherent uncertainties;
 - climate projections used in the assessments/baseline only extend to 2099 and some aspects of the projections only extend to 2079. Thus, projections do not cover the full lifetime of the Proposed Scheme; and
 - there are limited high speed rail assets in the UK and therefore limited data/evidence on this type of asset, and the assessment therefore uses evidence from other similar infrastructure, both in the UK and internationally, such as Network Rail.

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 other routes (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;
 - displacement from re-location of receptors and resources;
 - isolation of communities from services that they typically connect with/access on a regular basis or residential properties from the wider community as a consequence of physical and psychological barriers. Isolation can occur as a result of either road closure and/or lengthy delay or disruption to journeys. It can also occur due to the physical presence of the Proposed Scheme through a settlement, or as the result of a visual barrier due to construction works surrounding residential properties;

- 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 effects). 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; and
- the temporary presence of construction workers and their demands on community facilities.

8.5.2 All significant (moderate or major) community effects identified at this stage of the design and assessment are reported.

Baseline

8.5.3 Information has been collected on the current location and use of community resources. Sources of information include:

- data collected during preparation of the 2016 Sustainability Statement, supplemented and updated as appropriate;
- existing local studies and information on community resources such as public open space;
- information gathered from stakeholder engagement and consultation;
- analysis and data from other relevant assessment topics; and
- new field surveys where appropriate, for example, relating to the condition of publicly accessible open spaces and recreational routes.

8.5.4 Community resources are described in the environmental baseline only where they are relevant to the assessment. Consequently, not all community resources within the study area are described.

Methodology

8.5.5 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 and Phase 2a of HS2.

8.5.6 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).

8.5.7 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 were identified during the course of design development of the Proposed Scheme and associated consultation. Where replacement open space or other land is provided as part of the Proposed Scheme, this has been assessed and reported in ES.

- 8.5.8 The assessment reported in the ES has drawn on other topics for the assessment of in-combination effects. This took 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.
- 8.5.9 The study area included the land required both temporarily and permanently for the construction and operation of the Proposed Scheme. It also included a wider area including proposed construction traffic routes within which community resources could be affected by a combination of two or more significant residual effects arising from, noise, vibration, poor air quality, HGV traffic and visual intrusion. Overall, the study area is taken as the area of land that encompasses the likely significant effects of the Proposed Scheme.

Assumptions and limitations

- 8.5.10 Key assumptions underlying the assessment include the following:
- the assessments consider the function of land rather than its ownership as the key parameter for assessing impacts associated with the Proposed Scheme;
 - where practicable, land required solely during the construction period will be returned to its previous use after construction unless that use cannot continue or resume within a reduced area. Where the use cannot resume, the effect is treated as permanent;
 - where reasonably practicable, public footpaths will be reinstated or convenient alternatives provided. HS2 Ltd will seek to provide a temporary or permanent alternative route in advance of a closure of a road or PRoW. No significant effects on these routes are likely once the mitigation measures have been implemented. If a temporary or permanent alternative route cannot be provided in advance of any road or PRoW closure, then this will be discussed with the relevant local authority and local groups; and
 - 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.

8.6 Ecology and biodiversity

Scope

- 8.6.1 The ecological impact assessment considers all ecological receptors that 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 due to collision with passing trains.

- 8.6.2 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.
- 8.6.3 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 EIA SMR.

Baseline

- 8.6.4 Existing biological data for the Proposed Scheme has been obtained from relevant Local Biological Records Centres and from national and local specialist data sources. National and local biodiversity action plans and ancient woodland inventories have also been consulted. The geographic extents of search areas varies, based on the likely value and mobility of the receptor involved.
- 8.6.5 A wide range of field surveys have been conducted to inform the ES. The survey methodologies used have been based on recognised best practice and have been consulted on with relevant regulators including Natural England and the Forestry Commission.

Methodology

- 8.6.6 The ecological impact assessment has taken account of the guidance published by the Chartered Institute of Ecology and Environmental Management (CIEEM)¹²⁴.
- 8.6.7 Each potential ecological receptor has been assigned a value according to one of the following geographical frames of reference: international; national; regional; county/metropolitan; district/borough¹²⁵; 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 and Volume 4, Off-route effects in relation to nationally and internationally 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.

¹²⁴ Chartered Institute of Ecology and Environmental Management (2019), *Guidelines for Ecological Impact Assessment in the UK and Ireland – Terrestrial, Freshwater and Coastal*. Available online at: <https://cieem.net/wp-content/uploads/2018/08/ECIA-Guidelines-Sept-2019.pdf>.

¹²⁵ Due to different administrative arrangements, the district/borough category is not used in Scotland.

- 8.6.8 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

- 8.6.9 A precautionary approach to valuation has been used for instances where baseline information is incomplete, to ensure that all likely significant effects 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.
- 8.6.10 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.
- 8.6.11 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 (except for utility works) will be lost except for areas included only for the purpose of ecological enhancement¹²⁶;
 - for most utility works, the same assumption has been taken where the extent of the works within the land required for the Proposed Scheme is uncertain. However, for some utility works, such as the decommissioning of existing utilities, the construction methods are such that it has been possible to exclude significant effects;
 - 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;
 - displaced ancient woodland soils will be translocated where possible to form the basis of new woodland planting;
 - 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

¹²⁶ The re-instatement and landscaping of these areas on completion of construction are considered as part of the proposed 'other mitigation measures, described in 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.

- the nominated undertaker will commit to monitoring habitats and species to measure the accuracy of predictions of effects and to ensure that mitigation/compensation is successful.

8.7 Electromagnetic Interference

Scope

- 8.7.1 High voltage electrical equipment creates electromagnetic fields (EMF) which, when at high levels, 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).
- 8.7.2 The primary source of EMF will come from the traction power system, comprising the overhead line equipment, 25 kilovolts (kV) trackside traction power cables along the route and supporting infrastructure such as feeder stations. The level of EMF diminishes with distance from the source, so the extent of any potential interference or harmful effects will be limited to only a short distance horizontally and vertically from the railway boundary or the boundary of any traction power sub-station or switching station.
- 8.7.3 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 50121-5-2017¹²⁷ and BS EN 50122-1-2011¹²⁸ and EU Directive 2013/35/EU¹²⁹, which is closely based on International Commission on Non-Ionising Radiation Protection (ICNIRP) guidance¹³⁰.
- 8.7.4 Equipment used during construction of the Proposed Scheme will also comply with applicable standards for 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 if correctly managed.

¹²⁷ British Standards Institute (2017), BS EN 50121-5-2017+A1:2019 *Railway Applications, Electromagnetic Compatibility Part 5: Emissions and immunity of fixed power supply installations and apparatus*.

¹²⁸ British Standards Institute (2011), BS EN 50122-1-2011+A1:2017 *Railway Applications, Fixed installations – Electrical safety, earthing and the return circuit. Part 1: Protective provisions against electric shock*.

¹²⁹ Directive 2013/35/EU of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields). Strasbourg, European Parliament and European Council.

¹³⁰ International Commission on non-ionizing radiation protection (2010), *Guidelines for limiting exposure to time-varying electric and magnetic fields (1Hz – 100 kHz)*.

Methodology

- 8.7.5 A desk-top study was undertaken to identify any potential sensitive sites within a 50m corridor either side of the centreline of the nearest track within the Proposed Scheme, or from proposed power equipment (e.g. traction substations). A 50m corridor was selected to identify all potentially sensitive receptors within that area to demonstrate that the level of risk will be limited to a much shorter distance than 50m from the railway. The assessment included receptors outside of the 50m corridor which were identified as having very sensitive electrical equipment or systems, which could be at risk of EMI.
- 8.7.6 Once each receptor site was identified, a risk assessment was undertaken to categorise the perceived level of risk and to identify any potential mitigation for each receptor site. The risk assessment considered the impact of EMF effects on nearby equipment, installations and people. In evaluating the risk from EMF, the assessment used data from the preliminary traction power modelling completed by HS2 Ltd. The method for assessment of EMI risk arising from the Proposed Scheme is set out in the EIA SMR.

Assumptions and limitations

- 8.7.7 Where information is not available, professional judgement has been used to reach a conclusion. This has included use of information from other recent and similar railway construction projects.
- 8.7.8 In accordance with good safety management principles, risks identified in Volumes 3 and 5 are considered to be managed as low as reasonably practicable (ALARP) if all mitigation measures outlined are correctly implemented.

8.8 Health

Scope

- 8.8.1 The definition of health used in the assessment follows that of the World Health 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 have the potential to impact on a number of health determinants (environmental or social factors that influence health), which in turn will affect health and wellbeing. Health effects are 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 are assessed at local (community area) level, and are reported in the Volume 2, Community Area reports and Volume 4, Off-route effects:

- impacts on neighbourhood quality (impacts on the physical environment in neighbourhoods along the route such as noise and visual impacts);
- impacts on access to services, health and social care, resulting from direct loss of services and facilities, impacts on the amenity of facilities, and changes to accessibility due to traffic and transport impacts;
- access to green space, recreation and physical activity, resulting from direct (loss) or indirect (amenity, access) impacts on green space, sport and leisure facilities, and impacts on non-motorised road users;
- direct (loss) or indirect (amenity, access) impacts on places of education; and
- impacts on social capital (the levels of social connections and the benefits they generate), resulting from community severance, direct impacts on community spaces, and the presence of the construction workforce.

8.8.4 The health effects resulting from impacts on the following determinants are 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 considered in Volume 3, Route-wide effects are:

- employment and income;
- housing;
- transport (traveller stress and road safety);
- uncertainty and stress; and
- airborne noise (railway and road 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 environmental topics, where relevant.

Baseline

8.8.7 Baseline data have been collected from a variety of publicly available online sources including Office for National Statistics (ONS), Public Health England (PHE), and English Indices of Deprivation (2019). The data have been 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 is based on a review of scientific evidence linking impacts on determinants with health outcomes. Most health effects cannot be 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.

Assumptions and limitations

- 8.8.10 The community profiles are informed by publicly available data and consultation, and stakeholder engagement.
- 8.8.11 The assessment is 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 is necessary to assess the likely health effects.

8.9 Historic environment

Scope

- 8.9.1 Impacts on the following types of heritage asset have been assessed as part of the EIA:
- archaeological and palaeoenvironmental remains¹³¹ including geological deposits that may contain evidence of the human past;
 - historic landscapes; and
 - historic buildings and the historic built environment.
- 8.9.2 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 effects arising from development within the setting of heritage assets).

¹³¹ The organic remains of plants, animals and sediments which are studied in order to examine past environments and human interaction with past environments.

- 8.9.3 The study area for the assessment of designated and non-designated heritage assets consists of the land required for the construction of the Proposed Scheme, plus 500m on either side in rural areas and 250m in urban areas. The terms urban and rural have been defined on a case by case basis in this topic, solely for the purpose of obtaining baseline data, and may be applied differently in other environmental topics.
- 8.9.4 The study area for data gathering to identify impacts upon designated heritage assets, and to understand the historic landscape, is 2km either side of the land required for the construction of the Proposed Scheme in rural areas and urban areas. Professional judgement has been used to determine the extent to which assets within the 2km study area require detailed assessment of effects.
- 8.9.5 The study area for designated and non-designated assets in the vicinity of bored and mined tunnels is 100m either side of the extent of tunnelling to allow for an assessment of the potential effects of ground movement (settlement) on heritage assets.

Baseline

- 8.9.6 Information about heritage assets has been obtained from a range of sources, including:
- the National Heritage List for England held by Historic England (the register of designated heritage assets) and data held by Historic Environment Scotland for designated assets in Scotland;
 - historic environment records;
 - historic landscape characterisation projects in England and the historic land-use assessment project in Scotland;
 - conservation area appraisals; and
 - historic maps and aerial photography.
- 8.9.7 Information has also been gathered from specific surveys and research, where available, such as:
- LiDAR surveys;
 - site visits; and
 - non-intrusive surveys (e.g. geophysical surveys).
- 8.9.8 Survey work has been discussed with Historic England, and relevant local authority archaeologists on a case-by-case basis.

Methodology

- 8.9.9 There is no national guidance on the methodology for assessment of impacts on the historic environment and heritage assets. However, the guidance on heritage impact assessments

for Cultural World Heritage Properties (International Council on Monuments and Sites)¹³², and a range of guidance notes from Historic England and Historic Environment Scotland have been considered during the development of the assessment methodology for the historic environment topic.

- 8.9.10 In England the NPPF requires that impacts on heritage assets are assessed in relation to the significance of the asset. Heritage significance is defined in the glossary to the NPPF as ‘the value of a heritage asset to this and future generations because of its heritage interest; that interest may be archaeological, architectural, artistic or historic.’ Scottish Planning Policy and Historic Environment Policy for Scotland (HEPS)¹³³ include similar and equivalent policies and terminology. The significance of a heritage asset is referred to throughout the ES as its ‘heritage value’. Heritage value derives not only from a heritage asset’s physical presence, but also from its setting.
- 8.9.11 The assessment of the significance of effects is determined by cross referencing the value of the asset and the type and magnitude of impact, such as whether construction and/or operation of the Proposed Scheme would entail the removal of the heritage asset or change to its setting. Appropriate mitigation measures have been identified and taken into account.

Assumptions and limitations

- 8.9.12 For the purpose of the historic environment assessment, it is assumed that heritage assets within the land required for the construction of the Proposed Scheme will be removed, unless otherwise stated in the assessment in the relevant Volume 2, Community Area report or the impact assessment table included in Volume 5: Appendices HE-002.
- 8.9.13 With respect to utilities and highway improvements, particularly overhead line diversions/realignments, it is likely that the majority of the heritage assets can in fact be retained, as the land may only be required to allow for raising or lowering of pylons and/or re-stringing of cables, or to provide an access route to the works. The impact assessment table included in Volume 5: Appendices HE-002 will identify effects that are not significant and assets where no effect is predicted.
- 8.9.14 No site-specific intrusive site investigations have been undertaken as part of the baseline data collection. Intrusive investigations will be undertaken at the pre-construction stage or later.
- 8.9.15 Not all areas within the land required for construction were available for field survey (due to land access and site conditions). Where survey data are limited, a precautionary assessment

¹³² International Council on Monuments and Sites (2011), *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties*. Available online at: https://www.iccom.org/sites/default/files/2018-07/icomos_guidance_on_heritage_impact_assessments_for_cultural_world_heritage_properties.pdf.

¹³³ Historic Environment Scotland (2019), *Historic Environment Policy for Scotland*. Available online at: <https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=1bcfa7b1-28fb-4d4b-b1e6-aa2500f942e7>.

has been undertaken making reasonable professional judgements in terms of baseline conditions and potential, according to the guidance provided in the EIA SMR.

- 8.9.16 Planting as a means of softening effects on heritage assets arising from development within their settings will not be fully effective until maturity. Landscape and hedgerow planting will increasingly reduce the effect of changes within the setting of heritage assets as it matures.
- 8.9.17 Heritage data from local lists held and maintained by the local planning authorities has only been obtained where data is publicly accessible; a comprehensive list of the data sources consulted for the ES are provided in the BID Historic environment baseline reports (BID HE-001).
- 8.9.18 Assessment of effects on heritage assets where they may be impacted by ground movement (settlement) as a result of the mined or bored tunnels has been undertaken on the basis of greenfield settlement predictions; therefore, the assessment identifies assets within the 10mm settlement contour, but does not propose specific mitigation for assets. General information regarding later stages of settlement assessment can be found in HS2 Information Paper C14: Ground Settlement.

8.10 Land quality

Scope

- 8.10.1 The assessment of land quality has considered the potential for impacts arising from:
- disturbance of pre-existing contamination during the construction phase;
 - disturbance or development over any areas of geological significance, such as mineral resources and geo-conservation sites (including geological Sites of Special Scientific Interest (SSSI) and Local Geological Sites (LGS)); and
 - operational sources of contamination.
- 8.10.2 Potentially contaminated sites have been identified within the footprint of the Proposed Scheme, within the boundary of the land required for the construction of the Proposed Scheme and within the study area. The study area has been widened where evidence suggests that it is required; for example where a potentially contaminated site lies just beyond, or straddles, the boundary. The assessment of groundwater abstractions as receptors has been extended to 1km from the boundary of the land required for the construction of the Proposed Scheme.
- 8.10.3 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.
- 8.10.4 Land contamination issues are closely linked with those involving waste and water resources. Issues regarding waste are addressed in Section 8.16 (Waste and material resources) of this document and Volume 3, Route-wide effects, Section 15 (Waste and

material resources). Issues regarding groundwater resources that are not related to land contamination are addressed in Section 8.17 (Water resources and flood risk).

- 8.10.5 The route of the Proposed Scheme will intercept mining and mineral resources, including salt extraction, sand and gravel extraction, coal mining and aggregate production from quarries, and the exploitation of other identified resources (e.g. hydrocarbons and coal bed methane). Where these resources will be impacted by the Proposed Scheme, they have been dealt with in the context of their value as an asset.

Baseline

- 8.10.6 Baseline information has been obtained from desktop sources, site visits and where available, previous ground investigations. Desktop sources include published geological/hydrogeological mapping, information from the Environment Agency, the Coal Authority and other organisations (particularly for existing and historical landfill and mining 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, where geological sites have been identified or where significant mineral resources are present and where mining and hydrocarbon extraction activities are concentrated.

Methodology

- 8.10.7 For the land contamination assessment, a conceptual site model (CSM) and risk assessment approach has been used, in line with the Environment Agency's Land Contamination Risk Management (LCRM) framework¹³⁴, based on CLR 11¹³⁵. 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.
- 8.10.8 This contaminant/pathway/receptor model has been 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 remediation required has been carried out). The significance of effects has been derived from the change in level of risk, taking account of the sensitivity of the receptor.
- 8.10.9 The remediation of existing contamination, as part of the construction works, will usually be regarded as beneficial.
- 8.10.10 The methods for assessment of the significance of effects arising from the Proposed Scheme on mineral resources and geo-conservation sites are set out in the EIA SMR. The mineral

¹³⁴ Environment Agency (2021), *Land Contamination Risk Management* (LCRM). Available online at: <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>.

