



High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 3: Route-wide effects



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Department for Transport

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

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

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Preface

The Environmental Statement

This document is Volume 3 of the Environmental Statement (ES) that accompanies the deposit of the hybrid Bill for Phase 2a of High Speed Two (HS2). Phase 2a comprises the second section of the proposed HS2 rail network, between the West Midlands and Crewe, and is referred to in this ES as the 'Proposed Scheme'. The ES sets out the Proposed Scheme, its likely significant environmental effects and the measures proposed to mitigate those effects.

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

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

Consultation on the Environmental Statement

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

Structure of the Environmental Statement

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

The ES documentation comprises the following:

Non-technical summary

This provides:

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

Glossary of terms and list of abbreviations

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

Volume 1: Introduction and methodology

This provides:

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

Volume 2: Community area reports and map books

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

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

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

Volume 3: Route-wide effects

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

Volume 4: Off-route effects

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

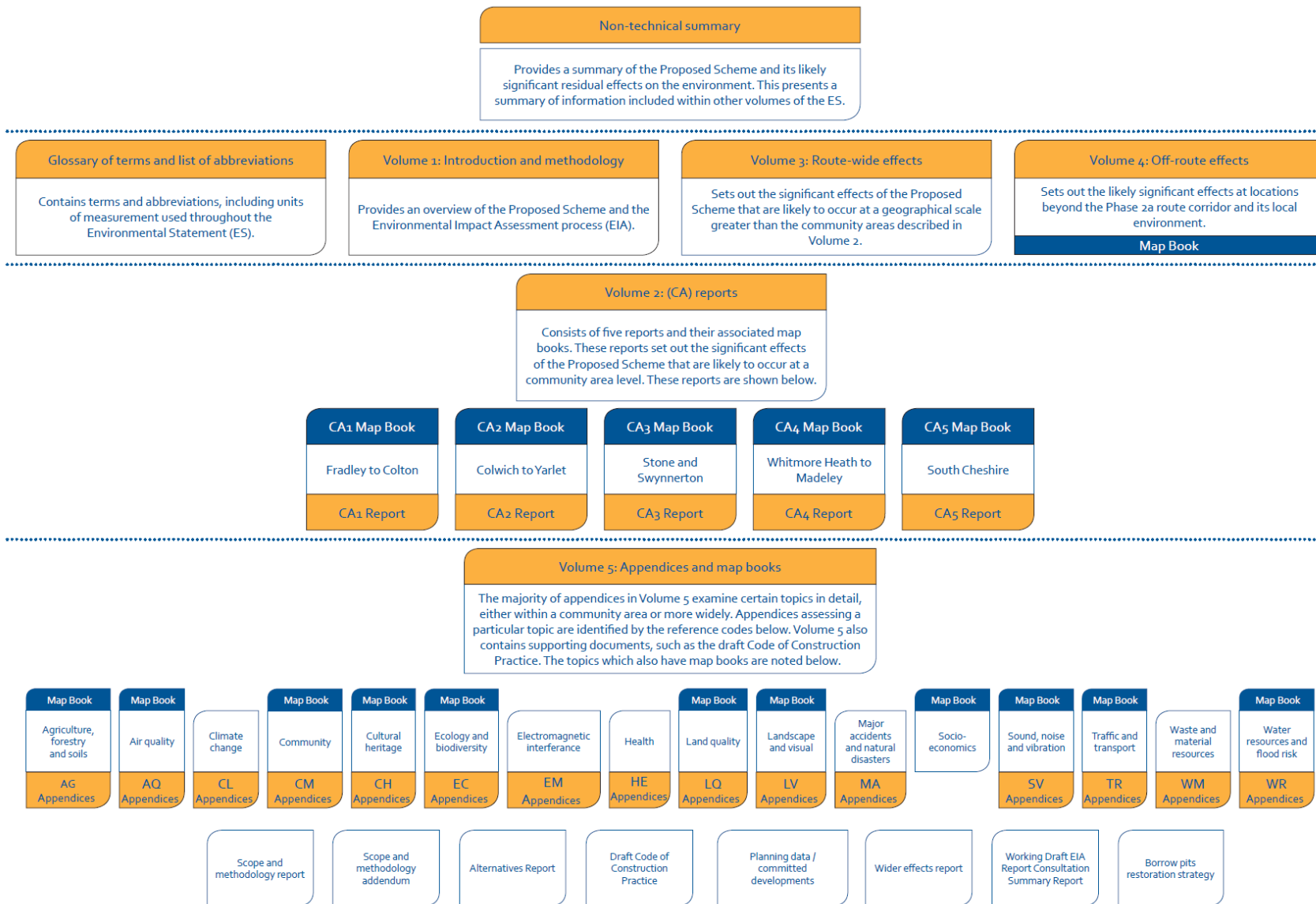
Volume 5: Appendices and map books

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

Background information and data (BID)

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

Figure 1: Structure of the Environment Statement



1 Introduction

1.1 Introduction to HS2

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. Stations in London, Birmingham, Leeds, Manchester and East Midlands and will be served by high speed trains running at speeds of up to 225mph (360kph). Trains will also run beyond the HS2 network to serve destinations including South Yorkshire, Liverpool, Glasgow, Edinburgh, Newcastle and York. The proposed HS2 network including the Phase 2a route between the West Midlands and Crewe is shown in Figure 2.

1.1.2 HS2 will be built in phases. Phase One comprises the first section of the HS2 rail network of approximately 143 miles (230km) between London, Birmingham and the West Midlands and is planned to become operational in 2026. It was the subject of an Environmental Statement (ES) deposited with the High Speed Rail (London–West Midlands) Bill in 2013. Subsequent ESs were deposited with Additional Provisions to that Bill in 2014 and 2015. The High Speed Rail (London–West Midlands) Bill achieved Royal Assent in February 2017 and initial works on Phase One have commenced.

1.1.3 Phase Two of HS2 will extend the line to the north-west and north-east: to Manchester, with connections to the West Coast Main Line (WCML) at Crewe and Golborne; and to Leeds with a connection to the East Coast Main Line approaching York completing what is known as the ‘Y network’.

1.1.4 Phase Two will be constructed in two phases:

- Phase 2a (the Proposed Scheme): the western section of Phase Two between the West Midlands and Crewe, comprising approximately 36 miles (58km) of HS2 main line (including the section which would connect with and form the first part of Phase 2b) and two spurs (approximately 4 miles (6km) south of Crewe that will allow trains to transfer between the HS2 main line and the existing WCML. Construction of the Proposed Scheme will commence in 2020, ahead of the rest of Phase Two, with operation planned to start in 2027, six years earlier than originally planned bringing more of the benefits of HS2 to the North sooner; and
- Phase 2b: comprising the remainder of Phase Two, between Crewe (where it would connect with the Proposed Scheme) and Manchester, and between the West Midlands and Leeds. Phase 2b will be the subject of a separate hybrid Bill with construction expected to commence in 2023 and operation planned to start by 2033.

1.1.5 The Proposed Scheme will connect with Phase One at Fradley, to the north-east of Lichfield, and connect to the WCML south of Crewe, to provide onward services beyond the HS2 network, and between the north-west of England and Scotland.

1.1.6 Section 4 of Volume 1 describes the interfaces with Phase One and the rest of Phase Two; the proposal for a new ‘Crewe Hub’ railway station (although this does not form

part of the Proposed Scheme); and the anticipated services and operational characteristics of the Proposed Scheme.

- 1.1.7 Phase One and Phase 2b are not the subject of this ES. However, the cumulative effects of the construction and operation of Phase One and Phase 2a have been assessed and reported in the Volume 2: Community area 1, Fradley to Colton and in the relevant sections of this report. The potential combined impacts of Phase One, Phase 2a and Phase 2b have been considered and are set out in Section 17 of this report.
- 1.1.8 For the purposes of environmental assessment and community engagement, the Proposed Scheme has been divided into five community areas. These are shown in Figure 3.

1.2 Purpose of this report

- 1.2.1 This volume of the ES presents the likely significant effects of the construction and operation of the Proposed Scheme on the environment that have been identified on a route-wide basis. The report also describes the means to avoid, prevent or reduce the likely significant adverse route-wide effects of the Proposed Scheme on the environment, along with any proposed monitoring measures.
- 1.2.2 The Proposed Scheme has been the subject of an environmental impact assessment (EIA). During the development of the Phase 2a proposals, a working draft EIA Report was consulted on to help inform the design and assessment of the Proposed Scheme.
- 1.2.3 The findings of the assessment of the Proposed Scheme are reported in an Environmental Statement (the ES), of which this Volume 3 report forms a part. The ES has been deposited alongside a hybrid Bill for Phase 2a, in accordance with the requirements of Parliamentary Standing Order 27A (SO27A)^{1,2}.
- 1.2.4 This report should be read in conjunction with the Volume 2 community area 1–5 reports and their corresponding map books. The community area reports present the elements of the Proposed Scheme and local alternatives studied within each area of the Phase 2a route. They also identify the likely significant environmental effects of the construction and operation of the Proposed Scheme, as well as any monitoring and mitigation measures, as appropriate to the respective area of study.

¹ Standing Order 27A of the Standing Orders of the House of Commons relating to private business (environmental assessment) - 2015, House of Commons.

² Standing Orders of the House of Lords - Private Business – 2015, House of Lords.

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Figure 2: The HS2 Core Network

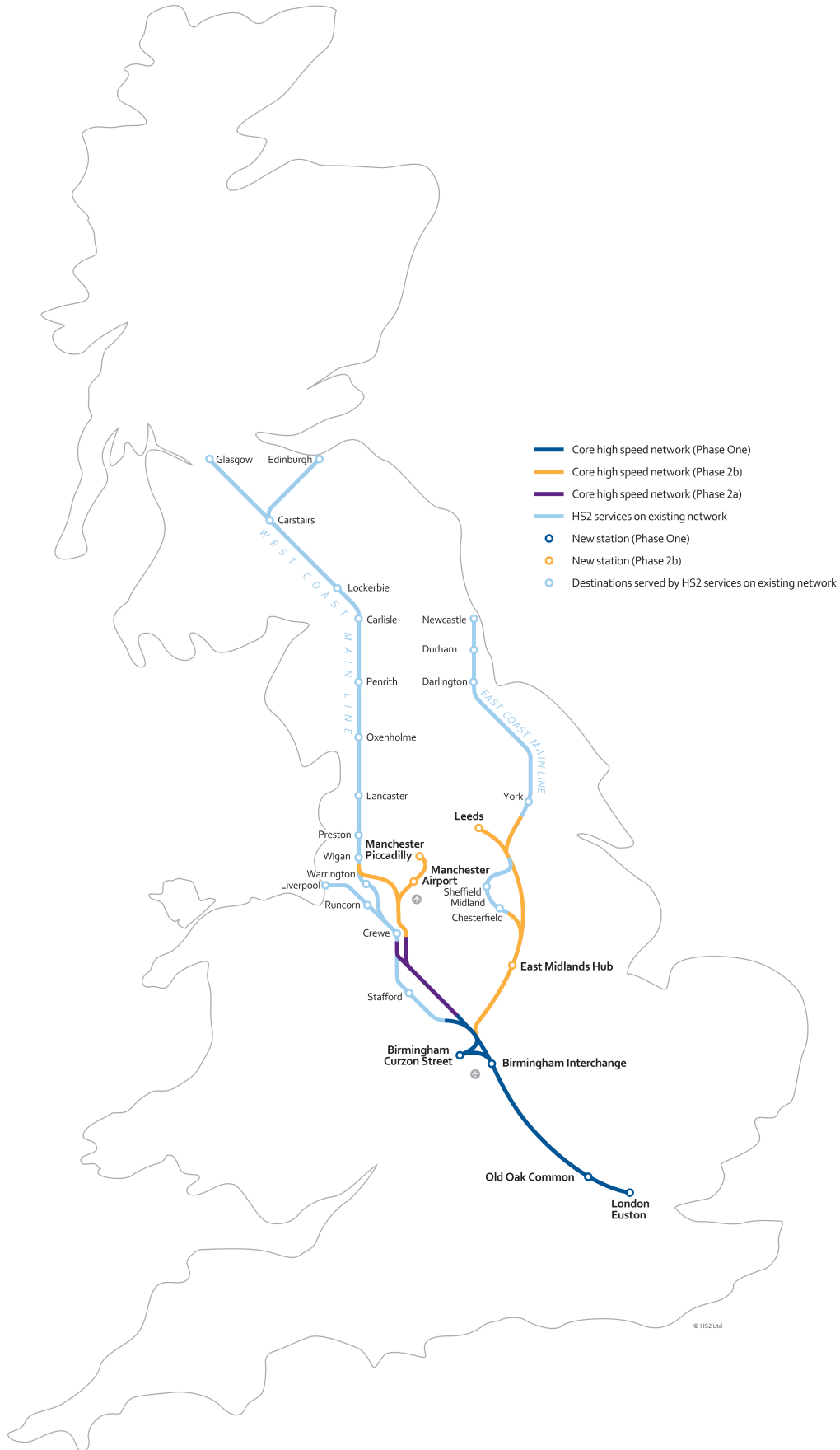
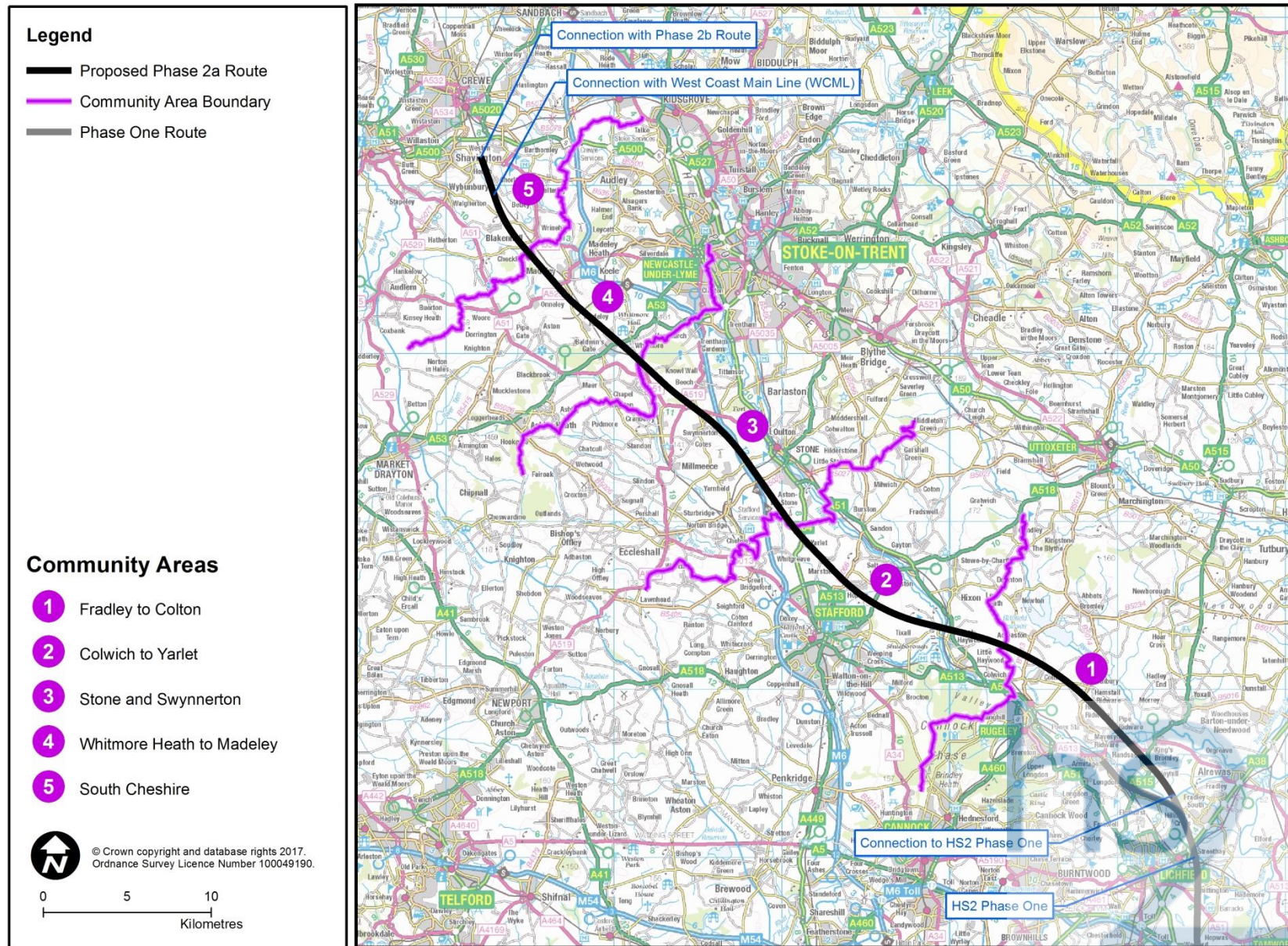


Figure 3: The HS2 Phase 2a route and community areas



1.3 Scope of this report

1.3.1 The effects reported in this volume are those considered to be appropriately assessed at a geographical scale greater than that presented within the Volume 2 community area reports. These include:

- overall effects on the agricultural, forestry and soil resource;
- effects relating to climate change;
- effects on ecological resources of greater than local importance and on protected species;
- route-wide effects on health;
- landscape and visual effects where there is the potential for these to occur at a geographical scale greater than the community areas. This includes an assessment on the special qualities of Cannock Chase Area of Outstanding Natural Beauty (AONB);
- effects resulting from major accidents and natural disasters;
- overall socio-economic effects;
- route-wide traffic and transport effects;
- effects associated with the off-site disposal to landfill of solid waste during construction and operation; and
- route-wide effects on water resources and on flood risk.

1.3.2 Of these topics, effects on health and effects resulting from major accidents and natural disasters are new topics in this Volume 3 of the ES relative to those included in the Phase One ES. They have been included for assessment due to the requirements of the EIA Regulations³, as described in Volume 1.

1.3.3 In addition to the environmental topics covered in Sections 2 to 16 of this report, electromagnetic interference is addressed in Volume 1⁴.

1.3.4 An assessment of potential environmental effects beyond the Phase 2a route corridor and its associated local environment has also been undertaken and this 'off-route' assessment is reported in Volume 4.

1.3.5 Given that each environmental topic assesses effects in a different way appropriate to that topic, the approach to route-wide effects varies between topics. The extent and basis of the route-wide assessment presented in this report is, therefore, explained in each of the topic sections. The scope of each topic and the general approach to

³ *Town and Country Planning (Environmental Impact Assessment) Regulations 2017. SI 2017 No. 571.* Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/ukksi/2017/571/pdfs/ukxi_20170571_en.pdf

⁴ Volume 1 explains that potential electromagnetic effects can be designed out of the Proposed Scheme. Further explanation is provided in Volume 5: Appendix EM-001-000.

assessment for this ES is described in Volume 1 and the Scope and Methodology Report (SMR)⁵ and the SMR Addendum⁶.

1.4 Structure of this report

- 1.4.1 This report presents the route-wide effects for each topic in the same order as reported in the community area reports, while including three additional sections describing the effects relating to climate change, major accidents and natural disasters, and waste and material resources. Where there are not considered to be significant route-wide effects (i.e. air quality, community, cultural heritage, land quality, and sound, noise and vibration), the topic is introduced and reasons for this conclusion are presented. The report concludes with a section summarising the potential combined impacts of Phase One, Phase 2a and Phase 2b.
- 1.4.2 This report presents the likely significant effects of the construction and operation of the Proposed Scheme on the environment on a route-wide basis. The report also describes the means to avoid, prevent or reduce the likely significant adverse route-wide effects of the Proposed Scheme along with any proposed monitoring measures associated with both the construction and operational phases of the Proposed Scheme. The draft Code of Construction Practice (CoCP⁷) includes commitments to monitoring significant effects during construction. Operational monitoring measures specific to route-wide topics are presented within this report, where relevant.
- 1.4.3 This report is structured as follows:
- introduction (Section 1);
 - agriculture, forestry and soils (Section 2);
 - air quality (Section 3);
 - climate change (Section 4);
 - community (Section 5);
 - cultural heritage (Section 6);
 - ecology and biodiversity (Section 7);
 - health (Section 8);
 - land quality (Section 9);
 - landscape and visual (Section 10);
 - major accidents and natural disasters (Section 11);
 - socio-economics (Section 12);
 - sound, noise and vibration (Section 13);

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

⁶ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

⁷ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

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- traffic and transport (Section 14);
- waste and material resources (Section 15);
- water resources and flood risk (Section 16); and
- Phase One, Phase 2a and Phase 2b combined impacts (Section 17).

2 Agriculture, forestry and soils

2.1 Introduction

- 2.1.1 This section provides an assessment of the route-wide impacts and likely significant effects on agriculture, forestry⁸ and soils arising from the construction and operation of the Proposed Scheme. The impacts and likely significant effects on individual farm holdings are reported in the Volume 2 community area 1–5 reports.
- 2.1.2 At a national level, paragraph 109 of the National Planning Policy Framework (NPPF⁹) states that the planning system should contribute to and enhance the natural and local environment by protecting and enhancing soils, valued landscapes and geological conservation interests. It goes on to state that new and existing development should not contribute to unacceptable levels of soil pollution or other pollution.
- 2.1.3 Paragraph 112 of the NPPF advises that the economic and other benefits of the best and most versatile (BMV) agricultural land (Grades 1, 2 and 3a in the Agricultural Land Classification (ALC) system) should be taken into account in development decisions, and states that where significant development of agricultural land is demonstrated to be necessary, poorer quality land should be used in preference to higher quality land.
- 2.1.4 As reported in the Phase Two Sustainability Statement 2013¹⁰ and the Sustainability Report (West Midlands to Crewe)¹¹, efforts have been made during the route development and Appraisal of Sustainability (AoS) process to select a route alignment that avoids the highest quality agricultural land. However, this has not always been possible given the need to satisfy or balance a number of other important environmental and engineering considerations.

2.2 Assessment of the effects of construction

Temporary effects

- 2.2.1 The total area of agricultural land required during the construction of the Proposed Scheme, will amount to approximately 2,090ha, of which approximately 1,370ha (66%) will be BMV agricultural land. Approximately 720ha (34%) will be poorer quality agricultural land.
- 2.2.2 Adopting the methodology set out in the Scope and Methodology Report (SMR)¹² for assessing the significance of effect of the loss of agricultural land within the community areas would place BMV land as a resource of medium sensitivity (with 42% of farmland in England estimated to be of this quality). With respect to the Proposed

⁸ The assessment of forestry in this section relates to land being used for commercial forestry.

⁹ Department for Communities and Local Government (2012), National Planning Policy Framework. Available online at: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

¹⁰ High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond, Sustainability Statement Volume 1: main report of the Appraisal of Sustainability A report by Temple-ERM for HS2 Ltd. Available online at:

<https://www.gov.uk/government/publications/hs2-phase-two-consultation-sustainability-statement>

¹¹ Temple/RSK (2015), High Speed Rail: Preferred Route to Crewe, Sustainability Report Phase Two Post-Consultation Update: West Midlands to Crewe. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480667/Sustainability_Report_Phase_Two_Post-Consultation_Update_West_Midlands_Crewe.pdf

¹² Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

Scheme, this resource will be subject to an impact of high magnitude (with 66% of the agricultural land required for construction being BMV), giving rise to a major/moderate adverse effect, which will be significant.

- 2.2.3 The proportion of Grade 1 land required during the construction of the Proposed Scheme will be lower than the proportion of this grade in England (0.4% compared to a national figure of 2.7%). The proportion of Grade 2 land required will be slightly higher than that for England (22.8% compared to 18.8%), whilst the proportion of Subgrade 3a land required will be substantially higher than the national figure (42.5% compared to 20.7%). Within the BMV land category, the highest proportion of land required temporarily during the construction of the Proposed Scheme will be Subgrade 3a.
- 2.2.4 The requirement for a total of 1,370ha of BMV agricultural land during construction of the Proposed Scheme, representing 66% of the total agricultural land required, gives rise to a major/moderate adverse effect at the route-wide level which will be significant. However, the BMV land required during construction represents only a very small percentage (about 0.03%) of the total amount of BMV agricultural land in England and approximately 1% of the estimated BMV land in Staffordshire County and the former Crewe and Nantwich Borough Council area.
- 2.2.5 The agricultural land required temporarily only for construction of the Proposed Scheme, including that required for borrow pits, will be available for restoration to agricultural use. Where agricultural uses are to be resumed on land disturbed during the construction of the Proposed Scheme, the design objective is to avoid any reduction in long term capability, which would downgrade the quality of the disturbed land. This will be through the adoption of good practice techniques in handling, storing and reinstating soils on that land, as set out in the draft Code of Construction Practice (CoCP¹³) and Defra's Construction Code of Practice for the sustainable use of soils¹⁴. Restoration of agricultural land will be followed by a period of aftercare and monitoring, as appropriate. This will assist in minimising soil degradation, in line with the objectives of the Government's White Paper¹⁵, such that soils will continue to provide a varied range of important services and functions such as food production, carbon storage and climate regulation, water storage and filtration, flood management and support for biodiversity. Some permanently displaced soils may be used to restore land to agriculture or other uses with slightly deeper topsoil and subsoil layers, where appropriate. This could improve the quality of agricultural land locally, for example where droughty soils are limited by soil depth, and make the restored soils more resilient to the effects of climate change.

Permanent effects

- 2.2.6 The area of agricultural land required permanently for the Proposed Scheme, following construction and restoration to the agreed end use, will be approximately

¹³ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

¹⁴ Defra (2011), *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*. Available online at: <https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites>

¹⁵ HM Government (2011), *The Natural Choice; securing the value of nature*. Available online at: <https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature>

1,010ha, of which 700ha (or 69%) will be BMV land and 310ha (31%) will be poorer quality land.

- 2.2.7 As indicated for temporary effects, BMV land is assessed as a resource of medium sensitivity which will be subject to an impact of high magnitude (with 69% of the agricultural land permanently required being BMV). This will give rise to a major/moderate adverse effect, which will be significant.
- 2.2.8 The proportion of Grade 1 land required permanently will be lower than the proportion of this grade in England (0.3% compared to a national figure of 2.7%). The proportion of Grade 2 land required permanently will be slightly higher than that for England (23.3% compared to 18.8%), whilst the proportion of Subgrade 3a land required permanently will be substantially higher than the national figure (45.4% compared to 20.7%). It is apparent, therefore, that within the BMV land category, the highest proportion of land required permanently will be Subgrade 3a.
- 2.2.9 The permanent requirement for 700ha of BMV agricultural land, representing 69% of the agricultural land required permanently for the Proposed Scheme results in a major/moderate adverse effect at a route-wide level which will be significant. However the BMV land required permanently for the Proposed Scheme represents only a very small percentage (approximately 0.02%) of the BMV agricultural land in England and approximately 0.4% of the estimated BMV land in Staffordshire County and the former Crewe and Nantwich Borough Council area.
- 2.2.10 The permanent requirement for approximately 1,010ha of all grades of agricultural land represents about 0.01% of the utilised agricultural land in England.
- 2.2.11 An area of approximately 76ha of woodland will be required permanently for the Proposed Scheme, of which approximately 20% is commercially managed forestry land. The loss of woodland represents less than 6% of the total permanent land requirements for the Proposed Scheme. Adopting the methodology set out in the SMR for assessing the significance of effect of the loss of forestry land within the community areas, this is assessed as an impact of low magnitude in land use terms.
- 2.2.12 Woodland is assessed as a resource of medium sensitivity in land use terms, with 9% of land within a 4km corridor along the Proposed Scheme being woodland, which is slightly lower than the national average (10%). Details of the area and type of woodland within the local area and the area and type of woodland required permanently for the Proposed Scheme are given in Volume 5: Appendix AG-001-001 to AG-001-005. This gives rise to a minor adverse effect on woodland, which is not significant in quantitative land use terms, and in terms of the agriculture, forestry and soils assessment. The qualitative assessment of loss of native woodland is addressed in Section 7, Ecology and biodiversity.

2.3 Assessment of effects during operation

- 2.3.1 It is considered that during the operation of the Proposed Scheme there will be no significant effects on agricultural activities at a route-wide level.
- 2.3.2 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

3 Air quality

3.1 Introduction

- 3.1.1 This section provides an assessment of the route-wide impacts and likely significant effects on air quality arising from the construction and operation of the Proposed Scheme.

3.2 Assessment of effects during construction

- 3.2.1 Air quality impacts from construction activities could arise from two sources: directly from the construction sites; and indirectly from changes in the volume, composition and location of traffic on the highway network.
- 3.2.2 The main air pollutant emitted from construction sites is dust, since emissions from the engines of construction equipment are anticipated to have a negligible effect off-site. Construction dust potentially can be carried a few hundred metres from construction sites. However, dust generation from the Proposed Scheme will be strictly controlled by application of best practice measures set out in the draft Code of Construction Practice (CoCP¹⁶). The result will be that significant effects from dust are not likely to occur at properties and other receptors outside the construction sites.
- 3.2.3 The emissions from fixed sources and vehicle movements within the construction sites will be relatively small in comparison to existing local emissions from fixed sources and highway traffic, and are unlikely to cause a significant impact. Implementation of measures set out in the draft CoCP will enable these activities to be controlled such that the off-site effects on air quality from the engines of construction equipment are likely to be negligible.
- 3.2.4 Construction traffic and changes in the volume and location of traffic on the highway network will result in effects further away from the construction sites. The geographic extent of these effects is assessed within the Volume 2, community area 1–5 reports and, where necessary, the Volume 4, Off-route effects. It is not predicted that there will be significant air quality effects on a route-wide basis associated with construction of the Proposed Scheme.

3.3 Assessment of effects during operation

- 3.3.1 There will be no route-wide air quality impacts arising directly from the operation of the trains on the completed high speed railway.
- 3.3.2 As described in the Scope and Methodology Report (SMR)¹⁷ and the SMR Addendum¹⁸ there will be no direct atmospheric emissions from the operation of trains that will cause an impact on air quality and therefore was scoped out of the assessment. Indirect emissions from sources such as rail and brake wear have been assumed to be negligible.

¹⁶ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

¹⁷ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

¹⁸ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

- 3.3.3 The Department for Transport (DfT) has provided estimates for nitrogen oxides (NO_x) emissions per passenger kilometre in 2030 from a range of travel sectors. As shown in Table 1, HS2 trains are estimated to have significantly lower emission rates than each of the other travel sectors. The HS2 emissions arise indirectly from the power stations supplying the electricity grid.

Table 1: DfT estimates of grams of NO_x emissions per passenger kilometre per travel sector in 2030^{19,20}

Sector	NO _x emissions per passenger km (2030)
Intercity rail	0.180
All domestic flights	0.749
Domestic flights/to from London	0.605
Inter-urban car journeys	0.140
HS2	0.031

- 3.3.4 The operation of the Proposed Scheme will result in local changes in road traffic location and volume, which may have an impact on air quality in some locations along the route as recorded within the relevant Volume 2, community area 1–5 reports. It is not considered that there will be any significant air quality effects on a route-wide basis arising from these changes during the operation of the Proposed Scheme.
- 3.3.5 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

¹⁹ Aviation emissions of NO_x, from aircraft operating at altitude, are dispersed over a wider area than ground level emissions, so have less of an impact on local concentrations of air pollutants than road emissions which mainly affect concentrations at the roadside.

²⁰ Source of data: HS2 Ltd (2013), *London-West Midlands Environmental Statement. Volume 3. Route-wide effects*. Available online at: <https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-3-route-wide-effects>. Original source of data: Department for Transport. Confirmed by Department for Transport in 2017 as being valid for this assessment.

4 Climate change

4.1 Introduction

4.1.1 This section of the report presents the three route-wide assessments undertaken within the climate change topic:

- the greenhouse gases (GHG) assessment;
- the in-combination climate change impacts assessment; and
- the climate change resilience assessment.

4.1.2 The GHG assessment quantifies and reports the GHG emissions associated with construction and operation of the Proposed Scheme in the form of the 'carbon footprint'. A carbon footprint is the total GHG emissions associated with a particular scheme, policy or development. The GHG emissions are converted into tonnes of carbon dioxide equivalent (tCO₂e) which standardises the global warming potential of the main GHG²¹ into one index based on the global warming potential of carbon dioxide (CO₂). Hereafter the term carbon is used to refer to the combined GHG emissions.

4.1.3 The in-combination climate change impacts assessment considers the combined effect of the Proposed Scheme and potential climate change impacts on the receiving environment during construction and operation²².

4.1.4 The climate change resilience assessment considers potential climate change impacts on the design, construction and operation of the Proposed Scheme's infrastructure and assets over their lifetime.

4.1.5 As stated in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) Synthesis Report²³, mitigation (i.e. reducing carbon emissions) and adaptation (i.e. responding to climate change impacts) are complementary approaches to reducing risks of climate change impacts over different timescales. Mitigation, in the short-term and medium-term, can substantially reduce climate change impacts in the latter decades of the 21st century. Benefits from adaptation can be realised now to address current risks, and can be realised in the future to address emerging risks. Innovation and investments in environmentally sound infrastructure and technologies can both reduce carbon emissions and enhance resilience to climate change.

²¹ The seven main GHGs are: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃). Source: National Atmospheric Emissions Inventory (2017), Overview of greenhouse gases. Available online at: <http://naei.defra.gov.uk/overview/ghg-overview>

²² The term in-combination climate change impacts refers to the combined effect of the impacts of the Proposed Scheme and potential climate change impacts on the receiving environment. It is not to be confused with the EIA terms 'combined effects' or 'cumulative effects'. The term 'potential climate change impacts' is not to be confused with the EIA term 'future predicted baseline'.

²³ Intergovernmental Panel on Climate Change (IPCC), 2014: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available online at: http://ar5-syr.ipcc.ch/topic_summary.php

4.2 Greenhouse gases assessment

Legal and policy framework

International level

- 4.2.1 IPCC AR5²⁴, published in September 2013, strengthened its statement on human influence being the dominant cause of the observed global average temperature increases from very likely (>90% certain) in the previous assessment report (Fourth Assessment Report (AR₄)²⁵) to extremely likely (95–100% certain).
- 4.2.2 The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)²⁶, adopted in 1997, provided legally binding limits on carbon emissions for 37 Annex 1 countries (of which the UK is one). The Protocol's first commitment period started in 2008 and ended in 2012; the 37 Annex 1 countries committed to reduce carbon emissions to an average of 5% below 1990 levels. The second commitment period began in 2013 and will end in 2020; parties have committed to reduce carbon emissions by at least 18% below 1990 levels²⁷.
- 4.2.3 In December 2015, a global climate agreement—the Paris Agreement²⁸—was adopted at the 21st Conference of the Parties (COP21). A central aim of the Paris Agreement is to strengthen the global response to climate change by limiting the global temperature increase this century to below 2 degrees Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. To achieve this aim, the Paris Agreement additionally sets a target for net zero²⁹ global carbon emissions in the second half of this century. The Paris Agreement was ratified and entered into force in November 2016.