¹³⁵ Environment Agency (2004), *CLR11 Model Procedures for the Management of Land Contamination*. Available online at: <http://webarchive.nationalarchives.gov.uk/20140328160926/http://cdn.environment-agency.gov.uk/scho0804bibr-e-e.pdf>. Note this is now withdrawn.

resources assessment has taken into account the degree of impact that the construction activities may have on such sites, their sensitivity and importance.

Assumptions and limitations

- 8.10.11 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.
- 8.10.12 The location of the Proposed Scheme was viewed from points of public access initially. In addition, and where permission could be obtained, visits to some key sites have been undertaken to verify desktop information.
- 8.10.13 For major above ground utilities, a pre-screening exercise has been completed to determine where these may break ground, or otherwise interact with land quality. In such cases, these are considered in the land quality assessment.
- 8.10.14 The majority of new and diverted minor utilities will be laid in the boundaries of existing highways within normal road construction layers and soils below. These have been considered in the context of the CSM approach. The lack of contact with nearby potentially contaminated sites, the usual approach to ensuring services are protected from contamination by design and choice of materials and the absence of sensitive receptors within the roadways, reduces the risk of an impact occurring. The potential impacts of laying these new and diverted utilities have, therefore, been scoped out of the assessment as they are unlikely to cause any significant land quality effects.
- 8.10.15 The minerals assessment is based upon the mineral resources¹³⁶ identified on published minerals plans, and existing planning or licensed areas. Any inference of mineral resources from geological maps/reports has been excluded (except where these are covered by the relevant minerals plans).
- 8.10.16 The geoconservation assessment is based upon publicly available local authority and publicly available local geological trust records.

8.11 Landscape and visual

Scope

- 8.11.1 The assessment includes consideration of the effects on landscape and on visual receptors within the study area. The landscape and visual assessment has been undertaken for the following scenarios:

¹³⁶ Defined in the EIA SMR as 'mineral body including aggregates, salt, coal and other hydrocarbons, Petroleum Extraction and Development Licence (PEDL), Shale Protection Area (SPA)'.

- construction – an assessment of landscape effects;
- construction – an assessment of visual effects (including night-time effects) in winter during the peak period¹³⁷ of the construction phase;
- operation – an assessment of visual effects in winter and summer¹³⁸ during operation year 1;
- operation – an assessment of visual effects (including night-time effects) in summer during operation year 15 and year 30, once any vegetation planted as part of the Proposed Scheme has matured further or has achieved its design intention; and
- operation – an assessment of landscape effects at year 1, year 15 and year 30.

8.11.2 The landscape assessment does not consider seasonal variations e.g. winter/summer, since these do not affect character.

8.11.3 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. The ZTV have been produced in line with the methodology described in the EIA SMR and are an indication of the extent of theoretical visibility of the Proposed Scheme. In some locations, extensive vegetation cover will mean the actual extent of visibility is substantially less than that shown in the ZTV, and professional judgement has been used to further refine the study area to focus on likely significant effects.

8.11.4 The Guidelines for Landscape and Visual Impact Assessment third edition (GLVIA3) states that ZTV mapping should ‘assume that the observer eye height is some 1.5 to 1.7 metres above ground level, based on the midpoint of average heights for men and women’. As set out in the EIA SMR, a datum of 1.6m above ground level has been used for the ZTV mapping to represent the eye level view of an average height person. The ZTV 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.

8.11.5 Thin bands of trees narrower than 10m are excluded as, during winter, these will provide only minimal screening.

8.11.6 The ZTV for the construction phase takes account of the tops of activities or structures that will be present during construction, including:

¹³⁷ The period during which the main construction works will take place, including the establishment of compounds, main earthworks and structure works.

¹³⁸ It should be noted that seasonal distinctions are only drawn for the visual component of the assessment and not for the assessment in relation to landscape character.

- construction plant along the route of the Proposed Scheme, in compounds, at tunnel portals, cut-and-cover tunnels, road diversions and any other known works;
- temporary fencing and hoarding;
- temporary stockpiling of materials;
- welfare facilities and storage;
- structures being demolished; and
- new permanent structures under construction.

8.11.7 The ZTV for the operation phase shows the visibility of the permanent structures, including:

- stations and depots;
- road/pedestrian diversions;
- bridges and viaducts; and
- fencing and noise fence barriers.

8.11.8 The ZTV for year 15 of operation (2053) illustrates how planting proposed along the route will reduce visibility of the Proposed Scheme.

8.11.9 Landscape and visual receptors within 1.5km of the route of the Proposed Scheme have been considered. However, this study area varies 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

8.11.10 Baseline information has been obtained from a combination of desktop research and fieldwork. Desktop sources include published landscape character assessments (national, county and local authority level landscape character assessments), and a wide range of supporting GIS data, aerial photography and Ordnance Survey mapping, plus desk study and fieldwork.

8.11.11 Published LCA have been adapted for this assessment, as appropriate, to provide LCA of an appropriate and consistent scale. The LCA have been determined as part of an integrated process of environmental characterisation, informed by the outcome from other topics including ecological assessments. These LCA have been refined upon review of historic landscape characterisation data and have been reviewed in consultation with Local Planning Authority (LPAs).

8.11.12 Fieldwork has been used to identify and verify visual receptors. Fieldwork has been undertaken in both summer and winter to capture best and worst-case visibility.

Methodology

8.11.13 The assessment methodology has been designed to ensure an integrated and iterative process of assessment and design, to directly inform landscape design outcomes for the

Proposed Scheme, in line with the objectives of the HS2 Design Vision and the Landscape Design Approach. The methodology for the landscape and visual assessment follows the guidance set out in the GLVIA3¹³⁹ and, where appropriate, the DMRB¹⁴⁰, Townscape Character Assessment, Technical Information Note, 05/2017¹⁴¹ and An Approach to Landscape Sensitivity Assessment, Natural England¹⁴². 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 is derived from the interaction between the magnitude of change (e.g. duration, geographic extent and reversibility or otherwise of effect, considering among other factors the extent of the land required for construction and/or operation or loss of features within a character area, plus introduction of new features) and the sensitivity of the landscape.

- 8.11.14 Engagement with the competent authorities has been undertaken. The purpose of this engagement was to discuss the assessment methodology, the extent of the landscape and visual study area, and the locations of visual assessment and verifiable photomontage viewpoints.
- 8.11.15 The significance of visual effects is derived from the interaction between the magnitude of change to these views and the susceptibility and sensitivity of receptors to the visual change. View value is also captured to inform the assessment. Impacts on selected views have been illustrated by preparing verified photomontages from locations discussed with the competent authorities for the ES. The focus for photomontage selection has been on complex aspects of the design where a photomontage will aid the assessment, or where level of effect is borderline between significant and non-significant.

Assumptions and limitations

- 8.11.16 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 amenity of receptors.
- 8.11.17 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 from publicly accessible land, professional judgement is used to approximate and record the likely views and visual effects from these locations.

¹³⁹ Landscape Institute and Institute of Environmental Management and Assessment (2013), *Guidelines for Landscape and Visual Impact Assessment, Third Edition*, Routledge, New York.

¹⁴⁰ Highways England (2020), *Design Manual for Roads and Bridges (DMRB) Sustainability and Environmental Appraisal, LA 107 Landscape and Visual Effects*, Highways Agency, London. Available online at: <https://www.standardsforhighways.co.uk/dmrbs/search/bc8a371f-2443-4761-af5d-f37d632c5734>.

¹⁴¹ Landscape Institute (2017), *Townscape Character Assessment, Technical Information Note, 05/2017*. Landscape Institute. London.

¹⁴² Natural England (2019), *An Approach to Landscape Sensitivity Assessment – to inform spatial planning and land management. NE724*.

- 8.11.18 Tall construction plant (for example tower cranes and piling rigs) is excluded from the ZTV for the construction phase, as there is a great degree of variability in the extent and timeframes of visibility of construction activity and plant. Overhead line equipment rarely gives rise to significant effects if it is the only element visible and has, therefore been excluded from the ZTV to give a better indication of the possible spread of significant effects to aid the assessment. However, overhead line equipment as well as tall construction plant are taken into account in the assessment of effects on LCA and visual receptors.

8.12 Major accidents and disasters

Scope

- 8.12.1 The assessment of the vulnerability of the Proposed Scheme to major accidents and disasters is introduced as a result of the English EIA Regulations. The English 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 major accidents and/or disasters which are relevant to the project concerned'. This includes compliance with legislative and regulatory requirements for existing facilities that present a potential risk to environmental receptors (for example storage of hazardous substances, hazardous pipelines, storage of waste), and where that risk profile may be affected by the construction or operation of the Proposed Scheme.
- 8.12.2 For the purposes of this assessment, vulnerability is defined as the 'exposure and resilience' of the Proposed Scheme to the risk of a major accident and/or disaster. A risk is defined as the likelihood of an impact occurring, combined with effect or consequence(s) of the impact on a receptor if it does occur.
- 8.12.3 Major accidents, in the context of the Proposed Scheme, are unplanned events or situations that threaten immediate or delayed serious damage to human health, welfare and/or the environment, and require the use of resources beyond those of HS2 Ltd or its contractors. Serious damage includes the loss of life or permanent injury and/or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.
- 8.12.4 A disaster, in the context of the Proposed Scheme, is an external occurrence leading to an event or situation that meets the definition of a major accident. It may result from natural sources, such as extreme weather (storm, flood, temperature) and ground-related hazard events (subsidence, landslide) or from man-made sources, such as large-scale fire, structural collapse, explosion, or transport accident.
- 8.12.5 The assessment of 'significant adverse effects' includes consideration of all factors identified in the English EIA Regulations (i.e. population and human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage and landscape).
- 8.12.6 The scope of this assessment follows that set out in the EIA SMR and addresses those unplanned events that have been determined as being relevant to the Proposed Scheme,

and are low likelihood but potentially high consequence with the potential to result in a significant adverse environmental effect. For the Proposed Scheme, a significant adverse effect is considered to mean the loss of life or permanent injury, and/or permanent or long-lasting damage to an environmental receptor.

Baseline

8.12.7 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 disaster risks.

Methodology

8.12.8 The assessment requires interaction with other assessment topics, in particular climate change, community, ecology and biodiversity, health, socio-economics, traffic and transport, and water resources and flood risk.

8.12.9 The assessment has been undertaken with reference to the regulatory requirements, legislation and design standards in place for the construction and operation of the Proposed Scheme.

8.12.10 The baseline for the assessment considers the regulatory requirements in place and does 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)¹⁴³.

8.12.11 The framework for the environmental risk assessment follows a standard source-pathway-receptor approach, where sources and pathways are based on existing risk assessments, and receptors include:

- members of the public and local communities;
- 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.

¹⁴³ 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*.

Assumptions and limitations

8.12.12 Key assumptions for the major accidents and disasters assessment are:

- the route of the Proposed Scheme shall not carry hazardous (combustible/explosive) freight. However, it is expected that off-route sections associated with the Proposed Scheme will carry freight, alongside HS2 services. However, in these instances freight will be carried on Network Rail owned and operated infrastructure, and as such falls under Network Rail's operating licence and safety plans;
- there are no new level crossings included as part of the Proposed Scheme design, however it is expected that off-route sections associated with the Proposed Scheme will pass level crossings. As these crossing exist on Network Rail owned and operated infrastructure these will continue to be managed under Network Rail's operating licence and safety plans;
- only those risk events with a feasible source-pathway-receptor model are considered in the assessment; and
- risk events identified in Volumes 3, Route-wide effects and Volume 5, Appendices are assumed to be managed as ALARP if all mitigation measures outlined are correctly implemented.

8.13 Socio-economics

Scope

- 8.13.1 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, Community Area reports and within Volume 4, Off-route effects. Wider economic benefits are reported within Volume 3, Route-wide effects.
- 8.13.2 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.
- 8.13.3 The route-wide assessment considers 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

- 8.13.4 Baseline information has been obtained at various geographical levels including national, regional and local authority level. Data are 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, commercial property data sets and stakeholder views.

Methodology

- 8.13.5 The assessment has drawn on guidance such as the Treasury Green Book¹⁴⁴, DfT Transport Appraisal Guidance¹⁴⁵ Homes and Communities Agency (HCA) Employment Density Guide¹⁴⁶ and the HCA Additionality Guide¹⁴⁷.
- 8.13.6 The significance of effects has been 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.
- 8.13.7 The economic case for the Proposed Scheme is based on the Government's long-term economic forecast for the UK which takes into account the impacts of COVID-19 to date and its expected medium and long term effects. The Government forecasts account for the short-term impacts of COVID-19 and the long-term behaviour impacts (e.g. reduced commuting due to increased working from home) is considered through sensitivity tests.
- 8.13.8 The impact of COVID-19 has been taken into account in relation to its short, medium and long term economic effects. The socio-economic assessment is based on information relating to businesses and their employees available as at October 2020. As a precautionary approach any business premises known to be vacated after that date is assumed to still be occupied for assessment purposes. This is to take account of the forecast recovery in the economy and any impact of the loss of business premises.

¹⁴⁴ HM Treasury (2020), *The Green Book: appraisal and evaluation in central government*. Available online at: <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>.

¹⁴⁵ Department for Transport (2021), *Transport analysis guidance: WebTAG*. Available online at: <https://www.gov.uk/guidance/transport-analysis-guidance-webtag>.

¹⁴⁶ Homes and Communities Agency (2015), *Employment Densities Guide*, 3rd Edition. Available online at: https://www.kirklees.gov.uk/beta/planning-policy/pdf/examination/national-evidence/NE48_employment_density_guide_3rd_edition.pdf.

¹⁴⁷ Homes and Communities Agency (2014), *Additionality Guide, Fourth Edition 2014*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf.

Assumptions and limitations

- 8.13.9 Changes to the environmental conditions 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).
- 8.13.10 Where land and premises are required for construction of the Proposed Scheme, it is assumed that 88% of the occupiers displaced will successfully relocate to alternative locations and no employment will be lost. The other 12% of occupiers are assumed to close rather than relocate and hence employment within these organisations will be lost.
- 8.13.11 Some business receptors lie within land required for construction of the Proposed Scheme which will be used for utility works only. Where this land is only required to allow for non-intrusive works such as re-stringing of overhead electricity lines, or to provide an access route to the works, and where there are therefore no impacts on the ground, such as demolition or loss of land for a prolonged period, construction activities are deemed to not impact business resource operations. Therefore, these business resources are not reported in the socio-economic assessment.
- 8.13.12 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 is reported within Volume 3, Route-wide effects and is calculated by:
- estimating the total employment of the business(es) affected; and
 - 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.
- 8.13.13 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.
- 8.13.14 Operational employment on the conventional network is assumed to remain the same as present as released capacity is utilised by new services.

8.14 Sound, noise and vibration

Scope

- 8.14.1 The assessment of sound, noise and vibration considers the noise and vibration likely significant effects arising from the construction and operation of the Proposed Scheme on:
- 'residential receptors'; people, primarily where they live, in terms of individual dwellings and on a wider community basis including any shared community open areas¹⁴⁸; and
 - 'non-residential receptors'¹⁴⁹ such as:
 - community facilities including schools, hospitals, places of worship and 'quiet areas'¹⁵⁰; and
 - commercial properties such as offices and hotels.
- 8.14.2 Potential noise and/or vibration effects on animals, the historic environment and tranquillity have been reported in the respective ecology and biodiversity, historic environment and landscape and visual sections of the ES, as appropriate.
- 8.14.3 In this assessment, significant noise or vibration effects may be:
- adverse from an increase in sound or vibration levels, or beneficial from a decrease in sound or vibration levels caused by the Proposed Scheme where the noise or vibration from the Proposed Scheme will exceed the relevant Lowest Observed Adverse Effect Level in line with Government noise policy¹⁵¹ and the EIA SMR;
 - temporary from construction or permanent from the operation of the Proposed Scheme;

¹⁴⁸ '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 or local green space) that is nearby.

¹⁴⁹ Non-residential receptors with multiple uses will be assessed either based on the most noise sensitive use or will be subject to multiple assessments as appropriate.

¹⁵⁰ 'quiet areas' are defined as either Quiet Areas as identified under the Environmental Noise Regulations 2007 (as amended) or are resources which are prized for providing tranquillity as noted in the NPPF and are therefore designated as such under the relevant local plan or are designated under local plans or neighbourhood development plans as local green spaces.

¹⁵¹ Department for Environment, Food and Rural Affairs (2010), *Noise Policy Statement for England (NPSE)* Available online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf and Department for Communities and Local Government (2019), *National Planning Policy Framework*, and Department for Communities and Local Government (2019), *National Planning Policy Framework*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf.

- 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.

8.14.4 HS2 Ltd has engaged with the environmental health practitioners acting for the local and county authorities along the route of the Proposed Scheme. The purpose of this engagement was twofold. Firstly, engagement undertaken on a route-wide basis covering matters including process, scope, methodology and the approach to baseline and mitigation strategy. Secondly, local engagement to obtain relevant information regarding residential and non-residential receptors and existing baseline sound levels, and to discuss the development of the mitigation to be included in the Proposed Scheme. Officers from local and county authorities were invited to attend and witness baseline sound measurements.

8.14.5 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 over 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

8.14.6 Information on the existing airborne sound environment has been obtained from desktop research, modelling of road and railway noise and extensive field surveys. Sound level monitoring has also been 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 described the existing sound environment that was supported by an assessment of the existing acoustic character at each location.