European level

- 4.2.4 Under the Kyoto Protocol's second commitment period of 2013–2020, the collective European Union (EU) target is to reduce carbon emissions by 20% relative to 1990 levels³⁰.
- 4.2.5 In 2014 the EU agreed to collectively reduce carbon emissions by at least 40% by 2030 compared to 1990 levels³¹, this commitment was reaffirmed in the EU's Intended

²⁴ IPCC (2013) *Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available online at: <https://www.ipcc.ch/report/ars/wg1/>

²⁵ IPCC (2007) *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Available online at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html

²⁶ United Nations (1998), *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. Available online at: <http://unfccc.int/resource/docs/convkp/kpeng.pdf>

²⁷ United Nations (1998), *The Kyoto Protocol to the United Nations Framework Convention on Climate Change*. Available online at: http://unfccc.int/kyoto_protocol/items/2830.php

²⁸ United Nations (2015), *Paris Agreement*. Available online at:

https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

²⁹ Net-zero means 'a balance between anthropogenic emissions by sources and removals by sinks of carbon emissions in the second half of this century'. As sourced from Article 4 Paragraph 1 of United Nations (2015). Available online at:

https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

³⁰ European Commission (2013) *Ratification of the second commitment period of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder*. Available online at:

http://ec.europa.eu/clima/policies/international/negotiations/docs/com_2013_768_en.pdf

³¹ European Commission (2014) *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A policy framework for climate and energy in the period from 2020 to 2030*. Available online at:

<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN>

Nationally Determined Contribution (INDC)³² submitted as part of the Paris Agreement.

- 4.2.6 The EU emissions trading system (EU ETS)³³ is a cornerstone of the EU's policy to meet its carbon emissions reduction targets and is a key tool for reducing carbon emissions cost-effectively. The EU ETS is a cap-and-trade mechanism whereby a total amount of allowable annual carbon emissions for electricity generation, large energy-intensive industries (such as cement and steel production) and commercial flights within the EU (including Norway, Lichtenstein and Iceland) has been agreed at the EU level. Those installations covered by the cap are allowed to trade emission allowances³⁴ with one another.
- 4.2.7 The emissions cap for 2013 from all fixed installations (power stations and other activities excluding aviation) was set at 2,084,301,856 allowances (tCO₂e). During the third phase of EU ETS (2013–2020) the total number of allowances issued decreases by 1.74% annually, equivalent to 38,264,246 per annum³⁵. This will result in 21% lower emissions (within the cap) in 2020 than 2005. To achieve the target of cutting EU carbon emissions by 40% by 2030 compared to 1990 levels the annual factor to reduce the cap on the maximum permitted carbon emissions will be changed from 1.74% to 2.2% from 2021 onwards. This will reduce carbon emissions from fixed installations to around 43% below 2005 levels by 2030³⁶.
- 4.2.8 There has been a surplus in emission allowances since 2009, partially due to slow economic growth in the EU, resulting in low carbon prices and a weaker incentive to reduce emissions. The European Commission (EC) has tried to address this by postponing (or 'back-loading') the auction of 900 million allowances. This was followed by an agreement to establish a market stability reserve as of 2018³⁷. The 900 million allowances that were back-loaded in 2014–2016 will be transferred to the reserve rather than be auctioned in 2019–2020. Unallocated allowances will also be transferred to the reserve. The EC hopes these measures will help address the market imbalance of allowances. Efforts to address the market imbalance would also be helped by a faster reduction of the annual emissions cap. This is part of the EC proposal for the revision of the EU ETS³⁸.
- 4.2.9 For the sectors of the economy not regulated under the EU ETS³⁹ the EC presented, in July 2016, proposals for binding annual carbon emissions reduction targets for

³² Latvian Presidency (2015) *Intended Nationally Determined Contribution of the EU and its member states*. Available online at: <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Latvia/1/LV-03-06-EU%20INDC.pdf>

³³ European Commission (2017), *EU Emissions Trading System*. Available online at: https://ec.europa.eu/clima/policies/ets_en

³⁴ Net-zero means carbon emissions can continue but must be balanced by negative emissions technologies. These range from tree-planting through to technological solutions that draw carbon from the air, or bioenergy with carbon capture and storage (BECCS). Definition from Carbon Brief (2017), *Paris Summit 2015. 13 February 2015. Briefing: The 15 options for net-zero emissions in the Paris climate text*. Available online at: <https://www.carbonbrief.org/briefing-the-15-options-for-net-zero-emissions-in-the-paris-climate-text>

³⁵ European Commission (2013), *Ratification of the second commitment period of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder*. Available online at: http://ec.europa.eu/clima/policies/international/negotiations/docs/com_2013_768_en.pdf

³⁶ European Commission, (2014) *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A policy framework for climate and energy in the period from 2020 to 2030*. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN>

³⁷ European Commission (2017), *Structural reform of the EU ETS*. Available online at: http://ec.europa.eu/clima/policies/ets/reform/index_en.htm

³⁸ European Commission (2017), *Climate Action, EU Action, The EU Emissions Trading System (EU ETS), Revision for phase 4 (2021-2030)*. Available online at: http://ec.europa.eu/clima/policies/ets/revision/index_en.htm

³⁹ These sectors include buildings, agriculture, waste management and transport.

Member States for the period 2021–2030⁴⁰. The legislative proposal states that non-ETS sectors across Member States should reduce carbon emissions by 30% by 2030 compared to 2005⁴¹.

- 4.2.10 The 2011 European Commission White Paper Roadmap to a Single European Transport Area⁴² sets out a number of initiatives to build a transport sector that contributes to EU carbon emissions reduction targets. It states that transport policy must be resource and energy efficient. Its goal is 'to help establish a system that underpins European economic progress, enhances competitiveness and offers high quality mobility services while using resources more efficiently'. It also states that curbing mobility is not an option. For high speed rail, the objective by 2050 is to 'complete a European high-speed rail network, triple the length of the existing high-speed rail network by 2030 and maintain a dense railway network in all Member States. By 2050 the majority of medium-distance passenger transport should go by rail'.

National level

- 4.2.11 The Climate Change Act 2008⁴³ established a framework for the UK to achieve its long-term goals of reducing carbon emissions by at least 80% from 1990 levels by 2050. The Climate Change Act 2008 includes an interim target of at least a 34% reduction from 1990 levels by 2020. To ensure that regular progress is made towards the target, the Climate Change Act 2008 also established a system of carbon budgets. The first five carbon budgets, leading to 2032, have been set in law. Meeting the fourth (2023–27) and fifth (2028–2032) carbon budgets will require that carbon emissions are reduced by 50% (by 2025) and 57% (by 2030) respectively relative to 1990 levels. It is expected that the Government will publish a plan for meeting the legislated carbon budgets in the second half of 2017.
- 4.2.12 In October 2016—in anticipation of the ratification of the Paris Agreement—the Committee on Climate Change (CCC) considered the domestic actions the UK Government should take as part of a fair contribution to the aims of the Paris Agreement. The CCC concluded that 'The UK already has stretching targets to reduce greenhouse gas emissions'. Achieving them will be a positive contribution to global climate action. In line with the Paris Agreement, the Government has indicated it intends at some point to set a UK target for reducing domestic emissions to net zero. We have concluded it is too early to do so now, but setting such a target should be kept under review. The five-yearly cycle of pledges and reviews created by the Paris Agreement provides regular opportunities to consider increasing UK ambition⁴⁴.

⁴⁰ European Commission (2014), *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A policy framework for climate and energy in the period from 2020 to 2030*. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN>

⁴¹ The UK national target is to achieve a 37% reduction in non-ETS carbon emissions.

⁴² European Commission (2011), *White Paper Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system*. Available online at: [http://ec.europa.eu/transport/themes/strategies/doc/2011_white_paper/white_paper_com\(2011\)_144_en.pdf](http://ec.europa.eu/transport/themes/strategies/doc/2011_white_paper/white_paper_com(2011)_144_en.pdf)

⁴³ *Climate Change Act 2008*. Her Majesty's Stationary Office, London. Available online at: <http://www.legislation.gov.uk/ukpga/2008/27/contents>

⁴⁴ Committee on Climate Change (2016), *UK climate action following the Paris Agreement*. Available online at: <https://www.theccc.org.uk/wp-content/uploads/2016/10/UK-climate-action-following-the-Paris-Agreement-Committee-on-Climate-Change-October-2016.pdf>

- 4.2.13 The Construction 2025 Industrial Strategy⁴⁵ sets out a partnership approach between Government and the construction industry to 'become dramatically more sustainable through its efficient approach to delivering low carbon assets more quickly and at a lower cost, underpinned by strong, integrated supply chains'. By 2025, the construction industry and Government aspire to achieve a 50% reduction in carbon emissions in the built environment⁴⁶. This will be achieved through resource efficiency and adapting the built environment to deal with the effects of climate change, in particular, by developing plans to drive carbon out of the built environment, led by the Green Construction Board.

Scope, assumptions and limitations

- 4.2.14 As detailed in the Scope and Methodology Report (SMR)⁴⁷ and the SMR Addendum⁴⁸ the GHG assessment takes a life cycle assessment (LCA) approach consistent with the principles set out in BS EN 15978⁴⁹, BS EN 15804⁵⁰ and PAS 2080⁵¹ standards. The scope of the GHG assessment is outlined in Table 2.

Table 2: Scope of the GHG assessment

Life cycle stage	Inclusions	Exclusions
Before use stage	Product manufacturing Transport of construction materials from the factory gate to the construction site Construction processes	Preliminary desk-based studies Transport of construction plant equipment to and from site
Use stage	Carbon sequestration from tree planting Replacement Operation of infrastructure Operation of rolling stock	Maintenance Repairs Refurbishment Operational water use Other operational processes
End of life	N/A	End of life deconstruction, transport, waste processing and disposal
Benefits and loads beyond the system boundary	Benefits and loads associated with modal shift of passenger and freight journeys	N/A

⁴⁵ HM Government (2013), *Construction 2025 Industrial Strategy: government and industry in partnership*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf

⁴⁶ Green Construction Board (2013), *Low Carbon Route map for the Built Environment*. Available online at: <http://www.greenconstructionboard.org/otherdocs/Routemap%20ofinal%20report%2005032013.pdf>

⁴⁷ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

⁴⁸ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

⁴⁹ British Standards Institution (2011), *Sustainability of Construction Works – Assessment of environmental performance of buildings – Calculation method*. BSI Limited, London, UK.

⁵⁰ British Standards Institution (2012), *Sustainability of Construction Works – Environmental Products Declarations. Core Rules for the product category of construction products*. BSI Limited, London, UK.

⁵¹ Construction Leadership Council & the Green Construction Board (2016), *PAS 2080: 2016: Carbon Management in Infrastructure*. BSI Limited, London, UK.

- 4.2.15 The GHG assessment adopts a number of assumptions, which are detailed in the GHG Technical Note, included in the SMR Addendum. The GHG Technical Note also outlines the limitations of the GHG assessment.

Environmental baseline

- 4.2.16 An environmental baseline provides a reference point against which the impact of a new project can be compared. The existing and future environmental baselines for the Proposed Scheme are based on a 'without the Proposed Scheme' scenario.

Carbon footprint

- 4.2.17 Table 3 summarises the Proposed Scheme's carbon footprint. The carbon footprint has been quantified for construction as well as 60 year and 120 year operational periods to align with the economic case and assumed design life. The carbon footprint is based on a 'reasonable worst case scenario' whereby certain assumptions are made for key elements of the GHG 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 Government projections⁵².

Table 3: The Proposed Scheme's carbon footprint from construction and over 60 and 120 year operational periods

Work stage	Life cycle stage	Tonnes CO ₂ e	
		60 years	120 years
Construction	Before use stage	1,370,000	
Operation	Use stage ⁵³	141,000	315,000
	Benefits and loads beyond project boundaries ⁵⁴	-159,000	-307,000
	Total residual carbon emissions	1,352,000	1,378,000

- 4.2.18 The following sections detail the Proposed Scheme's carbon footprint, assessed over a 120 year operational period, by life cycle stage.

Before use stage emissions

Product manufacturing

- 4.2.19 Product manufacturing stage emissions are 666,000 tCO₂e for the Proposed Scheme, constituting 49% of the construction carbon emissions. Figure 4 presents the product

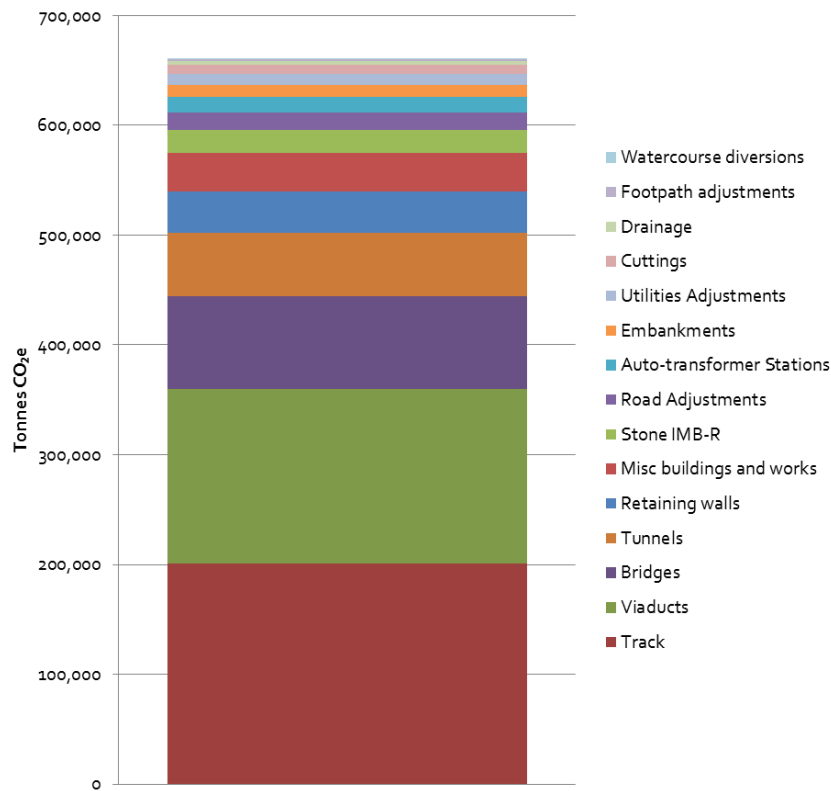
⁵² Full details of the GHG assessment assumptions are provided in the SMR and the SMR Addendum.

⁵³ The Use stage is a net carbon emission figure, which includes a carbon sequestration benefit from tree planting estimated to be -144,000 tCO₂e over 60 years and -174,000 tCO₂e over 120 years. Refer to GHG Technical Note contained within the SMR Addendum.

⁵⁴ The benefits and loads stage is the net carbon emission figure, which includes loads (i.e. increase in carbon emissions) from additional surface access journeys to access the Proposed Scheme, and benefits (i.e. reduction in carbon emissions) from freight and passenger modal shift.

manufacturing stage carbon emissions broken down by asset type. Notable contributions to total product manufacturing stage emissions are track⁵⁵ (28%), viaducts (24%), bridges (13%) and tunnels (8%).

Figure 4: The Proposed Scheme’s product manufacturing stage carbon emissions by asset type



Transport to work sites

4.2.20 Carbon emissions from the transport of construction material to construction compounds are 171,000 tCO₂e. This represents approximately 12% of the construction carbon emissions.

Construction and installation processes

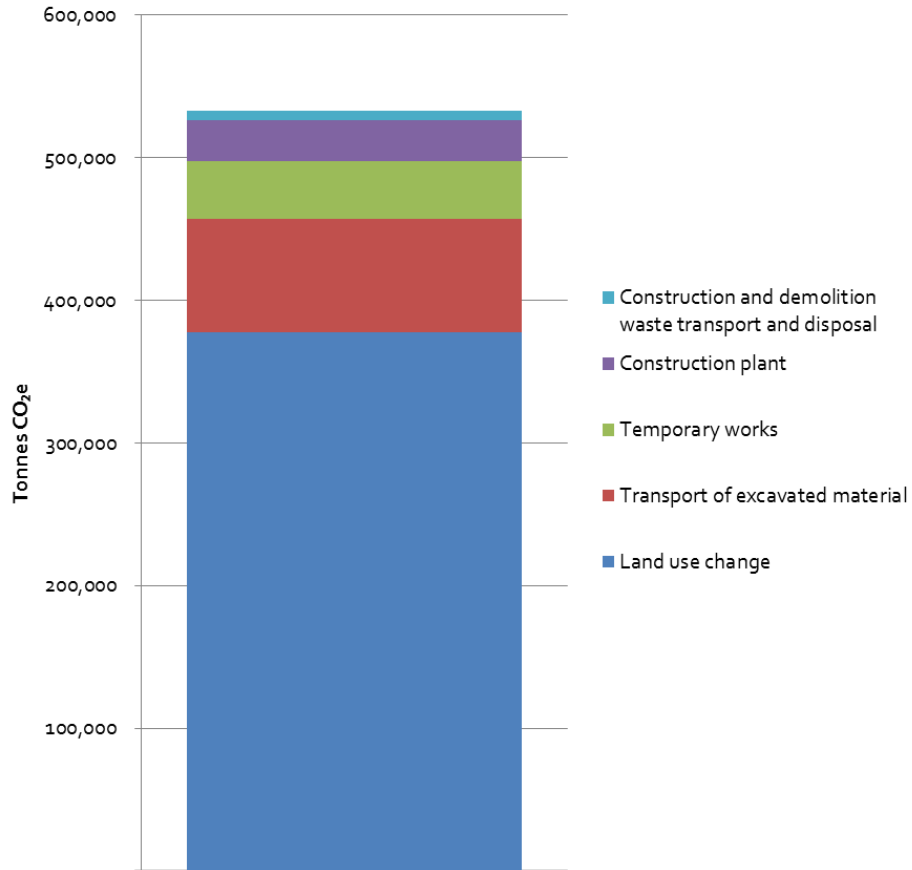
4.2.21 Carbon emissions from construction and installation processes are 533,000 tCO₂e. Figure 5 presents a breakdown of construction and installation process related carbon emissions by source. The majority, 378,000 tCO₂e (71%), result from the disturbance or permanent loss of carbon sinks (e.g. soil and trees) brought about by land use change during the construction process.

4.2.22 The transport of excavated material accounts for 15%, the remaining 14% of the total is associated with the transportation and disposal of construction and demolition waste, construction plant fuel use, and temporary works.

⁵⁵ Track includes the track structure as well as the overhead line equipment and communication/signalling assets.

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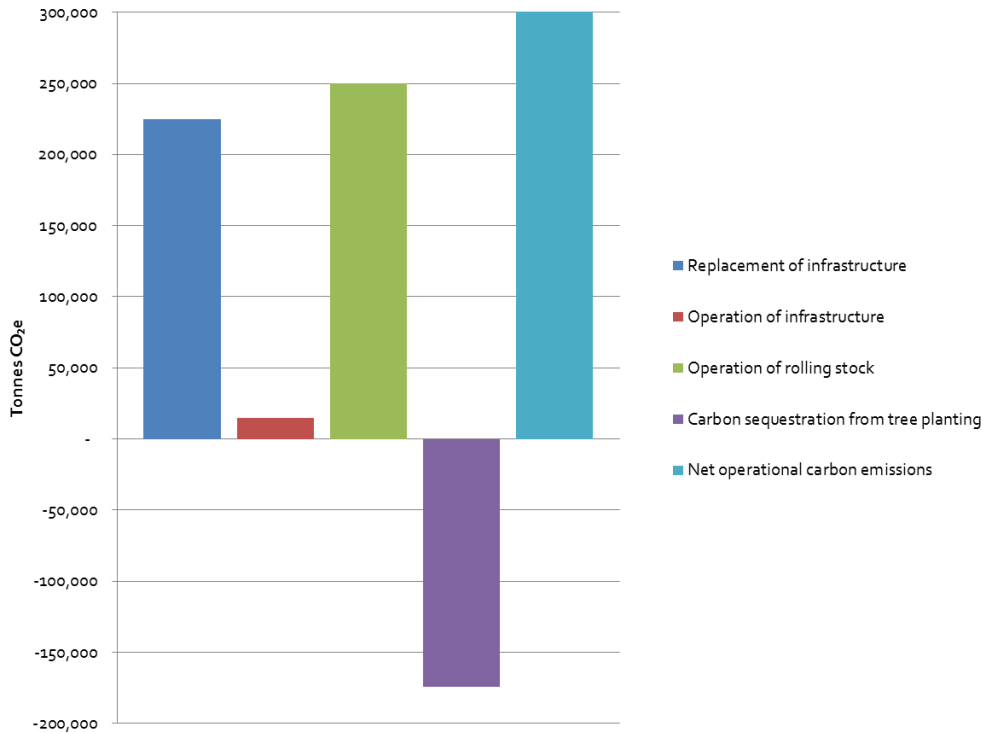
Figure 5: The Proposed Scheme's construction and installation processes stage carbon emissions by activity



Use stage emissions

4.2.23 Figure 6 presents the operational carbon emissions by life cycle stage including net operation carbon emissions.

Figure 6: Operational carbon emissions by life cycle stage



Carbon sequestration from tree planting

4.2.24 It is forecast that 174,000 tCO₂e will be sequestered by planted trees⁵⁶.

Replacement of infrastructure

4.2.25 The carbon emissions associated with replacement activities is estimated at 224,000 tCO₂e.

Operation of infrastructure

4.2.26 Carbon emissions associated with the operation of asset integrated systems (e.g. signalling and communications) are reported at 15,000 tCO₂e.

Operation of rolling stock

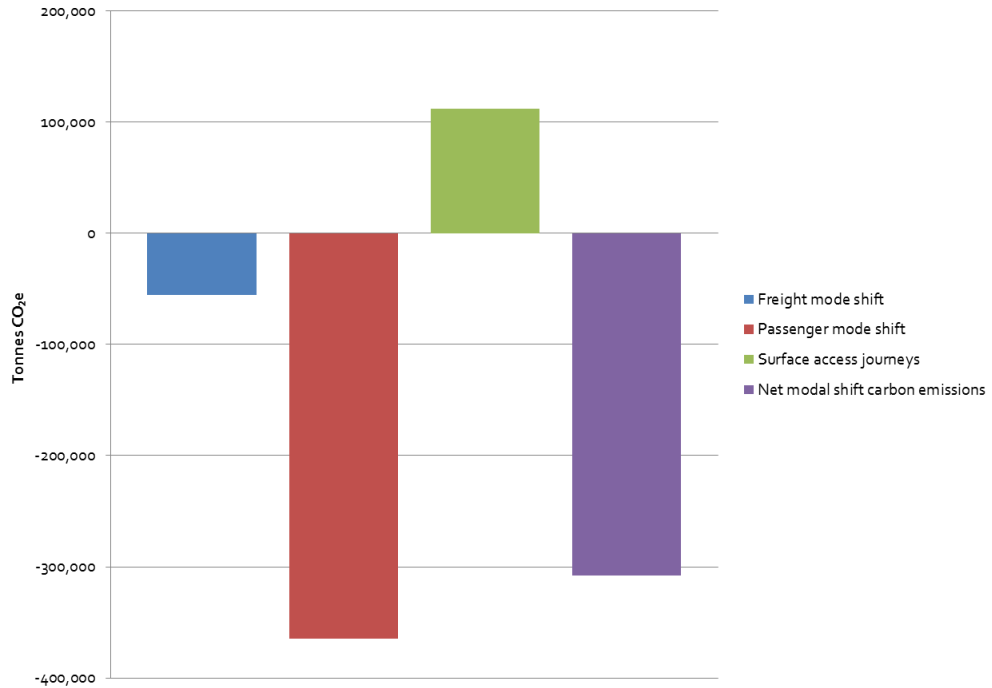
4.2.27 The largest contributor to the Proposed Scheme’s use stage carbon emissions is from the electricity required to operate the rolling stock. These are reported at 250,000 tCO₂e.

Benefits and loads beyond the project boundary

4.2.28 Figure 7 presents the carbon emissions breakdown for benefits and loads beyond the project boundary.

⁵⁶ Refer to GHG Technical Note contained within the SMR Addendum.

Figure 7: Benefits and loads carbon emissions breakdown



Benefits

4.2.29 The Proposed Scheme is expected to save 419,000 tCO₂e through modal shift. This includes road, rail and domestic air passengers switching to high speed rail (saving 364,000 tCO₂e) and road freight moving on to existing rail lines due to released capacity from the Proposed Scheme (saving 55,000 tCO₂e).

Loads

4.2.30 Carbon emissions associated with surface access journeys to access the Proposed Scheme are estimated at 112,000 tCO₂e.

Benchmarking

4.2.31 In order to better understand the carbon implications of the Proposed Scheme it is useful to benchmark and compare its performance against other transport modes, the wider construction sector and UK wide carbon emissions.

UK carbon targets and budgets

4.2.32 Table 4 compares Phase One and the Proposed Scheme’s construction carbon emissions to the UK’s combined third (2018–2022) and fourth (2023–2027) carbon budgets. Construction carbon emissions are expected to contribute 0.15% of the UK’s total carbon budget between 2018 and 2027.

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Table 4: Phase One and the Proposed Scheme's construction carbon emissions as a proportion of the third and fourth UK carbon budgets

	Carbon emissions
Combined third and fourth UK carbon budgets	4,494 MtCO ₂ e
Phase One and the Proposed Scheme's combined construction carbon footprint	6.96 MtCO ₂ e
Phase One and the Proposed Scheme's construction carbon emissions as a proportion of the third and fourth carbon budgets	0.15%

Construction sector comparison

- 4.2.34 The Green Construction Board (GCB)⁵⁷ forecasts that by 2026 UK construction carbon emissions will total 30.3 million tCO₂e. The Proposed Scheme's annualised construction carbon emissions account for less than 1% of the projected 2026 UK construction carbon emissions.

Transport sector comparisons

- 4.2.35 Opening year (2027) operational carbon emissions for the Proposed Scheme are estimated at 12,500 tCO₂e. This includes energy consumption from the rolling stock, non-traction energy and track maintenance. This is equivalent to less than 0.01% of all UK transport-related carbon emissions (107 MtCO₂e) projected by the Department for Business, Energy & Industrial Strategy⁵⁸ (BEIS) in 2027. Operational carbon emissions associated with the Proposed Scheme are expected to gradually decrease as the UK grid is decarbonised over time. This is reflected in the per passenger kilometre carbon emissions associated with the operation of the rolling stock. Table 5 shows how carbon emissions reduce from 13.64 grams of CO₂e per passenger km (gCO₂e/pkm) in 2027 (opening year) down to 2.93 gCO₂e/pkm by 2041 (full capacity) and 1.64 gCO₂e/pkm by 2087 (60 years after the opening year).

Table 5: The Proposed Scheme's projected carbon emissions per passenger kilometre (gCO₂e/pkm)

Year	2027	2041	2087
gCO ₂ e/pkm	13.64	2.93	1.64

- 4.2.36 Figure 8 benchmarks the Proposed Scheme's emissions per passenger kilometre against rail, road and air travel⁵⁹. In terms of emissions per passenger kilometre, the Proposed Scheme is 10 gCO₂e/pkm as compared to intercity rail⁶⁰ (22 gCO₂e/pkm);

⁵⁷ The Green Construction Board (2013) *Low Carbon Route map for the Built Environment*. Available online at:

<http://www.greenconstructionboard.org/otherdocs/Routemap%20ofinal%20report%2005032013.pdf>

⁵⁸ Department for Business, Energy & Industrial Strategy (2017), *Updated energy and emissions projections: 2016*. Annex A. Available online at:

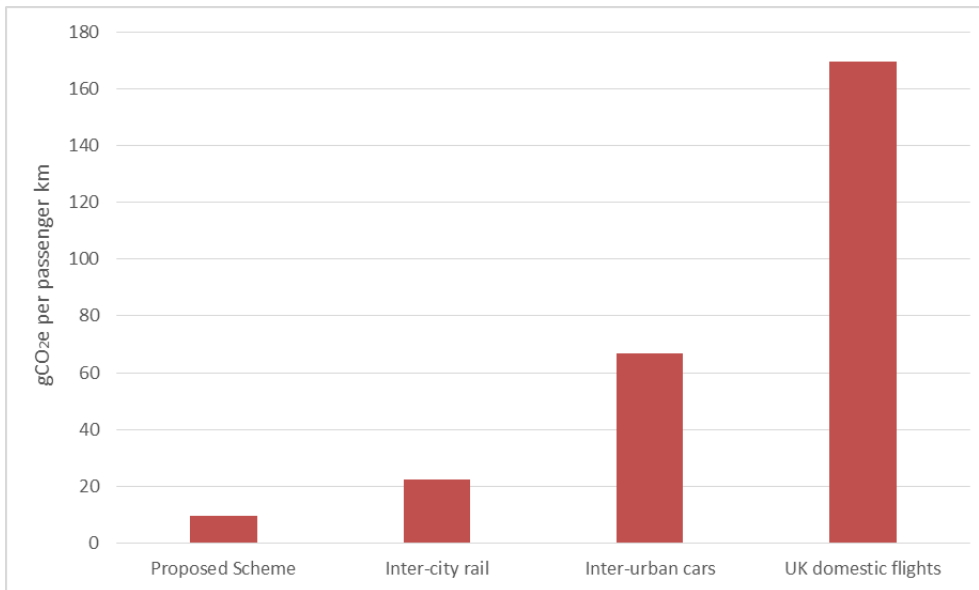
<https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2016>

⁵⁹ DfT (2013) Personal communication based on data from National Transport Model outputs consistent with Road Transport Forecasts 2013; Aviation model outputs consistent with UK Aviation Forecasts 2013, and Rail Emissions model outputs. Confirmed by Department for Transport in 2017 as being valid for this assessment.

⁶⁰ It should be noted that the intercity rail forecast is for the entire classic network, including the predicted mix of both diesel and electric trains in 2030.

inter-urban cars (67 gCO₂e/pkm); and UK domestic flights (170 gCO₂e/pkm), based on projected carbon emissions in 2030.

Figure 8: Carbon emissions per passenger kilometre by transport mode in 2030



Sensitivity analysis

4.2.37 The GHG assessment covers a long timescale and as such requires a number of assumptions to be made. This includes the rate of replacement of fossil fuel generation capacity with low carbon alternatives, the ability of the steel and cement industries to implement greater efficiencies and the rate of uptake of electric cars. It is acknowledged that the carbon footprint is sensitive to the assumptions adopted and that there is a level of uncertainty, particularly when projecting into the future. Accordingly, a series of alternative future scenarios, which are summarised below, have been assessed to illustrate the sensitivity of the Proposed Scheme’s carbon footprint.

Cement and steel

4.2.38 The majority of the construction carbon emissions are from the use of cement (a key constituent of concrete) and steel. The GHG assessment assumes no improvement in the carbon intensity of the production of cement and steel is achieved through time. However, the cement and steel industries are committed to reducing their carbon emissions (e.g. through the use of alternative fuels, innovation and investment in efficient plants)^{61, 62}. If the improvements in the carbon intensity of cement and steel production are achieved by 2050 the Proposed Scheme’s residual carbon footprint could decrease by 260,000 tCO₂e. This equates to a 19% decrease in overall net carbon emissions.

⁶¹ Mineral Products Association (2013) *The UK cement industry aims to reduce greenhouse gases by 81% by 2050*. Available online at: http://cement.mineralproducts.org/documents/MPA_Cement_2050_Strategy.pdf

⁶² The Boston Consulting Group (2013), *Steel’s Contribution to a Low-Carbon Europe 2050 – technical and economic analysis of the sector’s CO₂ abatement potential*.

Grid electricity

- 4.2.39 The Proposed Scheme's operational carbon emissions are dependent on energy consumption from the rolling stock and wider network combined with the carbon intensity of the UK grid itself (kgCO₂e per kWh). The GHG assessment assumes that the carbon intensity of UK grid electricity will reduce in line with Government grid decarbonisation projections⁶³—reaching 0.018kgCO₂e by 2050. However, the CCC recommends⁶⁴ that for the UK to meet its 2050 carbon target the UK grid needs to reach 0.001 kgCO₂e per kWh by 2050. If the rate and extent of decarbonisation of UK grid electricity as projected by the CCC is achieved the Proposed Scheme's residual carbon footprint could reduce by 219,000 tCO₂e. This equates to a 16% decrease in overall net carbon emissions.

Modal shift—increased uptake of electrical vehicles

- 4.2.40 In line with Government projections⁶⁵ the GHG assessment assumes that the road fleet share of Plug-in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (BEV) will increase from its current level (less than 1% of cars on UK roads are electric) to 35% by 2050.
- 4.2.41 However, the CCC recommends⁶⁶ that 30% of the UK's car fleet should be PHEV or BEV by 2030. It also re-iterates the need to completely decarbonise the transport sector, along with other sectors (e.g. energy), by 2050. This could be achieved in a number of different ways; one such way would be through more aggressive market penetration of PHEVs and BEVs reaching 100% by 2050. Under this scenario the Proposed Scheme's residual carbon footprint could increase by 100,000 tCO₂e. This equates to a 7% increase in overall net carbon emissions. This is because all electric cars will decarbonise at the same rate as the Proposed Scheme, hence the larger the UK's electric car fleet the lower the modal shift carbon benefit for the Proposed Scheme.

Approach to mitigation

- 4.2.42 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'⁶⁷. Through the calculation of the carbon footprint of the Proposed Scheme, opportunities will be identified to avoid carbon in the scheme design and reduce embedded carbon in construction materials and carbon emissions from construction works. Where reasonably practicable, the energy requirements of the Proposed Scheme will be reduced and energy efficiency of operations will be maximised. Low carbon energy will be used or generated insofar as reasonably practicable. Further opportunities for efficiencies would include:
- increased use of recycled materials (particularly steel);

⁶³ Department of Energy & Climate Change (2015), *DECC Updated Energy & Emissions Projections – November 2015*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/501265/Web_Figures_2015.xls

⁶⁴ Committee on Climate Change (2015), *The Fifth Carbon Budget – The next step towards a low-carbon economy*.

⁶⁵ Department for Transport (2017), *Fleet fuel efficiency model (FFEM) outputs*. Excel outputs issued in March 2017.

⁶⁶ Committee on Climate Change (2015), *Sectoral scenarios for the Fifth Carbon Budget – Technical Report*.

⁶⁷ HS2 Ltd (2017), *Environmental Policy*. Available online at: <https://www.gov.uk/government/publications/hs2-environmental-policy>

- use of less carbon intensive concrete blends;
- improved design and construction of rolling stock to reduce weight where possible;
- better management and control of non-traction (e.g. signalling, communications, lighting) energy usage;
- maximise management and reuse of excavated material in the construction process for landscaping and other mitigation measures;
- adoption of efficient logistics management for transport of construction materials and excavated material;
- maximise materials transport via rail rather than road;
- energy efficiency in site management and transport; and
- adoption of resource efficiency measures to tackle inefficiencies across supply chains, overuse of resources (e.g. materials, energy and water) and waste generation.

Conclusion

- 4.2.43 The significant passenger capacity of the Proposed Scheme, combined with its ability to draw power from an increasingly decarbonised national grid, means that it will be an effective low carbon transport solution for travel between the West Midlands and Crewe in 2030. In terms of emissions per passenger kilometre, the Proposed Scheme will emit 10 gCO₂e/pkm as compared to intercity rail (22 gCO₂e/pkm⁶⁸); interurban cars (67 gCO₂e/pkm); and UK domestic flights (170 gCO₂e/pkm), based on projected carbon emissions in 2030.
- 4.2.44 The carbon emissions associated with the construction of the Proposed Scheme are substantial, as might be expected from a national level infrastructure scheme. The construction carbon footprint is estimated to be 1,370,000 tCO₂e. The Proposed Scheme's operational emissions are anticipated to result in 8,000 tCO₂e over the 120 year operational assessment period, once modal shift, carbon sequestration from tree planting and freight benefits from released capacity on the conventional network is taken into account. When the operational and construction carbon footprints of the Proposed Scheme are combined, the residual carbon emissions are estimated to be 1,378,000 tCO₂e.
- 4.2.45 The operational and construction carbon footprints of the Proposed Scheme does not account for (i.e. subtract) the emissions associated with an alternative option to address the projected future transport infrastructure constraints between the West Midlands and Crewe.
- 4.2.46 The benchmarking of the Proposed Scheme's annualised construction emissions against the GCB's 2026 projected UK construction sector as a whole shows that the scheme's contribution is less than 1% of the projected 2026 total UK construction

⁶⁸ It should be noted that the intercity rail forecast is for the entire classic network, including the predicted mix of both diesel and electric trains in 2030.

carbon emissions. Operational carbon emissions are less than 0.01% of UK total transport emissions in 2027 (the Proposed Scheme's opening year). This is further reinforced when comparing both Phase One and the Proposed Scheme's construction emissions with the UK's third and fourth carbon budgets. Construction emissions are estimated to account for 0.15% of the UK's allocated carbon budget.