8.14.7 Future changes in the airborne sound baseline have been 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 and/or noise reduction provided in Important Areas identified in

Defra's Noise Action Plans for Agglomerations¹⁵², Roads¹⁵³ or Railways¹⁵⁴. HS2 Ltd has engaged with the competent authorities responsible for the relevant Important Areas.

- 8.14.8 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. The assumption that there is no baseline vibration provides a reasonable worst-case basis for the assessment of likely significant effects.

Methodology

- 8.14.9 The assessment identifies likely significant noise and vibration effects (both beneficial and adverse) and describes the measures proposed to avoid or reduce significant adverse effects.
- 8.14.10 The methodology for the assessment of likely significant noise and vibration effects was developed in alignment with Government noise policy¹⁵⁵, planning policy and planning practice guidance on noise (PPGN)¹⁵⁶ and relevant project precedent. HS2 Phase One was the first major infrastructure project to set out the interaction between Government noise policy and the EIA Regulations. During the parliamentary examination of the Phase One hybrid Bill, HS2 Ltd's interpretation of noise policy, planning guidance and EIA regulations was formalised in a number of Information Papers. Equivalent Information Papers have been adopted for Phase 2b.

¹⁵² Department for Environment, Food and Rural Affairs (2019), *Noise Action Plan: Agglomerations (Urban Areas)*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813663/noise-action-plan-2019-agglomerations.pdf.

¹⁵³ Department for Environment, Food and Rural Affairs (2019), *Noise Action Plan: Roads (including major roads)*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813666/noise-action-plan-2019-roads.pdf.

¹⁵⁴ Department for Environment, Food and Rural Affairs (2019), *Noise Action Plan: Railways (including major railways)*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813664/noise-action-plan-2019-railways.pdf.

¹⁵⁵ Department for Environment, Food and Rural Affairs (2010). *Noise Policy Statement for England (NPSE)*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69533/pb13750-noise-policy.pdf and Department for Communities and Local Government (2019), *National Planning Policy Framework*, and Department for Communities and Local Government (2019), *National Planning Policy Framework*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf.

¹⁵⁶ Department for Communities and Local Government (2019), *Planning Practice Guidance – Noise*. Available online at: <http://planningguidance.planningportal.gov.uk>.

- 8.14.11 The assessment will inform the EMR¹⁵⁷ that 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 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.
- 8.14.12 Government planning guidance on noise is based on the premise that once the level of noise 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.
- 8.14.13 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 EIA SMR. These thresholds are based on national and international regulations, standards and guidance.
- 8.14.14 ‘Significant adverse’ effects on 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 EIA SMR.

Assumptions and limitations

Construction assumptions

- 8.14.15 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 and any additional mitigation has been identified within the relevant community area report. 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.
- 8.14.16 The assessment takes account of people’s perception of noise during the day, evening and night¹⁵⁸. More stringent criteria are applied during evening and night-time periods, when people are more sensitive to noise, compared to the busier and more active daytime period.

¹⁵⁷ For example please refer to HS2 Phase One and Phase 2a Information Papers: <https://www.gov.uk/government/publications/hs2-information-papers-environment> and <https://www.gov.uk/government/publications/environment-hs2-phase-2a-information-papers>.

¹⁵⁸ Day, evening and night-time periods are defined in Volume 5: Appendix SV-001-00000, *Sound, noise and vibration methodology, assumptions and assessment*.

- 8.14.17 In line with (and as will be controlled by) the draft CoCP, the assessment assumes that the following construction activities will require extended (evening) working hours for periods of greater than one month at some stage, or stages, of the overall construction programme:
- embankments, cuttings and landscape earthworks (during summer months to make best use of suitable weather); and
 - bridges, viaducts, retaining walls, tunnel vent shafts and station buildings (associated with, for example, piling and large concrete pours).
- 8.14.18 It is anticipated that there may be some night-time working during ‘possessions’ or ‘blockades’ 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. Where night-time work will be required over extended periods, for example at tunnel portals, it is assessed against night-time noise criteria.
- 8.14.19 During certain construction processes, there may be the need to operate fixed construction plant such as generators¹⁵⁹ and water pumps for reasons of safety or engineering practicability on a continuous basis. Noise will be controlled and reduced by the management processes set out in the draft CoCP and this equipment will be sited, or locally screened, to control noise at neighbouring residential premises to avoid likely significant effects.
- 8.14.20 Likely significant effects from ground-borne noise and/or vibration generated from temporary construction traffic (road vehicles) within the construction sites will be avoided through the commitment given in the draft CoCP that the surface of temporary and permanent access roads and temporary site haul routes for the Proposed Scheme will be maintained through the construction of the Proposed Scheme.
- 8.14.21 Taking into account the control and management processes set out in the draft CoCP, including the provision of advanced notification, the short relative duration of the works (often less than one month) and/or the rises and falls in level as the works pass by a given receptor mean that the following activities are unlikely to cause a noise or vibration significant effect during construction:
- the use of vibratory rollers for minor works, such as road surfacing and reinstatement, etc.;
 - the use of pneumatic breakers to break up existing concrete structures during demolition;
 - standard utilities work; and

¹⁵⁹ As required by the CoCP, the use of diesel or petrol-powered generators will be reduced by using mains electricity or battery-powered equipment where reasonably practicable.

- track laying, power system and signalling installation works along the route of the Proposed Scheme.

8.14.22 Certain types of piling and vibratory compaction will likely result in short-term appreciable ground-borne vibration at a small number of dwellings, situated very close to these activities. These receptors will also be exposed to appreciable noise from the construction of the Proposed Scheme.

Operational assumptions

8.14.23 The effects of noise and vibration from the operation of the Proposed Scheme are assessed based on the reasonably foreseeable worst case train flows which differ from the train flows described in section 4.3. Flows for the assessment of operational noise and vibration have been established by selecting the highest flow on each section of route from following two potential Train Service Specifications (TSS):

- Reference Case TSS. This is for the scenario with HS2 services only on the Proposed Scheme without NPR connections or Crewe Northern Connection. The sound, noise and vibration assessment includes an element of growth from the year of opening.
- Additional Scope TSS. This scenario includes alterations to HS2 services due to the Crewe Northern Connection and NPR connections. It also includes NPR services running on the HS2 network the between the NPR connections on the Manchester spur.

8.14.24 Figure 39 shows the resultant peak hour one-way train flow by route section across the Proposed Scheme that has been assumed for the purpose of sound, noise and vibration assessment reported in the ES. The number of trains shown either side of each junction does not necessarily total the number in the subsequent section of the route of the Proposed Scheme. This is because the values shown are from a combination of flow scenarios describing the reasonable worst case for each route section, enabling flexibility for delivery and future operation.

8.14.25 For the purpose of the operational sound, noise and vibration assessment, 16-hour daytime and 8-hour night-time flows have been projected on the worst-case basis of a 'full' timetable. The 'full' timetable is the theoretical maximum flows within the constraints of the TSS and operating hours 05:00 until midnight. This timetable considers running up of passenger services from 05:00 and running down of passenger services to finish at midnight, and includes empty carriage movements for stabling or rebalancing of rolling stock.

Environmental Statement

Volume 1

Figure 39: Peak hourly train flow assumptions for the operational sound, noise and vibration assessment



- 8.14.26 For the purposes of the operational sound, noise and vibration assessment, passenger services have been assumed to operate at up to 360kph (225mph), but typically 330kph (200mph), where the alignment will permit. It is assumed that around 10% of the services will operate at the full speed of 360kph (225mph). Where the alignment will constrain train speed, the sound, noise and vibration assessment has assumed the speed profile prepared as part of the journey time analysis in Section 4.
- 8.14.27 There will be regular line inspections and planned maintenance work at night 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.
- 8.14.28 To support the regular line inspection or planned maintenance work, on most nights, a small number of diesel-powered specialist engineering trains will travel from the infrastructure maintenance facilities to remote locations on the route of the Proposed Scheme. These trains will leave the infrastructure maintenance facilities as soon as possible after passenger services finish at midnight and are likely to return 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. The operation of these maintenance and inspection trains is considered as part of the assessment of the Proposed Scheme's operation as reported in Volume 2, Community Area reports and Volume 4, Off-route effects.
- 8.14.29 Through the procurement process for the trains and the track, the use of proven international technology will enable the railway to be quieter than implied by current minimum UK¹⁶⁰ and European standards¹⁶¹. HS2 trains will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 300kph (186mph) with current pantograph designs. The reduction in aerodynamic noise draws on proven technology in use in East Asia. Overall it is assumed that proven international technology would reduce noise emissions by approximately 3dB at 360kph (225mph) compared to the current minimum European standards.

Noise and vibration effects considered unlikely to be significant

- 8.14.30 Taking account of the avoidance and mitigation measures included in the Proposed Scheme and the transient/irregular use of the following receptors, it is unlikely that significant effects will result from construction and/or operation of the Proposed Scheme at:

¹⁶⁰ Department for Transport (2020), *Railway interoperability: National Technical Specification Notices*. Available online at: <https://www.gov.uk/government/publications/railway-interoperability-national-technical-specification-notices-ntsns>.

¹⁶¹ European Commission (2014), *Technical Specification for Interoperability (TSI) Noise – Regulation No 1304/2014*.

- facilities that permit short term occupation, typically up to two weeks, such as static moorings, camp sites or caravan parks, but which do not permit permanent residential use;
- PRoW; and
- public open spaces and outdoor sports/recreation community facilities (e.g. football pitches, golf courses).

- 8.14.31 PRoW are, by their nature, transitory in their use, with users not staying in any one location for any length of time. Levels of noise from the construction and operation of the Proposed Scheme will vary as the PRoW moves closer to and further from the Proposed Scheme. During construction, noise will be controlled and managed in accordance with the draft CoCP as described in Section 6 of this report. During operation, noise levels on PRoW will be reduced by engineering cuttings, landscape earthworks provided to reduce the visual impact of the Proposed Scheme and noise mitigation provided to protect adjacent residential and non-residential receptors. Train noise from the Proposed Scheme will be intermittent. Significant noise effects are, therefore, considered unlikely on PRoW during either construction or operation although increases in noise due to the Proposed Scheme may adversely affect the acoustic character of the area around PRoW.
- 8.14.32 Public open spaces and outdoor sports/recreation community facilities (e.g. football pitches, golf courses, etc.) are, by their nature, transitory in their use. Outdoor sport activities are unlikely to be significantly affected by noise at the levels associated with operation of the Proposed Scheme. Increases in noise due to operation of the Proposed Scheme may adversely affect the acoustic character of the area around such open spaces and facilities. However, as users will not be exposed to any increased noise for long periods and hence use of the open spaces and facilities will not be disrupted, the adverse noise effects on users are not considered significant.
- 8.14.33 Quantitative assessments have been undertaken for any outdoor community facility formally identified or designated as a 'quiet area' under Government regulations or policy and reported in the ES.

8.15 Traffic and transport

Scope

- 8.15.1 The traffic and transport assessment covers the likely impact on all forms of transport, including pedestrians, cyclists, equestrians, mobility impaired people, highways, public transport, waterways and canals and air transport. The assessment includes consideration of effects resulting from physical changes to transport networks (including road, rail, bus routes and PRoW diversions) and from the additional trips generated by the Proposed Scheme both during construction and, where appropriate, during the operational period. The construction assessment includes HGV and LGV movements and workforce trips. The operational assessment includes HS2 demand, changes to demand and levels of crowding on the conventional rail network and trips associated with employees at stations and depots.

- 8.15.2 The spatial scope of the traffic and transport assessment has been informed by the construction and operational impacts being assessed. For construction, the assessment focuses on traffic and transport issues resulting from:
- land required for the Proposed Scheme;
 - land required for the worksites;
 - presence of construction traffic on the local and strategic road network;
 - road closures and associated realignments and diversions; and
 - alternative routes for PRow.
- 8.15.3 The extent of the assessment includes the: highway network including safety, parking and loading; public transport system, transport interchange arrangements; pedestrian, cyclist and equestrian routes; and navigable waterways in the vicinity of the Proposed Scheme and those affected by construction traffic, together with possessions and blockades on the conventional rail network and, where relevant, the use of railways to transport materials and excavated materials.
- 8.15.4 For operation, the spatial scope includes the transport routes where there is a substantial change in usage either through people accessing the Proposed Scheme, or from changes to travel demand on other routes or modes. It also includes roads and other rights of way that are permanently closed, realigned or diverted. The extent of the assessment for the operational phase includes the highway network, including safety, parking and loading, the public transport system (and transport networks used to access the public transport system), pedestrian, cyclist and equestrian routes and navigable waterways, in the vicinity of the Proposed Scheme, as well as areas affected by changes to travel demand due to operation of the Proposed Scheme.
- 8.15.5 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 during construction mainly focus on the impacts on rail passengers and rail freight during rail possessions and blockades. The route-wide effects during operation include the potential for the Proposed Scheme to provide improved journey times on HS2 services building on the benefits of Phase One and Phase 2a and the impacts on travel patterns, including as a result of released capacity on the conventional rail network and resulting from mode switch from highway and air. The off-route effects focus on effects at off-route stations during construction where works are required as part of the Proposed Scheme and at off-route stations during operation where changes in footfall are predicted to exceed EIA SMR criteria.

Baseline

- 8.15.6 Existing transport conditions have been determined through site visits, traffic and transport surveys, liaison with Highways England, local authority and other organisations such as Network Rail (including provision of information on traffic and highways, public transport,

PRoW and accident data¹⁶²) and desktop analysis. Future baseline conditions have been derived by taking into account both changes in the demand for travel (by using transport modelling or applying growth factors to the baseline traffic and incorporating, where relevant, committed and planned developments) and changes to the transport supply network (by considering committed and planned transport improvement schemes). Transport modelling has been used, where appropriate, to inform the future baseline conditions.

Methodology

- 8.15.7 The assessment has taken account of best practice guidance published by the DfT and other organisations together with local guidance where relevant and appropriate. 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 the significance of these effects takes account of guidance including:
- DMRB Volume 11: Environmental Assessment (1993 and updates);
 - DfT Transport analysis guidance (TAG)¹⁴⁵;
 - Guidelines for the Environmental Assessment of Road Traffic¹⁶³;
 - DfT (2015) Transport evidence bases in plan making and decision taking¹⁶⁴;
 - Guidelines for Traffic Impact Assessment¹⁶⁵; and
 - assessment criteria used for assessing the Elizabeth Line (formerly Crossrail)¹⁶⁶ and other major infrastructure schemes including HS2 Phase One and Phase 2a.
- 8.15.8 The assessment criteria for both construction and operation comprise:
- changes to rail journey times;
 - changes to rail travel options and capacity;
 - public transport delay;

¹⁶² The term accident in this report refers to injury related collisions reported to/recorded by the police. This data, known as STATS19, relate only to personal injury accidents on public roads that are reported to the police, and subsequently recorded, using the STATS19 accident reporting form.

¹⁶³ Institute of Environmental Assessment (1993), *Guidelines for the environmental assessment of road traffic*.

¹⁶⁴ Ministry of Housing, Communities & Local Government (2015), *Guidance: Transport evidence bases in plan making and decision taking*. Available online at: <https://www.gov.uk/guidance/transport-evidence-bases-in-plan-making-and-decision-taking>.

¹⁶⁵ Institution of Highways and Transportation (1994), *Guidelines for Traffic Impact Assessment*. Institution of Highways and Transportation.

¹⁶⁶ Crossrail (2005), *Crossrail Environmental Statement: Volume 8a Appendices Transport Assessment: Methodology and Principal Findings (Section 5 Assessment Criteria)*. Available online at: http://74f85f59f39b887b696f-ab656259048fb93837ecc0ecbcf0c557.r23.cf3.rackcdn.com/assets/library/document/v/original/volume_08a.pdf.

- disruption at stations/interchange;
- traffic delays to vehicle occupants;
- effects on vulnerable road users including;
 - traffic related severance (due to changes to the ease with which non-motorised users can cross roads);
 - non-traffic related severance (due to, for example, extended travel distances or ‘broken links’); and
 - changes to amenity or ambience;
- accident and safety risk;
- changes to parking and loading provision or demand; and
- impact of works affecting the navigation or amenity of waterways.

Assumptions and limitations

8.15.9 The following assumptions are relevant to the traffic and transport assessment:

- operational patterns and capacities of the Proposed Scheme;
- change in operational patterns and stations served by other operators;
- changes to both temporary and permanent highways and PRoW; and
- construction related volumes (HGV and other) and workforce trips.

8.15.10 The approach to the transport assessment and demand forecasts for future years has required a number of assumptions to be made relating to:

- committed developments and transport schemes;
- socio-economic forecasts (e.g. population, employment, economic conditions); and
- travel characteristics, including: modal share of trips; traffic flows; public transport passenger flows; traffic speeds and congestion; and journey times.

8.15.11 Future baseline flows have been sourced from strategic transport models where relevant and appropriate or from factoring observed data to the relevant future baseline year using traffic growth from the DfT Trip End Model Presentation Program (TEMPRro). PRoW surveys have been used as the basis for pedestrian and cyclist flows.

8.15.12 The assessment of construction traffic has been based on estimates of the quantum of HS2 construction traffic and their routing to the strategic and/or primary network with the use of the local road network limited insofar as reasonably practicable. There will generally be one primary inbound and one outbound route to and from each compound (and these will often use the same route).

8.15.13 The construction traffic forecasts included in the traffic modelling for the ES are based on preliminary estimates of the movement of excavated material between compounds and how these will vary over the duration of the construction period. The assessment presented in the ES is based on the outputs from this modelling. As the design of the Proposed Scheme

has continued to be refined, small differences between the HGV movements included in the traffic modelling for some construction routes and the number of trips generated to and from compounds accessed from these routes have been identified. These differences will be considered further in ongoing design and assessment.