- 4.2.47 The EU ETS, a cap-and-trade system with a decreasing cap over time, is a significant policy tool available to the UK to meet its carbon reduction targets. The emissions of the UK's electricity generation sector used to power the Proposed Scheme are regulated by the EU ETS, as are EU cement and steel industries which are likely to be used in the construction of the Proposed Scheme. The carbon emissions associated with the construction and operation of the Proposed Scheme will therefore be largely regulated through the EU ETS. This means that, overall, most of Proposed Scheme's carbon emissions will not contribute to an increase in Europe-wide carbon emissions.
- 4.2.48 Additionally, carbon emissions from journeys currently (and in the future) made by road and classic diesel rail that are currently not traded within the EU ETS cap, which will shift to the Proposed Scheme, will become tradable within the EU ETS cap.
- 4.2.49 Carbon emissions not regulated by the EU ETS, predominantly from construction, will be managed through other policy tools as part of the Climate Change Act target of at least an 80% reduction in emissions by 2050. Nevertheless HS2 Ltd is committed to minimising insofar as is reasonably practicable carbon emissions both in the traded and non-traded sectors by implementation of its Environmental Policy.
- 4.2.50 It should be noted that HS2 Ltd cannot directly influence all of the elements that underpin the carbon footprint. Some of the elements of the carbon footprint are only influenced by Government, whilst others are related to the commercial decision of private companies, outside the direct control of both HS2 Ltd and the Government.

Monitoring

- 4.2.51 There currently is no specific guidance or carbon emissions threshold which if exceeded is considered significant. Nevertheless carbon emissions from relevant construction and operation activities will be monitored as outlined below.

Construction

- 4.2.52 The draft Code of Construction Practice (CoCP⁶⁹) requires that the nominated undertaker's lead contractors produce carbon management plans detailing 'the approach to energy and carbon dioxide (CO₂) monitoring and reporting from relevant site activities'.

Operation

- 4.2.53 Monitoring will be undertaken in accordance with PAS 2080 and HS2 Ltd's Environmental Management System (EMS) in line with HS2 Ltd's objective to minimise the scheme's carbon footprint as far as reasonably practicable. PAS 2080 expects all value chain members to adopt carbon reduction targets set at a minimum

⁶⁹ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

to align with the infrastructure asset owner/manager, which are monitored and communicated to other value chain members.

4.3 In-combination climate change impacts assessment

Legal and policy framework

International level

- 4.3.1 There is no relevant overarching international legislation or policies affecting in-combination climate change impacts assessment within the EIA process.

European level

The relevant European Directive for the in-combination climate change impacts assessment is EIA Directive 2014/52/EU⁷⁰ and the related EC Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment⁷¹.

National level

- 4.3.2 The relevant legislation and policies for the in-combination climate change impacts assessment at the national level are:

- the Climate Change Act 2008⁷² and within that the National Adaptation Programme⁷³ and Adaptation Reporting Power⁷⁴;
- the Environment Agency guidance on climate change allowances to be used in flood risk assessments as set out in the National Planning Policy Framework (NPPF⁷⁵); and
- NPPF Planning Practice Guidance (PPG) on climate change⁷⁶ which prioritises addressing climate change impacts in the planning and decision making process for major transport infrastructure projects.

Scope, assumptions and limitations

- 4.3.3 The technical scope of the in-combination climate change impacts assessment incorporated an initial assessment of potential climate change impacts during construction and operation for all environmental topics. This determined the

⁷⁰ Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052>

⁷¹ European Commission (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*. Available online at: <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf>

⁷² *Climate Change Act 2008*. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf

⁷³ Department for Environment, Food and Rural Affairs, (2013), *National Adaptation Programme – Making the Country Resilient to a Changing Climate*. Available at <https://www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme>

⁷⁴ Committee on Climate Change (undated), *UK Adaptation Policy*. Available online at: <https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-adaptation-policy/>

⁷⁵ Environment Agency (2016), *Guidance. Flood risk assessments: climate change allowances*. Available online at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

⁷⁶ Department for Communities and Local Government (2014), *Planning Practice Guidance. Climate change*. Available online at: <http://planningguidance.communities.gov.uk/blog/guidance/climate-change/why-is-it-important-for-planning-to-consider-climate-change/>

requirement for a more detailed assessment of significant in-combination climate change impacts and effects for relevant topics.

- 4.3.4 The spatial scope of the assessment was route-wide and included all five of the community areas which comprise the Proposed Scheme. The assessment took into account the study areas within which other topics are undertaking their own assessment of effects.
- 4.3.5 The temporal scope of the in-combination climate change impacts assessment considered '2020s' and the '2080s'⁷⁷. The '2020s' time period covers the effects of construction which is estimated to commence in 2020 and continue until 2026 including commissioning. The '2080s'⁷⁸ time period covers as much of the operational life (2027–2147) of the Proposed Scheme as the UKCP09 projections are available for.
- 4.3.6 For further detail on the scope of the in-combination climate change impacts assessment refer to Section 8 of the SMR and the SMR Addendum.
- 4.3.7 The assumptions which have informed the assessment are as follows:
- the assessment has assumed that mitigation measures for effects assessed by other topics will be implemented effectively; and
 - the measures set out in the draft CoCP will provide appropriate mitigation for extreme weather related effects during construction.
- 4.3.8 The limitations of the in-combination climate change impacts assessment are as follows:
- climate change uncertainty is not incorporated in the projections used;
 - the assessment was essentially qualitative with the exception of the assessment for flood risk and drainage design which was quantitative and took into account current Environment Agency climate change allowances for increases in peak river flow and rainfall intensity⁷⁹;
 - there is limited methodological guidance on in-combination climate change assessment from Government and other institutions; and
 - the evidence base relating to climate change impacts for some environmental topics (i.e. air quality and water resources) is limited due to material uncertainty in projections for specific climate variables.

Environmental baseline

- 4.3.9 This baseline section presents an overview of existing and projected future climate conditions, including extreme weather events relevant for the in-combination climate change impacts assessment. It is also relevant to the climate change resilience assessment and therefore is cross-referenced in Section 4.4.9.

⁷⁷ The '2020s' refers to the period between 2011 and 2039. The '2080s' refer to the period between 2071 and 2099.

⁷⁸ The operational life of HS2 is 120 years (i.e. from 2027 to 2147) but the climate change assessments only take into account climate change projections to the '2080s'. This is because UKCP09 projections data is only available up to the '2080s'.

⁷⁹ Environment Agency (2017), *Flood risk assessments: climate change allowances*. Available online at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Existing baseline

- 4.3.10 This section provides an overview of current climate and extreme weather events experienced in and around Fradley and Crewe. These locations are considered generally representative of the climatic conditions in the area in which the Proposed Scheme would be located. Four grid points centred on these locations at either end of the route were selected to obtain the baseline data. Met Office gridded observational data⁸⁰ has been used to obtain current baseline climate metrics at a spatial resolution of 5km.
- 4.3.11 The time period 1961–1990 has been considered for comparison with the baseline period used in UKCPog. The extreme weather events metrics were obtained using the UKCPog Weather Generator⁸¹. In line with UKCPog good practice⁸², a validation assessment was carried out to compare the UKCPog Weather Generator baseline data with observed data. The results of this assessment are contained in Volume 5: Appendix CL-001-000. The period 1961–2011 has been used to assess and identify possible trends in historical data. At the time of this assessment, these are the most up to date datasets and time periods available.
- 4.3.12 Overall the local climate in the region of the Proposed Scheme does not vary significantly between Fradley and Crewe, and similar values for the main climate characteristics are observed for both locations. The main differences are higher temperatures, lower annual and summer precipitation, a higher number of days with heavy rainfall and a higher number of dry spells in Fradley. The maximum difference between Fradley and Crewe is approximately 2°C in mean daily summer maximum temperature.
- 4.3.13 The current climate and extreme weather events experienced in the region (based upon the data obtained for Fradley and Crewe using the Met Office gridded baseline data⁸³ for average conditions and UKCPog Weather Generator⁸⁴ simulated baseline data for extreme weather events) can be summarised as follows:
- winter mean temperature is approximately 3.9°C and ranges from an average minimum and maximum temperature of 1°C to 6.2°C. Summer mean temperature is 15°C and ranges from 10°C to 19°C;
 - precipitation levels are similar in winter and summer at 1.9mm/day;
 - there are almost no days per year when mean temperature is above 25°C and there are approximately six frost days per year; and
 - there is an average of one day a year with 'heavy rain' (defined as precipitation greater than 25mm per day) and three dry spells (defined as 10 or more consecutive days with no precipitation, which are days with precipitation less

⁸⁰ Met Office (undated), *Climate monitoring, UKCPog: Available datasets*. Available online at:

<http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcpog/available/index.html>.

⁸¹ UK Climate Predictions (undated), *UKCPog Weather Generator*. Available online at: <http://ukclimateprojections.metoffice.gov.uk/23261>.

⁸² UK Climate Predictions (undated), *UKCPog Validation of Weather Generator outputs*. Available online at:

<http://ukclimateprojections.metoffice.gov.uk/media.jsp?mediaid=87941&filetype=pdf>.

⁸³ Met Office (undated), *Climate monitoring, UKCPog: Available datasets*. Available online at:

<http://www.metoffice.gov.uk/climatechange/science/monitoring/ukcpog/available/index.html>

⁸⁴ UK Climate Predictions (undated), *UKCPog Weather Generator*. Available online at: <http://ukclimateprojections.metoffice.gov.uk/23261>

than or equal to 0.2mm).

- 4.3.14 The results from the trend analysis showed that there is no conclusive trend (i.e. the projected changes include both potential increases and decreases) for any of the precipitation indicators assessed (mean precipitation, greatest single day precipitation and maximum number of consecutive dry days). However, there is a concurrent trend in all the temperature indicators (mean, maximum and minimum daily temperature). Overall the difference in mean, maximum, and minimum temperature between the period 1961–1986 and 1987–2011 is approximately 0.9°C.
- 4.3.15 Local Climate Impacts Profiles (LCLIPs) have been produced by Birmingham City Council (2008)⁸⁵ and Cheshire East Council (2010)⁸⁶ to gain an understanding of the nature of extreme weather events and the impact they have on the community, environment and economy. These two LCLIPs are the nearest representative locations to Fradley and Crewe and provide a list of the past extreme weather events that have had an impact in the region. For example, heavy rain and flash floods have in the past caused flooded drains, collapsed culverts and contamination, among other impacts. The types of weather impacts described in these LCLIPs, whilst localised, could potentially occur anywhere across the route of the Proposed Scheme.
- 4.3.16 The LCLIPs provide useful context about extreme weather events which currently occur, and may occur more frequently as a result of climate change, but the region has been subject to a number of extreme weather events since they were produced in 2010. The most recent of these was a 1-day duration heatwave, which occurred on 1 July 2015 affecting the whole of the UK, including the Midlands and north-west England⁸⁷. Whilst there is no official definition of a heatwave in the UK, the Met Office tend to use the World Meteorological Organization definition which is 'when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5°C, the normal period being 1961–1990'⁸⁸. However, shorter periods of hot weather relative to the expected conditions such as 1 July 2015 are in some cases also categorised as a heatwave by the Met Office.
- 4.3.17 Strategic and Preliminary Flood Risk Assessments for Staffordshire⁸⁹ identified notable flood events that occurred in October 2010 and in 2012 between June and November, which resulted in numerous local flooding issues across Staffordshire. Most recent anomalous temperature recordings include spring 2011, the warmest spring on record in the UK in the last 100 years, and in November and December in 2010 when the UK experienced two spells of severe winter weather with very low temperatures and significant snowfalls. Between 2010 and 2012, England experienced one of the 10 most significant droughts of one to two years duration in the last 100

⁸⁵ Kotecha, R., Thornes, J. and Chapman, L. (2008), *Birmingham's Local Climate Impacts Profile (LCLIP). Final Draft*. Available online at: www.bebirmingham.org.uk/uploads/LCLIP.pdf. University of Birmingham, BeBirmingham and Birmingham City Council.

⁸⁶ Cheshire East Council (undated), *Cheshire East Council Local Climate Impacts Profile*. Available online at: <https://www.whatdotheyknow.com/request/197245/response/490315/attach/3/Cheshire%20East%20LCLIP.pdf>

⁸⁷ Met Office (2015), Heatwave 1 July 2015. Available online at: <http://www.metoffice.gov.uk/climate/uk/interesting/july2015>

⁸⁸ Met Office (2016), Heatwave. Available online at: <http://www.metoffice.gov.uk/learning/learn-about-the-weather/weather-phenomena/heatwave>

⁸⁹ Staffordshire County Council (2011), *Staffordshire Preliminary Flood Risk Assessment*. Available online at: <http://webarchive.nationalarchives.gov.uk/20140328084622/http://cdn.environment-agency.gov.uk/flh01211bvro-e-e.pdf>

years⁹⁰. The drought resulted in low reservoir levels and hosepipe bans across north-west England affecting six million consumers.

Future baseline

- 4.3.18 As for the current climate conditions, climate change projections for Crewe are similar to those for Fradley. Climate change projections were obtained for the main climate variable characteristics for the medium and high emissions scenarios and the 10%, 50% and 90% probability levels from the UKCP09 projections⁹¹. Table 5 summarises the overall climate change trends obtained using UKCP09 projection data for changes in average conditions and the UKCP09 Weather Generator for changes in extreme weather events⁹². The data source for each metric is indicated in Table 6. The trends summarised represent the average of the projected changes for Fradley and Crewe. Data for the low emissions scenario has not been considered in line with the precautionary approach taken by the majority of organisations who submitted progress reports under the second round of the climate change adaptation reporting power⁹³. More detailed information on climate change projections for central estimate climate conditions and extreme weather events for the '2020s' and the '2080s' is set out in Volume 5: Appendix CL-001-000.

Table 6: Summary of main climate change trends for Fradley and Crewe and future extreme weather events

Climate variable characteristic (baseline value in brackets for period 1961–1990)	Overall trend (increase or decrease)	Quantitative summary—central estimate 2080s ⁹⁴		Qualitative summary
		Medium emissions scenario	High emissions scenario	
Winter mean temperature* (3.94°C)	↑	+2.7°C	+3.3°C	The largest increase in temperature is estimated to be in the daily mean temperature in summer, which is projected to increase from approximately 15.3°C to 19.3°C by the 2080s (high emissions scenario and 50% level).
Summer mean temperature* (15.35°C)	↑	+3.1°C	+4.0°C	
Winter mean precipitation* (1.93 mm/day)	↕	+0.6 mm/day	+0.7 mm/day	Winter precipitation is projected to remain similar to current mean precipitation for the 2020s and increase slightly by the 2080s for both the medium and high emission scenarios.
Summer mean precipitation* (1.89 mm/day)	↓	-0.3 mm/day	-0.3 mm/day	Summer precipitation is projected to decrease for the 2020s and 2080s.

⁹⁰ Met Office (2013), *England and Wales drought 2010 to 2012*. Available online at: <http://www.metoffice.gov.uk/climate/uk/interesting/2012-drought>

⁹¹ UK Climate Projections (undated), *UKCP09 climate change projections*. Available online at: <http://ukclimateprojections.metoffice.gov.uk/21684>

⁹² UK Climate Projects (undated), *UKCP09, Weather Generator*. Available online at: <http://ukclimateprojections.metoffice.gov.uk/23261>

⁹³ Defra (2017), *Climate change adaptation reporting: second round reports*. Available online at: <https://www.gov.uk/government/collections/climate-change-adaptation-reporting-second-round-reports>

⁹⁴ Quantitative summary values are an average of the climate change projection values for Fradley and Crewe at the 50% level for the 2080s.

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Climate variable characteristic (baseline value in brackets for period 1961–1990)	Overall trend (increase or decrease)	Quantitative summary— central estimate 2080s ⁹⁴		Qualitative summary
		Medium emissions scenario	High emissions scenario	
Annual number of days with high temperature (mean temperature higher than 25°C)** (0.02 days)	↑	+1.6 days	+2.8 days	Up to 3.2 days per year in the 2080s for the high emissions scenario and 1.5 days for the medium emissions scenario.
Annual number of frost days** (6 days)	↓	-4.5 days	-4.8 days	The annual number of frost days is projected to decrease for the 2020s and 2080s.
Annual number of days with 'heavy rain' (precipitation higher than 25mm/day)** (0.93 days)	↑	+0.6 days	+0.8 days	Increase in the variability of rainfall patterns in the region for both the medium and high emission scenarios.
Annual number of dry spells (10 or more consecutive days without precipitation)** (3.21)	↑	+1.9	+2.2	
Summer highest daily maximum temperature** (19.31°C)	↑	+5.0°C	+6.0°C	Projected increase by the 2020s and 2080s.

* = metric from UKCP09 projections

** = metric from UKCP09 Weather Generator

Results and conclusions

4.3.19 The results of the in-combination climate change impacts assessment are summarised below for construction and operation. Further details about the assessment results are included in Volume 5: Appendix CL-002-000.

Construction

4.3.20 There are two significant in-combination climate change effects arising from construction with effects during operation for two topics; the agriculture, forestry and soils topic and the landscape and visual topic. Therefore additional mitigation measures are required to be implemented during the construction phase. These two effects are highlighted under construction but described further under operation.

4.3.21 All other potential in-combination climate change effects during construction are mitigated by the implementation of the measures contained within the draft CoCP

and existing topic specific mitigation measures. These mitigation measures are summarised in Volume 5: Appendix CL-002-000 and examples are provided below.

Operation

- 4.3.22 Two significant in-combination climate change effects during operation have been identified in relation to permanently displaced soil resources arising during construction. Drier and wetter conditions in the future as a result of climate change have been found to potentially affect the ability of 'dry' and 'wet' soils to both retain and drain moisture, respectively. These effects are relevant to both the agricultural, forestry and soils topic and the landscape and visual topic due the relationship between the resilience of soils and the resilience of planted vegetation.
- 4.3.23 The additional mitigation measures proposed to address the significant in-combination climate change effects during operation on permanently displaced soils arising from construction are:
- the creation of deeper, more moisture retentive soil profiles to mitigate longer term drought effects; and
 - the creation of better draining soil profiles to mitigate longer term flood effects on restored and reinstated soils where practicable.
- 4.3.24 Permanently displaced soils will be used to reinstate soils with deeper profiles than the original where reasonably practicable. In these situations, 'wet' soils could be better drained and so more resilient to intense rainfall and 'dry' soils could be thicker and more moisture retentive to better retain water in the profile. In both cases, higher total organic matter content (in the thicker topsoil) would make them more resilient. There is also the possibility of mixing soil textures to make coarse-textured soils less droughty and fine-textured soils less prone to wetness.
- 4.3.25 These additional mitigation measures will be based on soil surveys which will be carried out to inform soil resources plans within construction zones and farm holdings along the route of the Proposed Scheme. These plans will set out suitable target soil profiles and allocate the necessary temporarily displaced topsoils and subsoils for the successful establishment of the different restored land uses and planted vegetation. Good practice techniques will also be adopted in handling, storing and reinstating soils to protect and retain soil structures for drainage and the establishment of ground cover on restored land.
- 4.3.26 All other potential in-combination climate change effects during operation are mitigated by embedded topic specific mitigation measures (examples summarised below). Therefore no additional mitigation measures to address adverse effects on the ability of resources and receptors to adapt to climate change during operation are proposed beyond those described above.
- 4.3.27 Together, the embedded mitigation measures and additional mitigation measures will effectively deal with the two significant in-combination climate change effects which the assessment has found. Therefore, as a result of the mitigation proposed, there are no likely residual significant effects to report.

Embedded mitigation measures

4.3.28 Embedded mitigation measures refer to those measures which have been incorporated within the design of the Proposed Scheme. Embedded mitigation measures relating to ecology and biodiversity, landscape and visual, water resources and flood risk aim to improve the resilience of habitats, species, planting and environmental resources and receptors, associated with the Proposed Scheme, to climate change impacts that may occur during the lifetime of the project. Examples include:

- ecological mitigation measures will enable habitats to adapt to climate change by maintaining and enhancing ecological conditions and creating and restoring habitats to increase species' resilience to changes in climate;
- trees will be selected from a range of latitudes and climate zones to increase species' resilience to hotter, drier and/or wetter conditions, and landscape planting palettes will be designed to increase species' resilience and adaptability; and
- the performance of the Proposed Scheme has been assessed against a range of design floods up to and including the 1% (1 in 100) annual probability event, including addition of the relevant future climate change allowances in line with the latest guidance from the Environment Agency. This assessment work, reported within the Volume 5 Flood Risk Assessments (Volume 5: Appendix WR-003-001 to 005), demonstrates that the Proposed Scheme will not increase flood risk to vulnerable receptors elsewhere, except in a small number of locations, where the potential need for additional mitigation measures has been identified. The Proposed Scheme itself will be resilient to a 0.1% (1 in 1,000) annual probability flood from any source.

4.3.29 All proposed mitigation measures are summarised in Volume 5: Appendix CL-002-000.

Conclusion

4.3.30 As a result of the embedded and additional mitigation measures proposed there are no residual significant effects to report for the in-combination climate change impacts assessment.

Monitoring

Construction

4.3.31 The draft CoCP includes a requirement for the nominated undertaker to monitor extreme weather events during construction.

4.3.32 Monitoring of the additional mitigation measures for the two significant in-combination climate change effects arising during construction will be incorporated into the monitoring of soil moisture and texture which is to be undertaken by HS2 Ltd during the five year aftercare period.

Operation

- 4.3.33 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.
- 4.3.34 No further monitoring is required for the additional mitigation measures for the two significant in-combination climate change effects beyond the five year aftercare period. There are no other significant in-combination climate change effects or additional mitigation measures which require monitoring during operation.
- 4.3.35 However, monitoring strategies for the ecology and biodiversity and landscape and visual topics will contribute to the resilience of environmental resources and receptors to climate change. For example:
- monitoring of habitats and species will be carried out at a route-wide level to monitor the effectiveness of ecological mitigation measures in maintaining and enhancing ecological conditions; and
 - monitoring of newly planted trees during the aftercare period will help to identify diseased or pest infested trees and any changes in growth patterns.

4.4 Climate change resilience assessment

Legal and policy framework

International level

- 4.4.1 There is no relevant overarching international legislation or policies affecting climate change resilience assessment within the EIA process.

European level

The relevant Directive and publications for the climate change resilience assessment at a European level is EIA Directive 2014/52/EU⁹⁵ and the related EC Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment⁹⁶.

National level

- 4.4.2 The relevant legislation and policies for the climate change resilience assessment at the national level are:
- the Climate Change Act 2008⁹⁷ and within that the National Adaptation

⁹⁵ Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052>

⁹⁶ European Commission (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*. Available online at: <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf>.

⁹⁷ *Climate Change Act 2008*. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf

Programme (NAP)⁹⁸ and Adaptation Reporting Power (ARP)⁹⁹;

- the Environment Agency guidance on climate change allowances to be used in flood risk assessments as set out in the NPPF¹⁰⁰; and
- NPPF PPG on climate change¹⁰¹ which prioritises addressing climate change impacts in the planning and decision making process for major transport infrastructure projects.

Scope, assumptions and limitations

- 4.4.3 The technical scope of the climate change resilience assessment incorporated an initial climate change resilience assessment of all potential climate hazards for all HS2 infrastructure major asset groups to the end of their design life; and a further climate change resilience assessment of significant climate hazards for relevant infrastructure and major asset groups associated with the Proposed Scheme to the end of their design life.
- 4.4.4 The spatial scope of the assessment comprises all five of the community areas within Phase 2a.
- 4.4.5 The temporal scope of the assessment included consideration of climate change risks relevant to the design and construction stages (the '2020s') and operation (the '2080s'^{102, 103}) of the Proposed Scheme. The design life of assets has been taken into account in the resilience assessment.
- 4.4.6 For further detail on the scope of the climate change resilience assessment refer to Section 8 of the SMR and the SMR Addendum.
- 4.4.7 The assumptions which have informed this assessment are that the Proposed Scheme will be designed to be resilient to impacts arising from current weather events and climatic conditions, and that it will be designed in accordance with HS2 technical requirements that are built upon best practice engineering codes and adapted to consider climate change where appropriate. These climate change adaptations were developed during the design of Phase One of HS2 and are considered 'embedded mitigation' for Phase 2a.
- 4.4.8 The limitations of the climate change resilience assessment are as follows:
- there is uncertainty around climate change projections;
 - there is limited methodological guidance on climate change resilience assessment in EIA from Government and other institutions; and

⁹⁸ Department for Environment, Food and Rural Affairs, (2013), *National Adaptation Programme – Making the Country Resilient to a Changing Climate*. Available at <https://www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme>

⁹⁹ Committee on Climate Change (undated), *UK Adaptation Policy*. Available online at: <https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-adaptation-policy/>

¹⁰⁰ Environment Agency (2017), *Flood risk assessments: climate change allowances*. Available online at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

¹⁰¹ Department for Communities & Local Government (2014), *Planning Practice Guidance – Guidance climate change*. Available online at: <http://planningguidance.communities.gov.uk/blog/guidance/climate-change/why-is-it-important-for-planning-to-consider-climate-change/>

¹⁰² The '2020s' refers to the period between 2011 and 2039. The '2080s' refer to the period between 2071 and 2099.

¹⁰³ The operational life of HS2 is 120 years (i.e. from 2027 to 2147) but the climate change assessments only take into account climate change projections to the '2080s'. This is because UKCP09 projections data is only available up to the '2080s'.

- the evidence base relating to climate change impacts for some categories of infrastructure and assets is limited.

Environmental baseline

- 4.4.9 The existing and future baselines in Section 4.3.9 also apply to the climate change resilience assessment.

Results and conclusions

- 4.4.10 The results of the climate change resilience assessment are summarised below for construction and operation. Further details about the assessment results are included in Volume 5: Appendix CL-002-000.

Construction

- 4.4.11 All climate change related risks to HS2 assets and infrastructure during construction have been assessed to be 'very low' and 'low' risk due to the implementation of the measures contained within the draft CoCP and adherence to relevant health and safety standards. Therefore no significant climate change resilience effects have been identified and no further climate change resilience measures are proposed.

Operation

- 4.4.12 All climate change related risks during operation have been assessed to be 'very low' or 'low' due to a range of mitigation measures (examples summarised below). Therefore no significant climate change resilience effects have been found and no further climate change resilience measures are required or proposed.

Mitigation measures

- 4.4.13 The mitigation of climate change related risks during operation is provided through one or more of the following categories of measures:

- existing resilience measures embedded within the design of the Proposed Scheme;
- measures which will be included in the development of maintenance and monitoring measures for the Proposed Scheme; and/or
- measures which will be considered and developed during detailed design.

- 4.4.14 Examples of mitigation measures within these categories are summarised below:

- the Proposed Scheme is designed to a 1 in 100 year plus climate change (increase dependent on river basin and flood zone) peak river flow event with an additional sensitivity test for resilience to a 1 in 1,000 year event. This will protect the railway infrastructure from floodwater ensuring that the Proposed Scheme will remain operational or can restart without undue delay;
- drainage is designed to a 1 in 100 year plus climate change (40% increase) peak rainfall event;
- lineside vegetation and landscape planting areas will be managed to minimise the likelihood of windborne debris blocking watercourses and drainage

systems, obstructing the tracks or causing damage to overhead line equipment; and

- measures to mitigate the risk of lightning strikes to structures and systems will be addressed during further design stages.

Conclusions

- 4.4.15 No significant climate change resilience risks have been found, therefore no significant climate change resilience effects have been identified and no further climate change resilience measures are required.

Monitoring

Construction

- 4.4.16 The draft CoCP includes a requirement for the nominated undertaker to monitor extreme weather events during construction.

Operation

- 4.4.17 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.
- 4.4.18 Weather and climate change resilience monitoring will be integrated into processes for developing asset management and procurement strategies for the Proposed Scheme.

5 Community

- 5.1.1 Community impacts arising from the construction and operation of the Proposed Scheme are considered to be of predominantly local significance and have accordingly been reported in the Volume 2 community area 1–5 reports. Impacts on the promoted¹⁰⁴ public rights of way (PRoW) that run through multiple community areas are considered to be localised, and therefore, are also appropriately reported in the individual community area reports.
- 5.1.2 Localised in-combination effects are also reported at community area level for both construction and operation in the individual Volume 2 community area 1–5 reports.
- 5.1.3 Construction worker impacts on community resources are considered at a route-wide level in Volume 5: Appendix CM-002-000, Route-wide construction worker impacts. The assessment takes into account the proposed numbers of workers, the type and location of accommodation, expected working hours, the facilities that will be provided on construction compounds, experience from the construction of other similar large projects (such as HS1 and Crossrail) and the measures contained in the draft Code of Construction Practice (CoCP¹⁰⁵) to manage any identified impacts.
- 5.1.4 It is concluded that there will be no significant effects at a route-wide level on community resources associated with the presence and occupation of the temporary construction worker accommodation.

¹⁰⁴ Promoted PRoW refers to those PRoW which are a 'promoted' destination in their own right as a recreational resource.

¹⁰⁵ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

6 Cultural heritage

- 6.1.1 Heritage assets can be affected through physical removal or through changes to their setting due to development. The loss of individual heritage assets and effects on setting are considered to be most appropriately assessed on a case by case basis and are therefore reported within Volume 2, community area 1–5 reports.
- 6.1.2 The Proposed Scheme will not have a direct physical effect on any World Heritage Site, scheduled monument, registered park and garden or registered battlefield and will not require the demolition of any listed buildings. Effects on ancient woodland are considered in Section 7, Ecology and biodiversity.
- 6.1.3 Across the entire route of the Proposed Scheme, a number of designated heritage assets will be significantly affected through direct physical impact, comprising:
- two Grade II listed mileposts which will be removed (and later replaced) (Volume 2: Community area 4 report, Whitmore Heath to Madeley), and Grade II listed buildings at Crewe Station which will be subject to non-structural changes (Volume 2: Community area 5 report, South Cheshire), and;
 - four Conservation Areas:
 - Trent and Mersey Conservation Area, adjacent to Kings Bromley Wharf (Lichfield District Council) (Volume 2: community area 1 report, Fradley to Colton);
 - Trent and Mersey Conservation Area (Stafford Borough Council) (Volume 2: community area 2 report, Colwich to Yarlet);
 - Ingestre Conservation Area (Volume 2: community area 2 report, Colwich to Yarlet); and
 - Swynnerton Conservation Area (Volume 2: community area 3 report, Stone and Swynnerton).
- 6.1.4 The loss of individual heritage assets and effects on setting are not considered to be of route-wide importance and are therefore considered on an individual basis within the relevant Volume 2, community area report.
- 6.1.5 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

7 Ecology and biodiversity

7.1 Introduction

- 7.1.1 This section of the report describes significant effects on ecological resources that will occur on a route-wide scale as a consequence of the construction and operation of the Proposed Scheme.
- 7.1.2 Significant effects arising from the construction and operation of the Proposed Scheme on individual ecological receptors that are of at least district/borough value are reported within Volume 2, community area 1–5 reports, Section 8. This section considers both significant effects at the regional and national levels, and in combination effects that are not discussed within the Volume 2 community area reports.
- 7.1.3 Local/parish level effects for each Volume 2 community area are listed within the Volume 5: Appendices EC-016-001, EC-016-002, EC-016-003, EC-016-004 and EC-016-005. This section considers the scope for local/parish level effects identified in the aforementioned appendices, when acting in combination, to result in significant effects (i.e. effects at a district/borough level or above).

7.2 Designated sites

- 7.2.1 There are five sites of international importance for nature conservation that are relevant to the assessment. These are Cannock Chase Special Area of Conservation (SAC), Midland Meres and Mosses Phase 1 Ramsar site, Midland Meres and Mosses Phase 2 Ramsar site, West Midlands Mosses SAC and Pasturefields Salt Marsh SAC. These have been considered in Habitats Regulations Assessment (HRA) screening reports and addenda (see Volume 5: Appendix EC-017-001 to Appendix EC-017-005), with the exception of Cannock Chase SAC.
- 7.2.2 Cannock Chase SAC is located to the south of Ingestre, approximately 830m south-west of a construction traffic route along the A51 Lichfield Road. There will be no significant effect on the qualifying features of the SAC due to the Proposed Scheme.
- 7.2.3 The Chartley Moss element of the Midland Meres and Mosses Phase 1 Ramsar site and the West Midlands Mosses SAC is located to the north-east of Great Haywood, approximately 4.3km north of the route of the Proposed Scheme and approximately 170m south of a construction traffic route along the A518 Uttoxeter Road. The HRA screening report concludes that there will be no likely significant effect due to the Proposed Scheme.
- 7.2.4 Pasturefields Salt Marsh SAC is located to the east of Ingestre, approximately 870m north of the route of the Proposed Scheme and approximately 60m west of a construction traffic route along the A51 Lichfield Road. The HRA screening report and addendum for this site concludes that there will be no likely significant effect due to the Proposed Scheme.
- 7.2.5 The Betley Mere element of the Midland Meres and Mosses Phase 1 Ramsar site is located to the south-west of Betley, approximately 280m north-east of the land required for the Proposed Scheme. The HRA screening report and addendum concluded that it is not likely there will be a significant effect due to the Proposed

Scheme. The addendum assesses the potential effects of a borrow pit north of Checkley Lane. It concludes, on the basis of the avoidance and mitigation measures identified, that it is not likely there will be a significant effect due to the Proposed Scheme.

- 7.2.6 The closest element of the Midland Meres and Mosses Phase 2 Ramsar site is Black Firs and Cranberry Bog, which is 1.1km from the Proposed Scheme. There will be no significant effect on the qualifying features of the Ramsar site due to the Proposed Scheme.
- 7.2.7 Cannock Chase SAC, the Chartley Moss element of Midland Meres and Mosses Phase 1 Ramsar site and West Midlands Mosses SAC, Pasturefields Salt Marsh SAC, the Betley Mere element of Midland Meres and Mosses Phase 1 Ramsar site, and the Black Firs and Cranberry Bog element of the Midland Meres and Mosses Phase 2 Ramsar site are also Sites of Special Scientific Interest (SSSIs). Chartley Moss SSSI is also designated as a National Nature Reserve (NNR). There will be no significant effect on any of these SSSIs or the NNR. There are no additional SSSIs within 500m of the Proposed Scheme. Several other SSSIs occur beyond 500m and have Impact Risk Zones that overlap the Proposed Scheme, as reported in the relevant Volume 2 community area reports. No significant effects on other SSSIs are expected.
- 7.2.8 Non-statutory wildlife sites will be affected by the Proposed Scheme as summarised in Table 7. These are divided into Local Wildlife Sites (LWS) and Biodiversity Alert Sites (BAS). LWS are of county value and BAS are of district/borough value.