8.15.14 Utilities works on existing highways (including diversions) have been assessed in detail where they involve major works and/or 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.

8.15.15 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.

8.16 Waste and material resources

Scope

- 8.16.1 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.
- 8.16.2 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).
- 8.16.3 To reflect the often complex movement of waste from source to final destination, the assessment of the likely significant environmental effects associated with solid waste that will be generated by the Proposed Scheme has been undertaken on a route-wide basis and is presented in Volume 3, Route-wide effects.
- 8.16.4 The consideration of material resources in this assessment is limited to the beneficial reuse of excavated materials arising from the construction of the Proposed Scheme. It does not include material inputs to construction (e.g. aggregates).
- 8.16.5 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 wastes¹⁶⁷, such as waste oil, are not considered as they will be limited in quantity, compared to solid wastes and have, therefore, been scoped out.

- 8.16.6 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). The direct and indirect effects of waste-related transport are also addressed in Volume 4, Off-route effects.
- 8.16.7 Issues relating to mineral resources and contaminated land are addressed within Volume 2, Community Area reports, Section 10 (Land quality).
- 8.16.8 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.
- 8.16.9 The spatial scope (and study area) for the assessment has been defined as the counties and districts (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

- 8.16.10 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.
- 8.16.11 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

- 8.16.12 Forecasts of the quantities of waste that will require off-site disposal to landfill are 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.
- 8.16.13 The quantities of surplus excavated material and other wastes requiring off-site disposal to landfill are compared to the projected landfill capacity that will be available during construction and operation.

¹⁶⁷ Commission of the European Communities (2002), *Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills Pursuant to Article 16 and Annex II of Directive 1999/31/EC on the Landfill of Waste (COM/2002/0512 Final)*. Available online at: <http://eur-lex.europa.eu/legal-content/et/TXT/?uri=CELEX:52002PC0512>.

- 8.16.14 Forecasts of the quantities of waste that will require off-site treatment and recovery at appropriate facilities are based on reasonable assumptions for the amount of waste likely to be generated and evidence-based recycling rates applicable to waste from construction, demolition and operational activities.
- 8.16.15 The quantities of wastes requiring off-site treatment are compared with the treatment and recovery capacity that will be available during construction and operation.
- 8.16.16 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

- 8.16.17 Assumptions have been made on the proportion of solid construction, demolition and operational waste that will be diverted from landfill via reuse, recycling and recovery. This has been informed by information gathered at the time of the assessment as to any waste management measures proposed to divert waste from landfill. Alternatively, landfill diversion performance for other similar rail-related projects, such as the Elizabeth Line, have been considered.
- 8.16.18 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.
- 8.16.19 Borrow pits will be restored to original levels, unless otherwise agreed, 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.

8.17 Water resources and flood risk

Scope

- 8.17.1 This assessment includes consideration of all surface water and groundwater bodies, including their associated water resources, water quality, hydromorphology, hydrology and flood risk.
- 8.17.2 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 Volume 2, Community Area reports and Volume 4, Off-route effects. The likely impacts and significant effects of the Proposed Scheme on flood risk and land drainage are also considered.
- 8.17.3 Volume 3, Route-wide effects 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 WFD; and
- route-wide flood risk issues related to application of the Sequential Test and Exception Test in the NPPF.

8.17.4 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, Appendices WR-003 – Water resources assessment; and
- Volume 5, Appendices WR-005 – Flood risk assessments.

8.17.5 Volume 5 also includes a detailed stand-alone route-wide WFD compliance assessment (Appendix, WR-001-00000) with WFD compliance assessment baseline data set out in BID (BID WR-002). In addition, a Draft water resources and flood risk operation and maintenance plan is set out in Volume 5: Appendix WR-007-00000 along with hydraulic modelling reports (Volume 5: Appendices WR-006) and groundwater modelling report (Volume 5: Appendix WR-008); Water resources assessment baseline data are included in BID (BID WR-004).

8.17.6 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 route of the Proposed Scheme, except where there is clearly no hydraulic connectivity. In urban areas the distance is 500m. 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 route of the Proposed Scheme, or where very high value receptors are in proximity, but outside of the 1km zone. These extensions to the study area are defined within the assumptions and limitations section of the relevant Volume 2, Community Area reports and Volume 4, Off-route effects.

8.17.7 Impacts to groundwater quality from existing land contamination are presented in Section 8.10 of this report and in Volume 2, Community Area reports and Volume 4, Off-route effects report. Assessment of impacts on water dependent ecological habitats and receptors are presented in Section 8.6 of this report and in Volume 2, Community Area reports, Section 7 and Volume 4, Off-route effects.

Baseline

8.17.8 Baseline information includes:

- 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.

- 8.17.9 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 waters, as well as hydraulic analysis. Hydrogeological information was obtained from geological maps and borehole logs where available.
- 8.17.10 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 have been considered in the assessment based on the recommended allowances contained in Environment Agency guidance issued in February 2016; Flood risk assessments: climate change allowances¹⁶⁸. 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 Volume 2, Community Area reports and Volume 4, Off-route effects.
- 8.17.11 Revised guidance for assessing the impact of climate change on peak river flows was published by the Environment Agency in July 2021¹⁶⁹. Comparison of the revised guidance with the guidance used to assess the impacts of the Proposed Scheme, indicates that the revised guidance is unlikely to change the significance of the effects of the Proposed Scheme reported in the Volume 2, Community Area reports and Volume 4, Off-route effects.
- 8.17.12 The latest WFD water body classification data are taken from the Environment Agency Cycle 2 River Basin Management Plan, as published on the Environment Agency Catchment Data Explorer¹⁷⁰. These classifications are the formal baseline against which the Environment Agency has assessed compliance with the no deterioration objectives. This information was supplemented by specialist surveys.

Methodology

- 8.17.13 The assessment has taken account of relevant policy and guidance, as set out in the EIA SMR. Effects are 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.

¹⁶⁸ Environment Agency (2016), *Adapting to Climate Change. Advice for Flood and Coastal Erosion Risk Management Authorities*. Available online at: <https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities>. Note that this guidance was withdrawn in July 2020, however the 2016 guidance and allowances remain as the basis of the assessment for the ES.

¹⁶⁹ Environment Agency (2021), *Flood Risk Assessments: Climate Change Allowances*. Available online at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>.

¹⁷⁰ Environment Agency (2020), Catchment Data Explorer. Available online at: <http://environment.data.gov.uk/catchment-planning/>.

- 8.17.14 There is no established methodology for assessing compliance with WFD legislation. The WFD compliance assessment is based largely on internal Environment Agency guidance¹⁷¹, the prior experience of HS2 Ltd on Phase One and Phase 2a and professional judgement. The approach applied is also in general accordance with recently published advisory note provided by the Planning Inspectorate¹⁷², and workshops have been held with the Environment Agency to agree the scope and approach to the WFD assessment.

Assumptions and limitations

- 8.17.15 The following assumptions have been made for the ES:
- the British Geological Survey Susceptibility to groundwater flooding and the Environment Agency's Flood Maps are used to provide an indication of area 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). It is assumed that they are of sufficient detail for the current level of assessment (hybrid Bill);
 - hydraulic analysis 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;
 - 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, are assumed to be of moderate, high or very high value, unless surveys have been completed that confirm otherwise;
 - springs, spreads, 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, and are assumed to be high value receptors unless surveys confirm otherwise;
 - in the absence of site-specific data, it is assumed that permeable superficial deposits that underlie watercourses are likely to be in hydraulic connection with them 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 of the Proposed Scheme; and

¹⁷¹ Environment Agency (2010), *Assessing new modifications for compliance with WFD: detailed supplementary guidance*.

¹⁷² Planning Inspectorate (2017), *Advice note 18, The Water Framework Directive*. Available online at: <https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-18/>.

- where there are limited borehole records available from which to understand the local geological and hydrogeological conditions, it is assumed that groundwater levels are at or just below the ground surface level and topography has some control over groundwater flow directions with groundwater level contours roughly parallel to topographic contours.

8.17.16 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 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 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 2017 require an ES to include “a description of any features of the proposed development, or measures envisaged in order to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment”. Such measures are described generally in the ES as mitigation measures. Priority has been given to avoiding or preventing effects; and then (if this is not possible), to reducing or abating them; and then, if necessary, to offsetting them through restoration or 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 EMR (see Section 1.4 of this report) will impose a general requirement 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 and operation of the Proposed Scheme. The draft CoCP has been produced in conjunction with the ES so that the EIA 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 shown in Map Series CT-06;
 - mitigation that requires additional physical features, which is shown on the scheme drawings; and
 - mitigation to be delivered through application of HS2 Ltd policies e.g. CoCP/Sustainability Policy.

- 9.1.6 Construction impacts will be mitigated through the application of the measures set out in the draft 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 EMR.
- 9.1.8 Mitigation that has been 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;
 - horizontal 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.

Monitoring

- 9.1.9 The English EIA Regulations require 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.
- 9.1.10 The English EIA Regulations 2017, make provision for post-EIA monitoring of significant adverse effects on the environment in appropriate cases. HS2 Ltd will work with the relevant responsible authorities to develop the necessary monitoring in appropriate cases.

Monitoring during construction

- 9.1.11 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 are presented in Section 6.3 of this report.

Monitoring during operation

- 9.1.12 Appropriate post-construction monitoring will be carried out during the operational phase for both:
- 'general' monitoring, for example, 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
 - 'geographically specific' monitoring settled in consultation for particular significant adverse effects where appropriate e.g. monitoring of a public water supply borehole.
- 9.1.13 Operational monitoring measures for each environmental topic are presented in Section 9 of this report. Operational monitoring geographically specific to significant effects reported in a community area is presented within the relevant Volume 2, Community Area report and also in the Volume 4, Off-route effects report 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. The effects of the Proposed Scheme on farm businesses has been mitigated where reasonably practicable by working with farmers and landowners. A guide for farmers and growers affected by the Proposed Scheme, the Phase 2b Farmers and Growers Guide, will be published following deposit of the Bill.
- 9.2.2 Topsoil and subsoil will be handled appropriately to enable agricultural land to be restored. The design objective is to avoid any reduction in long term capability, which will 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. Following discussion and negotiation with land owners/occupiers, new accesses will be provided where agreed 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 Although financial compensation does not fall to be considered as environmental mitigation, further details of the approach to compensation for land compulsorily acquired can be found within Section 1.6 of this report.

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 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 relevant Soil Resource Plans. Contractors will also provide an audit of soil resources following a soil survey within six months of completion of the restoration. The nominated undertaker will put in place agricultural liaison officers who will be available by telephone 24 hours a day, seven days per week, during the construction of Proposed Scheme works on agricultural land.
- 9.2.8 On completion of construction, soils restored to agricultural, forestry or landscape uses will be monitored to identify any unsatisfactory growing conditions for up to five years.

Operation

- 9.2.9 No significant agriculture, forestry and soils effects are anticipated during the operation of the Proposed Scheme. Therefore, no further operational monitoring is required.

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 route-wide transport management plan.
- 9.3.2 These include the following general measures:
- contractors being required to manage dust, air pollution, odour and exhaust emissions during construction and mineral extraction 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 and mineral extraction 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 reduce as far as reasonably practical the need to use public roads.
- 9.3.4 Best practice engine emission standards have been set for construction vehicles and non-road mobile machinery (NRMM).
- 9.3.5 The use of borrow pits will reduce the need for longer distance transport and import of materials.
- 9.3.6 Prior to commencement of activities, there will be further detailed assessment for each worksite and borrow pit to determine site specific dust mitigation.
- 9.3.7 The high speed railway will operate efficient, non-polluting electrically powered passenger trains.

Monitoring

Construction

- 9.3.8 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 location of continuous dust monitors for high and medium risk sites.
- 9.3.9 Monthly 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.
- 9.3.10 Monitoring of dust and particulate matter during construction of the project will be undertaken following the current best practice guidance (currently IAQM 2018).
- 9.3.11 Monitoring and reporting of significant air quality effects adjacent to highways will be undertaken following current best practice guidance (currently Defra's Local Air Quality Management Technical Guidance¹⁷³).
- 9.3.12 Further information on general air quality monitoring during construction is set out in Section 7.3 of the draft CoCP.

Operation

- 9.3.13 Given that no significant adverse air quality effects are anticipated during operation of the Proposed Scheme, no operational monitoring is required.

9.4 Climate change

Greenhouse gas emissions

Mitigation

- 9.4.1 One of the themes of HS2 Ltd's Environmental Policy is to minimise the carbon footprint of HS2 and deliver low-carbon, long distance journeys that are supported by low-carbon energy. As part of the commitment to minimising the carbon footprint of the Proposed Scheme, HS2 Ltd is implementing a carbon management process.
- 9.4.2 HS2 Ltd's Net Zero Carbon Plan seeks to accelerate the ambition of the construction industry to realise net zero during the construction phase of the Proposed Scheme and also to procure zero carbon electricity from day one of operation. These aspirations have not driven

¹⁷³ Department for Environment, Food and Rural Affairs (2018), *Local Air Quality Management Technical Guidance (TG16)*. Available online at: <https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf>.

the main results of this assessment but have been considered as part of the sensitivity analysis.

- 9.4.3 Publicly Available Specification (PAS) 2080 Carbon Management in Infrastructure¹⁷⁴ has been adopted as a best practice framework for the carbon management process. It has been independently accredited demonstrating that effective controls are in place for reducing whole life carbon.
- 9.4.4 The greenhouse gas assessment establishes a benchmark for the Proposed Scheme and will be used as a tool to assess the potential to reduce carbon across the design, construction and operational phase.
- 9.4.5 The application of the carbon management process to early design stages of the Proposed Scheme has supported identification of opportunities to reduce carbon, some of which are location-specific, and some of which are applicable across the route of the Proposed Scheme. The approach will continue to be developed and applied to the Proposed Scheme.
- 9.4.6 HS2 Ltd has a supplier innovation programme through which HS2 works with suppliers and construction firms to continually identify opportunities within the supply chain to be developed and implemented. The carbon management process also provides a mechanism for managing contractor carbon impacts during construction.
- 9.4.7 The future design and delivery of the Proposed Scheme must be considered against the wider climate change policy context in the period between now and when the Proposed Scheme becomes operational in 2038. The UK is committed to achieving net zero by 2050, and in pursuit of this key sectors will continue to decarbonise. As the UK continues to decarbonise then additional opportunities to reduce the lifetime carbon impact of the Proposed Scheme will be identified and implemented.
- 9.4.8 The use of electricity for operating rolling stock, stations, and rail systems is a prominent carbon source within the lifetime impacts of the Proposed Scheme. The procurement of zero carbon electricity for the operation of the Proposed Scheme offers a considerable opportunity to reduce these impacts.
- 9.4.9 This is set out in more detail in Volume 3, Route-wide effects.

Monitoring

- 9.4.10 There is currently 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.

¹⁷⁴ The British Standards Institution (2016), *PAS 2080:2016: Carbon Management in Infrastructure*. BSI London, UK.

Construction

- 9.4.11 The draft CoCP requires the nominated undertakers' lead contractors to produce carbon management plans detailing 'the approach to energy and carbon dioxide (CO₂) monitoring and reporting from relevant site activities'.

Operation

- 9.4.12 Carbon dioxide emissions will be monitored during operation.

In-combination climate change impacts

Mitigation

- 9.4.13 The ICCI assessment considers how climate change, in combination with the impacts of the Proposed Scheme, may affect the receiving environment.
- 9.4.14 The mitigation of potential ICCI effects during construction will be provided by the measures set out in the draft CoCP and existing topic specific mitigation measures. The mitigation of potential ICCI effects during operation will be provided by embedded topic specific mitigation measures.
- 9.4.15 Where practicable, any significant ICCI effects identified during construction or operation will be mitigated by additional measures which will address adverse effects on the ability of resources and receptors to adapt to climate change.

Monitoring

Construction

- 9.4.16 The draft CoCP includes a requirement for the nominated undertaker's lead contractor to monitor extreme weather events during construction.

Operation

- 9.4.17 Monitoring of any significant adverse ICCI effects during operation will form part of the operational monitoring strategies for the relevant topics.

Climate change resilience

Mitigation

- 9.4.18 The HS2 Sustainability Policy 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...'.

- 9.4.19 To address this policy theme the CCR assessment considers how climate change impacts may affect the resilience of infrastructure and assets associated with the Proposed Scheme.
- 9.4.20 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, monitoring measures and/or replacement strategies 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 for the ES.
- 9.4.21 The approach to ensuring the resilience of the Proposed Scheme is further described in the EIA SMR and Volume 3, Route-wide effects.

Monitoring

Construction

- 9.4.22 The draft CoCP includes a requirement for the nominated undertaker's lead contractor to monitor extreme weather events during construction.

Operation

- 9.4.23 Requirements for weather and CCR monitoring will be integrated into processes for developing asset management and procurement strategies for the Proposed Scheme.

9.5 Community

Mitigation

- 9.5.1 Significant effects on a community resulting from the loss of public open space or of a community facility can be mitigated in a number of ways, including:
- improvements or alterations to the remaining portion of the public open space (in instances where the public open space is partially occupied);
 - improvements to other public open spaces or community facilities in the area;
 - improving accessibility to other existing public open space or community facilities; and/or
 - identifying land owned by the relevant local authority that could be brought into use as public open space or used to accommodate community facilities with its agreement.
- 9.5.2 Land used as open space or a community facility temporarily required for the Proposed Scheme will be restored to its former use, in agreement with the original owners or users of the land and the local planning authority. For permanent effects mitigation may include

provision of compensatory measures such as provision of open space or other community facilities as part of the design of the Proposed Scheme.

- 9.5.3 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.
- 9.5.4 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 and isolation effects on community facilities, residential properties and open space.
- 9.5.5 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

- 9.5.6 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 sections of this report.

9.6 Ecology and biodiversity

Mitigation

- 9.6.1 The Proposed Scheme has been designed to avoid or reduce impacts on habitats, species and other features of ecological value where reasonably practicable.
- 9.6.2 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.
- 9.6.3 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 outside the area required for construction or following the completion of construction.

- 9.6.4 In accordance with the Ecological Principles of Mitigation set out in the EIA SMR, a route-wide, integrated strategic approach has been developed to compensate for loss of widely distributed habitats, especially woodland and grassland. 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 while at the same time, where reasonably practical, integrating the Proposed Scheme into the character of the local landscape.
- 9.6.5 The Environmental Memorandum (which forms part of the EMR) includes a commitment to provide long-term management of habitat creation areas to ensure that the 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.
- 9.6.6 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 appropriate sized culverts and ecological underbridges to facilitate the movement of species across the route.
- 9.6.7 Formal applications for derogation licences for protected species will be made once Royal Assent has been received.

Monitoring

Construction

- 9.6.8 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.
- 9.6.9 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. HS2 Phase 2b Information Paper E2: Ecology¹⁷⁵ states that monitoring will be put in place throughout the habitat establishment period to measure its success and to

¹⁷⁵ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E2: Ecology*.

inform whether any changes in management are required. This may need to continue beyond the establishment period.

- 9.6.10 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 HS2 Phase 2b 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.

Operation

- 9.6.11 The nominated undertaker will be required to monitor the effective management and performance of ecological mitigation and compensation measures.

9.7 Electromagnetic interference

Mitigation

- 9.7.1 The generation of electromagnetic fields will be managed during construction and operation of the Proposed Scheme to ensure that electrical equipment and human health are not adversely affected. EMI will be managed during construction in line with British and European standards and industry best practice. The main source of electromagnetic fields from operation of the Proposed Scheme will be the power supply system along the railway. The voltage and current generated by the power supply system will not be high enough to cause significant electromagnetic fields outside the railway boundary.
- 9.7.2 HS2 Ltd is undertaking on-going engagement with the owners and operators of facilities that may be affected to establish the electromagnetic sensitivity levels and risk of EMI. Any appropriate mitigation measures will be identified during on-going engagement.

Monitoring

Construction

- 9.7.3 Features such as tower cranes can cause temporary interference to TV reception. 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 where reasonably practicable will be taken to restore signal integrity at affected properties (e.g. by replacing aerials or boosting signal strength).

9.8 Health

Mitigation

- 9.8.1 Design-based interventions to reduce health impacts have been incorporated through the scheme design and wider EIA process – for example, route alignment and design selected 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. The assessment of the incorporated mitigation has been reported in the ES. 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 draft 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 environmental topic sections in Volume 2, Community Area reports, Volume 3, Route-wide effects and Volume 4, Off-route effects.

9.9 Historic environment

Mitigation

- 9.9.1 The design of the Proposed Scheme has sought to avoid direct impacts on all heritage assets as far as reasonably practicable. Where this has not been possible, a range of measures will be implemented to mitigate the impact on such assets.
- 9.9.2 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, Historic Environment Scotland, 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 EMR (as described in Section 1.4 of this report).
- 9.9.3 Route-wide research approaches will be developed in consultation with Historic England, Historic Environment Scotland and local authorities to produce a route-wide research strategy for the Proposed Scheme, the historic environment research and delivery strategy (HERDS). The HERDS document will set out the research framework and general principles for design, evaluation, investigation, recording, analysis, reporting and archive deposition for the historic environment to be adopted for the design development and construction of the Proposed Scheme. The HERDS will be 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 to ensure that there is suitable recording, analysis, reporting and publication of the results of all historic environment investigations, and will archive the resulting records, artefacts and materials in suitable repositories.

- 9.9.4 The Bill disapplies various legislative provisions currently in place for affected designated heritage assets. The Bill identifies the affected assets and provides 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 as appropriate for agreement within specified timescales.
- 9.9.5 The Bill also disapplies the various legislative provisions where construction of the Proposed Scheme directly affects burial grounds, human remains and associated 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.
- 9.9.6 Mitigation measures have been developed in consultation with other disciplines, notably landscape, to ensure that heritage assets have been considered when designing mitigation works, for example designing landscape mitigation works to be in keeping with the historic landscape character. Discussion with other disciplines will be undertaken during detailed design to identify any measures that can avoid or reduce impacts on heritage assets.

Monitoring

Construction

- 9.9.7 The nominated undertaker will require its lead contractors to implement appropriate monitoring of the consequences of construction work, as required, on all heritage assets (designated and non-designated) to ensure the effectiveness of management measures and compliance with agreed approaches to construction activities and heritage assets.
- 9.9.8 Risk assessments identifying appropriate surveys, for example, structural or condition surveys, and settlement 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 Bill and the ES.

Operation

- 9.9.9 No specific monitoring requirements are proposed in relation to heritage assets during operation of the Proposed Scheme, although monitoring specified during the construction phase may continue during the operational phase. It is assumed that all heritage assets

within the land required for construction will be removed unless expressly excluded as a result of the scheme design or mitigation process. Noise effects can contribute to effects arising as a result of development within the setting of a heritage assets (for example where the quietness of an asset's setting makes a positive contribution to its heritage value). 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 specifically in relation to the predicted effects on the asset's heritage value, either during operation or construction.

9.10 Land quality

Mitigation

- 9.10.1 Methods to mitigate temporary effects during the process of remediation, within the construction period, are described in the draft CoCP.
- 9.10.2 Mitigation of the effects of pre-existing contaminated soils or groundwater that is required will take place as close to the point of excavation/deposition as possible. It will mainly take the form of various established methodologies for soil and groundwater remediation, such as:
- soil washing;
 - soil stabilisation;
 - reed beds;
 - bio-remediation; and
 - in-situ or ex-situ groundwater treatment.
- 9.10.3 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.
- 9.10.4 Appropriate remediation methods will also be used to reduce mobilisation of contamination, including that associated with ground gases, leachates and groundwater within old landfills and mine workings. Such measures could include vertical and horizontal barriers, soil cover systems and venting systems. Where piling through contaminated soils is required, appropriate piling techniques and preventative measures will be adopted to mitigate the potential for contaminant migration.
- 9.10.5 Mitigation measures for sand, gravel, clay and other similar mineral resources may include prior extraction of the resource for use within the Proposed Scheme or elsewhere. A plan will be discussed with relevant mineral/landowners, mineral planning authorities and other stakeholders to help manage affected minerals, where this is reasonably practicable.
- 9.10.6 For salt and brine, any mitigation will need to be agreed between HS2 Ltd and the relevant mineral resource owner/operator.

- 9.10.7 Mitigation measures for hydrocarbon mineral resources will require discussion with relevant stakeholders. A plan will be discussed with relevant Petroleum Extraction and Exploration Licence (PEDL) holders, mineral planning authorities and other stakeholders to help manage affected areas, where this is reasonably practicable.
- 9.10.8 Mitigation measures for geoconservation sites, such as geological SSSIs, may include preservation of any new exposures created during the construction works. A plan will be discussed with relevant stakeholders.

Monitoring

Construction

- 9.10.9 The nominated undertaker will require gas, groundwater and/or leachate monitoring procedures to be implemented, as appropriate, in contaminated land, which may comprise landfill, made ground, former and existing industry sites, quarries and naturally occurring gassing strata.
- 9.10.10 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 a piling risk assessment has indicated a potential effect on below ground contamination.
- 9.10.11 Monitoring of any works that have the potential to impact identified mineral resources will be carried out. Such procedures will be settled in consultation with the relevant licence holders and stakeholders.
- 9.10.12 Monitoring of any works that have the potential to impact identified geoconservation sites will be carried out. Such procedures will be settled 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.
- 9.10.13 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

- 9.10.14 Requirements for monitoring during the operational phase will be determined as part of the investigation, treatment and validation of contamination on a site-specific basis as part of the detailed design process. During the operational phase, monitoring works for groundwater and landfill or mine gas will continue, where required and in consultation with the Coal Authority. Monitoring requirements may include water quality, air quality and/or landfill bulk and trace gases, depending on the site being considered.

9.11 Landscape and visual

Mitigation

- 9.11.1 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 design proposals for the Proposed Scheme incorporate mitigation measures for landscape and visual, noise, ecology and biodiversity, agriculture, historic environment and open space.
- 9.11.2 Mitigation measures have been developed to:
- avoid or reduce effects on the character of the landscape, including valued, designated and historic landscape features and their settings;
 - seek to enhance such resources where appropriate and to secure wider landscape, green infrastructure and ecological connectivity; 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.
- 9.11.3 Landscape design and mitigation has been considered at a strategic scale to help integrate the Proposed Scheme into the surroundings. Specific measures include:
- design of earthworks to achieve visual screening, integration of the route of the Proposed Scheme by reflecting the character of local topography, and to facilitate the restoration of agricultural land where appropriate;
 - provision of new planting to connect with existing woodland and vegetation, reinstatement of lost historic planting where possible, reconnecting to locally fragmented woodland or vegetation/habitats, as well as to provide habitat creation and contribute to HS2 Ltd's policy to create a Green Corridor along the route of the Proposed Scheme;
 - design of earthworks and large-scale planting to help integrate new structures, such as bridges, viaducts, depots and ancillary structures such as an ATFS into the landscape;
 - provision of compensatory green space where this is affected by the Proposed Scheme, and to contribute to wider green infrastructure connectivity, wherever possible;
 - design of new, diverted or realigned roads and PRow to reconnect routes severed by the Proposed Scheme, integrate into wider access networks and promote walking and cycling initiatives;
 - design of noise mitigation earthworks to integrate into the local landscape;
 - location of diverted watercourses, balancing ponds and ecological ponds to ensure integration with the local landscape and the promotion of multi-functional green infrastructure; and

- provision of public realm, including tree planting and green space in urban areas, to help integrate new railway stations and associated operational requirements into their local context, and to contribute to urban green infrastructure networks and city resilience.

- 9.11.4 The design or external appearance of new structures will be subject to the approval of the relevant local authority.
- 9.11.5 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 and reasonably practicable. Planting away from the route will also be established to reduce adverse landscape and visual effects, where this is appropriate to landscape character and context.
- 9.11.6 The draft CoCP includes measures to limit landscape and visual impacts during construction including provisions to mitigate night-time effects.
- 9.11.7 The nominated undertaker will maintain landscape areas within the rail corridor to an appropriate standard. The aim is to ensure that planting successfully establishes and develops, so that it achieves and maintains its mitigation objective. HS2 Phase 2b Information Paper E20: Maintenance of Landscaped Areas¹⁷⁶ outlines how the new areas of woodland, grassland and wetland planting created along the route of the Proposed Scheme will be maintained.
- 9.11.8 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.
- 9.11.9 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

- 9.11.10 The nominated undertaker will require its contractors to implement appropriate monitoring of any new advance permanent or temporary planting to ensure it becomes established and is properly maintained throughout the construction period.
- 9.11.11 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

¹⁷⁶ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E20: Maintenance of landscaped areas*.

and in the specification. This will allow the contractor(s) to fully understand the required landscape mitigation measures.

- 9.11.12 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

- 9.11.13 The nominated undertaker will monitor all new landscape areas to ensure that all planting (woodlands, trees, grasslands, wetlands and hedgerows) successfully establishes and develops, so that it achieves its wide range of functions and remains effective thereafter.
- 9.11.14 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.
- 9.11.15 Further detail on the successful establishment and maintenance of all planting (advance permanent or temporary and planting in operation) is described in the HS2 Landscape Design Approach (which guides and directs the development of integrated and multi-functional 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).

9.12 Major accidents and disasters

Mitigation

- 9.12.1 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 legislative and regulatory requirements must be complied with, to demonstrate the management of safety risks throughout the design, construction, management, operation and maintenance of the Proposed Scheme.
- 9.12.2 Measures to mitigate health, safety and environmental risks related to the potential for major accidents and disasters during construction and operation of the Proposed Scheme will be embedded through the detailed design, technical standards and specifications for the Proposed Scheme.
- 9.12.3 In addition, the CoCP will include the requirement for construction contractors and suppliers to prepare plans and protocols that address accident and disaster risk issues. This includes the preparation of community emergency plans (where relevant), traffic management plans, measures to control pollution risks, and plans to prevent fires and deal with the impacts of extreme weather events.

Monitoring

Construction

- 9.12.4 The draft CoCP describes the control measures and standards to be implemented to protect communities and the environment during construction works, including a requirement to monitor weather events and take due consideration of the potential impacts of extreme weather events and related conditions.
- 9.12.5 Specific monitoring solutions, for example during tunnelling activities, will be developed as part of detailed design.

Operation

- 9.12.6 A rigorous safety management system (SMS) will be established and adhered to as part of the Proposed Scheme. This is a legal requirement of the Railways and Other Guided Transport Systems (Safety) Regulations 2006¹⁷⁷. The SMS will ensure the Proposed Scheme appropriately manages risks and mitigations in terms of both safety and health during the operation and maintenance of the Proposed Scheme.

9.13 Socio-economics

Mitigation

- 9.13.1 Businesses displaced by the Proposed Scheme will be eligible for compensation within the provisions of the Compensation Code. 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.
- 9.13.2 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, as it has done on Phase One and Phase 2a.
- 9.13.3 A Communities and Environment Fund and Business and Local Economy Fund have been made available for Phase One and Phase 2a. These funds help offset the impacts of the Proposed Scheme on local communities and their economies. The funds will be extended to be available to local communities and businesses affected by the Proposed Scheme. The objective of the Business and Local Economy Fund is to add benefit over and above

¹⁷⁷ *The Railways and Other Guided Transport Systems (Safety) Regulations 2006. No. 599.* Her Majesty's Stationery Office, London. Available online at:
http://www.legislation.gov.uk/uksi/2006/599/pdfs/ukxi_20060599_en.pdf.

committed mitigation and statutory compensation to support local economies that are demonstrably disrupted by the construction of HS2.

- 9.13.4 All reasonably practicable steps are and will be undertaken to limit the impact of the Proposed Scheme on existing businesses.
- 9.13.5 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. HS2 Ltd will adopt a policy to work with its suppliers to build a skilled workforce that promotes further economic growth across the UK as it has done on Phase One and Phase 2a.
- 9.13.6 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.

Monitoring

- 9.13.7 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, Community Area reports, Volume 3, Route-wide effects and Volume 4, Off-route effects.

9.14 Sound, noise and vibration

Mitigation

Introduction

- 9.14.1 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.
- 9.14.2 The Proposed Scheme has been designed to manage and control the impact of railway noise and vibration, and so far as is reasonably practicable:
- avoid residual significant adverse effects on health and quality of life due to noise or vibration;
 - mitigate and reduce adverse effects on health and quality of life due to noise or vibration and hence avoid or reduce likely significant effects identified on a community due to noise change arising from the Proposed Scheme; and

- contribute to improvements to health and quality of life by reducing, where possible¹⁷⁸, existing exposure to noise or vibration through the provision of mitigation.

9.14.3 Mitigation of likely significant adverse noise or vibration effects has, where practicable, been incorporated into the Proposed Scheme in the following order since they will reduce effects on the environment as a whole, and on amenity, as well as inside properties:

- 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
- then by reducing noise entering property.

9.14.4 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

9.14.5 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

9.14.6 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 will protect many communities from likely significant noise or vibration effects.

Airborne noise

9.14.7 HS2 trains will be quieter than the relevant current European Union specifications. Through the procurement process for the trains and the track, the use of proven international technology will enable the railway to be quieter than implied by current minimum UK and European standards. HS2 trains will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 300kph (186mph) with current pantograph

¹⁷⁸ HS2 Ltd will engage with the Competent Authorities responsible for the Important Areas identified in Defra's Noise Action Plans for: Agglomerations (large urban areas) (2019) Department for Environment, Food & Rural Affairs (Defra); Roads (including major roads) (2019) Department for Environment, Food & Rural Affairs (Defra); or Railways (including major railways) (2019) Department for Environment, Food & Rural Affairs (Defra).

designs. The reduction in aerodynamic noise draws on proven technology in use in East Asia. Overall it is assumed that proven international technology would reduce noise emissions by approximately 3dB at 360kph (225mph) compared to the current minimum European standards.

- 9.14.8 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. Tunnel portals are designed to avoid significant airborne noise effects caused by the trains entering the tunnel. Significant noise effects from the operational static sources such as line-side equipment, station ventilation equipment and public address systems will be avoided through their design and the specification of noise emission requirements.
- 9.14.9 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 has been identified, taking account of:
- environmental and health benefit;
 - cost;
 - engineering practicability;
 - other environmental effects caused by the further noise mitigation; and
 - responses from consultation and stakeholder engagement (such as a stated preference for a noise barrier in the form of landscape earthworks rather than a fence).
- 9.14.10 The assessment has been based on the assumption that noise fence barriers are acoustically absorbent on the railway side and are located 5m from the outer rail. In practice, noise barriers may differ from this general assumption while maintaining the required acoustic performance. For example, where noise barriers are in the form of landscape earthworks, they need to be higher above rail level to achieve similar noise attenuation to a noise fence barrier because the crest of the earthwork will be further than 5m from the outer rail.
- 9.14.11 Noise insulation measures will be offered for qualifying buildings as defined in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996¹⁷⁹. The assessment provides an estimate of the buildings that are likely to qualify under the Noise Insulation Regulations. Qualification for noise insulation under the Noise Insulation Regulations is identified and noise insulation offered in time to enable it to be installed when the Proposed Scheme becomes operational.
- 9.14.12 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.
- 9.14.13 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

¹⁷⁹ *The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996*. Her Majesty's Stationery Office, London.