Table 7: LWS affected by county

County	LWS type	Number of LWS affected by construction of Proposed Scheme	Number of LWS type in county	% of total LWS in county affected by Proposed Scheme
Staffordshire	LWS (previously Site of Biological Interest (SBI))	15	921 ¹⁰⁶	2%
	BAS	8	159 ¹⁰⁶	5%
Cheshire	LWS	0	Approx. 1,000 ¹⁰⁷	0%

- 7.2.9 The Proposed Scheme will result in significant loss and/or fragmentation effects to 15 LWS and eight BAS. A number of other LWS and BAS sites lie in the vicinity of the Proposed Scheme and the potential for adverse effects on them was considered as part of the assessment, as reported in the relevant Volume 2 community area reports.

¹⁰⁶ Staffordshire Ecological Record (2017). Available online at: http://www.staffs-ecology.org.uk/html2015/index.php?title=Main_Page

¹⁰⁷ Cheshire Wildlife Trust (2017). *Local Wildlife Sites*. Available online at: <https://www.cheshirewildlifetrust.org.uk/localwildlifesites>

- 7.2.10 LWS and BAS form an important component of ecological networks¹⁰⁸. They provide 'core habitat'¹⁰⁹ and/or 'stepping stones'¹¹⁰, which are likely to be important in maintaining the conservation status of a range of habitats and species. These networks benefit the species and habitats for which the LWS and BAS are designated and also a wide range of other species that use them for migration and dispersal. In addition to the adverse effects on LWS and BAS identified in the Volume 2 community area reports, it is possible that, without mitigation, the construction of the Proposed Scheme could lead to additional adverse effects on other features of the ecological networks of which they form a part.
- 7.2.11 Where a significant adverse effect on the integrity of a LWS or BAS is expected, compensation has been incorporated into the Proposed Scheme to address effects on the conservation status of the habitats and species for which that LWS and BAS was designated. The location, size and form of compensatory habitat creation areas that will be provided has sought, where reasonably practicable, to adhere to the Lawton report¹¹¹ principles of 'bigger, better, more joined up'. In so doing, the design of compensatory habitat creation will seek to maintain and enhance existing ecological networks (see Volume 1, Section 9), by enhancing existing core habitats, providing new core habitats, and/or promoting connectivity between habitat fragments. As a result, route-wide effects on ecological networks will be reduced to a level where they are unlikely to be significant.
- 7.2.12 Where there is a significant effect at a LWS or BAS, it is not possible to directly compensate for the effect on designation status (as the responsibility for designating lies with external bodies). However, it is expected that when mature, many of the compensatory habitats to be created are likely to meet relevant LWS and BAS criteria. Once ecological compensation areas are of sufficient biodiversity value to meet LWS and BAS criteria, then HS2 Ltd will encourage the formal designation of these areas as part of the LWS and BAS network.
- 7.2.13 Overall, the mitigation and compensation measures proposed will ensure that no permanent significant residual effects at the regional or route-wide levels are likely to occur.
- 7.2.14 The Proposed Scheme crosses the Meres and Mosses NIA. Whilst not a designated site, the NIA is one of 12 national NIAs set up by the government in 2012 to create joined up, resilient ecological networks at the landscape scale. The focus is to improve and protect core sites within the network and connect them by restoring wetland habitats in and around these core sites, resulting in connectivity of high quality habitats that can provide both better conditions for wildlife and enhance the capacity for species to move from one core site to another.

¹⁰⁸ Networks of natural habitats which link sites of biodiversity importance and provide routes or stepping stones for the migration, dispersal and genetic exchange of species in the wider environment.

¹⁰⁹ Core habitat may be defined as an area of relatively intact habitat that is sufficiently large to support particular species; as distinct from small fragments of habitat with high edge to centre ratios and which are surrounded by modified land-uses that are hostile to most wildlife.

¹¹⁰ Stepping stones are small patches of habitat that help to provide connectivity between core areas of habitat, aiding the movement of species between core areas.

¹¹¹ Lawton, J (2010), *Making space for nature: A review of England's wildlife sites and ecological network*, Defra, London.

- 7.2.15 Betley Mere SSSI (a constituent part of the Midland Meres and Mosses Phase 1 Ramsar site) falls within this NIA and the commitment to avoid adverse effects to this site are consistent with the NIA objectives. Species groups associated with wetland habitats (such as amphibians and invertebrates) will not be significantly impeded during the construction process through the implementation of measures that are described in the draft Code of Construction Practice (CoCP¹¹²). In accordance with the NIA objectives, opportunities to enhance wetland habitat in the vicinity of the Proposed Scheme will be considered.

7.3 Habitats

- 7.3.1 The Proposed Scheme will result in the loss of areas of a range of habitats, including habitats of principal importance (as identified under Section 41 of the Natural Environment and Rural Communities Act, 2006)¹¹³.
- 7.3.2 Where reasonably practicable, habitat loss has been avoided or reduced. Areas of habitat creation have been identified along the route of the Proposed Scheme to provide compensation where habitat loss has been unavoidable. As described in relation to designated sites, where appropriate, these areas have been identified based on consideration of the goal of working towards the creation of 'bigger, better and more joined up' ecological networks.
- 7.3.3 Approximately 6.2ha of ancient woodland will be lost to the Proposed Scheme within two woodlands listed on the Ancient Woodland Inventory (AWI); namely Whitmore Wood and Barhill Wood.
- 7.3.4 On the basis of heritage review undertaken by HS2 Ltd, Natural England has confirmed that 11 woodlands of potential relevance to the assessment will be added to the AWI. Eight of these ancient woodlands occur within, or partially within, the Proposed Scheme and approximately 4.3ha of ancient woodland will be lost from these sites. The total loss of ancient woodland is therefore approximately 10.5ha.
- 7.3.5 Ancient woodland is an irreplaceable resource and this loss is considered to be a permanent adverse residual effect, which is significant at a national level. The loss of woodland will be partly compensated through a range of measures. Ancient woodland soil with its associated seed bank will be salvaged and translocated to receptor sites that have, wherever possible, been chosen because they link to and/or are adjacent to ancient woodland fragments. This will seek to increase the connectivity of fragmented ancient woodland parcels. Other measures such as planting native tree and shrub species of local provenance, and translocation of coppice stools and dead wood, will be undertaken as appropriate.
- 7.3.6 Planting of compensatory areas of lowland mixed deciduous woodland will be undertaken in the vicinity of the ancient woodlands where losses occur. These planting areas are in response to loss of both ancient and other woodland. In accordance with the Ecological Principles of Mitigation in the SMR Addendum¹¹⁴, they are designed to increase the extent of woodland in the area and/or to enhance

¹¹² Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

¹¹³ *Natural Environment and Rural Communities Act (2006)*, Her Majesty's Stationery Office, London.

¹¹⁴ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

connectivity between woodlands. These planting areas are in the Colwich to Yarlet area, the Stone and Swynnerton area (primarily in the vicinity of Cliffords Wood LWS) and the Whitmore Heath to Madeley area (primarily in the vicinity of Whitmore Wood). In addition, retained ancient woodland at Whitmore Wood, extending to 11.9ha, will be enhanced through the introduction of appropriate management, for example through the introduction of measures to manage adverse impacts of deer on woodland regeneration.

7.3.7 The most notable habitat losses that will occur as a consequence of the construction of the Proposed Scheme are:

- semi-natural broadleaved woodland: loss of approximately 46ha across the Proposed Scheme¹¹⁵. The loss represents less than 0.01% of the resource in England¹¹⁶;
- neutral grassland: loss of approximately 102ha of unimproved and semi-improved neutral grassland across the Proposed Scheme. This loss represents less than 0.02% of the total neutral grassland resource in England¹¹⁶;
- inland saltmarsh¹¹⁷: loss of approximately 1.5ha across the Proposed Scheme;
- ancient and veteran trees: loss of 27 ancient and veteran trees across the Proposed Scheme. It is difficult to assess the total national veteran and ancient tree resource, however, this loss is likely to represent somewhere in the region of 0.02% of the resource in England¹¹⁸; and
- ponds: loss of 277 ponds across the Proposed Scheme. This loss is likely to represent approximately 0.15% of the national resource¹¹⁶.

7.3.8 On a precautionary basis, assuming the loss of all hedgerows within the land required for the Proposed Scheme, there will be an overall loss of up to approximately 180km of hedgerows, representing 0.04% of the resource in England¹¹⁶. This total, however, includes some hedgerows that are likely to be retained, such as those located within land required for overhead line diversions/realignments and those located within land required for the creation of woodland and grassland habitat.

7.3.9 During construction, the loss and severance of hedgerows will result in a temporary adverse effect on the hedgerow network that is significant at the county level. In accordance with the Ecological Principles of Mitigation in the SMR Addendum and draft CoCP efforts will be made (where reasonably practicable) to limit effects on species by minimising habitat loss and through the early creation of replacement features.

7.3.10 Loss of hedgerows will be compensated through a range of measures, including translocation of important hedgerows that are a reason for LWS designation, creation of new hedgerows and linear planting features, and tree and shrub planting for

¹¹⁵ This loss is the total of woodland habitats of principal importance that are lost, namely lowland mixed deciduous woodland and wet woodland. The majority of ancient woodland lost is also semi-natural broadleaved woodland and these areas are therefore included within this total. Areas of ancient woodland that are Plantation on Ancient Woodland Sites (PAWS) are not included within this total.

¹¹⁶ Natural England (2008), *State of the Natural Environment 2008 (NE85)*.

¹¹⁷ The loss is of non-natural inland salt marsh, which is considered to be a rare habitat type although no national figures for the extent of this habitat are known to exist.

¹¹⁸ Based on the 125,700 figure stated within the Woodland Trust Ancient Tree Inventory. Available online at: <http://www.ancient-tree-hunt.org.uk/>

landscape purposes. A network of hedgerows and other linear planting will be restored on either side of the Proposed Scheme. Opportunities to create linkages across the route of the Proposed Scheme have been taken where required, including planting on the approaches to three underbridges (Trent Walk underbridge, Swynnerton Estate South underbridge and Swynnerton Estate Central underbridge) and five green overbridges (Colwich Bridleway 23 accommodation green overbridge, Ingestre green overbridge, Swynnerton Estate North accommodation green overbridge, Swynnerton Footpath 15 green overbridge and Madeley Bridleway 1 accommodation green overbridge) with planting on the approaches and across them. Following reinstatement, it is likely that significant residual effects on the hedgerow network will be offset by the beneficial effects of other linear planting. As such, at a route-wide level no permanent significant residual effect is likely to occur.

- 7.3.11 Once restoration of arable farmland and compensatory habitat creation is taken into account, the loss of arable field margins and ponds is not likely to give rise to significant adverse residual effects at greater than district/borough level.
- 7.3.12 The design of the Proposed Scheme is such that, where reasonably practicable, watercourses are crossed by bridges or viaducts. Where it has been necessary to introduce culverts, their lengths have been designed to be as short as possible. In compensation for use of culverts, and also where stretches of watercourses will be realigned, the ecological quality of the new lengths of watercourse will be enhanced with the introduction of, for example, meanders and natural bank features. Overall, no significant residual effect on watercourses (as ecological receptors) is likely.
- 7.3.13 The results of a separate Water Framework Directive (WFD) compliance assessment undertaken to consider the Proposed Scheme's compliance against WFD objectives¹¹⁹ are presented in Volume 5: Appendix WR-001-000, with a summary provided in Section 15 of this Volume 3 report.
- 7.3.14 Where habitats of principal importance will be lost, opportunities for the creation of compensatory habitat have been explored. Overall, approximately 107.8ha of habitats of principal importance will be lost as a result of construction of the Proposed Scheme, including up to 42.7ha of lowland mixed deciduous woodland and 39ha of lowland meadow.
- 7.3.15 A total of approximately 394ha of habitats of principal importance will be created, mainly lowland mixed deciduous woodland and lowland meadow. In addition, there will be further areas of landscape planting of native broadleaved woodland, which will also contribute to habitat creation.

7.4 Species

- 7.4.1 The protected and notable faunal species relevant to the assessment are described below.

¹¹⁹ European Commission Official Journal (2000), Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Bats

- 7.4.2 Of England's 17 resident bat species, 12 have been recorded along the route of the Proposed Scheme, including the rarer species: lesser horseshoe, noctule, serotine, Brandt's bat, and Nathusius' pipistrelle¹²⁰.
- 7.4.3 Effects on two bat population assemblages of significance at up to the regional level will occur as a result of the following works:
- construction of Moreton Brook viaduct will result in the permanent loss of a maternity roost of an unknown bat species in a tree near Moreton Brook, which is assumed to be used by a rarer bat species; and
 - excavation of Brancote South cutting will result in the permanent loss of a Myotis species maternity roost in a tree at Ingestre Park Golf Club and the permanent loss of a whiskered bat maternity roost in a building at Upper Hanyards.
- 7.4.4 Key impacts on bats will be those associated with the loss and disturbance of roost sites and the severance of existing habitat through removal of important flight lines. The loss of hedgerows and other habitats that provide connectivity in the landscape will affect the ability of some bat species to move between roost sites and foraging areas. The impact of such a disturbance or displacement would be greatly increased if bats are hampered in moving between breeding sites, hibernation sites and other roosts which they commonly utilise.
- 7.4.5 There is also a risk of bat mortality due to collision with passing trains and associated air turbulence. However, when travelling at high speed, trains will pass quickly (approximately four seconds), and therefore, exposure to the risk of collision will be intermittent and of short duration. The point at which these potential impacts would result in a significant adverse effect on the bat population concerned would differ depending on a number of factors including: the size and status of the bat population, the flight characteristics of the bat species, and the design of the Proposed Scheme at the point the potential impact occurs (i.e. whether the railway is in cutting, on embankment, on viaduct or at grade).
- 7.4.6 The loss of active roosts located within the land required for the Proposed Scheme will be compensated through the provision of suitable replacement features in accordance with the Ecological Principles of Mitigation identified in the SMR Addendum. All replacement provision for loss of active roosts will be provided within land identified as required as part of the Proposed Scheme.
- 7.4.7 At the route-wide level, the loss of trees and buildings identified as having high potential to support roosting bats will result in a reduction in the availability of a roosting resource in the immediate vicinity of the Proposed Scheme until compensatory planting establishes. As any such losses are likely to represent a small proportion of the roosting opportunities available to the range of populations concerned, it is considered unlikely that these effects will result in a significant effect on the conservation status of the species concerned. However, as a precaution, and to

¹²⁰ Wray, S., Wells, D., Long E., Mitchell-Jones, T. (2010), *Valuing bats in Ecological Impact Assessment. In Practice*, (pp. 23-25).

ensure that populations are not constrained by the availability of additional alternative roosting provision (i.e. provision in excess of that legally required due to loss of confirmed roosts), mitigation will be provided within ecological compensation areas, which will comprise the provision of bat boxes and other methods, such as tree surgery, to provide artificial roosting features within retained trees as appropriate.

- 7.4.8 Site specific measures to address the effects of habitat severance, such as the provision of green bridges and underpasses, have been provided on a precautionary basis where they are required to address significant effects on the local populations concerned. Planting will be provided to reinstate key commuting routes and to promote the use of suitable safe crossing points across the route, including those provided by viaducts.
- 7.4.9 Proposed planting will not be sufficiently mature to provide habitat linkages immediately, and therefore, there is the potential for significant temporary adverse effects on bat populations until these habitats establish. A series of measures will be implemented to limit the duration and scale of temporary habitat severance, which include establishing key alternative flight lines as early as is reasonably practicable, and the use of temporary features such as artificial hedgerows. All such measures will be provided in accordance with the Ecological Principles of Mitigation within the SMR Addendum.
- 7.4.10 The implementation of these measures will reduce the scale and intensity of impacts on bat populations as a result of temporary habitat severance. Although temporary adverse effects on bat populations are likely to occur during construction, the resulting effect on the conservation status of the populations concerned is not expected to be significant, and no in-combination significant adverse effects are likely.
- 7.4.11 Mitigation provided by crossing points and measures to address effects of habitat severance will help to mitigate potential effects of mortality arising from collisions with trains during the operation of the Proposed Scheme. Green bridges, underpasses, and viaducts will provide safe crossing points at discrete locations where the route of the Proposed Scheme crosses key bat foraging and commuting routes.
- 7.4.12 Following the implementation of the measures proposed, bat mortality as a consequence of the Proposed Scheme will be reduced, but not avoided. Through providing safe crossing points and accompanying planting to mitigate potential impacts at high risk locations (taking into consideration the rarity and the conservation status of the species in question), it is expected that mortality will be reduced to a level at which, for each species, it is negligible. An appropriate monitoring programme will be developed in consultation with Natural England, and implemented during operation in order to assist in meeting relevant requirements under the Conservation of Habitats and Species Regulations 2010¹²¹.
- 7.4.13 With the implementation of the measures proposed, it is likely that adverse effects on bat populations as a consequence of the construction and operation of the Proposed Scheme (including those on rarer bat species), will be reduced to the local/parish level

¹²¹ *The Conservation of Habitats and Species Regulations 2010. SI 2010 No. 490.* Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/2010/490/pdfs/uksi_20100490_en.pdf

or below. The mitigation and compensation provided to address population level effects is also appropriate to ensure that there will be no cumulative effects on the species concerned. Therefore, no significant residual effects on the conservation status of bats are likely to occur.

Great crested newt

- 7.4.14 The Proposed Scheme will pass through areas within the core geographical range of great crested newt and they are widespread throughout the route of the Proposed Scheme. In some areas, breeding ponds will be lost, terrestrial supporting habitat will be lost and/or fragmentation of habitat will occur. However, in the long term, the Proposed Scheme is not expected to act as a barrier to movement of great crested newts.
- 7.4.15 Compensatory habitat, to address impacts on great crested newt and other amphibian populations, will be provided in accordance with the Ecological Principles of Mitigation in the SMR Addendum. Compensation will include the provision of replacement ponds, terrestrial habitat and hibernation habitat sufficient to maintain the favourable conservation status of the populations affected.
- 7.4.16 Wherever reasonably practicable, the required mitigation and compensation will be provided at the location of the individual populations concerned. However, where existing populations are severed, there will, in some cases, be a requirement to relocate severed populations. In all such cases, the necessary compensation will be provided in accordance with the Ecological Principles of Mitigation in the SMR Addendum in proximity to the Proposed Scheme. No significant change in the distribution of the species is expected at a route-wide scale. However, some changes in the distribution of the species at the local/parish scale are likely to occur.
- 7.4.17 Following the implementation of the measures proposed, it is likely that adverse impacts on great crested newts and other amphibians during construction of the Proposed Scheme will be reduced such that it is considered unlikely that a significant effect will occur.

Otter

- 7.4.18 Otters are present along some parts of the route of the Proposed Scheme and the assessment assumes that this species is likely to have spread to all suitable watercourses by the commencement of operation of the Proposed Scheme. At each point where the Proposed Scheme will cross a watercourse suitable for otter, the detailed design will allow for the safe passage of otter. The Proposed Scheme is not expected to affect either the movement of existing populations or the potential continued spread of this species in the future to an extent that would be significant above the local/parish level.
- 7.4.19 The potential for temporary adverse effects on otter populations as a consequence of disturbance of watercourses during construction will be reduced through the implementation of measures within the draft CoCP and through the implementation of the Ecological Principles of Mitigation in the SMR Addendum. Following mitigation, no significant residual effects on individual otter populations are likely to occur.

Water vole

- 7.4.20 Whilst water voles are found throughout England, this species has undergone significant contraction in range during recent years due to habitat loss and increased predation by American mink. Evidence of water vole was found in a small number of watercourses within, and in the vicinity of, the route of the Proposed Scheme. Mitigation will be provided within the ecological compensation areas (which form part of the Proposed Scheme) in accordance with the Ecological Principles of Mitigation in the SMR Addendum.
- 7.4.21 Where the Proposed Scheme will cross watercourses, a dry passage for mammals (such as otter and water vole) will be provided as required, to prevent isolation of populations, taking into account flood events.
- 7.4.22 The potential for temporary adverse effects on water vole populations as a consequence of disturbance of watercourses during construction will be reduced through the implementation of measures within the draft CoCP and through the implementation of the Ecological Principles of Mitigation in the SMR Addendum.
- 7.4.23 Following mitigation, no significant residual effects on water vole populations are likely to occur.

Birds

- 7.4.24 For the majority of birds, impacts arising from construction of the Proposed Scheme are not likely to result in permanent adverse effects on breeding and wintering populations. This is because the habitats supporting these species will be recreated once construction is complete. However, temporary adverse effects on individual populations of less common species, significant at up to county level, are likely to occur for the duration of construction.
- 7.4.25 Barn owl will be subject to significant adverse effects due to displacement, loss of nesting sites and foraging habitat during construction. In addition, during operation, there is a risk of barn owl mortality due to collision with passing trains resulting in further significant adverse effects. Overall, on a precautionary basis, there may be loss of up to 10 potential barn owl nest site territories due to these combined effects, which is equivalent to 0.3% of the UK population¹²². Route-wide, these losses will result in a residual significant effect on the conservation status of barn owl at the county level.
- 7.4.26 To offset the likely loss of barn owls from the vicinity of the Proposed Scheme, opportunities to provide barn owl nesting boxes and foraging habitat in areas greater than 3km from the route will be explored with local landowners. As the availability of nesting sites is a limiting factor for this species, the implementation of these measures would be likely to increase numbers of barn owls within the wider landscape and thus offset the adverse effect. If the proposed mitigation measures for barn owl are implemented through liaison with landowners, the residual effect on barn owl would be reduced to a level that is not significant.

¹²² Current UK population estimated at 4,000 pairs. Barn Owl Trust (2013), *About the Barn Owl - Current distribution and numbers*. Available online at: <http://www.barnowltrust.org.uk/infopage.html?id=115>

- 7.4.27 Noise of passing trains has the potential to disturb birds within habitats close to the Proposed Scheme. Birds habituate to loud noises that occur regularly and frequently, and hence, it is considered that this will not generally cause significant effects. There is some evidence to suggest that breeding bird densities can be reduced where there is persistent noise from busy roads due to birds being unable to hear each other's songs¹²³. However, this is not expected to occur as a result of the Proposed Scheme, as trains will pass quickly. The effect of train noise on breeding birds is, therefore, not considered likely to result in significant adverse effects.

Common reptiles

- 7.4.28 The Proposed Scheme does not pass through areas that are known to support England's rarer reptile species, which are also European Protected Species (smooth snake and sand lizard). One of the more common species of reptile (grass snake) was recorded within the land required for the Proposed Scheme. Compensatory habitat creation to address loss of habitat supporting reptiles will be provided within ecological compensation areas in accordance with the principles of mitigation identified in the SMR Addendum.
- 7.4.29 Effects will be mitigated at the level of individual populations. As a consequence, following the implementation of the measures proposed, it is expected that adverse impacts on reptiles during the construction of the Proposed Scheme will be reduced to a level at which they will not result in significant effects on the conservation status of either the population concerned or the species.

Badger

- 7.4.30 The badger is common throughout much of lowland England and numerous badger setts were found within the land required for the Proposed Scheme.
- 7.4.31 Mitigation measures to address the potential disturbance of badgers during construction of the Proposed Scheme will be provided in accordance with the Ecological Principles of Mitigation in the SMR Addendum. This will include the provision of badger-proof fencing, replacement setts and underpasses where necessary.

Fish

- 7.4.32 There is a nationally important population of spined loach in the River Trent, and assemblages of fish at up to the district/borough level in other watercourses. These will not be directly affected by the Proposed Scheme and any indirect effects will be controlled through implementation of measures in the draft CoCP to reduce any effects to a level that is not significant.

Invertebrates

- 7.4.33 A single white-clawed crayfish population recorded outside of the land required for the Proposed Scheme is likely to use the connected watercourse within the land

¹²³ Radford, A., Morely, E., and Jones, G. (undated) The effects of Noise on Biodiversity. Report for Defra.

required for the Proposed Scheme (Basford Brook). There is also potential for this species to occur in a small number of other locations.

- 7.4.34 The potential for temporary adverse effects on white-clawed crayfish populations as a consequence of disturbance of watercourses during construction will be reduced through the implementation of measures within the draft CoCP and through the implementation of the Ecological Principles of Mitigation in the SMR Addendum. Following mitigation, no significant residual effects on white-clawed crayfish populations are likely to occur.
- 7.4.35 Potential effects on terrestrial invertebrate populations such as white-letter hairstreak butterfly (considered to be of district/borough value or above) will be mitigated within ecological compensation areas through habitat creation in accordance with the Ecological Principles of Mitigation identified within the SMR Addendum.
- 7.4.36 In order to prevent in-combination effects on aquatic invertebrate populations, replacement habitats will (where reasonably practicable) be provided in advance of habitat loss to allow replacement habitats to be colonised, and thus reducing temporary adverse effects to a level where they are not likely to be significant.

7.5 Climate change

- 7.5.1 Over the timeframe considered by the environmental impact assessment (EIA) (as defined in Volume 1, Section 7), it is unlikely that ecological baseline conditions will change materially as a consequence of climate change, although future climate change scenarios have been considered. Nevertheless, in developing the ecological compensation and landscaping design of the Proposed Scheme, climate change adaptation has been considered. In particular, the design of mitigation and compensation has sought to ensure that the Proposed Scheme will not hamper the ability of biodiversity to adapt to climate change. It is recognised that, in the future, species and habitats will seek to adapt to climate change, but within many countries (including the United Kingdom), species will be constrained in their ability to adapt due to fragmented landscapes and insufficient and poorly distributed semi-natural habitat. The Proposed Scheme provides an opportunity to address these issues by creating a linear corridor of habitat (excluding where the route is in tunnel, on viaduct or on a bridge) and by de-fragmenting the landscapes through which it passes.
- 7.5.2 Thus, as well as considering the significance of combinations of ecological effects at a regional or route-wide level, the ecological assessment has considered the potential impact of changes in the ecological baseline due to climate change acting in combination with the predicted effects on ecology. Potential changes in the baseline could arise from projected changes and trends for climate averages¹²⁴ and extreme weather including:
- low flows and decreases in water levels in watercourses, lakes, ponds and wetland habitats as a result of drought;
 - loss of open water habitats as a result of flooding;

¹²⁴ Morecroft, M and Speakman, L (eds.) (2013), *Terrestrial Biodiversity Climate Change Impacts Summary Report, Living with Environmental Change*, Natural England, London.

- tree loss and associated degradation of woodland and hedgerow habitats caused by drought conditions and high winds;
- degradation of lowland heathland and grassland habitats due to changes in species composition resulting from alterations in temperature and precipitation; and
- consequent effects on animal species supported by these habitats.

7.5.3 These changes are not likely to have a noticeable effect on the future baseline considered in this assessment.

7.5.4 In seeking to control and reduce potential future adverse effects of climate change on biodiversity, the need to create a permeable landscape through which species (and habitats) can move in response to changes in climatic and ecological conditions, thereby enabling them to respond to the potential impacts of climate change, is crucial. The development of the landscape mitigation and habitat creation within the Proposed Scheme has been heavily influenced by this imperative (as discussed in Volume 1, Section 9). The aims of maintaining and enhancing habitat connectivity within the landscape and of increasing the size of core habitat areas have clear advantages for the future resilience of biodiversity in response to climate change¹²⁵.

7.5.5 Thus the avoidance, mitigation, compensation and enhancement measures incorporated within the Proposed Scheme have been aligned with the future resilience of biodiversity to climate change, as follows:

- existing areas of biodiversity value have been preserved where reasonably practicable;
- habitat creation areas are often adjacent to protected areas and areas managed for biodiversity with a view to increasing their size/resilience to climate change;
- strong linkages will be created between habitat fragments and islands to ensure that the landscape is permeable to species that move in response to climate change;
- the amount, quality and distribution of suitable habitat will be enhanced in order to allow robust and sustainable colonies to establish as species move in response to climate change;
- varied landscapes will be created with a diversity of features and structure; and
- measures to avoid the spread of invasive alien species (which may be competitively favoured by climate change) will be implemented, mainly through the implementation of measures within the draft CoCP and associated documents.

¹²⁵ Refer, for example, to: Tyldesley, D. (2009), *Climate change and biodiversity adaptation: the role of the spatial planning system*. Natural England Commissioned Report, Number 004; Defra – UK Biodiversity Partnership (2007), *Conserving Biodiversity in a Changing Climate: guidance on building capacity to adapt*; MONARCH Partnership (2007), *Modelling Natural Resource Responses to Climate Change*; Natural England and BRANCH Partnership (2007), *Planning for biodiversity as climate changes*.

7.5.6 Once mitigation habitats, landscape planting and other mitigation measures (e.g. green bridges) are in place and established, it is unlikely that the Proposed Scheme will represent a significant barrier to the movement of species in response to changes in climatic and ecological conditions. The habitats that establish alongside the Proposed Scheme will provide areas suitable for a wide range of species, minimising potential barrier effects from the operational railway.

7.6 Monitoring

7.6.1 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

8 Health

8.1 Introduction

8.1.1 The health effects of the Proposed Scheme are reported at both route-wide and community area levels. This section identifies the impacts of the Proposed Scheme that may affect the population across the route as a whole, and also at the wider regional level. It reports changes that are considered to be potentially important for the health and wellbeing of people within this population. Potential health effects arising from localised impacts, which will affect specific communities along the route of the Proposed Scheme, are reported in the Volume 2, community area 1–5 reports. A full list of the impacts of the Proposed Scheme that will affect health, and where these are reported, is provided in Volume 1, Section 8.

8.2 Scope, assumptions and limitations

8.2.1 The scope, assumptions and limitations for the health assessment are set out in Volume 1, the Scope and Methodology Report¹²⁶ (SMR) and the SMR Addendum¹²⁷.

8.2.2 As set out in the SMR, the health assessment is based on broader understanding of health, consistent with the World Health Organization (WHO) definition of health as 'a state of complete physical, mental and social well-being and not merely an absence of disease or infirmity'. An individual's health is mostly determined by genetics and lifestyle factors, but for a large enough population many other factors, or 'health determinants', are known to be important, and these factors may be affected by the Proposed Scheme.

8.2.3 The assessment has considered the impacts of the Proposed Scheme on a range of environmental and socio-economic 'health determinants', which could result in adverse or beneficial effects on health and wellbeing. This process is documented in the health assessment matrices in Volume 5: Appendix HE-001-003. Based on this a professional judgement has been made to identify those effects on population health and wellbeing that are sufficiently important to report within the health assessment sections found in this report and Volume 2, community area 1–5 reports.

8.2.4 The health determinant impacts of relevance to the population along the route as a whole are considered to be:

- impacts during construction:
 - employment and income;
 - housing;
 - transport (traveller stress and road safety); and
- impacts during operation:
 - airborne noise (railway noise).

¹²⁶ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

¹²⁷ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

- 8.2.5 The health assessment identifies those areas where impacts on health determinants are predicted to occur. In some cases, such as for airborne noise, this comprises a fixed study area (1km either side of the route of the Proposed Scheme in rural areas, 500m in urban areas). In other cases, such as employment impacts, there is no defined study area. Direct impacts such as demolition of commercial and residential properties occur within the boundaries of the Proposed Scheme, although the health effects may be felt by people further afield (such as employees of affected businesses). As regards traffic and transport, the health assessment focuses on the rural communities and villages close to the Proposed Scheme where the majority of transport impacts will occur.
- 8.2.6 The health assessment methodology is based, in part, on a review of published evidence showing how impacts on health determinants are linked to health 'outcomes' (i.e. effects) in a large population. The evidence varies in its strength; for example, the evidence linking sound, noise and vibration to health outcomes is strong, whereas the evidence linking employment with health outcomes is moderate. The strength of evidence does not necessarily determine the importance of a health effect, but is an indication of the level of certainty in the assessment. Additionally, there is greater reliability in the prediction of an impact on a health determinant than the consequent effect on health.
- 8.2.7 There is no established or widely accepted framework for assessing the 'significant' health effects of a development proposal. The SMR and the SMR Addendum set out a methodology for describing the impacts on health determinants in terms of the magnitude and duration of the change to health determinants and the extent of the population exposed to this change. It also draws attention to the strength of evidence that links a change in health determinant with health effects. This framework permits the assessment to describe the impacts on determinants in a largely qualitative manner, with some structure to the relative scale of these impacts to give a sense of the importance of the potential health effects. However, this does not provide a clear basis for drawing conclusions as to whether a health effect is likely to be 'significant'.

8.3 Environmental baseline

Existing baseline

- 8.3.1 The Proposed Scheme will pass through mainly rural areas, which are sparsely populated. At its northern end, the route of the Proposed Scheme will pass through increasingly populated areas on the approach to Crewe.
- 8.3.2 Data provided by the Office of National Statistics¹²⁸ and the Association of Public Health Observatories (APHO)¹²⁹ show that the population within the rural areas that will be crossed by the route of the Proposed Scheme are, by comparison with national averages, in good health and experience low levels of deprivation. This rural population as a whole is considered to be more resilient than the national average, with regard to changes in the relevant health determinants, and with relatively few

¹²⁸ The Office of National Statistics (ONS) provides spatial data on levels of deprivation, using indicators of: 'multiple deprivation', 'employment', 'education', 'barriers to housing and social services', 'crime' and 'living environment'. These data are based on the 2011 census and available by Lower Super Output area.

¹²⁹ Public Health England <https://www.gov.uk/government/organisations/public-health-england>

vulnerabilities. One vulnerability that is apparent is a slightly higher than average proportion of older people across the majority of the route. Another is that the population is more deprived than the national average with regard to the indicator of 'barriers to affordable housing and social services'. In part, this reflects the rural nature of the area and the distance people have to travel to access services.

- 8.3.3 The more urban communities in Crewe East and Crewe South, within the South Cheshire community area (CA5), have a number of vulnerabilities that are specific to this part of the route of the Proposed Scheme. Levels of employment deprivation and education and skills deprivation are higher than the national average and the proportion of children living in low income families is also above average. Parts of this area also have above national average levels of health and disability deprivation.
- 8.3.4 The available data permits a profile to be made of the whole population along the route of the Proposed Scheme and provides detail down to ward level¹³⁰. The description of the whole population and the populations within wards does not exclude the possibility that there will be some individuals or small groups of people who do not conform to the overall profile.
- 8.3.5 Detailed community profile data for each community area along the route of the Proposed Scheme are set out in Background Information and Data (BID)¹³¹, (see BID-HE-002-001 to BID-HE-002-005).

Future baseline

Construction (2020)

- 8.3.6 Volume 5: Appendix CT-004-000 provides details of the developments on or close to the Proposed Scheme that are assumed to have been implemented by 2020. Implementation of all outstanding development consents and land allocations that can be built within the search area¹³² could result in approximately 35,500 additional jobs and approximately 13,000 new homes by 2020.

Operation (2027)

- 8.3.7 No additional committed developments have been identified in this area that will materially alter the baseline conditions in 2027 for health receptors.

8.4 Avoidance and mitigation measures

- 8.4.1 Consideration of potential health issues is an integral part of the planning and design of the Proposed Scheme, alongside other environmental, community and economic issues. Adverse effects on health determinants have been reduced as far as reasonably practicable through mitigation measures, which have been incorporated into the design of the Proposed Scheme. The mitigation measures that are most relevant to this route-wide health assessment include:

- reducing the loss of property and community assets, as far as reasonably

¹³⁰ Electoral wards are the spatial units used to elect local government councillors. National Census data are published at ward level.