Interim Target defined by the World Health Organisation (WHO) Night Noise Guidelines for Europe¹⁸⁰, 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 assessed¹⁸¹. The WHO Interim Target is set at a lower level of noise exposure than the Noise Insulation Regulations trigger threshold for night noise. In these particular circumstances, following the methodology set out in the Noise Insulation Regulations (i.e. pertaining to new or additional railways) where night-time noise levels are predicted to exceed 55dB¹⁸², or the maximum noise level (dependent on the number of train passes) as a train passes exceeds this criterion (in line with the EIA SMR), noise insulation will be offered for these additional buildings.

Ground-borne noise and vibration

- 9.14.14 Significant ground-borne noise or vibration effects will be avoided or reduced through the design and maintenance of the track and track-bed.
- 9.14.15 Operation of modern high speed railways has demonstrated that it is unlikely that vibration from the operation of the Proposed Scheme will present any risk of building damage.
- 9.14.16 The occurrence of high levels of vibration from 'Rayleigh or bow waves' (analogous to the bow waves caused by a ship on the surface of the water) is a rare situation which can occur where trains are travelling at a speed, known as the critical speed, over a railway situated on very soft ground. The critical speed is dependent on the ground conditions below and is not confined to high speed railways. This phenomenon is well understood and is mitigated by appropriate design and construction techniques (e.g. HS1 across Wennington Marshes). Where this could occur, measures such as soil strengthening or bridging over soft ground to ensure bow waves do not adversely affect train operations, or damage the infrastructure, will be incorporated. Experience from the design and environment assessment of HS2 Phase One indicates that any effects are unlikely to be significant.

Monitoring

Construction

- 9.14.17 The nominated undertaker will require its contractors to undertake and report 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

¹⁸⁰ World Health Organization (2010), *Night Noise Guidelines for Europe*. Available online at: http://www.euro.who.int/data/assets/pdf_file/0017/43316/E92845.pdf.

¹⁸¹ 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 Lp_{AFmax} (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB Lp_{AFmax} (where the number of train pass-bys exceeding this value is greater than 20).

¹⁸² Equivalent continuous level, Lp_{Aeq,23:00-07:00} measured without reflection from the front of buildings.

lead contractors' noise and vibration management plans. Proposals for monitoring locations will be set out in each LEMP. The Section 61 applications under the Control of Pollution Act 1974 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

- 9.14.18 The noise and vibration monitoring strategy and commitments are set out in full in HS2 Phase 2b Information Paper E12: Operational Noise and Vibration Monitoring Framework¹⁸³.
- 9.14.19 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 rail corridor. These data, together with noise and vibration measurements, will be used to monitor the operational noise and vibration performance of the Proposed Scheme.
- 9.14.20 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).
- 9.14.21 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.

9.15 Traffic and transport

Mitigation

Construction

- 9.15.1 Section 14 of the draft CoCP includes measures that aim to reduce the adverse impacts and effects on local communities and maintain public access. This includes the impacts of deliveries of construction materials and equipment. These include:

¹⁸³ High Speed Two Ltd (2022), *Phase 2b Western Leg Information Paper E12: Operational noise and vibration monitoring framework*.

- local traffic management measures and plans, which will be prepared in consultation with the highway and transport authorities and emergency services;
- measures to reduce the impacts of temporary road and PRow closures or disruption to railways or navigable waterways;
- use of rail access where practicable to reduce use of public roads;
- use of site 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: controls on vehicle types and hours of operation and agreed routes for construction (HGV) vehicles, including use of the main road network (e.g. motorways and strategic trunk roads and other primary 'A' roads) where reasonably practicable; and
- workforce travel plans that will include a range of potential measures to mitigate the impacts of workers' traffic and transport movements associated with construction of the Proposed Scheme.

- 9.15.2 Measures to be used to mitigate traffic impacts during construction and utility works may include temporary lane closures, junction signal retiming, temporary traffic signals, one way shuttle working, reduced lane widths and overnight/weekend (instead of daytime/weekday) road closures. Traffic diversions will be provided where temporary road closures are required.
- 9.15.3 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.
- 9.15.4 It will be necessary to close, realign or divert certain local roads and PRow along the route of the Proposed Scheme, both during construction and, in some cases, permanently. In these cases, alternative routes will be available either through the use of temporary alternative routes or the existing wider PRow network as far as reasonably practicable.
- 9.15.5 During the construction phase, PRow routes will be kept 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 around construction compounds and interface with site haul routes. Where this is necessary, the movement around the compounds and across site haul routes will be managed to limit, as far as reasonably practicable, any conflict with construction vehicles and to provide safe routes for users.
- 9.15.6 Temporary highway measures including junction improvements, passing places and carriageway widening to manage the safe passing of construction vehicles will be provided

to avoid impacts that could otherwise occur. Further information is provided in Volume 2, Community Area reports and, where these are off-route, in Volume 4, Off-route effects.

- 9.15.7 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.
- 9.15.8 The construction of the Proposed Scheme is expected to require a number of rail possessions and blockades to enable the construction of scheme elements. Disruption to rail users will be reduced by limiting possessions, where reasonably practicable, to existing maintenance periods. HS2 Ltd will work with Network Rail and the train and freight operating companies to ensure that any need for possessions and blockades can be reduced with good planning and communication (including appropriate advance notice).
- 9.15.9 Temporary workers' accommodation provided at some construction compounds (as identified in the Volume 2 Community Area reports) will reduce the level of construction employee traffic travelling to and from the compounds during the week and will encourage off-peak travel.
- 9.15.10 Where reasonably practicable, movement of construction material, machinery and/or construction workers between the construction compounds and work sites will be via site haul routes. These site haul routes will reduce the need for construction vehicles to use the public road network, therefore helping to reduce traffic related impacts.
- 9.15.11 Excavating borrow pits will enable acceptable engineering 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 has the potential to considerably reduce the number of HGV movements on the highway network.

Framework travel plan

- 9.15.12 An over-arching framework travel plan will be developed, based on the framework travel plan for HS2 Phase One and Phase 2a and amended where relevant for the Proposed Scheme covering construction, operation and maintenance. For construction, it will include a construction workforce travel plan that will contain a range of potential measures to mitigate the impacts of traffic and movements associated with construction of the Proposed Scheme. The construction workforce travel plan 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.

Operation

- 9.15.13 A number of measures have been included as part of the design of the Proposed Scheme and will avoid or reduce impacts on transport users. For HS2 stations these include:
- provision for access by sustainable mode, including public transport, walking and cycling to promote non-car access;
 - provision of dedicated taxi, private hire vehicle and private vehicle drop-off and pick-up facilities sized to accommodate the anticipated future demand;
 - changes to the highway and public transport network to accommodate users of the HS2 services; and
 - provision of cycle access to the station together with cycle parking.
- 9.15.14 In addition, the following measures have been included both around Proposed Scheme stations and along the route of the Proposed Scheme:
- reinstatement of roads on or close to their existing alignments, where reasonably practicable; and
 - replacement, diversion or realignment of PRoW if relevant.
- 9.15.15 Specific travel plans for each high speed station and depot will include measures that aim to reduce the impacts and effects of traffic and transport movements.

Monitoring

Construction

- 9.15.16 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 (LTMP) 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 LTMP and construction travel plans by the lead contractors' EMS.

Operation

- 9.15.17 Station or depot travel plans for the HS2 stations or depots will detail monitoring of travel associated with operation of the relevant HS2 station or depot. There are no other area-specific monitoring requirements required for traffic and transport.

9.16 Waste and material resources

Mitigation

- 9.16.1 Sustainable materials will be sourced and used efficiently for construction of the Proposed Scheme. The aim is to minimise waste and maximise the proportion of material diverted from landfill.
- 9.16.2 The principles of the waste hierarchy will be followed, with priority given to the prevention of waste generation, followed (where this is not reasonably practicable) by reuse, recycling and recovery of waste respectively, with disposal to landfill adopted only as a last resort.
- 9.16.3 The principles of the circular economy will be proactively considered throughout specification, design, procurement, construction and operation of the Proposed Scheme, in accordance with the HS2 Circular Economy Principles. The circular economy is an alternative approach to the typical 'linear' way of using resources. By finding opportunities of remanufacturing, reusing or recycling materials and keeping them in use for longer, both resource use and waste generation can be reduced.
- 9.16.4 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.
- 9.16.5 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.
- 9.16.6 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

- 9.16.7 Monitoring of waste management activities will be undertaken by lead contractors in accordance with Section 15.3 of the draft CoCP.
- 9.16.8 An effective and robust programme for recording appropriate waste metrics will be established and undertaken by contractors. Recording and reporting enhanced resource and waste data will improve awareness and focus the management of waste.

Operation

- 9.16.9 Monitoring of waste management activities will be undertaken by train operating companies and other users of the Proposed Scheme in accordance with statutory requirements.

9.17 Water resources and flood risk

Mitigation

- 9.17.1 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 adverse impacts on receptors cannot 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 Volume 2, Community Area reports.
- 9.17.2 Where the Proposed Scheme has the potential to increase flood risk, its design will reflect the approach required by 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.
- 9.17.3 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.
- 9.17.4 Existing groundwater abstraction boreholes or monitoring points will be protected from physical damage, insofar as reasonably practicable, including appropriate decommissioning of abandoned boreholes in order to remove potential pollution pathways. If boreholes are to be decommissioned and replaced with alternatives, the lead contractors will follow the latest industry standard. This principle will also be applicable to springs potentially affected by the Proposed Scheme, although additional measures may be required to mitigate temporary construction impacts. Wherever a spring is to be covered or displaced by design elements then where reasonably practicable, additional mitigation measures may be required to relocate the spring.
- 9.17.5 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.

- 9.17.6 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.
- 9.17.7 Engagement has been, and will continue to be, undertaken with the Environment Agency, Scottish Environment Protection Agency (SEPA), 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

- 9.17.8 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 not be limited to, procedures to monitor the effectiveness of the mitigation measures associated with potentially significant effects outlined in Volume 2, Community Area reports and Volume 4, Off-route effects.
- 9.17.9 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 (physio-chemical) and quantitative (flow/level) impacts on surface water bodies; and
 - hydromorphological impacts on surface water bodies.
- 9.17.10 The nominated undertaker will require its contractors to consult the relevant regulatory body 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 runoff. This 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.
- 9.17.11 The nominated undertaker will require its contractors to undertake monitoring to identify:
- pollution risks that are unacceptably high (e.g. cause adverse impacts to water quality or quantity);
 - spillages and leakages;

- non-compliance with the CoCP; and
- suspected pollution incidences.

9.17.12 Appropriate actions will be taken where pollution risks are unacceptably high (as confirmed by the relevant regulatory body), where there is non-compliance with the CoCP, where spillages and leakages are unacceptable or where there are any suspected pollution incidents.

9.17.13 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.

9.17.14 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

9.17.15 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.

9.17.16 The duration of this monitoring will be agreed in consultation with the Environment Agency or SEPA and will depend on the nature of the potential impact concerned.

9.17.17 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 water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-007-00000).

10 Strategic, route-wide and route corridor alternatives

10.1 Introduction

Background

- 10.1.1 This section of the report sets out the background to the reasonable 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 reasonable alternatives, how they were studied and the main reasons for the choices made can be found in Volume 5: Appendix CT-003-00000, Alternatives report.
- 10.1.2 A summary of the strategic alternatives to the high speed rail network (the Y network incorporating Phase One and Phase Two) is set out in Section 10.2 of this report, with further details provided in the Phase One Alternatives report (2013)¹⁸⁴.
- 10.1.3 Local alternatives relevant to the Phase 2b Western Leg studied prior to the Government's announcement of the 2017 preferred route for the full Phase 2b scheme in July 2017 are summarised in Section 11 of this report. Alternatives studied since July 2017 are addressed in Volume 5, Alternatives report and off-route alternatives in Volume 4, Off-route effects. Further details on local alternatives studied both prior to, and since July 2017, can also be found in Volume 5, Alternatives report.
- 10.1.4 The reasonable alternatives considered for the borrow pits, all located within the Wimboldsley to Lostock Gralam (MA02) area, are reported separately within Sections 2, 5 and 6 in the detailed Borrow pit report (Volume 5: Appendix CT-008-00000).

Regulatory requirements

- 10.1.5 The 2017 English EIA Regulations require an ES to include:

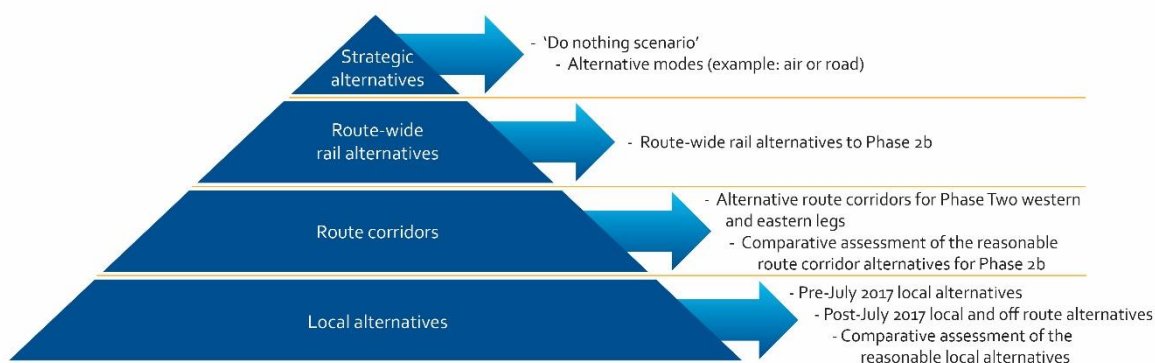
"A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for selecting the option chosen, taking into account the effects of the development on the environment."

¹⁸⁴ High Speed Two Ltd (2013), *High Speed Rail (London – West Midlands) Environmental Statement, Volume 5, Technical Appendices. Alternatives Report (CT-002-000)*. Available online at: <https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-5-alternatives-report>.

Definition of alternatives

10.1.6 The alternatives reported here are grouped into categories, as shown in Figure 40.

Figure 40: Hierarchy of alternatives considered



10.2 Strategic alternatives to the high speed rail previously studied

- 10.2.1 As set out in the Phase One ES³⁵ published in November 2013, the Government 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 railway as well as upgrades to the existing conventional rail network and roads.
- 10.2.3 The potential for capacity upgrades to the existing conventional rail network was explored. The Government rejected this option as further upgrades will not provide the scale of capacity increase and connectivity needed to fulfil the Government's objectives¹⁸⁵. This would also fail to meet Government objectives for future performance of the conventional rail network and would cause considerable disruption to existing train services during construction.
- 10.2.4 High speed rail has some of the lowest carbon emissions of any intercity transport option. The capacity of London's airports is limited and providing for future growth in international travel will be a significant challenge on its own without factoring in the need to serve

¹⁸⁵ Department for Transport (2017), *High Speed Two, Phase Two Strategic Case*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629393/high-speed-two-phase-two-strategic-case.pdf.

additional demand for domestic air services. HS2 will provide a low carbon alternative for passengers and increase and spread capacity demand for domestic journeys.

- 10.2.5 The Government decided not to give further consideration to major new motorways as an alternative to HS2. This is because high speed rail is preferable in terms of increasing capacity, connectivity and sustainability of intercity travel, while decreasing journey times and providing carbon free services as a significant part of a zero carbon multimodal transport network.
- 10.2.6 The cost of a new conventional speed railway will be almost as high as those of high speed rail without delivering the reduced journey times and would have only marginally fewer environmental impacts. For these reasons, a new conventional rail line option was rejected.
- 10.2.7 Prior to the introduction of the Phase One Bill into Parliament in November 2013, the Government considered and reported on alternative configurations of the high speed rail network. The Government's conclusion and its reasons for promoting the Y network were reported in the Command Paper High Speed Rail: Investing in Britain's Future (2012)³⁷ and subsequently in the Phase One Alternatives report (2013) deposited in Parliament alongside the Phase One Bill. The Phase One Bill was enacted in February 2017 and construction works on Phase One have commenced.

10.3 Strategic alternatives to Phase 2b

Do nothing

- 10.3.1 Consideration of 'doing nothing' for the Y network is provided in the Phase One Alternatives report.
- 10.3.2 For the Phase 2b Western Leg, the 'do nothing' scenario implies not delivering the Proposed Scheme between Crewe and Manchester, nor connections to the WCML. This scenario would therefore not provide: additional new rail network capacity to meet long term rail demand; increased train services to key markets; reduced journey times; improved rail connectivity to the northern cities and Scotland, from and to, the West Midlands and London; the ability for other strategic transport investment programmes, including NPR and Crewe Hub, to realise ambitions to deliver improved connectivity, reduced journey times, greater capacity and reliability on train services between the cities of the North and the West Midlands; support for economic growth in the West Midlands and the North; and a vital contribution to the UK's environmental targets.
- 10.3.3 The Government concluded that action is required to meet the forecast demand for inter-city travel, to reduce crowding, to address the growing rail congestion on Britain's inter-city rail network, to support economic growth and environmental targets. 'Doing nothing' is therefore not considered an option³⁷.

Alternative modes (air or road)

- 10.3.4 Consideration of alternative modes of transport to high speed rail is provided in the Phase One Alternatives report (2013).
- 10.3.5 The Government considers that the medium and long term trajectory of the predicted growth in rail travel will create a need over the next 20 to 30 years for additional capacity to cater for inter-city journeys between London and the major cities in the Midlands, the north of England and Scotland. It does not, however, believe transferring rail demand to road or domestic aviation to be an appropriate solution. Rather than building additional roads or airports, the Government considers that it is the rail network which needs to be in a position to play the lead role in delivering new capacity and that a clear case exists for this new capacity to be a new high speed rail network. HS2 will be capable of operating carbon free services as a significant part of a zero carbon multimodal transport network.

10.4 Route-wide rail alternatives

Background

- 10.4.1 In line with the requirements of the HM Treasury Green Book¹⁴⁴, the DfT considered alternatives to the full Phase 2b scheme throughout its development to ensure the case for it is robust. As part of the development of a strategic outline business case for Phase 2b, the DfT commissioned a series of reports to develop and appraise potential route-wide rail alternatives.
- 10.4.2 The Phase 2b Strategic Alternatives report (2016)¹⁸⁶ for the full Phase 2b scheme, was completed by Atkins in November 2016, and updated previous work completed on route-wide rail alternatives in 2013¹⁸⁷, taking account of design updates including the decision by Government to deliver Phase 2a ahead of the remainder of Phase Two. The report identified upgrades to existing rail infrastructure as alternatives and analysed how these would perform compared to full HS2 Phase 2b scheme infrastructure and train services. The DfT specified that the appraisal of rail alternatives be undertaken against the Government's strategic objectives for HS2, and in particular, Phase 2b.
- 10.4.3 Following the Oakervee Review and the subsequent announcement by Government in February 2020 for the High Speed Rail (Crewe – Manchester) Bill, Mott MacDonald developed two route-wide rail options that sought, to various degrees, to overcome capacity and

¹⁸⁶ Atkins (2016), *Strategic Alternatives to HS2 Phase 2b. A report for the Department for Transport*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/568309/strategic-alternatives-to-hs2-phase-2b-atkins-report.pdf.

¹⁸⁷ Atkins (2013), *HS2 Strategic Alternatives: Final Report*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253456/hs2-strategic-alternatives.pdf.

journey time limitations on the WCML. This work took into consideration the options and findings of the previous work undertaken by Atkins in 2016 and considered a range of different combinations of infrastructure upgrades to the existing conventional network to deliver improved journey times, service frequency and capacity, similar to the 2013 confirmed route for the Proposed Scheme.

Alternatives studied (2016)

Study assumptions

- 10.4.4 The 2016 study appraised the route-wide rail alternatives to the full Phase 2b scheme.
- 10.4.5 To do this Atkins developed five options, that all sought to varying degrees to overcome capacity and journey time limitations on the WCML on the Western Leg of the route, and on the East Coast Main Line (ECML) and Midland Main Line (MML) on the Eastern Leg of the route. The route-wide rail alternatives were compared to the 2016 preferred route to Manchester and Leeds and a 'do minimum' (Phase 2a) scenario¹⁸⁸.
- 10.4.6 The 2016 options (Option 1, Option 2S, Option 2L, Option 3 and Option 4) considered a range of different combinations of infrastructure upgrades to the existing conventional network and sections of new track to deliver improved journey times and similar train frequencies to the 2016 preferred route to Manchester and Leeds, as far as reasonably practicable. A TSS¹⁸⁹ was produced for the operation of the route-wide rail alternatives, as considered in the Phase 2b strategic alternatives report (2016), which delivered a comparable level of connectivity to the proposed full Phase 2b scheme TSS. This allowed a consistent approach between the route-wide rail alternatives and the methodology applied to the Phase 2b Western Leg¹⁹⁰.
- 10.4.7 On the Western Leg to Manchester it was assumed that Phase 2a will have been built. As a result, the sections of the route-wide rail alternatives proposed as alternatives to the Phase 2b Western Leg were constrained to a single, similar option along the WCML north of Crewe. Train services from Birmingham could only be accommodated at Manchester Victoria Station, not Manchester Piccadilly Station. It was necessary to utilise Manchester Victoria

¹⁸⁸ The 'do nothing' scenario provides a model for the operation of train services from 2033 assuming the Proposed Scheme does not go ahead and provides a reference against which the 'do something' options can be compared. The 'do minimum' operational train timetable assumptions are based on future committed schemes only and assumes that Phase One and Phase 2a will have been built.

¹⁸⁹ High Speed Two Ltd (2016), *HS2 Phase Two Assumptions Report: PLANET Framework Model version 6.1c*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/574740/Planet_Framework_Model_Assumptions_Report.pdf.

¹⁹⁰ Following the route-wide rail alternatives options study completed by Atkins in 2016, the Phase 2b service pattern was revised. The service pattern produced for the route-wide rail alternatives is considered not to be materially affected by the revision to the Phase 2b service pattern. As a result, the route-wide rail alternatives options can be compared to both the 2016 preferred route to Manchester and Leeds and the Proposed Scheme.

Station to deliver sufficient capacity and to provide the same number of services as the full Phase 2b service pattern, which could not otherwise be accommodated on the approach to, or at, Manchester Piccadilly Station.

- 10.4.8 The 2016 study also included route-wide rail alternatives for the Phase 2b Eastern Leg to Leeds. For completeness it is summarised briefly here, however the Eastern Leg is not the subject of this Bill. Atkins concluded that all the route-wide rail alternatives would have required a new section of high speed line from Phase One to the Birmingham to Derby Railway, which would have needed to be electrified and upgraded. All the alternatives in the study would have served the East Midlands via Derby and Nottingham. The study set out a number of different ways of reaching Nottingham, Leeds and Edinburgh via upgrades to existing conventional lines, all of which would have served Sheffield Midland Station via existing line upgrade. The study also included a high level environmental appraisal.

Option 1

- 10.4.9 Option 1 would require upgrades to the WCML north of Crewe and would provide (as would Option 4) one additional service to Manchester relative to Options 2S, 2L and 3.
- 10.4.10 The key elements of this option, relevant to the Phase 2b Western Leg are summarised as follows:
- partial four tracking of the Crewe (Wilmslow) – Weaver Junction on the WCML and provision of an alternative freight route via Sandbach;
 - substantial grade separation between Crewe and Preston on the WCML and some platform lengthening so trains can split and join at both stations; and
 - a chord from Phase One that would allow two trains per hour to connect with the WCML Stoke branch via Stone to Manchester Piccadilly Station.

Option 2S and 2L

- 10.4.11 Like Option 1, both Options 2S and 2L Western Leg train services would run along the WCML, although the Stoke via Stone chord would not be required as only one conventional train per hour would operate via Stoke between Manchester and London Euston Station. The WCML services would broadly match the TSS at the time of the study, albeit at a lower speed and sometimes with less capacity per train.

Option 3

- 10.4.12 Option 3 would require the least upgrades to the existing conventional network when compared to the other route-wide rail alternatives. It would be the same as Option 2S except that Edinburgh, and Glasgow, would be reached via a joint high speed service from London Euston, as per the TSS at the time of the study, except the WCML would be joined at Crewe

Option 4

10.4.13 Option 4 was the same as Option 2S.

Appraisal of alternatives

10.4.14 The appraisal of alternatives found that:

- **journey times:** the Phase 2b Western Leg would offer the fastest journey times between London and Manchester;
- **additional network capacity:** both the Phase 2b Western Leg and the route-wide rail alternatives would create extra capacity on the existing conventional rail network for other services, when compared to the 'do minimum' (with Phase 2a) scenario. However, only the Phase 2b Western Leg would create extra capacity for potential additional high speed services on the Western and Eastern Legs north of Birmingham and therefore meet the Government's strategic objectives for HS2;
- **train seating capacity:** the route-wide rail alternatives would provide more train seating than the 'do minimum' scenario, but fewer seats than the Phase 2b Western Leg to some key destination cities. The Phase 2b Western Leg would, operate significantly longer trains (400m in length) than the route-wide rail alternatives to Manchester, and therefore, would provide more seating overall to these destinations. The Phase 2b Western Leg would operate shorter trains (200m long) than the route-wide rail alternatives to destinations including Liverpool, Glasgow and Edinburgh;
- **reliability and punctuality:** network resilience would be less for the route-wide rail alternatives than the Phase 2b Western Leg because the route-wide rail alternatives would require greater use of the existing rail network. No punctuality and reliability benefits were identified for the existing conventional rail network from the introduction of the route-wide rail alternatives or the released capacity generated by the Phase 2b Western Leg. However, the route-wide rail alternatives would typically be less punctual and less reliable than the Phase 2b Western Leg as they would add additional trains on to the conventional rail network from Phase One and Phase 2a;
- **disruption:** an assessment of the likely disruption caused by constructing the route-wide rail alternatives found that each would require: between approximately 710 and 725 weeknight closures; approximately 360 'equivalent Sunday'¹⁹¹ closures; and approximately 100 full or extended weekend closures; and
- **environmental impact:** the high level environmental appraisal found that the route-wide rail alternatives would have fewer environmental impacts than the Phase 2b Western Leg, largely because they could be delivered through upgrades and alterations to sections of the existing conventional rail network within or adjacent to existing railway land.

¹⁹¹ The closure of a service for a day in order for maintenance/improvement work on the railway.

Conclusions

- 10.4.15 The DfT commissioned study identified that there is no route-wide rail alternative that could deliver the same level of resilience, capacity, connectivity and service as the Phase 2b Western Leg scheme. As these route-wide rail alternatives did not meet the Government's strategic objectives for HS2 they were not taken forward. Consequently, the Phase 2b Western Leg emerged as the preferred scheme as it best meets the Government's strategic objectives
- 10.4.16 The Midlands Connect and TfN propose to use additional capacity created by the full Phase 2b scheme as a first step to transforming and connecting the economies of the Midlands and the North. This would rely particularly on some sections of the Phase 2b Western Leg that would not be built as part of the route-wide rail alternatives. It follows, therefore, that the aspirations of Midlands Connect and TfN would likely cost more and be more disruptive or difficult to achieve utilising the route-wide rail alternatives.

Alternatives studied (2021)

Study assumptions

- 10.4.17 Following the Oakervee Review and the subsequent announcement by Government in February 2020 for the High Speed Rail (Crewe - Manchester) Bill, Mott MacDonald developed two route-wide rail options that sought, to various degrees, to overcome capacity and journey time limitations on the WCML.
- 10.4.18 A TSS was produced for the operation of the Western Leg route-wide rail alternative which would deliver a comparable level of connectivity to the proposed Phase 2b Western Leg TSS.
- 10.4.19 The study assumes that Phase 2a will have been built and as a result, the route-wide rail alternatives were focused on a single, similar option along the WCML north of Crewe. The study did not consider connection to NPR, which would rely on the passive provision for junctions to connect to sections of the Proposed Scheme
- 10.4.20 Two groups of Western Leg route-wide rail alternatives capable of delivering the Phase 2b Western Leg TSS, and comprising various infrastructure upgrades and interventions to existing rail infrastructure, were considered as follows:
- alternatives to the Phase 2b Western Leg between Knutsford and Golborne (also referred to as the Golborne link); and
 - alternatives to the Phase 2b Western Leg between Crewe and Manchester.

Alternatives to the Knutsford to Golborne alignment

- 10.4.21 Four rail alternatives to the Knutsford to Golborne alignment were appraised that would differ in terms of likely service punctuality/resilience, construction complexity, cost and environmental impacts. These can be summarised as:

- Option A1: Crewe to Weaver Junction south section (between Crewe and Hartford) four-tracking;
- Option A2: Crewe to Weaver Junction north section (between Hartford and Weaver Junction) four-tracking, together with a doubling of sections of the Middlewich Line and the provision of a Northwich Line to WCML down chord to accommodate freight traffic;
- Option A3: combined WCML south and north sections four tracking between Crewe and Weaver Junction, and the provision of a Northwich Line-WCML down chord to accommodate freight traffic; and
- Option A4: Four tracking the WCML in full between Crewe and Weaver Junction, together with a Northwich Line-WCML down chord to accommodate freight traffic.

Alternatives to the Crewe to Manchester alignment

10.4.22 Two rail alternatives to the Phase 2b Western Leg between Crewe and Manchester were appraised that would differ in terms of likely service punctuality/resilience, construction complexity, cost and environmental impacts. Neither alternative would be able to serve Manchester Airport nor accommodate NPR services. The alternatives can be summarised as:

- Option B1 - minimum package: provision of new platform at Manchester Piccadilly Station, grade separation of Slade Lane junction, and four tracking of the WCML between Goostrey Junction and Chelford Junction; and
- Options B2 - full package: all of the minimum package upgrades, plus grade separation of Heaton Norris and Edgely rail junctions, speed improvements to Cheadle Hulme junction and extra platform capacity at Stockport Station.

Appraisal of alternatives

10.4.23 The appraisal of alternatives found that:

- **journey times:** the Phase 2b Western Leg would offer the fastest journey times compared to the route-wide rail alternatives for the Knutsford to Golborne alignment. Similarly, the Phase 2b Western Leg would offer the fastest journey times compared to the route-wide rail alternatives for the Crewe to Manchester alignment. The Phase 2b Western Leg would also serve a new station at Manchester Airport. Overall, the route-wide rail alternatives would not meet the Government's strategic objectives for HS2 to the same extent that the Phase 2b Western Leg would bring in terms of journey time and economic benefits;
- **additional network capacity:** the route wide alternatives to the Knutsford to Golborne alignment would not create significant additional network capacity. The route-wide alternatives for the Crewe to Manchester alignment would also not create significant additional network capacity and therefore would not support NPR aspirations without further substantial investment at Manchester stations and their approaches;
- **train seating capacity and crowding:** the route-wide rail alternatives to the Knutsford to Golborne alignment would deliver the same number of seats to Scotland as per the

Phase 2b Western Leg. The route-wide rail alternatives for the Crewe to Manchester alignment would also deliver the same number of seats as the Phase 2b Western Leg into Manchester Piccadilly but would not serve Manchester Airport and its wider catchment. The study did not assess levels of crowding;

- **reliability and punctuality:** network resilience would be less for all the route-wide rail alternatives compared to the Phase 2b Western Leg because the route-wide rail alternatives would require greater use of, and dependence on, the existing rail network. Train services may therefore be less reliable and punctual;
- **disruption:** no route-wide rail alternative was identified on the Phase 2b Western Leg that would not be substantially more disruptive to the existing rail network when compared to the construction of the Phase 2b Western Leg. However, the total disruption impact associated with the construction of the route-wide rail alternatives would not necessarily make them undeliverable; and
- **environmental impact:** the Volume 5: CT-003-00000, Alternatives report provides a high level indication of the environmentally sensitive features and impacts identified by the Mott MacDonald 2021 study¹⁹², commissioned by DfT, that could potentially be affected by the route-wide rail alternatives. Overall, the study concluded the environmental impacts associated with the construction of the route-wide rail alternatives would be notably less than for the Phase 2b Western Leg as the upgrade works would be undertaken mainly within the existing rail corridor.

10.5 Route corridor alternatives

- 10.5.1 The Proposed Scheme has developed through a refinement process referred to as sifting. The sifting process consisted of a sequentially more detailed appraisal of route options. At the end of each appraisal stage or sift sustainability performance was considered alongside cost, operational and engineering considerations. Preferred options were identified to progress to the next level of sift for a more detailed appraisal.
- 10.5.2 The following environmental factors were considered as part of the appraisal of sustainability performance: climatic factors and adaptability; greenhouse gases; landscape; townscape and cultural heritage; biodiversity and geodiversity; water resources; flood risk; air quality; noise and vibration; community integrity; accessibility; health and well-being; security and safety; economic prosperity; economic welfare; soil and land resources; waste generation; and resource use.
- 10.5.3 The sequence of sifts were aimed at considering a progressively smaller number of options at increasing levels of detail (e.g. by avoiding centres of population and/or key environmental features). In the later sifts, the predicted impacts of the remaining options were further mitigated by refining the vertical and/or horizontal alignments and by introducing certain structures such as viaducts or cuttings with retained walls, where

¹⁹² Mott MacDonald (2021), *Strategic Alternatives to High Speed 2 Phase 2b, West Coast Main Line: Final Report*. Pending publication.

appropriate. In this way, the route development process has ensured that mitigation, so far as reasonably practicable, is inherent within the design from the outset.

Appraisal of sustainability options report (March 2012)

- 10.5.4 Route options appraisal between 2010 and 2012 focused on establishing a preferred route from the West Midlands to Manchester and Leeds and many route section options had been appraised. As described in the Options for Phase Two – Appraisal of Sustainability report (2012)¹⁹³, 42 separate route sections for the Western Leg to Manchester and 32 for the Eastern Leg to Leeds were considered. This equates to up to 144 and 112 possible route combinations respectively. The 74 route sections presented in the report had been sifted down from several hundred through the earlier route options appraisal process described previously.
- 10.5.5 Work undertaken on the route options appraisal for the Western Leg considered three reasonable alternative groups of options and approaches into Manchester. All three groups would commence at Swynnerton and from there would take different routes north across the Cheshire plains. As the different groups would approach south Manchester, alternative approaches into both Manchester Piccadilly Station and Manchester Salford Station were considered as well as onward connectivity to the WCML north of Golborne.

Sustainability summary (January 2013)

- 10.5.6 Following the route options appraisal, the Western Leg of the route that was presented in the 2013 proposed scheme for consultation approached Manchester via a new high speed station near Manchester Airport. It included a new station in Manchester city centre adjacent to the existing Manchester Piccadilly Station and a connection to the WCML north of Golborne. Two depots were proposed at sites near Basford south of Crewe for the IMD, and near to the WCML connection north of Golborne for the RSD. The sustainability appraisal of this scheme was published in the Phase Two initial preferred scheme sustainability summary (2013)¹⁹⁴.

Sustainability statement (July 2013)

- 10.5.7 Following this, engagement took place with a number of key stakeholders including MPs, particularly those potentially affected by the route. As a result, a small number of further refinements were made to the route. These refinements culminated in the 2013 proposed scheme for consultation. The sustainability appraisal of the 2013 proposed scheme for

¹⁹³ Temple-ERM (2012), *Options for Phase 2 of the high speed network – Appraisal of Sustainability*. Available online at: <https://www.gov.uk/government/publications/options-for-phase-two-of-the-high-speed-rail-network-appraisal-of-sustainability>.