¹³¹ HS2 Ltd (2017), *High Speed Two (HS2) Phase 2a (West Midlands - Crewe) Background Information and Data*, Available online at: www.gov.uk/hs2

¹³² Information on committed developments, defined as approved planning applications and adopted allocations, has been collected for an area of up to 2km (5km for larger schemes such as nationally significant infrastructure projects) from the land required to construct the Proposed Scheme.

practicable;

- design of the track and track bed to avoid or reduce ground-borne noise and vibration; and
- provision of noise fence barriers and bunds to provide acoustic screening.

8.4.2 The design of the Proposed Scheme has also reduced the impacts of construction traffic through the following incorporated mitigation measures:

- site haul routes will be created adjacent to the route of the Proposed Scheme, and construction materials and equipment will be transported along the site haul routes where reasonably practicable to reduce Heavy Goods Vehicle (HGV) movements on the public highway;
- borrow pits¹³³ have been included to reduce HGV movements on the local road network;
- a temporary railhead will be provided near Stone to enable materials and equipment for the construction of the Proposed Scheme to be transported by rail where reasonably practicable and thereby reduce HGV road movements; and
- worker accommodation at three locations¹³⁴ will be provided which will reduce the traffic impact of daily worker trips.

8.4.3 Contractors will be required to comply with the Environmental Minimum Requirements for the Proposed Scheme, which will include the Code of Construction Practice (CoCP).

8.4.4 The CoCP will be the means of controlling the construction works associated with the Proposed Scheme to ensure that the effects of the works upon people and the natural environment are reduced or avoided so far as reasonably practicable.

8.4.5 The draft CoCP¹³⁵ includes mitigation measures to reduce transport impacts during construction of the Proposed Scheme. These include, but are not limited to, the following measures:

- engagement with vulnerable road users (pedestrians, motorcyclists, cyclists, equestrians), to provide for road safety for users of all modes of transport for the public and construction staff during traffic management works and temporary traffic control measures;
- contractor implementation of driver training programmes relevant to their specific environment (e.g. to protect pedestrians and non-motorised traffic);
- vehicle safety measures including signage, mirrors, prevention of under-running and use of technology to remove blind spots according to vehicle size;

¹³³ Refer to Volume 1, Section 6 for a description of borrow pits

¹³⁴ Worker accommodation will be provided at: Trent South Embankment main compound, Yarnfield North Embankment satellite compound and Basford Cutting main compound, as described in Volume 2, Community area 2, Colwich to Yarlet, Community area 3, Stone and Swynnerton and Community area 5, South Cheshire.

¹³⁵ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

- a list of roads that may be used by construction traffic in the vicinity of the site, including any restrictions to construction traffic on these routes, such as the avoidance of large goods vehicles operating adjacent to schools during drop-off and pick-up periods;
- regular operation of traffic liaison groups with key stakeholders to ensure that programmes of HS2 works are shared and which will assist the highways authorities to carry out their network management duties, traffic liaison groups will consider appropriate engagement with local communities directly affected by site specific traffic management plans on a case-by-case basis;
- installation of appropriate signage indicating all temporary and permanent diversions of public rights of way (PRoW); and
- retaining access for cyclists and pedestrians, where safe and appropriate.

8.4.6 HS2 Ltd has adopted a series of strategic aims, which include skills, employment and education (SEE). These aims are intended to extend through the supply chain using procurement and contractual requirements. All major contracts will contain contractual requirements to provide SEE outputs, including apprenticeships, workless job starts and schools engagement.

8.4.7 HS2 Ltd has committed to providing a minimum of 2,000 apprenticeships over the lifetime of the entire project (which includes Phase One and Phase Two). The majority of these apprenticeships will be delivered through the supply chain across a wide range of trades and professions from construction to accountancy, quantity surveying to business administration.

8.4.8 Businesses required to relocate due to the construction of the Proposed Scheme will be eligible to claim compensation in accordance with the Compensation Code¹³⁶. HS2 Ltd recognises the importance of businesses being able to relocate to alternative premises and, therefore, offers additional support over and above statutory requirements to facilitate this process and to reduce and/or offset the effects of the Proposed Scheme.

8.4.9 As described in Volume 1, HS2 Ltd is committed to providing trains that are quieter than the relevant current European Union specifications. Noise barriers in the form of landscape earthworks and noise fence barriers will avoid or reduce significant airborne noise effects. Significant ground-borne noise and vibration effects will be avoided or reduced through the design and maintenance of the track and track bed.

8.5 Effects arising during construction

Education, employment and income

8.5.1 There is strong evidence for links between employment and income and physical and mental health. The benefits of work are linked to increased opportunities for participation in society and increased access to healthier lifestyle choices, which are

¹³⁶ HS2 Ltd (2017), *Claim compensation if your property is affected by HS2. 1. Overview*. Available online at: <https://www.gov.uk/claim-compensation-if-affected-by-hs2/overview>. Refer to Volume 1, Section 1 for details of the Compensation Code and how it relates to the Proposed Scheme.

associated with improved mental and physical health. Employment also has direct health benefits such as social and psychological wellbeing, with work being an important aspect of individual identity and social status. A review of published research evidence linking employment, income and education with health and wellbeing can be found in Volume 5: Appendix HE-003-000.

Construction employment and training

- 8.5.2 The Proposed Scheme will increase opportunities for employment and training during the construction phase. The socio-economic assessment (Section 12) estimates that the construction sites located along the route will generate 22,400 person years of construction jobs (the equivalent of 2,240 permanent full-time construction jobs), ranging from unskilled and low skilled jobs to technical and managerial roles. Of these, an estimated 11,700 person years of construction employment (equivalent to 1,170 permanent full time construction jobs) will be based at worksites along the Proposed Scheme. Communities within commuting distance of the Proposed Scheme will potentially benefit from these new employment opportunities, as well as from the training opportunities provided by HS2 Ltd's apprenticeship scheme.
- 8.5.3 A further estimated 8,400 person years of employment (the equivalent of 840 full-time jobs) could be created as a result of additional demand for goods and services through the business supply chain and expenditure effects of workers.
- 8.5.4 Contractors generally appoint the majority of skilled and managerial staff from their existing workforce or recruit nationally, and therefore uptake of construction jobs from within local communities is likely to be predominantly in lower skilled roles. However, depending on skill levels required, and the skills of local people, construction employment will be accessible to residents within the Staffordshire and Cheshire East areas. These may include a range of occupations, such as skilled construction workers, labourers, tunnelling specialists, mechanical fitters, steel fixers, electricians, engineering professionals, and management and planning professionals. The local jobs created will last for the duration of the works, after which the training, skills and experience gained may continue to benefit people through improved future employment prospects in the construction sector.
- 8.5.5 The extent of beneficial health effects within the local communities arising from construction employment will depend on the number of people who are able to, and choose to, take up opportunities for employment and training. For those who do, this may result in improved income and employment status, with potential health and wellbeing benefits ranging from improved self-esteem to physical health benefits associated with increased access to healthy lifestyle choices.
- 8.5.6 Beneficial effects are likely to be greatest in the more urban areas such as Stafford, Stoke-on-Trent and Crewe, as these areas contain a higher proportion of people of working age and with skills in the construction sector. Above regional average levels of unemployment and deprivation in areas such as Crewe and Stoke-on-Trent will mean that, subject to uptake of opportunities such as apprenticeships, these communities would potentially have the most to gain from the employment and training opportunities and associated beneficial effects on health and wellbeing.

Direct and indirect business impacts and associated income and employment impacts

- 8.5.7 The land required for the Proposed Scheme will result in direct impacts on some local businesses. These will include the displacement of some businesses, and loss of land with the potential to impact on business activities at others. The socio-economic assessments (Volume 2, community area reports 1–5, Section 12) identify a small number of businesses that will be directly impacted by the Proposed Scheme. As described in Section 12, approximately 140 jobs, including agricultural jobs, will be displaced as a result of land required to construct the Proposed Scheme. Of these, it is assumed that approximately 15 jobs could be lost.
- 8.5.8 The socio-economic assessment in Section 12 predicts that five businesses along the route will be indirectly affected by a combination of noise, visual and transport and severance impacts with the potential to affect trade. Any reduction in levels of trade could lead to reduced business incomes, potentially affecting the earnings of owners and employees.
- 8.5.9 The total estimated job losses route-wide from direct and indirect business impacts and associated impacts on supply chains and expenditure in the local economy is predicted to be approximately 40, as set out in Section 12, Socio-economics. Job losses will directly impact on incomes, and the extent to which these are recovered will depend on the type of alternative employment secured by the individuals affected.
- 8.5.10 The level of job losses and reductions in income resulting from the construction of the Proposed Scheme are very small in the context of the local and regional labour markets, and will not affect health at the population level. Further, the low level of unemployment within the study area, serves to reduce the likelihood of individuals remaining unemployed in the medium to long term, or settling for lower paid employment. In terms of overall employment and income, the construction of the Proposed Scheme will result in a net health and wellbeing benefit as a result of construction employment opportunities for local people. However, some individuals may be adversely affected, particularly those who are less able to adapt due to personal circumstances and vulnerabilities. For example, workers on low incomes or with impaired mobility may face difficulties commuting to a new location. Such impacts could result in long-term effects on employment status, leading to potential adverse health and wellbeing effects.

Housing

- 8.5.11 There is moderate to strong evidence on the links between housing and health, relating to the quality and security of housing, and also to the effects of involuntary relocation. Relocation of people from their homes has been shown to influence health outcomes, as disturbance to people's living and social environment and routine may precipitate stress and related symptoms. Moving house involves disruption, uncertainty and changes to social networks and familiar environments and routines.

Residential relocations

- 8.5.12 The number of demolitions of residential properties, and subsequent relocation of residents, has been reduced as far as reasonably practicable through the design of the

Proposed Scheme. However, the Proposed Scheme will result in the demolition of a total of 26 residential properties across the route as a whole, as described in the Volume 2, community area 1–5 reports.

- 8.5.13 Homeowners whose properties are acquired for the construction of the Proposed Scheme will be eligible for compensation in accordance with the Compensation Code. However, the majority of residents whose properties are required for the construction of the Proposed Scheme are likely to experience some degree of adverse effect on their wellbeing resulting from the requirement to move, such as a temporary increase in stress. The rural nature of the study area means that there will be a limited choice of alternative properties within the immediate locality. Those affected are, therefore, also likely to experience some disruption and weakening of their social networks following the move.
- 8.5.14 The degree of health effect associated with moving will depend on the vulnerability or resilience of the individuals affected. Older people are likely to find it more difficult to adapt following involuntary relocation, as are disabled people, and those with existing mental or physical health conditions. Parents and carers may need to move their children to different schools, or face longer journeys to school, particularly in rural areas. Children may be particularly affected if the move results in a change of school.
- 8.5.15 The onset of adverse effects such as increased stress is likely to occur before the compulsory acquisition of properties. Residential owner occupiers within the land which is safeguarded for the Proposed Scheme can avoid prolonged uncertainty by selling their homes through the Express Purchase Scheme¹³⁷.

Housing market

- 8.5.16 The prospect of construction of the Proposed Scheme may affect local property values prior to and during construction. Homeowners whose properties are within the 'rural support zone' (outside the safeguarding zone and up to 120m from the centre line of the Proposed Scheme in rural areas) may sell their property at its unblighted open market value to the Secretary of State through the Voluntary Purchase Scheme, or alternatively apply for a cash offer of 10% of this value. Homeowners outside of this area may be entitled to sell their property at its unblighted open market value to the Secretary of State through the Need to Sell Scheme¹³⁸, if they have a 'compelling reason' to sell, such as relocation for a job or ill health, and are unable to sell other than at a substantially reduced value because the location of the property and the effect of the Proposed Scheme.
- 8.5.17 HS2 Ltd recognises that home-owners close to the route of the Proposed Scheme have been, and will continue to be, affected by the Proposed Scheme. Past experience of infrastructure projects and other kinds of development suggest that blight tends to be at its worst before building starts, when there is most uncertainty and least definite information about the impacts of the development¹³⁹. HS2 Ltd has worked to reduce

¹³⁷ HS2 Ltd (2017), *Claim compensation if your property is affected by HS2. 2. Express Purchase Scheme*. Available online at: <https://www.gov.uk/claim-compensation-if-affected-by-hs2/express-purchase-scheme>

¹³⁸ HS2 Ltd (2017), *Claim compensation if your property is affected by HS2. 4. Need to Sell Scheme*. Available online at: <https://www.gov.uk/claim-compensation-if-affected-by-hs2/need-to-sell-scheme>

¹³⁹ Department for Transport (2012), *Review of Property Issues*. Available online at: <https://www.gov.uk/government/publications/review-of-property-issues>

uncertainty by engaging with local communities on the preferred line of the route directly, and consulting through the working draft Environmental Impact Assessment Report. However, notwithstanding the measures in place to reduce these impacts, there is a potential for homeowners to be impacted by property blight, particularly in the period leading up to construction. Those most affected are likely to include older people, for whom the period of uncertainty ahead of construction will constitute a larger proportion of their years in their home, and young people who have recently purchased their first homes. Evidence from consultation responses suggests that people are experiencing anxiety in relation to potential property blight.

Transport effects

Traveller stress

- 8.5.18 Government guidance¹⁴⁰ has identified 'traveller stress' as an outcome of transport delays and disruption, affecting both drivers and public transport users. This comprises feelings of discomfort, annoyance, frustration or fear, culminating in physical and emotional tension that detracts from the quality and safety of a journey. Factors influencing traveller stress include fear of potential accidents, journey time and route uncertainty.
- 8.5.19 The Volume 2, community area 1–5 reports, Section 14, Traffic and transport, describe the impacts on the local road network during the construction of the Proposed Scheme. Delays will be caused by increased traffic flows, temporary road or lane closures and associated diversions, temporary signals and speed restrictions. This will lead to temporary increases in journey times on some routes, which may cause frustration for drivers. Additionally, temporary road closures and diversions will increase route uncertainty, and temporary large increases in the proportion of HGVs on some roads may increase fear of accidents. It is considered that the combination of these impacts will lead to temporary increases in the levels of stress experienced by drivers on the affected routes. Stress experienced during journeys is not expected to lead to an increase in levels of stress more generally. However, concerns about traveller stress may deter some people from travelling on the affected routes.

Road safety

- 8.5.20 Overall traffic flows affect the likelihood of accidents occurring, and the HGV content of traffic can affect road safety, particularly for pedestrians, cyclists and equestrians. The national rate of fatal or serious accidents involving HGVs is reducing due to improved awareness and safety measures, with fatal or serious accidents involving HGVs falling by 45% between 2006 and 2015¹⁴¹.
- 8.5.21 The construction of the Proposed Scheme will increase the amount of traffic, including HGVs, on local roads. The CoCP will require contractors to produce traffic management plans including measures to address road safety and reduce the risks to non-motorised users from construction vehicles on the roads. Contractors will be required to gain accreditation from the Fleet Operator Recognition Scheme¹⁴², or

¹⁴⁰ Department for Transport (2017 as updated), *Transport analysis guidance: WebTAG (or TAG)*. Available online at: <https://www.gov.uk/guidance/transport-analysis-guidance-webtag>

¹⁴¹ Department for Transport (2016), *Reported road casualties in Great Britain: main results 2015*.

¹⁴² Fleet Operator Recognition Scheme (FORS). Available online at: <https://www.fors-online.org.uk/cms/>

equivalent, in order to demonstrate that all drivers have appropriate training in pedestrian, equestrian and cycle awareness and specific issues relating to driving on rural roads.

- 8.5.22 Impacts on road safety during the construction of the Proposed Scheme are assessed in Volume 2, community area 1–5 reports, Traffic and transport. These assessments identify locations where construction traffic is predicted to change the average daily traffic flows by 30% or more, then consider the baseline accident rate on the affected link or junction and apply professional judgement to evaluate the accident risk. The assessments also identify existing accident clusters and assess the potential for construction traffic to impact on these.
- 8.5.23 Traffic flow is a factor in determining the risk of accidents occurring, and any increase in traffic, particularly HGVs, may affect road safety across the road network. There are no locations where elevated baseline accident rates coincide with changes of greater than 30% in average daily traffic flows. Therefore, no specific locations have been identified as having a quantifiable increase in the risk of accidents.
- 8.5.24 Feedback from community consultation indicates that changes in road safety, particularly associated with HGVs, is a key issue of concern to local communities. In addition to the direct impacts on health and safety should an accident occur, concerns about road safety have the potential to affect wellbeing adversely through increased anxiety, and behavioural changes, such as a reduction in levels of cycling or walking children to school.

Other mitigation

- 8.5.25 HS2 Ltd will engage with local authorities and communities on road safety during construction works.
- 8.5.26 Businesses displaced by the Proposed Scheme will be compensated in accordance with the Compensation Code. HS2 Ltd recognises the importance of businesses, displaced from their existing premises, being able to relocate to suitable alternative premises and will, therefore, offer additional support over and above statutory requirements to facilitate this process.
- 8.5.27 The construction of the Proposed Scheme offers considerable opportunities to businesses and residents along the line of route in terms of supplying goods and services and obtaining employment. HS2 Ltd is committed to working with its suppliers to build a skilled workforce that promotes further economic growth across the UK.
- 8.5.28 HS2 Ltd is continuing to engage with local businesses, including farmers and growers, affected by the Proposed Scheme to identify reasonably practicable measures to avoid or reduce the loss of business resulting from impacts such as severance.

8.6 Effects arising during operation

Airborne noise

- 8.6.1 There is a strong link between transport noise and health, with long-term exposure to higher levels of transport noise being associated with adverse health outcomes. At the population level, it is possible to quantify the effects on health resulting from long-

term exposure to transport noise, using established exposure-response relationships for specific health outcomes. A Defra-led group of Government analysts¹⁴³ published three reports between 2008 and 2010 detailing current understanding of the links between transport noise and various effects including sleep disturbance, annoyance, hypertension and ischemic heart disease. These reports provided expert advice to Defra which, in 2014, published a report and appraisal tool for the valuation of transport noise¹⁴⁴. More information on the published research, including more recent evidence, can be found in Volume 5: Appendix SV-001-000.

- 8.6.2 The Defra report presents recommended methods to assess the impacts of noise on health to support project appraisal. This includes guidance on how to both quantify the expected number of people affected and then value this impact in terms of Disability-Adjusted Life Years (DALYs)¹⁴⁵. These recommended methods have been adopted by the Department for Transport and incorporated into the environmental impact appraisal unit of the Government's Transport Appraisal Guidance (TAG). The following assessment of the Proposed Scheme has been carried out using these methods to calculate the number of DALYs lost over a 60 year appraisal period.

Health burden of noise within the study area

- 8.6.3 By comparison to existing ambient sound levels, exposure to noise from the Proposed Scheme will be comparatively small. This reflects the amount of mitigation that has been incorporated into the Proposed Scheme. An assessment of existing ambient sound levels documented in Section 13 of the Volume 2, community area 1–5 reports, identified that residential properties within the airborne sound study area (defined as 1km either side of the route of the Proposed Scheme in rural areas and 500m either side in urban areas) are currently exposed to a health impact due to noise resulting in a loss of approximately 500 DALYs over a 60 year appraisal period. The sources of sound that result in this existing health effect primarily consist of road traffic noise as described in the Volume 2, community area 1–5 reports. The Proposed Scheme is estimated to result in an additional 85 DALYs, or a 17% increase in DALYs lost due to noise within the airborne sound study area.
- 8.6.4 The noise-induced health effects from the Proposed Scheme can be presented based on the distance from the route of the Proposed Scheme. Figure 9 presents the DALYs in days per person for each health pathway in 50m distance bands from the route of the Proposed Scheme. The figure includes several dwellings that are likely to qualify for an offer of noise insulation. If accepted, this could help reduce the estimated health effect due to noise from both the Proposed Scheme and existing sources of sound. It can be seen that the risk of a noise induced health effect from the Proposed Scheme will diminish with distance. Figure 10 presents the number of residential dwellings within the airborne noise study area in 50m distance bands from the route of the Proposed Scheme. As a result of designing the route to avoid residential properties where reasonably practicable, it can be seen that the majority of dwellings are located between 500m and 1km of the route of the Proposed Scheme.

¹⁴³ The Interdepartmental Group on Costs and Benefits - Noise Subject Group.

¹⁴⁴ Defra (2014). *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet*.

¹⁴⁵ DALYs indicate the estimated number of healthy life years lost in a population from premature mortality or morbidity, i.e. the health burden. For the Proposed Scheme, this is calculated using the central disability weighting values from WHO and 2.3 people per residential dwelling.

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Figure 9: Health burden due to noise from the Proposed Scheme as changes in DALYs lost (days per person)

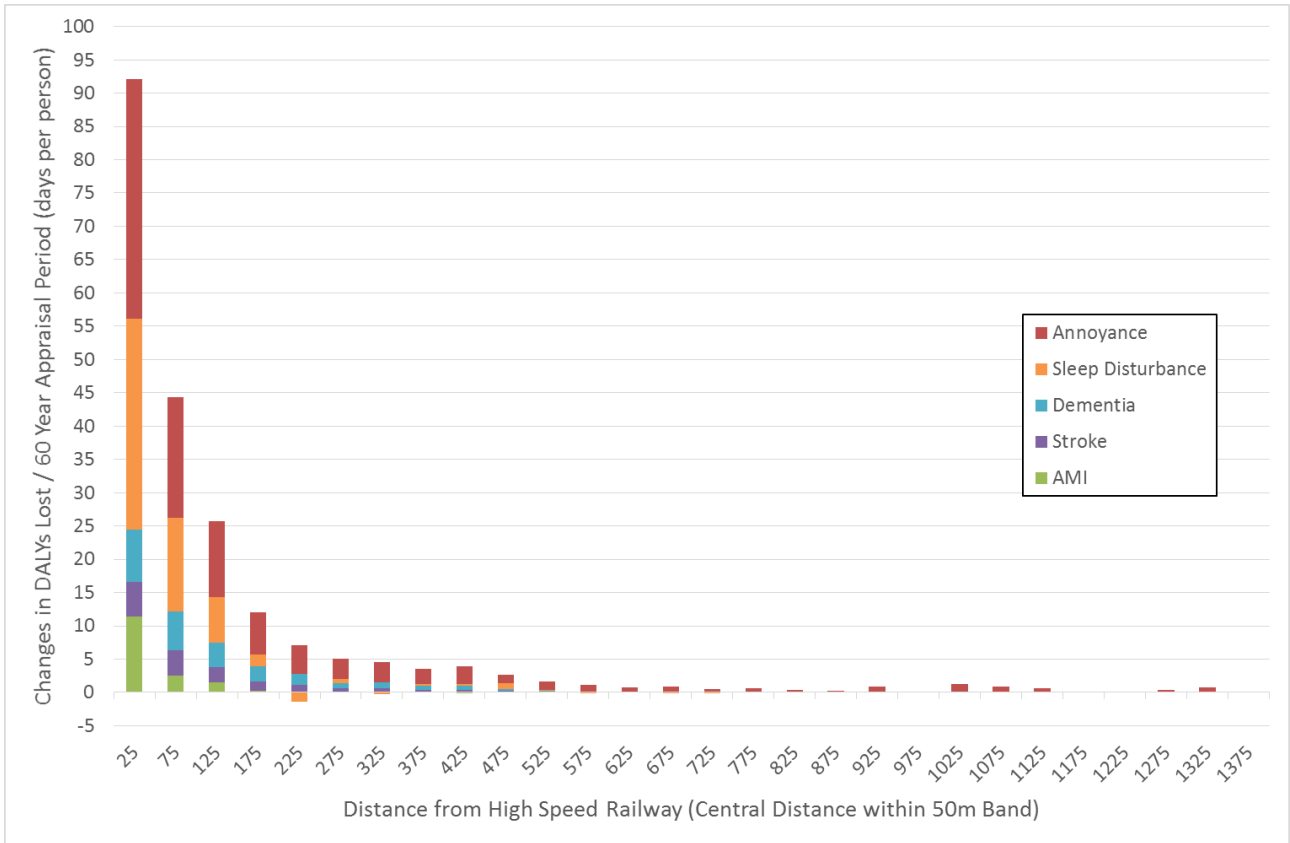
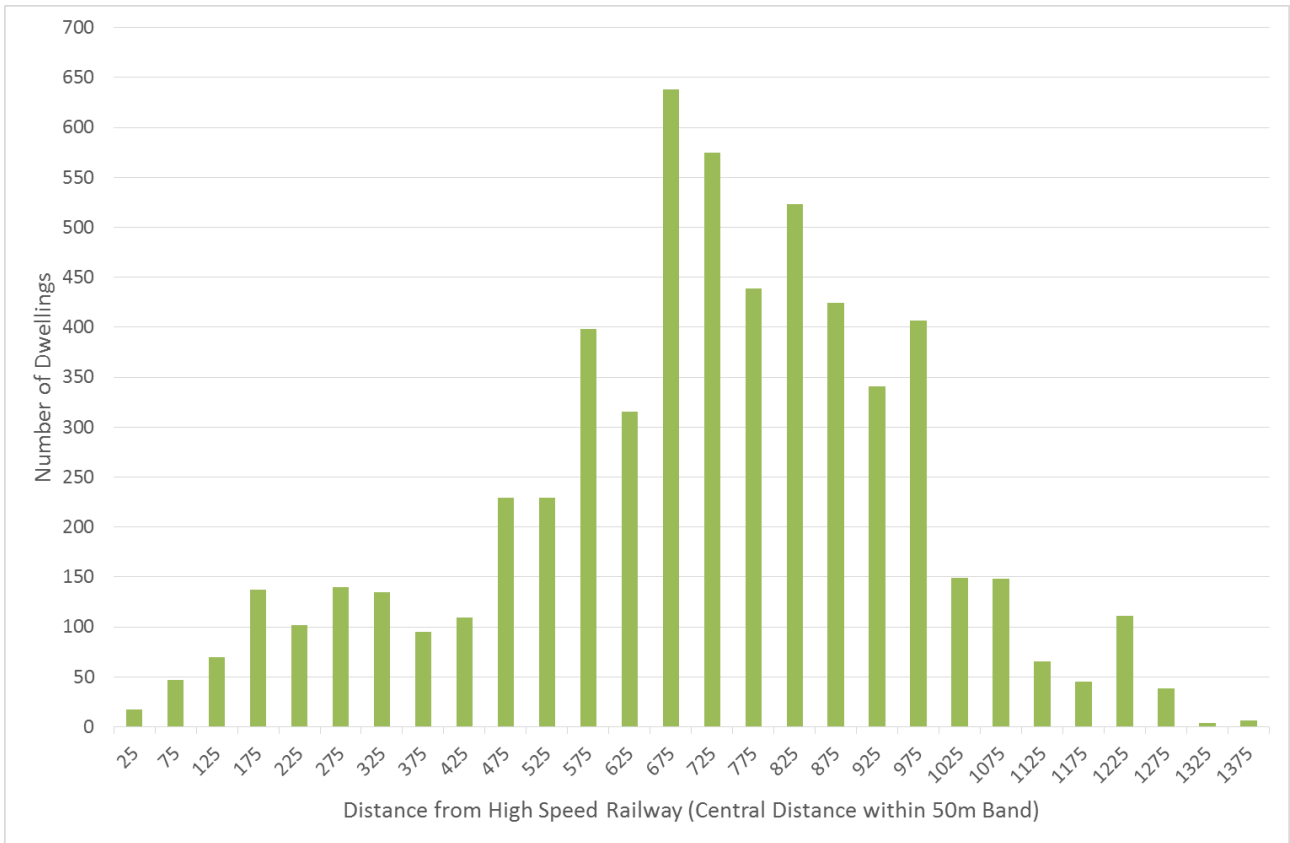


Figure 10: Number of residential properties within the airborne noise study area



- 8.6.5 The following sections present the breakdown of the total health burden due to operational noise from the Proposed Scheme into each individual health effect presented in the Defra reports.

Sleep disturbance

- 8.6.6 The WHO Night Noise Guidelines for Europe¹⁴⁶ cites numerous studies that detail the effects of transport noise on sleep. Studies have shown that noise can affect sleep in terms of immediate effects (e.g. arousal responses, sleep state changes, awakenings, body movements, total wake time, autonomic responses), after-effects (e.g. sleepiness, daytime performance, cognitive function) and long-term effects (e.g. self-reported chronic sleep disturbance). The health impact of sleep disturbance due to noise from the Proposed Scheme, in changes in DALYs lost, is estimated from: the direct assessment of outdoor night time noise levels L_{night} at residential properties; the recommended exposure-response functions; and the weighting factor from WHO reflecting the severity of sleep disturbance on health.
- 8.6.7 The direct assessment of night time noise at residential properties has identified approximately 500 dwellings where the Proposed Scheme has the potential to decrease sleep disturbance and approximately 1300 dwellings where the Proposed Scheme has the potential to increase sleep disturbance¹⁴⁷. However, only a small proportion (in the region of 2–8%) of the total number of people living in these dwellings would be expected to report a change in noise-induced sleep disturbance. The health impact of sleep disturbance due to noise at these dwellings is a loss of approximately 13 DALYs over a 60 year appraisal period.

Annoyance

- 8.6.8 It is well established that transport noise can cause annoyance to local residents. Whilst annoyance is not a disease in itself, it does affect wellbeing and could act as a gateway to more serious health impacts. Therefore, using the broader definition of health, it is possible to estimate the changes in DALYs due to noise from the Proposed Scheme, valuing high annoyance as a distinct health endpoint. The health impact of annoyance due to the Proposed Scheme, in changes in DALYs lost, can be estimated using: the direct assessment of daytime noise $LA_{\text{eq},16\text{h}}$ at residential properties; the recommended dose-response functions; and the weighting factor from WHO reflecting the severity of annoyance on health.
- 8.6.9 The direct assessment of daytime noise at residential properties has identified approximately 170 dwellings where the Proposed Scheme has the potential to reduce noise annoyance and approximately 5,150 dwellings where the Proposed Scheme has the potential to cause or increase noise annoyance. However, only a small proportion (in the region of 5–20%) of the total number of people living in these dwellings would be expected to become annoyed or experience an increase in annoyance. The health impact of annoyance due to noise at these dwellings is a loss of approximately 50 DALYs over a 60 year appraisal period.

¹⁴⁶ World Health Organization (2009). *Night Noise Guidelines for Europe*.

¹⁴⁷ The numbers of dwellings are calculated using the predicted sound levels within the airborne sound study area and the 3dB banding within the WebTAG Noise Workbook. Available online at: www.gov.uk/government/publications/webtag-environmental-impacts-worksheets. The beneficial effects occur in locations where existing noise sources have been reduced, for example a realigned road.

Noise and cardiovascular effects

Hypertension

- 8.6.10 A link between transport noise and hypertension is relatively well established in the relevant academic literature. A leading hypothesis for this association is that exposure to noise could lead to arousals of the autonomic nervous system and endocrine system, including increases in systolic and diastolic blood pressure, changes in heart rate, and the release of stress hormones. Dependent upon the level of exposure, the duration of the exposure and certain attributes of the person exposed, this may make a person hypertensive¹⁴⁸.
- 8.6.11 It is important to note that hypertension is considered a risk factor for disease rather than a disease state itself¹⁴⁹. However, Defra has recommended steps which have been incorporated into the Government's Transport Appraisal Guidance (TAG) to value the expected incidents of hypertension by quantifying and valuing consequential changes in incidence of both dementia and stroke. The health impact of hypertension, in changes in DALYs lost, is estimated using: the direct assessment of daytime noise $L_{Aeq,16h}$ at residential properties; the odds ratio for the marginal probability of hypertension from railway noise; and the weighting factors from WHO reflecting the severity of strokes and dementia on health.
- 8.6.12 The direct assessment of daytime noise at residential properties has identified approximately 250 dwellings where the Proposed Scheme has the potential to reduce noise-induced hypertension, reducing the risk of stroke or dementia and approximately 3,400 dwellings where the Proposed Scheme has the potential to increase that risk. However, the evidence is that each decibel change in noise would change the risk of hypertension by less than 1% for people living in these dwellings, a very small amount. Based on this, the assessed health impact of hypertension (stroke and dementia) due to noise at these dwellings is a loss of approximately 19 DALYs over a 60 year appraisal period.

Acute myocardial infarctions

- 8.6.13 There is evidence to suggest an association between exposure to transport noise and cardiovascular effects. The recommended approach to assessing the health impact from acute myocardial infarctions (AMI) is reflecting using the dose-response relationship proposed by Babisch¹⁵⁰. The Babisch model attempts to show the direct and indirect causal pathways through which noise can affect cardiovascular health. Although concerns have been raised regarding the limitations of this approach, it is considered by Defra as the best method currently available for estimating prevalence of AMI based on sound levels¹⁵¹.

¹⁴⁸ Note, Hypertension is a medical condition of the cardiovascular system characterized by a consistently high blood pressure. So high blood pressure is not a condition in itself, but a symptom.

¹⁴⁹ World Health Organization (2011), *Burden of disease from environmental noise: Quantification of healthy life years lost in Europe*.

¹⁵⁰ Babisch, W. (2006), *Transportation Noise and Cardiovascular Risk, Review and Synthesis of Epidemiological Studies, Dose-Effect Curve and Risk Estimation*, WaBoLu-Hefte 01/06. Umweltbundesamt. Available online at: http://www.bruit.fr/images/stories/pdf/babisch_transportation_noise_cardiovascular_risk.pdf

¹⁵¹ Berry, B and Flindell I (2009), *Estimating Dose-Response Relationships between Noise Exposure and Human Health Impacts in the UK: Technical Report*.

- 8.6.14 Defra has recommended steps to estimate the change in the risk of incidences of AMI through the odds ratio estimated by the Babisch function, and value the consequential changes in incidence of AMI. The health impact of AMI, in changes in DALYs lost, is estimated using: the direct assessment of daytime noise $LA_{eq,16h}$ at residential properties; the odds ratio for the marginal probability of AMI from transport noise; and the weighting factors from WHO reflecting the severity of AMI on health.
- 8.6.15 The direct assessment of daytime noise at residential properties has identified approximately 100 dwellings where the Proposed Scheme has the potential to reduce the risk of AMI due to noise and approximately 800 dwellings where the Proposed Scheme has the potential to increase the risk of AMI. However, the evidence suggests that each decibel change in noise would change the risk of AMI by less than 0.01% for people living in these dwellings. The health impact of AMI due to noise at these dwellings is a loss of approximately 3 DALYs over a 60 year appraisal period¹⁵². Where it occurs, the severity of effect of AMI on health is high; however, relatively high noise levels are required to change the risk of incidence of AMI and overall only a small effect on a small population has the potential to occur as a result of the Proposed Scheme.

8.7 Monitoring

- 8.7.1 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

¹⁵² For those dwellings likely to be affected by noise from the Proposed Scheme, this amounts to an average of less than 1 day lost per person due to AMI.