¹⁹⁴ Temple-ERM (2013), *HS2 Phase Two Initial Preferred Scheme - Sustainability Summary*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/68971/hs2-phase-two-initial-preferred-scheme-sustainability-summary.pdf.

consultation is described in the Phase Two sustainability statement (2013)¹⁹⁵ which was consulted publicly between July 2013 and January 2014.

¹⁹⁵ High Speed Two Ltd (2013), *Consultation on the route from the West Midlands to Manchester, Leeds and beyond, Sustainability Statement Volume 1: main report of the Appraisal of Sustainability A report by Temple-ERM for HS2 Ltd (July 2013)*. Available online at: <https://www.gov.uk/government/publications/hs2-phase-two-consultation-sustainability-statement>.

11 Local and regional alternatives Crewe - Manchester

11.1 Introduction

- 11.1.1 This section of the report describes: the reasonable local alternatives that were studied and sifted during development of the Proposed Scheme following publication of the 2013 proposed scheme for consultation and prior to the Government's announcement of the preferred route for the full Phase 2b scheme in July 2017.
- 11.1.2 Alternatives studied since the Government's announcement of the preferred route in July 2017 are reported in Volume 5, Alternatives report. Further details on local alternatives studied both prior to and since July 2017 can be found in the Alternatives report (Volume 5: Appendix CT-003-00000).
- 11.1.3 The reasonable local alternatives were studied prior to the Government's announcement of the preferred route for the full Phase 2b scheme in July 2017 following public consultation between July 2013 and January 2014, in 2015 and following public consultation between November 2016 and March 2017. The local alternatives considered route refinements on discrete sections of route to address comments arising from consultation and ongoing engagement and to reduce environmental impacts, construction complexity and cost.
- 11.1.4 In some locations it was concluded that the alternatives proposed did not offer any net benefit and were therefore not taken forward and in other areas the route was amended. The revised scheme formed the basis of the route that was the subject of the Government's announcement of the preferred route for the full Phase 2b scheme in July 2017.
- 11.1.5 The local alternatives relevant to the Phase 2b Western Leg scheme considered during this process prior to the Government's announcement of the preferred route for the full Phase 2b scheme in July 2017 are set out in Table 6, Table 7 and Table 8. In each case, the issue considered is given and the project response (i.e. to amend the scheme or not) is explained.

11.2 Route development – refinement of the 2013 proposed scheme for consultation

- 11.2.1 The 2013 proposed scheme for consultation was subject to a series of refinements (termed local alternatives) as a consequence of post-consultation feedback, improved baseline data, design development and lessons learnt from Phase One.
- 11.2.2 Following this, and building on an earlier recommendation from Sir David Higgins in 2014, the Government announced its intention to bring forward the construction of a section of Phase Two from Lichfield to Crewe as Phase 2a in November 2015. This split the Western Leg of the 2013 proposed scheme for consultation in two and included a connection with Phase

One to the north of Lichfield, a connection with the WCML near the A500 south of Crewe, and an IMD at Basford.

- 11.2.3 In November 2016, the Government announced the 2016 preferred route to Manchester and Leeds, (from Crewe to Manchester, including a connection to the WCML and from the West Midlands to Leeds, including a connection to the ECML) as described in the Phase 2b Sustainability Statement and Post Consultation Update (November 2016)³⁰. This was based on refinements made to the route as a result of earlier consultation, updated design standards and the recommendations of the *Sheffield and South Yorkshire Report* published in July 2016. In some locations, substantial changes had been made to the 2013 proposed scheme for consultation.
- 11.2.4 As a result of these changes, a further period of public consultation was launched alongside the announcement of the 2016 preferred route to Manchester and Leeds. The consultation ran from November 2016 to March 2017 and focused on seven sections of the route, across both the Eastern Leg to Leeds and Western Leg to Manchester (see Section 3 of this report).
- 11.2.5 Further route refinements were undertaken to address specific consultee concerns raised during the consultation period and, in July 2017, the Government announced the '2017 preferred route to Manchester and Leeds' with decisions confirmed to proceed with six of the seven proposed changes that were consulted on. The exception was the consulted change to the route at Measham on the Eastern Leg.
- 11.2.6 A historical overview of the development of the route corridors identified during the evolution of the full Phase Two scheme between the West Midlands and Manchester between 2010 and July 2017, from which the Proposed Scheme has emerged is provided in the Volume 5: CT-003-00000, Alternatives report. This includes the route of Phase 2a between the West Midlands and Crewe, which subsequently received Royal Assent in February 2021.

11.3 Local alternatives considered post 2013/2014 consultation

- 11.3.1 HS2 Ltd published the High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond - Sustainability Statement in July 2013 to assist with public consultation from July 2013 to January 2014. Following this consultation, HS2 Ltd investigated a number of local alternatives to the scheme (referred to as the 2013 proposed scheme for consultation). The Western Leg of the 2013 full Phase 2b scheme for consultation was divided into geographically based refinement areas that were subject to further design and appraisal as detailed in Table 6.

Table 6: Main reasonable local alternatives considered post 2013/2014 consultation for the Phase 2b Western Leg prior to July 2017 preferred route announcement

Location	Concern or proposal considered	Project response
Crewe surface	The route through or around Crewe and possible integration with Network Rail proposals for a Crewe Hub station.	The 2013 proposed scheme for consultation was retained as the preferred option, which will approach Crewe in a cutting alongside the WCML before entering an approximately 3.8km bored tunnel under the existing Crewe Station. The alternative options would have run on surface in a cutting through the centre of Crewe alongside the WCML. The preferred option of a tunnel will have substantially less sustainability impacts than the alternative options, as well as lower construction complexity. The surface options would also have major implications for the existing road network through Crewe.
Middlewich to Pickmere (routes through salt mining areas)	The proximity of the route to Lostock Green, Lostock Gralam and Pickmere Telescope. Risks associated with crossing the large expanse of salt fields, salt mining and gas storage operations north of Crewe. Further review of alternative route corridors from Crewe north-east towards Manchester Airport via Mobberley.	<p>The 2016 preferred route to Manchester was maintained as the preferred option on the basis that the alternative options would have similar or greater impacts on the local environment or have greater construction complexity and cost.</p> <p>An option was adopted that runs at a minimum elevation of approximately 1m above the ground (rather than in cutting and at ground level) to avoid salt mining and gas storage area compared to the 2013 proposed scheme for consultation.</p> <p>North of Crewe the route would initially follow a similar horizontal profile to the 2013 proposed scheme for consultation, but would cross the River Dane on a 26m high viaduct, as opposed to a 10m high viaduct, and then cross the Trent and Mersey Canal on three occasions. The route would head north-east alongside the existing A556 and to the west of Lostock Green, before continuing north to the east of Lostock Gralam and Pickmere Telescope.</p>
WCML connections north of Crewe	Opportunity for a WCML connection to the north of Crewe.	The 2013 proposed scheme for consultation was retained as there was no requirement to provide a connection to the WCML to the north side of Crewe at this stage of the project. The alternative options considered would have greater landscape and visual impacts or require more land.
Delta junction zone 1	Clearance and navigational visibility when crossing the Bridgewater Canal and Agden Brook; and local concerns regarding visual impact.	An option was adopted that would follow a similar route to the 2013 proposed scheme for consultation under the M56, but at a shallower depth. Further north, a viaduct would cross over the Agden Brook, before rising onto an embankment over the Bridgewater Canal. The alternative options would have similar environmental impacts, although would have greater cost and construction complexity associated with a section of cut-and-cover tunnel in a floodplain environment under the Bridgewater Canal.
Delta junction zone 2	Configuration of the delta junction between the HS2 WCML connection and the Manchester spur.	An option was adopted that would follow a similar route to the 2013 proposed scheme for consultation, but the section of the spur to Manchester would pass under, rather than over, the HS2 WCML connection. This would reduce the overall height of the junction and will result in less visual impacts.
Manchester Ship Canal	Reduce landscape, visual and noise impacts where the route will cross the Manchester Ship Canal.	An option was adopted that would follow a similar route to the 2013 proposed scheme for consultation with a reduction in line speed to 300kph (186mph) on the canal crossing. This would allow for lower embankments either side of the canal, with associated lower noise impacts.

Environmental Statement
Volume 1

Location	Concern or proposal considered	Project response
East and west of Culcheth	Reduce impacts of the route past Culcheth, particularly in relation to Taylor Business Park and Culcheth Linear Park.	An option was adopted that would broadly follow a similar route to the 2013 proposed scheme for consultation over the Manchester Ship Canal and past Holcroft Moss. A more westerly route would be taken approaching Culcheth. This route would be further from Culcheth and avoid direct impacts on the Taylor Business Park, Culcheth Linear Park and Leigh Golf Club, as well as avoiding the demolition of the Grade II Listed Newchurch Old Refectory.
Lowton gap	Alignment of the route through Lowton gap (the section of route between Lowton and Lowton Common) and impacts on the community of Lowton.	The 2013 proposed scheme for consultation was retained as the alternative option did not have significantly less sustainability impacts to justify the greater construction complexity and cost of the alternative option of a retained cut. There would be similar noise impacts to Lowton although the alternative option would require fewer residential demolitions when compared to the preferred option.
Alternative RSD locations	RSD location and layout and compatibility with wider network operational requirements.	An option to locate the RSD to the north of Crewe, east of Wimboldsley between the HS2 WCML connection and the WCML was adopted. At a central location on the Western Leg and in proximity to the WCML, the Crewe north depot will have less sustainability impacts at Golborne, including avoiding a direct impact on the Grade II* listed Lightshaw Hall. Removal of the depot at Golborne would remove the requirement of northern chord, thus removing the associated costs and environmental impacts.
Golborne (without RSD)	Connectivity of the HS2 WCML connection with the WCML at Bamfurlong without provision for an RSD at Golborne.	An option was adopted which would run to the south of Byrom Hall on low embankment, approximately 500m closer to Golborne than the 2013 proposed scheme for consultation. This option will have lower sustainability impacts and be further away from the Grade II* listed Lightshaw Hall, Abram Flashes SSSI and the Leeds and Liverpool Canal. This option would also be further from Slag Lane abstraction borehole.
Maintenance loops at Golborne	Provision of maintenance loops in the vicinity of Golborne (without provision for an RSD).	An option was adopted which would include the provision for maintenance loops. This would take the route closer to Lowton but further from the Grade II* listed Lightshaw Hall, Abram Flashes SSSI, Leeds and Liverpool Canal and Slag Lane abstraction borehole. However, since this refinement and, as a result of further design development, the maintenance loop at Golborne is no longer required.
Manchester Airport vicinity	Reduce impacts on the local environment in proximity to Tatton Park, Ashley, Rostherne Mere and Manchester Airport.	The 2013 proposed scheme for consultation was maintained as the preferred option on the basis that the alternative options would have similar or greater impacts on the local environment or have greater construction complexity and cost.
Manchester Piccadilly High Speed station and approaches	Refinement of the proposed high speed station and approach with the aim of improving engineering and operational arrangements. Review of the demolitions of a block of 47 residential	An option was adopted whereby the tunnel portal would be located approximately 500m further north within the Ardwick depot, when compared to the 2013 proposed scheme for consultation. It would therefore be further away from West Gorton, the associated Corn Brook flood plain, West Gorton major development site and a cluster of residential demolitions. This option would also provide an improved engineering arrangement and operational performance of trains.

Location	Concern or proposal considered	Project response
	properties on Chapeltown Street.	

11.4 Local alternatives considered in 2015/2016

11.4.1 HS2 Ltd considered a number of further refinements in 2015/2016 in response to updated design principles and to address comments arising from consultation and ongoing engagement. These alternatives were considered against the scheme as amended following public consultation from July 2013 to January 2014 (which is referred to as the baseline in this section). These alternatives for the Phase 2b Western Leg are detailed in Table 7.

Table 7: Main reasonable local alternatives considered in 2015/2016 for the Phase 2b Western Leg prior to the July 2017 preferred route announcement

Location	Concern or proposal considered	Project response
Crewe tunnel northern portal (further refinement)	Review the length of the tunnel under Crewe following changes in design requirements and improve the crossing of the Fowle Brook.	An option was adopted which would move the northern tunnel portal approximately 265m further south, resulting in a shorter tunnel under Crewe. Whilst this option would have slightly greater noise and visual impacts, it would have lower flood risk associated with the crossing the Fowle Brook due to the tunnel surfacing in a different location.
Crewe north RSD (further refinement)	Sufficiency of the RSD footprint at Crewe north and junction layout.	An option was adopted that would provide capability to stable more trains. This would move the RSD junction further north to address operational issues, without bringing the HS2 WCML connection and RSD closer to Wimboldsley. The alternative option would be closer to and have greater visual impacts on Wimboldsley.
Manchester Airport station (further refinement)	Operational requirements and layout of Manchester Airport High Speed station.	An option was adopted whereby the high speed station footprint would include highway connections to the M56 junction 6 and A538 Hales Road. Both options would have broadly similar impacts and the same number of demolitions. Whilst the preferred option would have a direct impact on the Grade II listed Buckhall, it would allow for highway connections to the M56 and A538 Hales Road.
Manchester junction (further refinement)	Watercourse clearance at the delta junction between the HS2 WCML connection and the Manchester spur.	An option was adopted whereby the Manchester spur would pass over, rather than under, the HS2 WCML connection and Millington Clough. This would allow Millington Clough to be culverted under the spur rather than diverted as part of the alternative option, which would have a higher flood risk.
Northern chord (further refinement)	Requirement for the northern chord of the Manchester delta junction, following the decision to relocate the RSD from Golborne to Crewe north. N.B. The northern chord was proposed to facilitate the	The baseline with no northern chord was retained. As the RSD was no longer to be located at Golborne, the northern chord and junctions at different levels were not required. The alternative option would have resulted in greater visual impacts on users of the Bridgewater Canal, greater noise impacts and demolitions, together with more land from Hancock's Bank Ancient Woodland.

Location	Concern or proposal considered	Project response
	movement of rolling stock from Manchester Piccadilly to the previously proposed Golborne RSD.	
M56 crossing	Depth of cutting across the M56 and approaching the high speed station.	The baseline was retained with a shallower depth of cutting, but a recommendation was made to review the construction options and potential for lowering the route during the design development. Both options would require the demolition of the Grade II listed Buckhall but the alternative option would have greater impacts on the surrounding landscape.
Manchester Ship Canal (further refinement)	Viaduct span and height over the Manchester Ship Canal.	The baseline was retained because there was no significant improvement compared to the other options, but with the recommendation of reviewing the construction options and height of the route across the Manchester Ship Canal during the design development. The alternatives considered would have similar or slightly greater visual impacts.
Manchester Piccadilly High Speed station (further refinement)	Operational requirements and layout of the station.	An option with a similar operational layout to the baseline was adopted, but with a footprint across the Mancunian Way and Fairfield Street to take into consideration works for the reconfiguration of existing highways. There would be similar environmental impacts, although the preferred option would require more commercial demolitions when compared to the alternative option.

11.5 Local alternatives considered post 2016/2017 consultation

- 11.5.1 Following the period of public consultation between November 2016 and March 2017 on the Sustainability Statement including Post-Consultation Update Phase 2b and areas of the route where substantial changes had been made from the 2013 proposed scheme for consultation, HS2 Ltd conducted further refinements which sought to address specific consultee concerns raised during the consultation period. This included previous decisions made, taking into account the additional information received during the consultation and, in some sifting new route sections against the preferred scheme that was consulted on between November 2016 and March 2017. These alternatives for the Phase 2b Western Leg scheme are detailed in Table 8.

Table 8: Main reasonable local alternatives considered post 2016/2017 public consultation for the Phase 2b Western Leg

Location	Concern or proposal considered	Project response
Crewe north RSD	Revisited the previously discounted options at Golborne and Knutsford alongside brownfield	The RSD would remain at Crewe north as it is centrally located on the Western Leg and the site would meet the requirements of an RSD, including providing connectivity to the WCML. A review of brownfield

Environmental Statement

Volume 1

Location	Concern or proposal considered	Project response
	sites to ensure that the location north of Crewe remained the optimal solution.	<p>sites confirmed that there were no brownfield sites that met the requirements of the RSD on the current line of route.</p> <p>Moving the RSD away from Golborne would remove direct impacts on the Grade II* listed Lightshaw Hall and Grade II listed Byrom Hall as well as at Abram Flashes SSSI. There would also be substantially less infrastructure at the junction between the HS2 WCML connection and the spur into Manchester, including the northern chord and associated junctions.</p>
Middlewich to Pickmere (routes through salt mining areas)	Strategic review of all previous route options in this area in light of alternatives suggested during consultation.	<p>The route between Middlewich and Pickmere was recommended to remain as per the 2016 preferred route to Manchester and Leeds following a strategic review by HS2 Ltd of all previous route options discounted and new options proposed during consultation. This was because this route would have the least risk regarding the construction, operation and long-term maintenance of HS2 throughout this area. The route would avoid direct interfaces with brining and gas storage infrastructure and would be raised to allow for management of drainage and geological risk. There would also be more flexibility for ground stability mitigation options.</p> <p>The alternatives proposed during consultation (a route closer to the M6 corridor, a tunnel under Sandbach, alignment route east of Middlewich, and options to reduce line speed) were not recommended on the basis of environmental impacts, construction complexity, cost and/or operational considerations.</p>
Manchester Piccadilly Station approach	Review of previously considered refinements for the approach to Manchester Piccadilly High Speed station and an alternative tunnel alignment.	<p>The tunnel alignment and approach into Manchester Piccadilly Station was recommended to remain as per the 2016 preferred route to Manchester and Leeds following the review of previously considered route alignments. This was the optimal approach into Manchester Piccadilly based on environmental, construction and operational considerations. The route would have lower risk of flooding at Corn Book floodplain, avoid a number of residential demolitions, a development site and community impacts at a primary school at West Gorton and have a lower impact on existing structures at Manchester Piccadilly Station.</p>

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