9 Land quality

- 9.1.1 This section presents the route-wide assessment of the likely significant land quality effects arising from the construction and operation of the Proposed Scheme. Land quality encompasses issues relating to existing land contamination, mineral or mining resources and geological conservation resources.
- 9.1.2 Most of the route of the Proposed Scheme runs through predominantly rural areas, where potentially contaminative land uses have been found only in isolated locations and remediation at the construction stage will give rise essentially to local effects. Controls to deal with the effects of encountering land contamination are set out in the draft Code of Construction Practice (CoCP¹⁵³) and may be enhanced by site-specific remediation measures.
- 9.1.3 Through more urban areas, where the incidence of potentially contaminative land uses could be more widespread, the effects will again be essentially local in nature due to the limited area over which contamination can spread. Although ground gases, leachate and contaminated groundwater can migrate some distance from their source, such migration is unlikely to lead to any regional effects. Where either groundwater, leachate or ground gas migration is encountered, measures will be put in place to control contaminant mobilisation as necessary to avoid the occurrence of adverse effects.
- 9.1.4 One local geological conservation resource (the Butterson-Swynnerton Dykes exposure noted by Charles Darwin) has been identified within the vicinity of the Proposed Scheme, but the effect of crossing this feature is localised and does not constitute a regional or route-wide effect on geological conservation areas.
- 9.1.5 Staffordshire County Council (SCC) is the Mineral Planning Authority responsible for the overall mineral and waste local plans for Staffordshire. The new Minerals Local Plan (MLP) for Staffordshire (2015 to 2030)¹⁵⁴ sets out the SCC policies aimed at controlling mineral related developments within Staffordshire up to the year 2030.
- 9.1.6 Cheshire East Council (CEC) is the Mineral Planning Authority responsible for mineral and waste local plans in South Cheshire. These are covered in the Cheshire Replacement Minerals Plan¹⁵⁵.
- 9.1.7 There are a number of existing mineral safe guarding areas (MSA), areas of search and active mineral extraction sites within the land quality study area. Sterilisation or isolation of reserves could occur, although such effects are likely to be local in nature.

9.2 Assessment of the effects of construction

- 9.2.1 It is intended to deal with contaminated soils by treating and reusing suitable material wherever safe, practicable and necessary. Any material that cannot be made suitable for use will be taken off site, for further treatment or disposal. The likely incidence of

¹⁵³ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

¹⁵⁴ Staffordshire County Council (2017), *The Minerals Local Plan for Staffordshire 2015 to 2030. Adopted 16 February 2017*. Available online at: <https://www.staffordshire.gov.uk/environment/planning/policy/thedevelopmentplan/mineralslocalplan/mineralsLocalPlan.aspx>

¹⁵⁵ Cheshire County Council (1999); *The Cheshire Replacement Minerals Local Plan 1999*; Available online at: http://cheshireeast.gov.uk/planning/spatial_planning/saved_and_other_policies/cheshire_minerals_local_plan/cheshire_minerals_local_plan.aspx

such materials is considered to be low, and therefore the route-wide disposal of contaminated soils is not considered to be a significant issue (see Section 15, Waste and material resources). With the application of the measures set out in the draft CoCP and site-specific remediation, it is anticipated that there will be no likely significant adverse route-wide effects during construction.

- 9.2.2 Much of the length of the route of the Proposed Scheme coincides with sand and gravel mineral deposits. MSAs and areas of search occur regularly along the line of the route. Where appropriate, sand and gravel excavated for the purposes of construction will be re-used in the Proposed Scheme. In addition, a number of borrow pits are proposed to provide high quality aggregates for construction of railway embankments along the route. Following extraction of the aggregate, these will be reinstated with clean natural materials excavated from elsewhere within the Proposed Scheme. Where construction does occur within a MSA, any pre-extraction of surface minerals would assist in reducing the sterilisation impact to a local mineral supply. The pre-extraction of identified minerals will be discussed with the landowner, the Mineral Planning Authorities and other relevant stakeholders to assist in achieving effective management of minerals.
- 9.2.3 There are some areas with salt deposits and some prospective hydrocarbon extraction areas occurring locally, in addition to widespread deposits of deep coal. It should be noted that the salt and deep coal deposits are no longer commercially exploited.
- 9.2.4 The hydrocarbon deposits potentially could be exploited by lateral drilling for coalbed methane or shale gas, but there are no such current proposals in relation to gas resources.
- 9.2.5 Overall, measures such as those outlined above are expected to reduce sterilisation effects. This should minimise or eliminate route-wide effects. These mitigation measures are described in the land quality chapters of the relevant Volume 2 community area reports. Any local effects during construction will not be significant.

9.3 Assessment of the effects of operation

- 9.3.1 The main potential contamination effects of the operation of the Proposed Scheme are the possibility for soil or groundwater impacts to occur as a result of the operation of the Infrastructure Maintenance Base-Rail (IMB-R) proposed near Stone in Staffordshire. The operations at this facility will be controlled by environmental protocols, with storage of potentially polluting materials according to good practice and any discharges operated under consents or permits issued by the regulatory authorities. Therefore the potential for pollution to occur will be minimal and inadvertent contamination, if any, will be localised.
- 9.3.2 Auto-transformer station and package substation sites will be located at intervals along the Proposed Scheme and could in principle be a source of contamination through accidental discharge or leakage of coolant. However, the proposed auto-transformer stations and package substations, in common with other modern electrical substations, will use secondary containment appropriate to the level of risk.
- 9.3.3 There exists the potential for minor leakage of oils from HS2 trains. However, such leakage or spillage is expected to be very small and be mitigated through standard management measures during operation. Hence this is highly unlikely to lead to any

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significant contaminative effects on a route-wide basis and is further discussed in Section 16, Water resources and flood risk.

- 9.3.4 On the basis of this evaluation, it is considered that there will be no significant route-wide effects for land quality during operation.
- 9.3.5 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

10 Landscape and visual

10.1 Introduction

- 10.1.1 Within the Volume 2, community area 1–5 reports, significant landscape effects are reported by landscape character areas (LCA) and significant visual effects on receptors are reported by reference to identified viewpoints. All landscape and visual effects including non-significant effects are reported in Volume 5: Appendix LV-001-001 to 005.
- 10.1.2 The LCAs have been determined as part of an integrated process of landscape characterisation, informed by the outcome from other topics including cultural heritage and ecology. Use has been made of published landscape character assessments and a wide range of supporting GIS data, aerial photography and Ordnance Survey mapping, plus desk study and fieldwork. Landscape character assessments reviewed include the relevant National Landscape Character Areas and the Staffordshire Landscape Guidelines¹⁵⁶. More detail on the approach to the landscape characterisation is set out in the Scope and Methodology Report (SMR)¹⁵⁷ and the SMR Addendum¹⁵⁸.
- 10.1.3 The Cannock Chase Area of Outstanding Natural Beauty (AONB) is the only landscape receptor area where effects have the potential to occur at a geographical scale greater than the community areas described in Volume 2 and Volume 5.
- 10.1.4 The study area includes the northernmost part of the AONB, which is approximately 600m from the Proposed Scheme at its closest point. The AONB is recognised as one of the most sensitive landscape receptors in the study area by virtue of its intrinsic landscape and scenic quality and through its designation and value at a national level.
- 10.1.5 The Cannock Chase AONB Management Plan defines the special qualities of the landscape¹⁵⁹; these have specific relevance to landscape character and experience of the area. After undertaking a review of the potential effects on the special qualities of Cannock Chase it is considered that overall there will be no significant route-wide effects on the AONB, its integrity or on the setting of the landscape arising from the construction or operation of the Proposed Scheme. The rationale for this conclusion is discussed below.

10.2 Cannock Chase AONB

Landscape character

- 10.2.1 Cannock Chase AONB (see Figure 11) forms part of an historic landscape dating back thousands of years. A former medieval hunting chase, whose existing deer herd remain a legacy of this period, it is the largest surviving area of lowland heathland in the Midlands. The AONB is also characterised by extensive areas of mixed woodland

¹⁵⁶ Staffordshire County Council (2000), *Planning for Landscape Change*. Available online at:

<https://www.staffordshire.gov.uk/environment/eLand/planners-developers/landscape/NaturalEnvironmentLandscapeCharacterTypes.aspx>

¹⁵⁷ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

¹⁵⁸ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

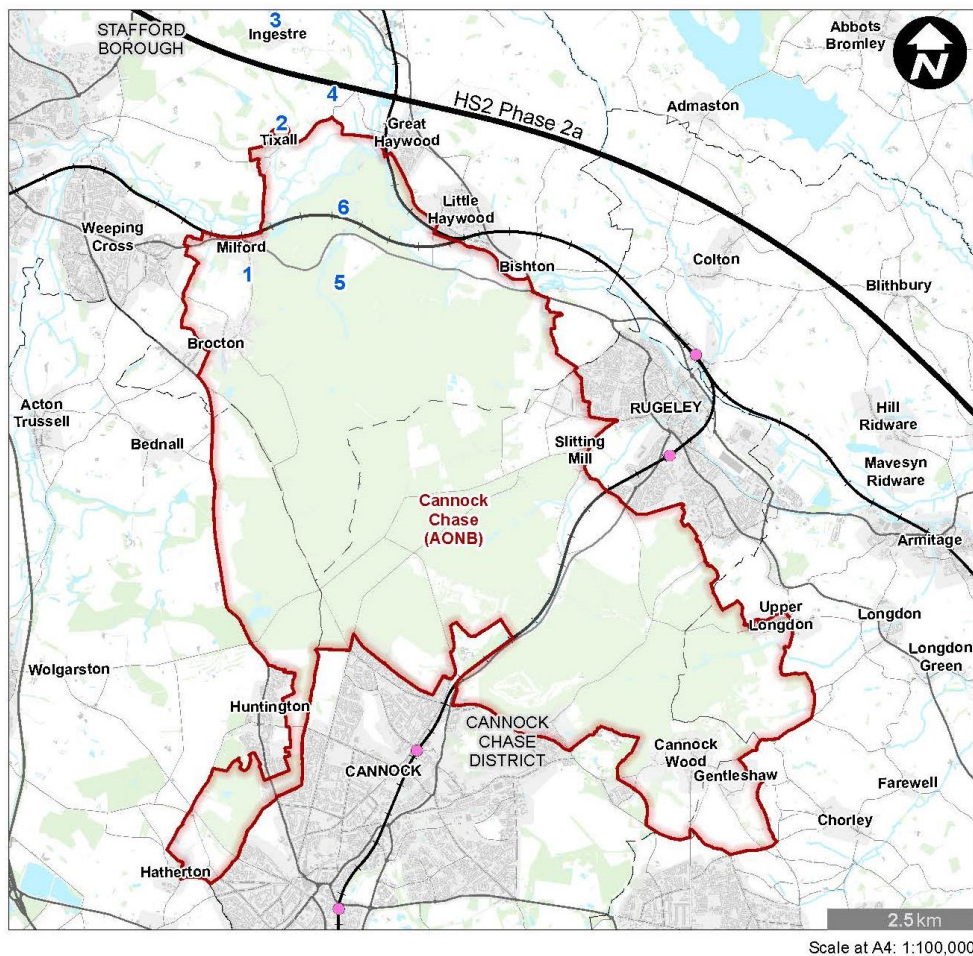
¹⁵⁹ DEFRA and Cannock Chase AONB Unit (2014), *Cannock Chase Area of Outstanding Natural Beauty Management Plan 2014-2019*.

(both broadleaf and coniferous plantations), which create a highly prominent backdrop to large parts of the Trent Valley. Historic parks and gardens, such as Shugborough, Beaudesert and Tixall¹⁶⁰ are also distinctive features in the AONB, as are mixed agriculture and sand and gravel quarries. Combined, these elements create a diverse and intricate 'mosaic' landscape and therefore a varied landscape experience.

Special qualities

- 10.2.2 The Cannock Chase AONB Management Plan lists a number of special qualities underpinning the designation of the AONB. In the Management Plan these are listed in detail by landscape character type (LCT). A summary of the special qualities and elements that represent these is provided below, followed by the potential impacts of the Proposed Scheme on these.
- 10.2.3 In addition a number of landscape key issues relevant to character and the special qualities are cited in the AONB Management Plan, notably development pressures and the potential for development to change the character of the AONB (KI6) and its setting, and maintaining views from and into the AONB (KI21).

Figure 11: Cannock Chase AONB boundary



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¹⁶⁰ A small part of Tixall Park, around the gatehouse, falls within the AONB.

Large tracts of open heathland with wide expanses of heather and scattered birch and fine, sweeping views to the surrounding countryside

- 10.2.4 These include the extensive tracts of open heathland and associated panoramic views at Broc Hill (1), near Milford (to the south of the A513 Rugeley Road and the Proposed Scheme), from where distant views are available to Tixall Park (2), Ingestre Park (3) and Lionlodge Covert (4), in the context of a wider, expansive view. Field survey has confirmed that there will be no view of the Proposed Scheme from the Satnall Hills (5) to the south of Shugborough Park (6) due to the density of the plantation woodland edge there (refer to Volume 2: Community area 2 report, Colwich to Yarlet, Section 11, Landscape and visual).
- 10.2.5 Construction of the Proposed Scheme, specifically the formation of the northern embankment for the Great Haywood viaduct and the excavation of the Brancote South cutting, will be visible as a small element of the panorama from Broc Hill. The visual presence of the Proposed Scheme will diminish further during operation due to the density of existing and replanted vegetation as it matures, so that only part of the embankment for the viaduct and the overhead line equipment will be visible after year 15 of operation of the Proposed Scheme, when the mitigation planting matures.
- 10.2.6 By virtue of the distance of the AONB from the Proposed Scheme, and the visual containment created by vegetation and topography both within the AONB and in the wider landscape of the nearby Trent Valley, it is judged that these special qualities will not be affected by the Proposed Scheme.

Undulating, distinctive landforms cut by small stream valleys and dominated by elevated woodland edges and scarp tops

- 10.2.7 These qualities are represented by the scarp slope and prominent hills, such as Broc and Satnall Hills, and associated foothills, all of which form a prominent hinterland to the south of the Proposed Scheme and which are accentuated by the often densely planted scarp top woodlands and plantations.
- 10.2.8 Due to the location of the Proposed Scheme within the Trent Valley, the presence of intervening valley floor vegetation and localised topographic variation, these special qualities will not be impacted by the Proposed Scheme during either construction or operation. The effects on Broc Hill have also been discussed above.

A varied range of landscape textures and seasonal colours

- 10.2.9 The frequent contrasts of open, wild heathland landscapes, such as at Broc Hill, with the darkness and ordered nature of coniferous plantations will not be impacted by the presence of the Proposed Scheme within the valley floor. This applies during construction and operation, by virtue of the density and interplay of existing vegetation both within the AONB and its wider setting.
- 10.2.10 The picturesque designed parkland at Shugborough, whilst a highly sensitive landscape, will also not experience significant effects due to distance and the fact that the Proposed Scheme will occupy only a small part of a designed view from within Shugborough Park. This is the view from the Triumphal Arch (sometimes also referred as Hadrian's Arch), from where the Great Haywood viaduct will be intermittently visible at a distance (approximately 2km away) in the Trent Valley, as one part of an

extensive panorama, partly filtered by layers of intervening vegetation. This will not materially impact on the special qualities of the overall designed landscape heritage of the AONB. Further details on the effects on the setting of the Triumphal Arch and the relevant viewpoint are reported in Volume 2: community area 2 report, Colwich to Yarlet, Section 7 and Volume 5: Community area report 2, Colwich to Yarlet, Appendix LV-001-002 (Photomontage viewpoint 009.03.013) respectively.

The unique designed landscape heritage, associated landscape quality and prominent set piece/landmark buildings

- 10.2.11 The locally listed designed parkland of Tixall lies approximately 600m south of the Proposed Scheme and the registered park and garden at Shugborough Park lies approximately 800m south of the Proposed Scheme. Both parklands include prominent set piece buildings designed to be seen within the wider landscape and to take advantage of views out. These include Tixall Gatehouse and the Triumphal Arch, the Dark Lantern (a structure within the park which is also known as the 'Lantern of Demosthenes') and Shugborough Hall within Shugborough Park. Existing mature vegetation provides screening in relation to Tixall Gatehouse, while the Dark Lantern and Shugborough Hall sit relatively low in relation to valley topography, limiting opportunities for views out. The Triumphal Arch has views towards the Proposed Scheme, but these are experienced at a distance and as a small part of an expansive view.
- 10.2.12 Construction and operation of the Proposed Scheme (excavation and presence of the Brancote South cutting) will impact on the setting of Tixall Park, as described within the Ingestre Park Sandstone Estate lands LCA (Volume 2: community area 2 report, Colwich to Yarlet, Section 11).
- 10.2.13 However, as these effects are localised and would not materially impact on the quality of the overall designed landscape heritage of the AONB or any of the prominent landmark buildings or set pieces within the designed landscapes, they have not been considered further in the route-wide effects assessment.

Small, irregular fields intersected by winding lanes with high hedge banks, connecting clustered farmsteads and roadside cottages

- 10.2.14 These special qualities are represented by an intricate patchwork of historic small scale fields around Brocton and Bednall Head to the south-west of Broc Hill (at approximately 2km distance south and south-west of the Proposed Scheme) and at Etchingill, south-west of Rugeley. The area around Bednall Head is traversed by a network of ancient lanes linking scattered areas of settlement.
- 10.2.15 All of these features are at such a distance as to be materially unaffected in landscape and visual terms by the construction and operation of the Proposed Scheme. They have therefore not been considered further in the route-wide effects assessment.

Sense of tranquillity and remoteness, which contrasts with some areas to the edges of the AONB with a more 'suburban' character

- 10.2.16 The primary areas where a relatively strong sense of tranquillity and remoteness persists are the hills, scarps and elevated heathlands (associated with the historic Chase), such as at Broc Hill, approximately 4km south-west of the Proposed Scheme,

together with the associated dense stands of mature mixed and plantation woodlands on Broc Hill and at Satnall Hills, approximately 2km south of the Proposed Scheme.

- 10.2.17 Due to the distance and elevation of these features in relation to the Proposed Scheme, the sense of relative tranquillity and remoteness will not be materially altered by the construction and operation of the Proposed Scheme. They have therefore not been considered further in the route-wide effects assessment.

Setting

- 10.2.18 The setting of the AONB is discussed in general terms within the landscape policy section of the AONB Management Plan. Reference is made to the conservation and enhancement of the AONB's distinctive landscape character including 'views into and out of the area' and the 'fixed point photography project' to capture information from specific vantage points on landscape and visual change over time.
- 10.2.19 The Trent Valley and parklands, such as Ingestre and the wider Tixall Park, are located outside the AONB but reflect the characteristics and special qualities of the AONB, and therefore contribute to its setting.
- 10.2.20 The setting of the AONB is also defined to some degree by features that erode character and quality, such as the urban edge of Rugeley and power station to the north-east; the West Coast Main Line (WCML) and associated overhead line equipment, which run through the Trent Valley; and the two prominent wind turbines to the south of Ingestre and Lionlodge Covert.
- 10.2.21 Construction and operation of elements of the Proposed Scheme such as the Great Haywood viaduct, associated embankments and Brancote South cutting will give rise to localised landscape impacts in relation to the AONB and its setting at Tixall and Ingestre. The setting of the AONB as a whole will largely be unaffected by the Proposed Scheme by virtue of the localised impacts in relation to the scale of the AONB and the degree of visual containment afforded by intervening vegetation and topography. Therefore, effects on the setting of the AONB have been discussed in the relevant LCAs within Volume 5, rather than discussed further within the route-wide effects assessment.
- 10.2.22 Further detail on the key landscape assets, which contribute to the special qualities and setting of the AONB, are discussed within the relevant LCA in Volume 5: Community area 2, Colwich to Yarlet (Volume 5: Appendix LV-001-002).
- 10.2.23 Significant landscape and visual effects on sensitive receptors within the AONB are described within the Volume 2: community area 1, Fradley to Colton and Community area 2, Colwich to Yarlet.

11 Major accidents and natural disasters

11.1 Introduction

- 11.1.1 This section presents the route-wide assessment of the likely significant environmental effects arising directly from the Proposed Scheme if it were to be affected by a major accident and/or natural disaster.
- 11.1.2 The assessment of the vulnerability of the Proposed Scheme to major accidents and natural disasters is included in this Environmental Statement (ES) following changes to EU and UK legislation. The revised EIA Directive 2014/52/EU (revised Directive) requires the assessment of the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or natural disasters. The Town and Country Planning (EIA) Regulations 2017¹⁶¹ has transposed the revised Directive into UK law.
- 11.1.3 The underlying objective of the assessment is to ensure that appropriate precautionary actions are taken for those projects which, 'because of their vulnerability to major accidents and/or natural disasters (such as flooding, sea level rise, or earthquakes), are likely to have significant adverse effects on the environment' (revised EIA Directive 2014/52/EU¹⁶²).
- 11.1.4 Based on the requirements of the revised Directive, this section deals with the following issues:
- the legal, contractual and management frameworks that are in place to ensure safety of the Proposed Scheme (as described in Sections 11.2 and 11.3);
 - the vulnerability of the Proposed Scheme to major accidents and disasters;
 - the likelihood of significant adverse environmental effect(s) arising from these major accidents and natural disasters; and
 - the measures required to prevent or mitigate the likely significant adverse effects of such events on the environment.

11.2 Legal and regulatory framework

EIA requirement

- 11.2.1 The revised Directive states that in order to ensure a higher level of protection of the environment, precautionary actions need to be taken for certain projects that have a high vulnerability to major accidents and/or natural disasters.
- 11.2.2 Part 1 of the Town and Country Planning (EIA) Regulations 2017 requires that the environmental impact assessment (EIA) shall identify, describe and assess in the appropriate manner, the direct and indirect significant effects of the Proposed

¹⁶¹ *Town and Country Planning (Environmental Impact Assessment) Regulations 2017*. SI 2017 No. 571. Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/ukxi/2017/571/pdfs/ukxi_20170571_en.pdf

¹⁶² *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment*. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052>

Scheme on population and human health, biodiversity, land, soil, water, air and climate, material assets, cultural heritage and landscape and the interaction between these factors, arising from the vulnerability of the Proposed Scheme to major accidents or disasters that are relevant to the Scheme.

Other relevant legislation

11.2.3 The design, management, operation and maintenance of the Proposed Scheme must comply with the following UK legislation and EU regulations:

- EU Regulation 402/2013 on the Common Safety Method on Risk Evaluation and Assessment¹⁶³ (CSM-RA) (as amended by EU Regulation 2015/1136). An EU Regulation that describes the methods required to be used to assess compliance with safety levels and safety requirements;
- Health and Safety at Work etc. Act 1974¹⁶⁴ (HSWA). This legislation places general duties on employers, people in control of premises, manufacturers and employees. Health and safety regulations made under this Act contain more detailed provisions. The Act provides the framework for the regulation of industrial health and safety in the UK. The overriding principle is that foreseeable risks to persons shall be reduced so far as is reasonably practicable and that adequate evidence shall be produced to demonstrate that this has been done;
- Construction (Design and Management) (CDM) 2015 Regulations¹⁶⁵. These regulations place specific duties on clients, designers and contractors, so that health and safety is taken into account throughout the life of a construction project from its inception to its subsequent final demolition and removal. Under CDM regulations, designers have to avoid foreseeable risks so far as reasonably practicable by: eliminating hazards from the construction, cleaning, maintenance, and proposed use and demolition of a structure; reducing risks from any remaining hazard; and giving collective safety measures priority over individual measures;
- The Railways and Other Guided Transport Systems (Safety) Regulations 2006¹⁶⁶ (as amended) (ROGS). ROGS place a duty on Railway Undertakings (RUs) and Infrastructure Managers (IMs) to:
 1. develop safety management systems (SMS) that must meet certain requirements;
 2. have a safety certificate (for RUs) or a safety authorisation (for IMs);

¹⁶³ Commission Implementing Regulation (EU) No 402/2013 of 30 April 2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009. Official Journal of the European Union. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0402>

¹⁶⁴ Health and Safety at Work etc. Act 1974. SI 1974 c.37. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/ukpga/1974/37/pdfs/ukpga_19740037_en.pdf

¹⁶⁵ The Construction (Design and Management) Regulations 2015. SI 2015 No. 51. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/uksi/2015/51/pdfs/uksi_20150051_en.pdf

¹⁶⁶ The Railways and Other Guided Transport Systems (Safety) Regulations 2006. SI 2006 No. 599. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/uksi/2006/599/pdfs/uksi_20060599_en.pdf

3. show that they have procedures in place to introduce new or altered vehicles or infrastructure safely;
4. carry out risk assessments and put in place the safety measures they have identified as necessary to make sure that the transport system is run safely; and
5. work together to make sure the transport system is run safely (ROGS regulation 22).

- The Railways (Interoperability) Regulations 2011¹⁶⁷ (as amended) (RIR). These regulations implement the EU Railway Interoperability Directive 2008/57/EC¹⁶⁸, which had the purpose of establishing common operational standards and practices across European railways, including adoption of the CSM-RA;
- all activities relating to the mainline network must comply with Railway Group Standards¹⁶⁹. The Railway Group Standards set out National Technical Rules and National Safety Rules for the Great Britain mainline railway. Compliance with the National Technical Rules and National Safety Rules is required under the Railways (Interoperability) Regulations 2011;
- The Management of Health and Safety at Work Regulations 1999¹⁷⁰. These regulations generally make more explicit what employers are required to do to manage health and safety under the HSWA; and
- Other UK safety related regulations. A number of other safety related regulations within UK law, including for example the Electricity at Work Regulations 1989¹⁷¹, which also apply to the Proposed Scheme.

11.2.4 In broad terms, risks associated with major accidents and disasters will be identified, assessed and mitigated during the design, construction, operation and maintenance of the Proposed Scheme. The legislation described above sets out the requirement, duties, and in some cases establishes the mechanisms for doing this.

11.2.5 In accordance with Paragraph 15 of the revised EIA Directive (2014/52/EU)¹⁷², safety assessments undertaken for the Proposed Scheme have been used to inform the identification and assessment of major accidents and natural disasters to which the Proposed Scheme may be vulnerable.

¹⁶⁷ *The Railways (Interoperability) Regulations 2011*. SI 2011 No. 3066. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/ukxi/2011/3066/pdfs/ukxi_20113066_en.pdf

¹⁶⁸ *Directive of the European Parliament and of the Council on the Interoperability of the Rail System in the Community*, 17 June 2008, 2008/57/EC.

¹⁶⁹ RSB (undated), *Standards and the rail industry*. Available online at: <https://www.rsb.co.uk/standards-and-the-rail-industry>

¹⁷⁰ *The Management of Health and Safety at Work Regulations 1999*. SI 1999 No. 3242. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/ukxi/1999/3242/pdfs/ukxi_19993242_en.pdf

¹⁷¹ *The Electricity at Work Regulations 1989*. SI 1989 No. 635. Her Majesty's Stationary Office, London. Available online at: <http://www.legislation.gov.uk/ukxi/1989/635/contents/made>

¹⁷² Recital 15 of the Directive states in its second part: 'In order to avoid duplications, it should be possible to use any relevant information available and obtained through risk assessments carried out pursuant to Union legislation, such as Directive 2012/18/EU of the European Parliament and the Council (4) and Council Directive 2009/71/Euratom (5), or through relevant assessments carried out pursuant to national legislation provided that the requirements of this Directive are met.' The specific Directives referred to in recital 15 are not applicable to the Proposed Scheme as they relate to operating sites containing large quantities of hazardous substances (for example oil refineries, oil storage depots and nuclear facilities). However, the principle of using relevant information obtained through risk assessments undertaken as part of the Proposed Scheme development is adopted here.

- 11.2.6 In addition to the other regulations described in Section 11.2, the Proposed Scheme is also being designed and its implementation guided by other industry standards and codes, many of which are mandatory. These require infrastructure and systems to be designed so that risks to people and the environment are either eliminated or reduced to levels that are considered acceptable.

11.3 HS2 Ltd safety and risk management framework

- 11.3.1 The Proposed Scheme will be designed, constructed, operated and maintained to reduce as low as is reasonably practicable, the risk of harm (including major accidents) occurring. This section briefly describes how HS2 Ltd will meet its legal and contractual obligations and deliver an exemplary project in terms of health, safety and the environment, since this provides the framework within which the risk of major accidents and/or natural disasters impacting the environment will be managed. All measures to manage and reduce risk described in this section are defined as 'embedded' measures for the purposes of this assessment.

Development agreement

- 11.3.2 The HS2 development agreement between the Government and HS2 Ltd¹⁷³ sets out HS2 Ltd's role in developing, building and operating the new railway. This includes HS2 Ltd's legal obligations with respect to health and safety, risk and liability. The railway shall be designed, constructed and operated so that safety risks are 'as low as reasonably practicable'. Furthermore the railway shall be designed and delivered to avoid, reduce and if possible, remedy adverse impacts on the environment, as far as reasonably practicable.
- 11.3.3 Annex 4 of the development agreement identifies the key project objectives and strategies to deliver HS2 Ltd's commitments, including those above. This includes a commitment that: 'HS2 Ltd will design, build and operate the Railway to meet or better the performance standard of HS1, to reduce safety risks as low as reasonably practicable and in line with best current international practice.'
- 11.3.4 HS2 Ltd's commitments in terms of both physical and cyber-security, are set out in Annex 4 of the development agreement. Key to the assessment presented in this report is that: '...measures to prevent unauthorised access to the Railway (primarily consisting of the physical separation of the Railway from the external environment) will be developed.'

System safety strategy

- 11.3.5 HS2 Ltd's System Safety Strategy explains HS2 Ltd's approach to demonstrating, through the whole lifecycle of the railway system, that the new HS2 High Speed Railway (HSR) system is safe to operate and maintain through:
- compliance with the Common Safety Method Regulation on Risk Evaluation and Assessment (CSM-RA) to support the application for HS2 Ltd to achieve authority from the rail regulator to place HS2 into service; and
 - the provision of suitable and sufficient information that allows future

¹⁷³ A copy of the development agreement is available on the Department for Transport's website.

infrastructure managers and transport undertakings to meet the requirements of their safety management systems in respect of the Railways and Other Guided Transport System (Safety) Regulations 2006 (as amended) (ROGS)¹⁷⁴ including the assessments of the operational procedures through the application of CSM-RA.

- 11.3.6 Ultimately, the HS2 Ltd System Safety Strategy and the activities it defines are required to achieve the authority to place HS2 into service. Failure to achieve this approval would mean that the Proposed Scheme could not be put into operation.
- 11.3.7 The HS2 Ltd System Safety Strategy sets out the hierarchy of documentation, governance, accountability and scope of the system safety, specifically how HS2 Ltd will undertake the CSM-RA.
- 11.3.8 Sections of the System Safety Strategy of particular relevance to this section include:
- safety principles;
 - legislation, standards and guidance;
 - definitions and abbreviations;
 - responsibilities (including roles and responsibilities, process and organisation for acceptance, safety aspects of organisation and contractual strategy, competency);
 - approach (including system definition, hazard identification, risk analyses and evaluation, safety requirements and demonstration of compliance); and
 - the CSM-RA compliance matrix presented in Annex B of the strategy.

Health and safety management system

- 11.3.9 The HS2 Ltd Health and Safety Policy¹⁷⁵ presents HS2 Ltd's high-level health and safety commitments, which will be delivered by HS2 Ltd's health and safety management system. It underlines HS2 Ltd's principles of health and safety, and sets out their areas of focus for eliminating, reducing and controlling risk.
- 11.3.10 HS2 Ltd's health and safety management system is founded on the principles of the Health and Safety Executive's guidance HSG65¹⁷⁶ and is certified to OHSAS 18001:2007¹⁷⁷. It defines the responsibilities at each level in the business, and establishes the organisational framework, the processes and tools to continually identify, prevent and manage health and safety risks, to comply with, or exceed legislative requirements and to monitor and review health and safety performance.

¹⁷⁴ *The Railways and Other Guided Transport Systems (Safety) Regulations 2006*, SI 2006 No. 599 (as amended by Regulations 2011 No. 1860, 2013 No. 950 and 2015 No. 1917). Her Majesty's Stationary Office, London. Available online at:

http://www.legislation.gov.uk/uksi/2006/599/pdfs/ukxi_20060599_en.pdf

¹⁷⁵ High Speed Two (HS2) Limited (2016), *Health and Safety Policy*. Available at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/537382/CS449_H_S_Policy_Final.pdf

¹⁷⁶ Health and Safety Executive (2013), *Managing for Health and Safety (HSG65)*.

¹⁷⁷ British Standards Institution (2016), *BS OHSAS 18001 Occupational Health and Safety Management*.

HS2 Ltd approach to risk management

11.3.11 Risk management is embedded as a fundamental tenet for the management of all aspects of HS2 and is undertaken in order to constrain threats within acceptable limits. HS2 Ltd's approach to risk management is based on a number of guiding principles, including that:

- risk management applies to all aspects of HS2;
- clear accountability for risk will be ensured; and
- risk management will be based on continuous improvement.

HS2 Ltd supply chain health and safety standards

11.3.12 Contractors and suppliers working on behalf of HS2 Ltd are expected to comply with HS2 Ltd's supply chain health and safety standards¹⁷⁸. These set out HS2 Ltd's expectations in terms of the health and safety commitments of its suppliers, HS2 Ltd's health and safety principles, and its strategic commitments. Contractors appointed by HS2 Ltd to design, assess and construct the railway (and undertake the enabling works) are required to further identify and mitigate risk during the detailed design stage and identify and mitigate construction risks. HS2 Ltd evaluates the competence of contractors to be able to do this as part of the procurement process. These strategic commitments cover:

- workforce safety;
- public and neighbour health and safety;
- occupational health and wellbeing;
- safe design;
- safe supply chain selection and management;
- safe operations; and
- assurance.

11.3.13 The draft Code of Construction Practice (CoCP¹⁷⁹) describes the control measures and standards to be implemented in order to protect communities and the environment during construction works. It sets out the principles that form the basis of the environmental management system (EMS), and measures to be defined within the Local Environmental Management Plans (LEMPs)¹⁸⁰.

11.3.14 Particularly relevant to this topic assessment, the draft CoCP includes the requirement for construction contractors and suppliers to have:

- a comprehensive community emergency plan, where relevant. This will ensure

¹⁷⁸ High Speed Two (HS2) Limited (2015), *Supply chain health and safety standard*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/510415/Supply_Chain_Health_and_Safety_Standard.pdf

¹⁷⁹ Volume 5: Appendix CT-003-000, *Draft Code of Construction Practice*.

¹⁸⁰ The LEMPs will set out how the Proposed Scheme will adapt and deliver the required environmental and community protection measures within each local authority area, through a series of topic-specific measures that reflect the general requirements of the CoCP.

that in the case of a major emergency, when working in partnership with the relevant emergency service, the community can be kept fully informed and that adequate arrangements are in place for the evacuation of an affected area if necessary;

- site specific assessments of security and trespass risk, and appropriate control measures;
- a procedure for assessing risks and putting response measures in place related to unexploded ordnance;
- pollution incident control, including pollution response plans and arrangements with spill response companies;
- emergency planning and emergency response procedures;
- appropriate plans and management controls to prevent fires; and
- due consideration to the impacts of extreme weather events and related conditions during construction.

11.3.15 The draft CoCP also presents requirements for measures to reduce the impacts of construction activities on specific categories of environmental receptors along the route, including: agriculture, forestry and soils; air quality; cultural heritage; ecology and biodiversity; ground settlement; land quality; landscape and visual; sound, noise and vibration; traffic and transport; waste and materials; and water resources and flood risk.

11.4 Scope, limitations and assumptions

11.4.1 The scope of this assessment topic follows that set out in Volume 1, Volume 5: Appendix MA-001-000, the Scope and Methodology Report (SMR)¹⁸¹ and the SMR Addendum¹⁸². It addresses those unplanned events or situations, that have been determined as being relevant to the Proposed Scheme, are considered to be major in scale and have been identified as having the potential to result in a significant adverse environmental effect. Key terms used in this assessment topic are defined in Table 8. A full review of terminology and selected definitions is presented in the SMR Addendum.

Table 8: Key definitions relevant to this assessment topic

Term	Definition
ALARP	As Low As Reasonably Practicable
CSM-RA	Common Safety Method (Risk Assessment)
Environmental receptor	Features of the environment that are subject to assessment under Article 3 of the amended 2014 EU EIA Directive, namely population and human health, biodiversity, land, soil, water, air and

¹⁸¹ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

¹⁸² Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

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	climate, material assets, cultural heritage and landscape. These are categorised consistently with the EIA structure.
Major accident	<p>A major accident, in the context of the Proposed Scheme, is an event or situation that threatens immediate or delayed serious damage to human health, welfare and/or the environment and requires the use of resources beyond those of HS2 Ltd or its contractors.</p> <p>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.</p>
Natural disaster	A naturally occurring phenomenon such as an extreme weather event (storm, flood, temperature) or ground-related hazard events (subsidence, landslide, earthquake) with the potential to cause an event or situation that meets the definition of a <i>major accident</i> above.
Reasonable worst case environmental effect	A challenging manifestation of the consequence(s) of a risk event occurring, after highly implausible or less significant consequences are excluded.
Risk	The likelihood of an impact occurring, combined with effect or consequence(s) of the impact on a receptor if it does occur.
Risk event	An identified, unplanned event, which is considered relevant to the Proposed Scheme and has the potential to be a major accident or natural disaster subject to assessment of its potential to result in a significant adverse effect on an environmental receptor.
Serious damage	Serious damage includes the loss of life, permanent injury and temporary or permanent destruction of an <i>environmental receptor</i> .
Vulnerability	In the context of the 2014 EU EIA Directive, the term refers to the ' <i>exposure and resilience</i> ' of the Proposed Scheme to the risk of a major accident and/or natural disaster. Vulnerability is influenced by sensitivity, adaptive capacity and magnitude of impact.

11.4.2 Environmental effects associated with unplanned events that do not meet the definition of major accidents and/or natural disaster (e.g. leaks and spills that may be contained within construction sites and the operational railway infrastructure) are addressed in the draft CoCP and Section 16, Water resources and flood risk.

11.4.3 Receptors addressed in the assessment are those relevant to the scope of the ES and 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.

Exclusions

11.4.4 Effects of the Proposed Scheme on employees of HS2 Ltd and/or its contractors and suppliers (e.g. construction and maintenance staff) and HS2 passengers are managed via other health and safety legislation, as described in Section 11.2, and are not addressed in the scope of this assessment. Effects on members of the public who

wilfully trespass are also considered to be outside the scope of this assessment, recognising that HS2 Ltd will take appropriate measures to provide a secure boundary as defined in Table 9 to reduce the likelihood of trespass. Finally, risk events that only present risks to HS2 Ltd as an organisation (e.g. cost and programme) are outside the scope of this assessment.

- 11.4.5 Further details on the exclusions and the scope of this assessment are set out in the SMR Addendum.

Risk event identification

- 11.4.6 Major accident and natural disaster 'risk events', to which the Proposed Scheme is considered vulnerable, have been identified by referring to risk assessments undertaken for the Proposed Scheme and determining whether there is potential for impact to an in-scope receptor. These risk assessments are part of other processes, many of which are required by law.
- 11.4.7 The identification of relevant risk events focuses on high-level major accident and/or natural disaster events that have the potential to cause significant harm. Many of the risk events to which the Proposed Scheme may be vulnerable have multiple causes; for example a train derailment may be caused by infrastructure condition, a natural disaster event, malicious intent or human error, amongst others. Unless the risk event is identified as having the potential to result in a likely significant effect, the underlying causes of the risk event are not the subject of assessment.
- 11.4.8 It is important to state that no additional risk assessments have been undertaken specifically for this section of Volume 3. Accidents on the railway, including those initiated by natural events, are controlled through the rail regulatory framework summarised in Section 11.2. The requirement to satisfy that framework has led to the identification of many safety-relevant hazards which include those that might have an environmental effect. These are identified in the documentation listed in Volume 5: Appendix MA-001-000. This section presents a review of risk assessments carried out for the Proposed Scheme to determine whether significant effects on the environment could occur, and whether such risks have been managed and mitigated to be as low as reasonably practicable.
- 11.4.9 System safety activities are required to be assessed by an independent body before being approved by HS2 Ltd's Safety Review Panel and then the Health and Safety Executive. Authorisation to place the Proposed Scheme into service must then be given by the Office of Road and Rail (the Regulator). This section does not seek to reproduce this extensive process, rather to summarise the current state of risk identification and assessment, in order to specifically assess whether any additional mitigation measures may be required to prevent any significant effects to the environment.
- 11.4.10 Safety risk assessments will remain live documents throughout the design, construction and operation of the Proposed Scheme.
- 11.4.11 The guiding principle of both the CSM-RA and the CDM risk assessment is that all foreseeable risks should be controlled to an acceptable level, which is defined as 'as low as reasonably practicable'.

11.5 Assessment methodology

11.5.1 The assessment for the major accidents and natural disasters assessment has been undertaken in accordance with the methodology described in the SMR and the SMR Addendum.

11.5.2 A full record of risk identification, risk screening and final risk assessment is provided in Volume 5: Appendix MA-001-000, Major accidents and natural disasters risk screening.

11.6 Baseline

11.6.1 The baseline relevant to this topic comprises:

- features external to the Proposed Scheme that contribute a potential source of hazard to the Proposed Scheme;
- sensitive environmental receptors at risk of significant effect; and
- current (without the Proposed Scheme) major accident and natural disaster risks.

Baseline features that contribute a potential source of hazard

11.6.2 As far as is reasonably practicable, the route of the Proposed Scheme avoids existing features that have the potential to present a hazard to the construction or operation of the Proposed Scheme. There are no sites where hazardous materials and/or substances are stored, used or made in types or quantities to trigger registration under the Control of Major Accidents Hazards (COMAH) Regulations¹⁸³ in proximity to the Proposed Scheme (the closest COMAH registered site to the Proposed Scheme is approximately 1.5km away).

11.6.3 Features external to the Proposed Scheme that lie within the land required to construct the Proposed Scheme and/or cross the route of the Proposed Scheme that present a potential source of hazard, either during construction or operation include, but are not limited to:

- oil, gas and electricity transmission;
- potential presence of unexploded ordnance;
- former landfill sites and the potential presence of landfill gas;
- potential presence of coal-bed methane and shale gas;
- below ground hazards such as salt and coal mining;
- existing operational railway lines; and
- adjacent highways, both local roads and motorways.

¹⁸³ *The Control of Major Accident Hazards Regulations 2015. SI 2015 No. 483.* Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/uksi/2015/483/pdfs/ukxi_20150483_en.pdf

- 11.6.4 These features, where present, have been considered and addressed as appropriate throughout the design development.

Environmental receptors

- 11.6.5 Environmental receptors that may be at risk in the event of a major accident and/or natural disaster include those close enough to be impacted by a major accident in the Proposed Scheme construction and operational areas. The receptors included and excluded under this definition are detailed within the SMR addendum.

Baseline accident and natural disaster risks

- 11.6.6 Major accident and natural disaster risks relevant to the baseline in the absence of the Proposed Scheme include extreme weather events, associated flooding and road traffic collisions. Baseline 'without project' conditions are described in the Volume 2 community area reports for Traffic and transport (Section 14) and Water resources and flood risk (Section 15) and Volume 3, Section 4, Climate change.

11.7 Construction phase assessment

- 11.7.1 Major accidents and natural disasters to which the Proposed Scheme may be vulnerable during the construction phase and the outcomes of the assessment are summarised in Table 9.
- 11.7.2 Table 9 describes those risk events whose impact on an environmental receptor (including members of the public who are not employees or passengers) has the potential to be a major accident as defined in Table 8. Key management and mitigation measures are described in Table 9. In all cases, compliance with the legal and regulatory requirements described in this Section to manage risks to be as low as reasonably practicable (ALARP) must be demonstrated.

Table 9: Assessment of major accident and/or natural disaster events during construction

ID ¹⁸⁴	Risk event	Reasonable worst consequence if event did occur	Key risk management and mitigation measures to demonstrate risks to be ALARP ¹⁸⁵
C3	Train derailment or collision on West Coast Main Line (WCML) due to construction activities on or adjacent to existing railway	Network Rail train derailment outside the boundary with potential to cause harm to member of public, property or adjacent land/water course	Working on or near an existing railway is managed in accordance with established industry procedures. CDM will identify specific risks to be managed. Mitigation measures may include speed restrictions in work areas, lifting plans, planned period of closure of railway etc. Consultation with Network Rail is already underway. The draft CoCP states that emergency procedures for works on the existing railway network should be produced in accordance with established industry procedures.

¹⁸⁴ ID: Risk identification number. Refer to Volume 5: Appendix MA-001-000, Major accidents and natural disasters risk screening, for detailed table.

¹⁸⁵ As low as reasonably practicable.

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ID ¹⁸⁴	Risk event	Reasonable worst consequence if event did occur	Key risk management and mitigation measures to demonstrate risks to be ALARP ¹⁸⁵
C4	Road traffic accident¹⁸⁶ due to construction work over or adjacent to existing highways, work on existing structures to move or realign, movement of construction vehicles along public roads and adjacent to public rights of way	Injury or fatality to a member of the public	<p>Risks identified and managed via CDM, construction planning, draft CoCP, traffic management plan, construction workforce travel plan.</p> <p>Example construction controls may include speed restrictions and diversions etc.</p> <p>Risk to public road users addressed via consultation on design with Highways England, through design and in construction method statements.</p> <p>Further detail is provided in Volume 2 community area reports for Traffic and transport (Section 14).</p>
C7	Fire and/or explosion or release of harmful gas , as a result of construction activities. For example: presence of former landfill sites along route; presence of ground gas along route; presence of unexploded ordnance; gas pipeline route; fuel storage at construction sites; wildfire	Fire and/or explosion affects neighbouring property and/or members of the public	<p>Risks identified and managed via CDM (e.g. site searches, ground investigations, consultation with utility providers, construction planning) and via draft CoCP.</p> <p>Appropriate permanent works design to control long term ground related risks like ground gases.</p> <p>Environmental Management Plans which guide and govern maintenance, and management of risks.</p>
C9	Flood event leads to release of stored construction related material (presence of construction materials, equipment and potential contaminants)	Release of contaminants onto land outside construction site	<p>The draft CoCP includes measures for contractors to manage risks of pollution due to severe weather events.</p> <p>The draft CoCP states, as appropriate, that stockpiles and mounds will be kept away from sensitive receptors, watercourses and surface drains where reasonably practicable, and sited to take into account the predominant wind direction relative to sensitive receptors.</p> <p>The draft CoCP states that reasonable precautions will be taken in relation to the handling and storage of material, including seeding or sealing of medium or long-term stockpiles as appropriate.</p>

¹⁸⁶ 'Road Traffic Accident' and 'Road Traffic Collision' are interchangeable terms, in the context of this report, as although there is a move towards the use of 'collision' the data received from Local Authorities uses the term 'accidents'.

ID ¹⁸⁴	Risk event	Reasonable worst consequence if event did occur	Key risk management and mitigation measures to demonstrate risks to be ALARP ¹⁸⁵
C10	Collapse of or damage to existing structures resulting from for example construction activities adjacent to, above/below existing structures	Falling debris or collapse of infrastructure affects a public right of way / public area or leads to injury or fatality of members of public Collapsed culvert leads to flood impact	Construction works adjacent / over public rights of way or to public property are managed via CDM and construction planning. Tunnel design and construction methods includes risk assessment for overlying structures and monitoring or mitigation if required. Construction sequencing - build culverts prior to embankment.
C11	Member of public using temporary access route at Crewe Station exposed to additional safety hazards related to passenger flow during emergency conditions	Injury or fatality to a member of public	Risks identified and managed via CDM. Measures include clear signage and routing; station evacuation strategy; station fire strategy to identify rendezvous points and through routes. Dedicated Network Rail Interface Team (see HS2 Ltd's Supply Chain Health & Safety Standard). Contractors, suppliers and manufacturers shall comply with all Network Rail requirements when on Network Rail railway infrastructure or in the manufacture and supply of components that could have an impact on their kinetic envelope and/or general operations.

11.8 Operational phase assessment

11.8.1 Risk events to which the Proposed Scheme may be vulnerable during the operational phase and the results of the assessment are summarised in Table 10. The table describes those risk events whose impact on an environmental receptor (including members of public who are not employees or passengers) has the potential to be a major accident as defined in Table 8. Key management and mitigation measures are described in Table 10. In all cases, compliance with the legal and regulatory requirements described in this section to manage risks to be ALARP must be demonstrated, including the requirement to:

- manage all train accident risks in accordance with the CSM-RA. Measures have to be accepted by the regulator as being adequate to manage risks to be ALARP in order for licence to be granted;
- comply with design standards (including HS2 Ltd Technical Standards), this will include designing to appropriate environmental parameters (flood, wind, lightning) including climate change. Design standards apply to rolling stock, controls and systems, civil infrastructure, and electrical infrastructure;
- comply with the Technical Specifications for Interoperability and the Railway

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Group Standards; and

- co-ordinate between HS2 and the conventional network.

Table 10: Assessment of major accident and/or natural disaster events during operation

ID ¹⁸⁷	Risk event	Reasonable worst consequence if event did occur	Key management and mitigation measures to demonstrate risk to be ALARP ¹⁸⁸
OM1A	<p>Train derailment or collision (HS2 trains). There are multiple potential causes of this event including: electrical infrastructure failure; human factors (drivers, signal control, points etc); infrastructure failure (structure, ground, drainage and/or track); natural hazards such as storm, high wind, freezing temperatures; poor wheel rail interface; rolling stock failure; objects on the line (unauthorised 3rd party access, animals, vehicle incursion, falling trees, debris); system/equipment failure; and vandalism and terrorism (including cyber attacks).</p>	<p>Off-track and outside boundary derailment causing severe disruption to rail transportation, major accident causing harm to staff, passengers and adjacent receptors.</p> <p><i>Note: this section focusses on receptors including members of public and the environment, not staff or passengers.</i></p>	<p>In addition to the mitigation measures outlined in 11.8.1, specific measures listed below (list is not exhaustive) include those to remove or reduce the likelihood of a train derailing (1) and mitigate the severity (2).</p> <p>(1)</p> <p>Training.</p> <p>Operation & Maintenance Manuals.</p> <p>Safe system of working.</p> <p>Interface with classic network must be timely and of high integrity—the interface is defined and all issues should be addressed.</p> <p>Rolling stock design standards.</p> <p>Use of single, unified and modern signalling system, (European Train Control System (ETCS) on HS2 network.</p> <p>Requirement for design to be adequate to protect railway from incursion by objects or vehicles.</p> <p>Provision of a secure boundary.</p> <p>(2)</p> <p>Use of derailment containment measures where reasonably practicable.</p> <p>The railway shall not carry hazardous (combustible/explosive) freight.</p>

¹⁸⁷ ID: Risk identification number. Refer to Volume 5: Appendix MA-001-000, Major accidents and natural disasters risk screening, for detailed table.

¹⁸⁸ As low as reasonably practicable.

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ID ¹⁸⁷	Risk event	Reasonable worst consequence if event did occur	Key management and mitigation measures to demonstrate risk to be ALARP ¹⁸⁸
OM2	<p>Train derailment or collision (Network Rail trains). As above, there are a number of potential causes of this event related to the interface between the Proposed Scheme and the existing railway, and shared use of tracks/interface between HS2 network and conventional network.</p>	<p>Off-track and outside boundary derailment of a non HS2 train (including freight), or a HS2 train using conventional track. Severe disruption to rail transportation, major accident causing harm to staff, passengers and adjacent receptors, spillage of pollutants</p>	<p>Must comply with Railway Group Standards¹⁸⁹ to be allowed on the conventional network.</p>
OM3	<p>Major road traffic accident related to presence of new infrastructure (e.g. new junctions, new road alignments, new bridges/underpasses)</p>	<p>Injury or fatality to a member of public.</p> <p>Spillage of pollutants</p>	<p>The traffic and transport sections in Volume 2 describe the baseline assessment - accident clusters are identified, and there are no locations during operation where there are existing safety issues.</p> <p>Road realignments designed in accordance with standards and in consultation with Highways England and local authorities etc.</p> <p>All new infrastructure designed would be subject to detailed design and safety audit processes to seek to minimise the risk of accidents.</p>
OM4	<p>Collapse or significant movement of structures leading to non-train incident, with multiple potential causes including: bridge strike; vandalism and terrorism; natural hazards (earthquake, scour, high wind); inadequate design; material quality; and lack of maintenance.</p>	<p>Injury or fatality to a member of public (pedestrians, cyclists or road users etc.)</p>	<p>Design to mitigate bridge strike likelihood (clearance, signs, bollards etc.).</p> <p>Structures designed and maintained in accordance with standards in consideration of environmental conditions including climate change. (See Volume 3, Section 4.5, Climate change resilience assessment)</p> <p>Seismic basis of design will be in place for the Proposed Scheme.</p> <p>Incident response plans for bridge strike.</p>

¹⁸⁹ Defined in Section 11.2.

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ID ¹⁸⁷	Risk event	Reasonable worst consequence if event did occur	Key management and mitigation measures to demonstrate risk to be ALARP ¹⁸⁸
OM6	<p>Fire and/or explosion on or near the Proposed Scheme, due to (e.g.) overheating of tunnels; maintenance activities; wildfire; electrical faults; explosive gases within drainage system.</p> <p>Secondary effect - fire causes degradation to track/infrastructure.</p>	<p>Contamination of aquifer/ drinking water supply resulting from run off of fire water</p> <p>Drift of fire from HS2 facility (e.g. Stone Infrastructure Maintenance Base-Rail (IMB-R) to adjacent property or land</p>	<p>Selected measures listed below are a combination of measures to prevent fire occurring through removing or reducing the cause (1); measures to respond and manage an outbreak of fire (2), and measures to mitigate the impact of the response activities (3).</p> <p>(1)</p> <p>A tunnel fire risk assessment must be carried out under legislation, to ensure the safety of the occupants of the tunnel and those in the immediate vicinity who are at risk.</p> <p>A fire management strategy for tunnels will be drawn up during detailed design in line with the Technical Specifications for Interoperability¹⁹⁰.</p> <p>HS2 rolling stock is electric—no flammable fuels.</p> <p>The railway shall not carry hazardous (combustible/explosive) freight.</p> <p>Inspection and maintenance of drainage.</p> <p>(2)</p> <p>Assess need for firefighting provision and provide facilities on-site if necessary (emergency procedures).</p> <p>IMB-R design to ensure access for emergency services.</p> <p>(3)</p> <p>The fire safety objectives of the project include the protection of the environment.</p> <p>Any water contaminated by firefighting operations will be discharged into an attenuation pond and discharged safely in agreement with the Environment Agency, local water company and local authority and any other relevant stakeholder.</p>

¹⁹⁰ RSSB (undated), Technical Specifications for Interoperability (TSI). Available online at: <https://www.rssb.co.uk/standards-and-the-rail-industry/standards-explained/technical-specifications-for-interoperability>

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ID ¹⁸⁷	Risk event	Reasonable worst consequence if event did occur	Key management and mitigation measures to demonstrate risk to be ALARP ¹⁸⁸
OM7	<p>The presence of the Proposed Scheme (e.g. embankments) leads to alteration of flood patterns during an extreme weather (flood) event.</p> <p>Flooding of underpasses or subways.</p>	<p>Flooding impact on property or land — which differs to flooding impact without the presence of the Proposed Scheme</p> <p>Flooding of underpasses or subways with potential harm to a member of public.</p>	<p>Viaducts, bridges and culverts —are designed to accommodate 1 in 100 (1%) annual probability flood plus a climate change allowance to the end of the 21st century.</p> <p>For a flood with an annual probability in excess 1 in 100 years, only minor localised alterations in the distribution of floodwaters relative to the baseline are expected¹⁹¹. Critical railway systems and assets are protected to a 1 in 1,000 (0.1%) annual probability flood (i.e. the assets are resilient to this event, but there is no design requirement that the railway should be operational in this event). The drainage infrastructure is designed to ensure that no increases in surface water runoff occurs from the footprint of the Proposed Scheme¹⁹¹, including a climate change allowance for projected increases in peak rainfall intensity for the end of the 21st century.</p> <p>All river, watercourse crossings and drainage infrastructure will be operated and maintained in accordance with the procedures outlined in the Draft water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-005-000, Water resources and flood risk). This plan includes provision for debris clearance and blockage removal.</p>
OM8	<p>Accidental drowning due to presence of balancing ponds¹⁹² and unauthorised 3rd party access.</p>	<p>Member of public accidentally falls into balancing pond and drowns</p> <p><i>Note: deliberate trespass including vandalism, terrorism or suicide not in scope of this section, which considers the accidents and their potential impact</i></p>	<p>Provision of a secure boundary and other appropriate mitigation measures.</p>

¹⁹¹ Volume 5: Appendix WR-003-001 to WR-003-005, Flood Risk Assessments for each community area.

¹⁹² Many balancing ponds along the route will for much of the year remain dry.

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ID ¹⁸⁷	Risk event	Reasonable worst consequence if event did occur	Key management and mitigation measures to demonstrate risk to be ALARP ¹⁸⁸
OM9	Non-motorist falling from bridges, viaducts, cuttings etc. , including potential electric shock due to contact with overhead line equipment.	Injury or fatality to a member of public	<p>Design of bridges (including fencing and barriers) will meet regulatory requirements for safety of pedestrians.</p> <p>Crossings must be designed and built to be fit for purpose and compliant with proven industry standards and best practice.</p> <p>Provide appropriate and easy to use crossings.</p> <p>Provision of a secure boundary and other appropriate mitigation measures.</p>
OM10	Vehicle falling from overbridge or adjacent road due to presence of overbridges; access roads adjacent to track; shared HS2 access with public right of way	Injury or fatality to a member of public	<p>Crossings must be designed and built to be fit for purpose and compliant with HS2 standards.</p> <p>Sufficient barrier/protection proportional to the risk.</p> <p>Allowance has been made for vehicle restraint systems (VRS) between track and access roads where roads are adjacent.</p> <p>Only trained rail staff to use access roads. Slow speed access roads.</p>
OM11	Traffic incident involving non-motorists due to e.g. changes to public rights of way, shared HS2 access and accommodation with public right of way. Inappropriate exposure of member of public to IMB-R activities.	Injury or fatality to a member of public	<p>Crossings (over and under) and new road layout must be designed and built to be fit for purpose and compliant with standards.</p> <p>Drivers using road vehicles for maintenance activities - travel time and distance to be limited, training, procedures and licencing to be in place.</p> <p>Design IMB-R to ensure segregation is appropriate.</p>
OM15	Injury to member of public using level crossing on WCML related to increased train frequency (shared use of Network Rail tracks)	Injury or fatality to a member of public	Level crossing risk assessment will be undertaken at GRIP ₃ ¹⁹³ and additional mitigation measures where appropriate.
OM16	Emergency response activities impacts on environmental receptors , due to the existence of incident management plans which focus on the safe evacuation of passengers and staff and have the potential to have an adverse effect on local receptors.	Harm to environmental receptor in the vicinity of an incident <i>Note: The specific risk related to discharge of firefighting water is presented separately above</i>	<p>Incident management plans should be developed and communicated sufficiently early enough to influence design. These should include consideration of the local environment and community.</p> <p>Ensure plans are maintained, audited etc.</p> <p>Integrity of communications and processes in event of fire or other incident.</p>

¹⁹³ The GRIP (Governance for Railway Investment Projects) process is used by Network Rail to manage developments. GRIP₃ is 'Option Selection'.

ID ¹⁸⁷	Risk event	Reasonable worst consequence if event did occur	Key management and mitigation measures to demonstrate risk to be ALARP ¹⁸⁸
OM17	<p>Electric shock due to exposure to live conductor/arcing etc. related to presence of live conductor and potential for inadvertent contact (both workers and 3rd parties). Overhead line equipment collapse in extreme weather event. Hazard to emergency services using water to fight fire.</p>	<p>Injury or fatality to a member of public</p>	<p>Electrical safety standards, SCADA (supervisory control and data acquisition) standards.</p> <p>Isolation and earthing procedures.</p> <p>Provision of a secure boundary and other appropriate measures.</p>

11.9 Conclusions

- 11.9.1 Given the processes that are in place, and the resulting measures that will be introduced to avoid and/or reduce the vulnerability of the Proposed Scheme to major accidents and/or natural disasters, it is considered that the risks of any such event occurring will be managed to be as low as reasonably practicable (ALARP). The application of the ALARP principle for the management of railway safety risks has been accepted by the regulator (Office of Rail and Road) and the Health and Safety Executive.
- 11.9.2 As a result it is considered that there will not be any likely significant environmental effects arising from the vulnerability of the Proposed Scheme to major accidents and natural disasters.
- 11.9.3 The Office of Rail and Road (ORR) will only authorise the Proposed Scheme to be placed into service, on the basis of an accepted and independently assessed application of the CSM-RA (which therefore must ensure that all risks are mitigated to be ALARP). Without this authorisation, the Proposed Scheme would not be granted a licence to operate.
- 11.9.4 The measures in place to avoid and/or reduce the vulnerability of the Proposed Scheme to major accidents and natural disasters will be considered and be subject to review under other legislative processes in addition to those put in place by the hybrid Bill.

11.10 Monitoring

- 11.10.1 Volume 1, Section 9, sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

12 Socio-economics

12.1 Introduction

12.1.1 Direct socio-economic effects of the Proposed Scheme are reported at both route-wide and community area levels. The potential overall changes to employment levels (i.e. both the wider socio-economic benefits and those that will arise from the construction and operation of the Proposed Scheme) are reported in this section at a route-wide level. Significant localised effects on employment are reported at a local level in Volume 2, community area 1–5 reports.

12.2 National policy and guidance

12.2.1 The key points from national policy and guidance, which have informed the planning and development context for the socio-economic assessment, are as follows:

- the UK Government’s commitment to sustainable development presented in the Defra publication ‘Mainstreaming sustainable development’¹⁹⁴. The document sets out an approach based on providing ministerial leadership and oversight, leading by example, embedding sustainable development into policy, and providing transparent and independent scrutiny;
- the National Planning Policy Framework (NPPF¹⁹⁵), which identifies the role of the planning system in promoting sustainable development and suggests that economic, social and environmental gains should be sought jointly and simultaneously. As well as the NPPF, local planning policy helps to define the significance of impacts. This is because it is planning policy that typically identifies areas and issues of environmental sensitivity and economic opportunity;
- the January 2012 Command Paper, which articulates a national strategy for high speed rail placing the Proposed Scheme as part of a wider network supporting the continuing growth of rail services in the UK to support ongoing economic growth; and
- the National Infrastructure Plan, which provides a strategic framework for the identification and prioritisation of infrastructure development within the UK and establishes a series of objectives for infrastructure investment. The original 2011 plan¹⁹⁶ identified HS2 as a priority project with the potential to deliver the essential capacity and connectivity, attract investment and secure long-term economic prosperity, and therefore, generate employment. An update was undertaken in 2012 in which the Government announced its decision to proceed with HS2, and a further update published in 2016¹⁹⁷, which

¹⁹⁴ Defra (2011), *Mainstreaming sustainable development – The Government’s vision and what this means in practice*. Defra, London.

¹⁹⁵ Department for Communities and Local Government (2012), *National Planning Policy Framework*. Department for Communities and Local Government, London.

¹⁹⁶ Infrastructure UK (2011), *National Infrastructure Plan 2011*. HM Treasury, London.

¹⁹⁷ Infrastructure and Projects Authority (2016), *National Infrastructure Delivery Plan 2016–2021*. HM Treasury and Cabinet Office, London.

set out the progress made on priority infrastructure investments.

- 12.2.2 Following the Sir David Higgins review 'Rebalancing Britain'¹⁹⁸, recommendations were made to accelerate the development of the route to Crewe, in order to bring forward the regeneration benefits, such as growth and jobs, associated with the Northern Powerhouse and the Midlands Engine initiatives. In the Command Paper of November 2015¹⁹⁹, the Government confirmed its intention to accelerate the section of the route from the West Midlands to Crewe so that it would open in 2027, six years earlier than originally planned, which now forms the basis of the Proposed Scheme.

12.3 Key themes of the assessment

- 12.3.1 This section presents the three types of impacts considered in the route-wide socio-economic assessment, using the methodology described in the Scope and Methodology Report (SMR)²⁰⁰. It also describes how socio-economic effects are presented.

Impacts on employment associated with construction

- 12.3.2 Two types of impact are defined:
- direct employment opportunities: the number of jobs that the Proposed Scheme is expected to directly generate throughout the construction phase; and
 - indirect employment opportunities: the number of jobs that the Proposed Scheme is expected to indirectly generate throughout the construction phase through multiplier effects²⁰¹.

Impacts on existing businesses and organisations

- 12.3.3 Three types of impact are defined:
- businesses and organisations (socio-economic resources) that will be displaced due to land being acquired for the construction of the Proposed Scheme. Socio-economic resources are defined as a property used by one business or organisation, or by a group of businesses and/or organisations;
 - socio-economic resources affected by a change in key environmental conditions as a result of construction and operation of the Proposed Scheme. A combination of factors such as: sound, noise and vibration; air quality; Heavy Goods Vehicle (HGV) traffic flows; and visual impacts could adversely affect the ability of a business unit to attract trade; and

¹⁹⁸ HS2 Limited (2014), *Rebalancing Britain – From HS2 towards a national transport strategy*. Department for Transport, London.

¹⁹⁹ Department for Transport (2015), *High Speed Two: East and West. The next steps to Crewe and beyond*. Available online at: http://webarchive.nationalarchives.gov.uk/20160811030455/https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf

²⁰⁰ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

²⁰¹ The additional impacts of construction employment creation on the business supply chain and their expenditure effects can be calculated using four economic adjustment factors: leakage, displacement, substitution and multiplier effects. These factors and their rates are explained in Homes and Communities Agency (2014), *Additionality Guide: A standard approach to assessing the impact of interventions* (4th Edition). Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf

- socio-economic resources affected by isolation²⁰² from customers/users as a result of the construction and operation of the Proposed Scheme. This analysis considered the consequence of these isolation effects on business operations.

Impacts on employment associated with operation

12.3.4 Two types of impact are defined:

- direct employment opportunities: the number of jobs that the Proposed Scheme is expected to directly generate throughout the operational phase; and
- indirect employment opportunities: the number of jobs that the Proposed Scheme is expected to indirectly generate throughout the operational phase through multiplier effects.

Socio-economic effects

12.3.5 Socio-economic effects are presented as either gross or net employment effects. Gross effects refer to the total effect of the Proposed Scheme. This includes:

- direct effects (such as jobs required to lay the track in the construction phase or operatives employed at the Infrastructure Maintenance Base - Rail (IMB-R) required in the operational phase); and
- indirect effects (or knock-on effects, such as supply chain and expenditure effects, which are collectively referred to as multiplier effects).

12.3.6 In calculating net effects, economic adjustments such as leakage, displacement and substitution²⁰³ are applied to reflect the interrelated nature of the economy. These effects can be beneficial or adverse.

12.4 Wider socio-economic benefits

12.4.1 The Proposed Scheme will enable the realisation of wider socio-economic benefits for businesses, communities and local authorities including:

- wider economic benefits identified in the case for accelerating the section of HS2 between the West Midlands and Crewe²⁰⁴ comprising: better linkages between firms—resulting in improvements in productivity (agglomeration impacts); extending labour markets and allowing businesses to attract more skilled employees (labour market impacts); and the additional value to customers of goods and services (imperfect competition). These wider economic benefits total £17.6bn (present value, 2015 prices) for the full 'Y network'²⁰⁵ and £0.7bn for Phase 2a alone (present value, 2015 prices). These

²⁰² The term isolation refers to the physical islanding or isolation of a resource which results in a change to businesses' and organisations' environments as defined in Table 32 of Volume 5: Appendix CT-001-001, Environmental Impact Assessment Scope and Methodology Report.

²⁰³ The additional impacts of construction employment creation on the business supply chain and their expenditure effects can be calculated using four economic adjustment factors: leakage, displacement, substitution and multiplier effects. These factors and their rates are explained in Homes and Communities Agency (2014), *Additionality Guide (4th Edition)*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf

²⁰⁴ Department for Transport (2015), *High Speed Two: East and West – The next steps to Crewe and beyond*.

²⁰⁵ Department for Transport (2017), *HS2 West Midlands to Crewe Outline Business Case: Economic Case*. Available online at: <https://www.gov.uk/hs2>

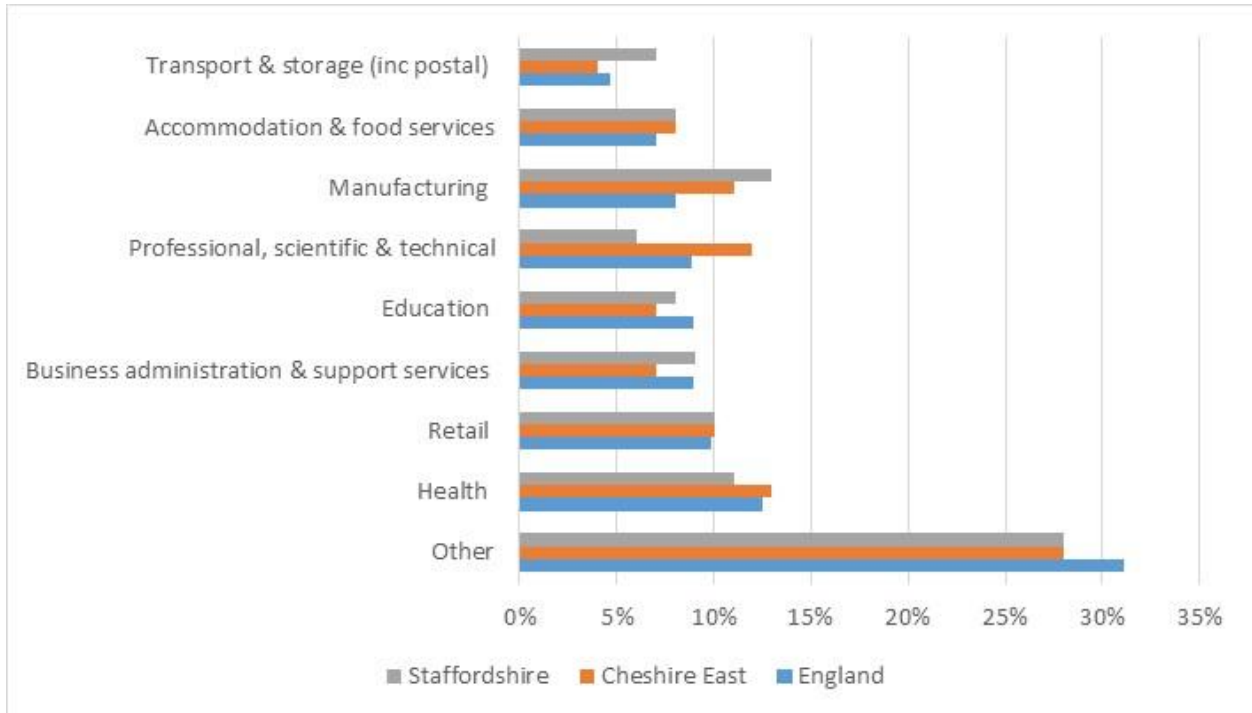
benefits will translate into increased employment and average household incomes on a scale substantially greater than the other immediate direct and indirect socio-economic impacts;

- generating additional economic activity around Crewe; and
- freeing up capacity on the conventional rail network as a consequence of passengers transferring from the conventional rail network to long distance services provided by the Proposed Scheme.

12.5 Socio-economic baseline

- 12.5.1 This section summarises key economic indicators for England and the two sub-regional economies of Cheshire East and Staffordshire, on which the Proposed Scheme will impact.
- 12.5.2 Gross value added (GVA) measures the contribution to the economy of each individual producer, industry or sector. England generated a total GVA of £1,377,900 million in 2015, of which Staffordshire contributed £15,300 million (1.1%) and Cheshire East Council (CEC) area £11,200 million (0.8%). GVA per person per year is higher in the CEC area (£30,000) than in Staffordshire (£17,800) and the England average (£25,400). The long term trend has been for both total GVA and GVA per person per year to grow.
- 12.5.3 In 2015, employment in England stood at 25.7 million, at 0.19 million (0.7%) in the CEC area and at 0.34 million (1.3%) in Staffordshire. The majority of employment in England is in the service sector (85%). The CEC area employment is marginally more heavily concentrated in services than Staffordshire (84% compared with 80%, respectively). A sector breakdown by industry in the CEC area and Staffordshire, benchmarked against England, is shown in Figure 12.

Figure 12: Proportion of employment by industry in Cheshire East, Staffordshire and England^{206, 207}



- 12.5.4 Figure 12 shows some clear similarities between the employment profile of the CEC area and Staffordshire compared to England, with health and retailing accounting for a significant share of total jobs. The CEC area has a higher proportion of employment in professional, scientific and technical jobs compared to both the England and Staffordshire share.
- 12.5.5 The average employment rate²⁰⁸ for those aged 16–64 is 76% in the CEC area and 78% in Staffordshire, compared with 74% for England as a whole.

12.6 Assessment of the effects of construction

- 12.6.1 There are broadly two types of impacts considered for the construction phase of the Proposed Scheme on a route-wide basis: employment associated with construction of the Proposed Scheme; and employment associated with businesses affected by construction of the Proposed Scheme.

Construction employment

- 12.6.2 The Proposed Scheme will support employment in the construction industry over the construction period. Overall, it is estimated that the construction phase will generate 22,400 person years of construction employment opportunities²⁰⁹ (equivalent to 2,240

²⁰⁶ 'Other' includes Construction; arts, entertainment, recreation & other services; Information & communication; wholesale; public administration & defence; financial & insurance; property; motor trades; agriculture, forestry & fishing and mining, quarrying & utilities.

²⁰⁷ Office for National Statistics (2016), *Business Register and Employment Survey 2015*.

²⁰⁸ Office for National Statistics (2016), *Annual Population Survey 2016*.

²⁰⁹ 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.

permanent full time construction jobs²¹⁰), which will be a major beneficial effect and is, therefore, considered to be significant.

- 12.6.3 Of these, an estimated 11,700 person years of construction employment opportunities (equivalent to 1,170 permanent full-time construction jobs)²¹¹ will be based at worksites along the Proposed Scheme, as described in Volume 2, community area 1–5 reports, Section 2. Depending on skill levels required, and the skills of local people, these jobs will be accessible to local residents and to others living within the travel to work area or farther afield.
- 12.6.4 It is anticipated that direct construction jobs will potentially offer a range of occupations and skillsets, such as: skilled construction workers, labourers, tunnelling specialists, mechanical fitters, steel fixers, electricians, engineering professionals, and management and planning professionals.
- 12.6.5 HS2 Ltd has committed to providing a minimum of 2,000 apprenticeships over the lifetime of the entire project (which includes Phase One and Phase Two²¹²). HS2 Ltd is committed to using the Proposed Scheme to maximise the creation of new apprenticeships, as well as affording existing apprentices employed in the supply chain the unique opportunity to experience working on the Proposed Scheme. Across the supply chain, apprentices will be employed in a wide range of trades and professions from construction to accountancy, quantity surveying to business administration.
- 12.6.6 The construction works will generate additional indirect demand for goods and services through the business supply chain and expenditure effects of workers, which could stimulate business growth and opportunities to generate further employment²¹³. As a consequence, a further 8,400 person years of employment could be created (equivalent to 840 full-time jobs)²¹⁴, which is a major beneficial significant effect.

Businesses affected

- 12.6.7 The construction phase will result in the displacement of some existing businesses through land required for the construction of the Proposed Scheme. These effects have been assessed and reported within Section 12 of the relevant Volume 2 community area reports. In most cases, it is concluded that the majority of businesses affected in this way will be able to relocate²¹⁵, given the availability of alternative premises and the payment of compensation, and thereby continue to operate. It is also concluded that a large proportion of employees who may lose their jobs as a

²¹⁰ 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.

²¹¹ Based on average employment at civils and rail system compounds.

²¹² Department for Transport (2015), *High Speed Two: East and West. The next steps to Crewe and beyond*. Available online at: http://webarchive.nationalarchives.gov.uk/20160811030455/https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480712/hs2-east-and-west.pdf

²¹³ The additional impacts of construction employment creation on the business supply chain and their expenditure effects can be calculated using four economic adjustment factors: leakage, displacement, substitution and multiplier effects. These factors and their rates are explained in Homes and Communities Agency (2014), *Additionality Guide (4th Edition)*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf

²¹⁴ Based on average employment at civils and rail system compounds except at CA5 where peak employment has been used for rail systems.

²¹⁵ A business decision to relocate is dependent on a number of factors, including market conditions at the time of relocation, business vulnerability, state of preparation and owner-specific drivers.

consequence of their employer closing or relocating and contracting, will be able to secure new employment relatively quickly given the current size and strength of the relevant local labour markets (if these conditions were to be sustained).

- 12.6.8 Whilst it is not possible to predict accurately the numbers of jobs that are at risk of being lost route-wide (as a result of businesses failing to relocate and closing, or relocating and contracting, and employees being unable to find work in the short term), an assumption can be made by drawing on previous research. The London Development Agency (LDA) carried out research into the relocation of companies and jobs on account of the London 2012 Olympic Games. This research²¹⁶ indicated that the majority of businesses (88%) relocated while 12% of businesses did not continue to trade.
- 12.6.9 Therefore, for the purpose of this assessment, the indicative rate of successful relocation is judged to be 88% and employment at these businesses will not be lost²¹⁷. Based on this, there is predicted to be a total relocation of 140 jobs from businesses as a result of land required for construction of the Proposed Scheme. This figure includes the loss of 10 agricultural jobs (full time equivalents) as a consequence of the permanent loss of land required by the Proposed Scheme.
- 12.6.10 If an assumption is made that 12% of all jobs associated with directly affected businesses as a result of the Proposed Scheme could be lost route-wide, then approximately 15 jobs could be lost.
- 12.6.11 The direct loss of businesses and employment will have knock-on effects through the business supply chain and expenditure effects alongside other economic adjustment factors²¹⁸. As a consequence, it is estimated that approximately 10 additional jobs could be lost through indirect effects, route-wide.
- 12.6.12 Businesses displaced by the Proposed Scheme will be compensated in accordance with the Compensation Code. HS2 Ltd recognises the importance of displaced businesses being able to relocate to alternative premises and will, therefore, offer additional support to facilitate this.
- 12.6.13 For those socio-economic resources affected by land required for construction of the Proposed Scheme, there is predicted to be a total relocation of employment of approximately 140 jobs. It is considered that the route-wide impact will be low. The route-wide sensitivity of businesses is assumed to be medium. As such, there will be a minor adverse effect, which is not considered to be significant.
- 12.6.14 In-combination and isolation effects on businesses have been assessed and reported within Section 12 of the relevant Volume 2 community area reports. Route-wide, there are five businesses across the length of the route that may experience

²¹⁶ In total, 208 businesses providing 4,946 jobs were relocated as part of the Compulsory Purchase Order (CPO) process. In total, 183 (88%) businesses relocated and continued to trade and 25 (12%) closed. See London Development Agency (LDA) (30th June 2008), *Request for Information/Freedom of Information Act by Mr Julian Cheyne, FOI291*.

²¹⁷ Of the businesses which closed (or may close), these businesses represent only 2% of total employment within businesses displaced by London 2012. Given the potential complexities associated with relocating some of the affected businesses, for the purposes of the route-wide assessment, it is assumed that a worst-case figure of 12% to represent total employment lost as a result of the Proposed Scheme.

²¹⁸ These knock-on effects are calculated using four economic adjustment factors: leakage, displacement, substitution and multiplier effects. These factors and their rates are explained in Homes and Communities Agency (2014), *Additionality Guide (4th Edition)*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf. Refer to Volume 1, Section 8 assumptions for further details on multipliers.

significant in-combination or isolation effects as a result of construction of the Proposed Scheme. As a consequence, the trade of these businesses will potentially be affected. Businesses that will be significantly affected are primarily in the hospitality, leisure and recreation and retail sectors of the local economy. In total, these businesses support approximately 120 jobs of which 10 jobs could potentially be lost or displaced. As a result of knock on effects through the business supply chain and expenditure effects, approximately five additional jobs could be lost or displaced. Route-wide, this is not considered to be a significant employment effect as a result of in-combination and isolation effects.

- 12.6.15 In total, approximately 40 jobs could be lost route-wide from businesses directly and indirectly affected during the construction phase. This impact will be mitigated over time as the UK and regional economies grow and new opportunities for employment for people who have lost their jobs, and have been unable to find work, come forward. As outlined in the Economic Case for HS2²¹⁹, in the longer term, the Proposed Scheme will enhance these opportunities through increased investment and economic activity above the baseline. In the context of the economies of West Midlands and the North West, which provide over 5.7 million jobs, the potential level of job loss is a relatively small proportion of total employment. Table 11 provides a summary of this assessment of construction effects.

Table 11: Summary of the construction socio-economic assessment

Construction employment created (direct)	
Magnitude	High
Sensitivity	High
Overall significance	Major beneficial
Construction employment created (indirect):	
Magnitude	High
Sensitivity	High
Overall significance	Major beneficial
Employment in businesses directly affected:	
Magnitude	Low
Sensitivity	Medium
Overall significance	Minor adverse (not significant)

12.7 Assessment of the effects of operation

- 12.7.1 There are two types of impacts considered for the operational phase of the Proposed Scheme: employment associated with the operation of the service and employment associated with businesses affected by operation of the service.

Direct operational employment

- 12.7.2 The Proposed Scheme will create direct operational employment at the IMB-R near Stone. There will be an estimated 100 direct operational jobs created at the IMB-R, which will be a moderate beneficial effect and is, therefore, considered to be significant.

²¹⁹ Department for Transport (DfT) (2017), *HS2 West Midlands to Crewe Outline Business Case: Economic Case*. Available online at: <https://www.gov.uk/hs2>

- 12.7.3 The Proposed Scheme will create indirect employment opportunities associated with the IMB-R. These indirect jobs will result from expenditure on supplies and services necessary for the operation of the Proposed Scheme. Indirect jobs will also result from expenditure by those directly employed at the IMB-R and by workers employed by suppliers contracted to the Proposed Scheme. It is estimated that 40 jobs will be created route-wide through indirect effects as a result of the operational phase of the Proposed Scheme. Route-wide, the indirect employment impact is a minor beneficial effect and is, therefore, not considered to be significant.

Businesses directly affected

- 12.7.4 The socio-economic assessment has not identified any businesses that could be directly affected (either negatively or beneficially) by the operations of the Proposed Scheme beyond those already covered in the construction phase analysis.

Total operational employment

- 12.7.5 In total, 140 direct and indirect permanent jobs are estimated to be created during the operational phase.
- 12.7.6 Table 12 provides a summary of this assessment of operational effects.

Table 12: Summary of the operational phase socio-economic assessment

Direct operational employment created:	
Magnitude	Low
Sensitivity	High
Overall significance	Moderate beneficial
Indirect operational employment created:	
Magnitude	Negligible
Sensitivity	High
Overall significance	Minor beneficial (not significant)

12.8 Monitoring

- 12.8.1 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

13 Sound, noise and vibration

13.1 Introduction

13.1.1 This section presents the route-wide assessment of the likely significant sound, noise or vibration effects arising from the Proposed Scheme.

13.2 Assessment of the effects of construction

13.2.1 Noise and vibration effects from construction activities will be confined to local areas in the vicinity of construction sites. Construction noise and vibration effects have been assessed on a local basis and are described for each area within the Volume 2 community area 1–5 reports.

13.2.2 It is considered that there will be no significant noise or vibration effects on a route-wide basis associated with the construction of the Proposed Scheme.

13.3 Assessment of the effects of operation

13.3.1 Noise and vibration effects from the operation of the Proposed Scheme will occur locally, affecting people and other sensitive receptors (including schools, churches, hospitals and offices). Operational noise and vibration effects have been assessed on a local basis and are described for each area within the Volume 2, community area 1–5 reports. A summary of any route-wide health effects arising from noise and vibration generated during the operation of the Proposed Scheme is presented in the Section 8 of this report.

13.3.2 It is considered that there will be no significant noise or vibration effects on a route-wide basis associated with the operation of the Proposed Scheme.

14 Traffic and transport

14.1 Introduction

- 14.1.1 The geographical extent of the Proposed Scheme is such that for some traffic and transport significant effects, consideration at a regional, and where appropriate route-wide, scale is required. This section provides an overview of the approach to and conclusions from the route-wide traffic and transport assessment (Volume 5: Appendix TR-000-001). Traffic and transport effects at a local scale are assessed in the Volume 2, community area 1–5 reports and Volume 4, Off-route effects.
- 14.1.2 The operational assessment of traffic and transport impacts and effects at regional and route-wide levels is primarily based upon the output from the PLANET Framework Model²²⁰, which forms the basis for the economic assessment.
- 14.1.3 The construction assessment of impacts has been based on analyses to identify works to the national rail network and includes consideration of the likely number, location, duration and nature of works.
- 14.1.4 The traffic and transport effects set out in the Volume 2 community area reports are structured to identify impacts by individual transport mode. The assessment of route-wide and regional effects in this volume adopts the same approach and criteria for identifying impacts and assessing their effects.

14.2 Effects arising during construction

- 14.2.1 During construction, traffic and transport effects could arise from the cumulative impact of all construction works on the wider strategic road network and the impact on the wider rail network as a cumulative result of closures or possessions.
- 14.2.2 The potential impacts that have been identified include:
- impacts on rail passenger users and rail freight during rail possessions, although these are likely to be short term with largely local impacts; and
 - overall combined traffic impacts during construction.

Impacts arising on the road network during construction

- 14.2.3 As part of the construction of the Proposed Scheme every effort will be made to re-use excavated material (where suitable and reasonably practicable). To minimise the impact of construction traffic on the road network, the Proposed Scheme includes the use of borrow pits, which will enable construction material to be obtained locally. Following excavation of construction material, the borrow pits will be backfilled with materials generated from the construction of the Proposed Scheme thereby reducing the wider potential effects on the road network of disposal of surplus excavated

²²⁰ The PLANET Framework Model (PFM) is the Department for Transport forecasting model which has been used to develop rail demand forecasts as a result of the Proposed Scheme. The PLANET Framework Model has been developed by HS2 Ltd from a suite of models originally developed by the Strategic Rail Authority (SRA). PFM is the most appropriate modelling tool to be used in terms of forecasting the demand of the Proposed Scheme given its strategic capability, covering all long-distance rail, car and air movements across England, Scotland and Wales. PFM has evolved over a number of years, and builds on existing model components. Its aim is to provide forecasts of demand and (generalised) costs to drive the appraisal of HS2. As is standard in transport modelling, 'generalised cost' is a combination of monetary costs and travel time components.

material. Furthermore, the use of the conventional railway, and in particular the railhead near Stone, to transport bulk materials (such as track slab, ballast, rails and sleepers), where reasonably practicable, will help to reduce wider traffic impacts of such movements.

- 14.2.1 The impacts of construction traffic are therefore focused on the road network close to the Proposed Scheme, which includes the principal corridors for movement of bulk material. These are considered within Volume 2 community area reports, Section 14. These reports consider the impact of construction activity on roads extending from the Proposed Scheme to the strategic network. It is considered that once on the strategic network, the cumulative impacts associated with the movement of excavated and fill materials, will not be significant as the construction traffic movements represent a very small proportion of total traffic on the strategic road network and therefore is considered no further within this section.

Impacts on the railway network during construction

- 14.2.2 The design of Proposed Scheme aims to reduce operational disruption to the conventional rail network during construction where reasonably practicable. Where it is safe to do so, works will be undertaken while conventional train services are still running. Where this would not be safe, works will have to be undertaken when trains are not running, in possessions.
- 14.2.3 In so far as reasonably practicable, many of these works will be undertaken in the normal night time maintenance possessions to reduce disruption to passenger and freight services. However, for certain major works that cannot be accommodated within these maintenance periods, weekend closures of a day's duration or longer will be required. These are referred to as weekend possessions. Where the works are particularly complex and require more time than a normal or bank holiday weekend, durations longer than a weekend will be required and are referred to as blockades.
- 14.2.4 Possessions are a standard technique widely used for the maintenance and renewal of the conventional railway. The possessions for the Proposed Scheme will be consistent with those adopted for current Network Rail working practices. HS2 Ltd will work with Network Rail to, where reasonably practicable, co-ordinate possessions with existing planned maintenance and renewals to reduce overall disruption to the travelling public and to ensure that the disruption impact of the works is not significant.
- 14.2.5 The assessment of impacts to conventional rail services during construction has been based on a review of the proposed works either on or near the national rail network. From this review the likely number, location, duration and nature of works, as well as how they will be carried out, has been established. These factors have been used to assess the potential levels of disruption to passenger services on the conventional rail network. There are a number of works proposed that are of sufficient scale that they could potentially create disruption and delay to rail passenger and freight services. These are outlined below with reference to the relevant community area.
- Great Haywood, Macclesfield to Colwich Line: (Colwich to Yarlet community area (CA2)). Works include Great Haywood viaduct, required to span the Macclesfield to Colwich Line. Possession of this part of the Macclesfield to Colwich Line will be required for temporary crossing of the railway, minor modifications to the overhead line equipment, access to pier locations and for

launching of the reinforced concrete trapezoidal box structure. Most of these works will be undertaken in non-disruptive possessions. However one 54-hour weekend possession will be required for the launch of the main structure. It is expected that diversionary routes via Norton Bridge will be kept open.

- Stone, Norton Bridge to Stone Railway (Stone and Swynnerton community area (CA3)). Works include Filly Brook viaduct, Norton Bridge to Stone Railway underbridge, Yarnfield South embankment and the railhead connection to the conventional railway. Possessions of the Norton Bridge to Stone railway will be required for viaduct foundations adjacent to the railway, for lifting precast beams into place to form the viaduct deck, and some finishing work to the viaduct structure which may be required above the railway. Possessions will also be required for the installation and commissioning of the Stone railhead connection to the Norton Bridge to Stone railway. Most of these works will be undertaken in non-disruptive possessions. However, six 54-hour weekend possessions will be required.
- Near Madeley, West Coast Main Line (WCML) (Whitmore Heath to Madeley community area (CA4)). Works include Stableford South embankment and the River Lea viaduct. At Stableford, possessions of the WCML will be required for diversion of an overhead power line and gas mains to be buried under the WCML. For the River Lea viaduct, a concrete box girder structure carrying the Proposed Scheme over the WCML, the disused Stoke to Market Drayton railway and Madeley Chord will require possessions to support area setup and installation of piling platform and sheet piling at foundation locations. These works are expected to be undertaken in non-disruptive possessions. However four 54-hour weekend possessions will be required for lifting portal structures into place and for pushing the viaduct structure across WCML.
- Crewe South, WCML (South Cheshire community area (CA5)). Works include utility diversions, multiple bridge demolitions and constructions, diversion/realignment of the WCML, installation of new junctions, signalling, telecoms and power equipment on the WCML and the connection to the Proposed Scheme, including testing and commissioning. The design facilitates a large amount of the diverted WCML and bridges over this section to be completed away from the operational railway. These works are expected to require 64 either 27 or 54-hour weekend possessions and two longer possessions of up to 100-hour weekend possessions. Two blockades are envisaged to be required for the more complex junction installation works, including testing and commissioning of signalling and power systems. These works will be staged so that weekend possessions and blockades are shared where possible. Utility diversions, site set up works and other preparatory works will be undertaken in non-disruptive possessions.
- Crewe Central, Manchester Independent Line (South Cheshire community area CA5)). Works include installation of an island platform and remodelling of the existing junctions. Site set up works and other preparatory works will be undertaken in non-disruptive possessions. Thirty-eight 54-hour weekend possessions will be required for major bridge construction works, installation

of new junctions and the commissioning of the Proposed Scheme. A longer blockade of the Manchester Independent Line is envisaged to be required for the more complex installation works. Diversionary routes for freight trains through the existing station exist, and detailed arrangements will need to be agreed.

- Crewe Central, WCML (South Cheshire community area (CA5)). Works include installation of signalling, telecoms, and other interfacing systems to allow HS2 trains to run from the WCML onto the Proposed Scheme. Most of these works will be undertaken in 'non-disruptive' possessions or interfaced with other weekend closures in the area.
- Off-route modifications to the Crewe to Manchester railway line (part of the WCML) at Maw Green and Sandbach, required to facilitate train operations that occur as a result of the Proposed Scheme. Works will include reconfiguration of the track layout, new track switches, raising of an existing footbridge and modifications to the existing rail systems including new or relocated signalling and overhead line equipment. These works are expected to be undertaken in non-disruptive possessions, 14 27-hour possessions, one 72-hour and two 100-hour weekend possessions. One blockade is envisaged to be required for the more complex works. These works will be staged so that weekend possessions and blockades are shared where possible.

- 14.2.6 A temporary railhead is proposed near Stone (Stone and Swynnerton community area (CA3)), which will connect to the conventional rail network and will be used as the delivery location for bulk rail-borne materials such as fill material, track slab, rails, ballast and sleepers. It will also be used for the removal of excavated material. Facilities at the railhead will include offices, storage, a rail marshalling yard and pre-assembly depot and rail reception maintenance loops. The railhead will operate 24 hours a day, seven days a week. On completion of the construction works, the railhead will be converted into a permanent maintenance facility, referred to as the Infrastructure Maintenance Base Rail (IMB-R) for the Proposed Scheme.
- 14.2.7 The potential scale of effect from these works on or near the national rail network will depend on a number of factors including the type and complexity of interaction, duration of interaction, level of use of the rail line affected and timing of the interaction. For example, railheads and rail sidings will not have a direct impact on the operation of the conventional rail network as they can be implemented without the need for disruption to the railway and delay to passenger journeys. However, major track re-modelling has greater potential to affect services. While most railway works will be undertaken overnight or during weekend possessions (and thus will have limited impacts in isolation), a long programme of such works across a route could, over a period of time, cause disruption to the travelling public and freight services.
- 14.2.8 The Proposed Scheme also includes connections to the conventional rail network as considered in Volume 2: community area 5 report, South Cheshire. The works are generally localised activities and short-term in duration (except as discussed in this section) and are not expected to have route-wide effects.
- 14.2.9 The method for implementing works will be through a series of overnight or weekend possessions (often referred to as planned non-disruptive possessions) of the

conventional rail network. This is a standard technique widely used for the maintenance of the railway. Nevertheless, it is expected that there will be a number of weekend possessions or blockades required during a six year period.

- 14.2.10 These possessions will be consistent with those adopted for current Network Rail maintenance working practices and will not substantially disrupt the travelling public. In addition to overnight possessions, there will be a need for some weekend and public holiday possessions where the works are more complex. HS2 Ltd will work with Network Rail to, where reasonably practicable, co-ordinate possessions with existing planned maintenance to reduce disruption to the travelling public and to ensure that the disruption impact of the works are not significant.
- 14.2.11 The assessment has concluded that there will be no significant route-wide effects on the travelling public arising as a result of the required railway possessions.

14.3 Assessment of the effects of operation

- 14.3.1 The introduction of the Proposed Scheme will provide improved journey times on HS2 services and build on the already significant beneficial effects of Phase One which were reported in the Phase One Environmental Statement. This section considers the effects of the Proposed Scheme where Phase One is included in the future baseline and then considers the cumulative effects of Phase One and the Proposed Scheme. The assessment also considers the impacts on the conventional rail network.
- 14.3.2 The Proposed Scheme includes the provision of the IMB-R near Stone in the Stone and Swynnerton area (CA3). The IMB-R is a permanent maintenance base situated between the route of the Proposed Scheme and the M6. The IMB-R is a facility with rail access and variable level of additional functional requirements based on the local infrastructure and adjacent maintenance facilities. It is required so that On-Track Machines (OTMs) and engineering trains²²¹ can be stabled along the route such that time spent travelling to and from work-sites is minimised and on-site productivity within a maintenance period is optimised.
- 14.3.3 The operation of HS2 services, together with the timetable, service and infrastructure changes on the conventional rail network have been assessed, including:
- potential journey time benefits that will be achieved by the introduction of the Proposed Scheme;
 - changes in passenger demand including the extent of changes in mode share;
 - changes in vehicle and passenger kilometres by mode and in typical journey times; and
 - any impact of released capacity.
- 14.3.4 The assessment of the Proposed Scheme includes an assumption that there will be no change to the conventional rail services as a result of released capacity over and above those changes resulting from the operation of Phase One. The assessment does however consider how the Proposed Scheme may change demand on conventional

²²¹ On-Track Machines (OTMs) and engineering trains are specialist engineering vehicles used to inspect and maintain the track.

rail. As a result of the infrastructure changes at Crewe Station, journey times for passengers on the Cardiff to Manchester conventional rail service have the potential to increase by approximately 6 minutes, depending on the operating speed and route through the station, between 2027 and 2033. However, this is not likely to result in any significant effects.

- 14.3.5 The PLANET Framework Model has been used to estimate travel on HS2 and other rail services and other transport modes; and hence, provide mode share information for car, rail and air modes both 'with' and 'without' the Proposed Scheme. The PLANET Framework Model also forecasts changes in passenger use at stations (including stations on the route of Phase One) and these are considered further in Volume 4, Off-route effects. The Economic Case for the Proposed Scheme carries out further sensitivity testing, to assess the impact of changes in external and internal factors on the mode share and passenger use estimations.

Impacts arising during operation

Potential journey time benefits

- 14.3.6 The Proposed Scheme is assumed to have the same service pattern as Phase One. This means that the same number of services is assumed for the Proposed Scheme as is proposed for Phase One (for details refer to Volume 1, Section 4 and Volume 5: Appendix TR-000-001). The service patterns assumed for Phase One indicate that there would be up to seven high speed conventional compatible services per hour in each direction from London to the north-west which would use the high-speed section of track from London and connect to the WCML via the Handsacre Link. The Proposed Scheme enables some of these services to use the new high-speed section of track before joining the WCML south of Crewe and therefore benefit from further journey time savings. The Proposed Scheme assumes that up to six high speed conventional compatible services per hour that would have used the Handsacre Link would benefit from use of the additional section of high-speed track reducing journey time from London Euston to stations including Glasgow Central, Liverpool Lime Street, Crewe and Manchester Piccadilly. The expected journey times for the Proposed Scheme are shown in Table 13 when compared against a future baseline which includes Phase One.

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Table 13: Fastest typical journey times between key destinations 'without' and 'with' the Proposed Scheme in operation (Phase One and Phase 2a)

Origin / destination	Journey time		
	Without HS2 (i.e. current)	Future baseline including Phase One	With Proposed Scheme
London Euston–Crewe	1 hour 30 minutes	1 hour 8 minutes	55 minutes
London Euston–Manchester Piccadilly	2 hours 7 minutes	1 hour 41 minutes	1 hour 30 minutes
London Euston–Preston	2 hours 8 minutes	1 hour 41 minutes	1 hour 30 minutes
London Euston–Liverpool Lime Street	2 hours 14 minutes	1 hour 46 minutes	1 hour 34 minutes
London Euston–Glasgow Central	4 hours 31 minutes ²²²	3 hours 56 minutes	3 hours 45 minutes

14.3.8 Table 13 shows that the Proposed Scheme is forecast to reduce journey times by up to 13 minutes from London to destinations including Crewe, Manchester Piccadilly and Liverpool Lime Street. This equates to a 19% reduction in journey times to Crewe and an 11% reduction in journey times to Manchester Piccadilly and Liverpool Lime Street. These savings are assessed as a minor beneficial effect, which is significant, on journey times between London and mainline stations in the north-west of the country.

14.3.9 When combined with Phase One, the Proposed Scheme will reduce journey times between London and Manchester Piccadilly by around 37 minutes, or 29%, between London and Liverpool Lime Street by around 40 minutes, or 30%, and between London and Crewe by around 35 minutes, or 39%. The resultant combined travel time savings for the Proposed Scheme with Phase One represents a major beneficial effect which is significant. This effect is unchanged from that presented for Phase One in isolation.

Changes in passenger demand

14.3.10 Table 14 and Table 15 show the daily and annual forecast numbers of HS2 passenger trips for 2027 and 2037, the numbers of generated new trips and, for the remainder, the mode of travel that they will have transferred from for Phase One and the Proposed Scheme.

²²² This route also has a faster train of 4 hours 5 mins (London-Preston-Glasgow) which runs once a day.

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Table 14: Origin mode of HS2 passenger trips—average daily

From mode	Origin of trips (average day, combined both directions)			
	2027 future baseline with Phase One	2027 with the Proposed Scheme	2037 future baseline with Phase One	2037 with the Proposed Scheme
Conventional rail	94,014	97,009	117,845	120,985
Generated by the Proposed Scheme	24,484	27,996	34,621	38,472
Air	886	1,079	1,106	1,293
Car	3,437	3,786	4,124	4,433
Total	122,820	129,871	157,697	165,182

Table 15: Origin mode of HS2 passenger trips—annual

From mode	Origin of trips (annual, combined both directions)			
	2027 future baseline with Phase One	2027 with the Proposed Scheme	2037 future baseline with Phase One	2037 with the Proposed Scheme
Conventional rail	30,552,446	31,577,275	38,202,613	39,281,907
Generated by the Proposed Scheme	7,476,739	8,560,978	10,550,761	11,738,277
Air	276,613	337,028	344,769	402,756
Car	1,112,623	1,230,751	1,332,609	1,436,970
Total	39,418,421	41,706,032	50,430,752	52,859,910

- 14.3.12 When expressed in annual terms, Table 15 shows that the Proposed Scheme will add up to a total of 2.3 million passenger trips per annum in 2027 rising to approximately 2.4 million passenger trips per annum as a result of the Proposed Scheme by 2037.
- 14.3.13 The introduction of the Proposed Scheme will increase the number of annual rail passenger trips and reduce the vehicle trips. This is quantified in Table 16 which shows an increase in rail trips in 2027 of approximately 1.2 million rising to 1.4 million in 2037 increasing the substantial growth in rail demand as a result of Phase One by a further 13% in 2027 and 11% in 2037. There is a corresponding fall in car trips of approximately 100,000 in 2027 and 2037.

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Table 16: Changes in annual long distance trips

	2027 future baseline with Phase One	2027 with the Proposed Scheme	2037 future baseline with Phase One	2037 with the Proposed Scheme
Annual change in rail passenger trips as a result of the Proposed Scheme	+ 8.9 million	+ 1.2 million	+12.2 million	+1.4 million
Annual change in car trips as a result of the Proposed Scheme	-1.1 million	-0.1 million	-1.3 million	-0.1 million

- 14.3.14 The transfer of passengers from the conventional rail network and from mode transfer from car will result in benefits through reducing forecast future congestion on both the strategic highway and the conventional rail network. The extent of reduction in vehicle kilometres as a result of the Proposed Scheme is shown in Table 17.

Table 17: Reduction in vehicle kilometres resulting from mode shift

	2027 future baseline with Phase One	2027 with the Proposed Scheme	2037 future baseline with Phase One	2037 with the Proposed Scheme
Annual reduction in vehicle kilometres as a result of mode shift to the Proposed Scheme	162.9 million	22.9 million	178.6 million	11.7 million

- 14.3.15 Table 17 shows that the Proposed Scheme will reduce annual vehicle travel by car on strategic long distance routes in 2027 by approximately 22.9 million kilometres and approximately 11.7 million kilometres in 2037. This represents an increase of approximately 14% in 2027 and 7% in 2037 over and above the substantial benefits derived from Phase One.
- 14.3.16 Once completed, Phase 2a has the potential to deliver a change in capacity however, the assessment of the Proposed Scheme includes a conservative assumption that there will be no change to the conventional rail or freight services as a result of released capacity over and above those resulting from Phase One.
- 14.3.17 Whilst the Proposed Scheme assumes the same service patterns as Phase One, passengers on conventional rail services will benefit from long distance passengers transferring from conventional rail services to high speed services and thereby releasing passenger capacity on existing services. Table 15 shows that the Proposed Scheme will attract 1.0 million users per annum from conventional rail services in 2027 and 1.1 million users per annum from conventional rail services in 2037.
- 14.3.18 The Proposed Scheme will also relieve pressure on bottlenecks, improve reliability and performance, and create extra capacity on the WCML and at stations between Handsacre and immediately south of Crewe. In particular, any released capacity could be used to run additional freight services to Basford Hall yard, a major freight interchange immediately south of Crewe although the benefits of this have not been considered within this assessment.

- 14.3.19 The Proposed Scheme is shown to increase demand for rail travel and provide beneficial relief to the conventional rail network as well as beneficial reductions in long distance travel by car. While these impacts in isolation are not significant, when combined with those provided by Phase One they are considered to provide a major beneficial effect, which is significant.

14.4 Monitoring

- 14.4.1 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.

15 Waste and material resources

15.1 Introduction

General

- 15.1.1 This section presents a route-wide assessment of the likely significant environmental effects associated with the off-site disposal to landfill of solid waste that **will** be generated by the construction and operation of the Proposed Scheme. This assessment considers:
- the types and quantity of waste that **will** be generated;
 - the quantity of waste that **will** require off-site disposal to landfill; and
 - the availability of off-site landfill disposal capacity.
- 15.1.2 This assessment does not consider liquid waste, the direct and indirect effects of waste-related transport, or mineral resources located along the route of the Proposed Scheme. Liquid wastes²²³, such as waste oil, are not considered as they will be insignificant compared to solid wastes and have, therefore, been scoped out. Effects related to pollution risk and water quality are assessed in Volume 2 community area reports (Section 13, Water resources and flood risk). Waste related transport is considered as part of the Traffic and transport assessment in Volume 5: Appendix TR-001-000. This assessment, in turn, is used by other topics, such as Climate change, to undertake their own assessments. Mineral resources are considered elsewhere within Volume 3 (Section 9, Land quality) and will be managed in accordance with the measures contained within the draft Code of Construction Practice (CoCP²²⁴).
- 15.1.3 Consideration of material resources in this assessment is limited to the beneficial reuse of excavated material arising from the construction of the Proposed Scheme. Only if excavated material is not required or is unsuitable for the construction of the Proposed Scheme will it be considered for use beyond the scheme or consigned as waste.
- 15.1.4 Details of the types and quantities of waste that will be generated within each community area are presented within Volume 5: Appendix WM-001-000.

Context

Need for route-wide assessment

- 15.1.5 The movement of waste from source to final destination is a complex process, as waste is often transferred across waste planning authority boundaries for treatment and disposal according to the type of waste and the nature of the waste management facility required.
- 15.1.6 Waste planning authorities have a statutory duty to plan for an appropriate amount of waste infrastructure capacity to be available over a defined time period according to projected waste arisings, targets to divert waste from landfill, requirements with

²²³ Article 6 of Council Directive 1999/31/EC on the landfill of waste prohibits the disposal of liquid waste in a landfill.

²²⁴ Volume 5: Appendix CT-003-000, Draft Code of Construction Practice.

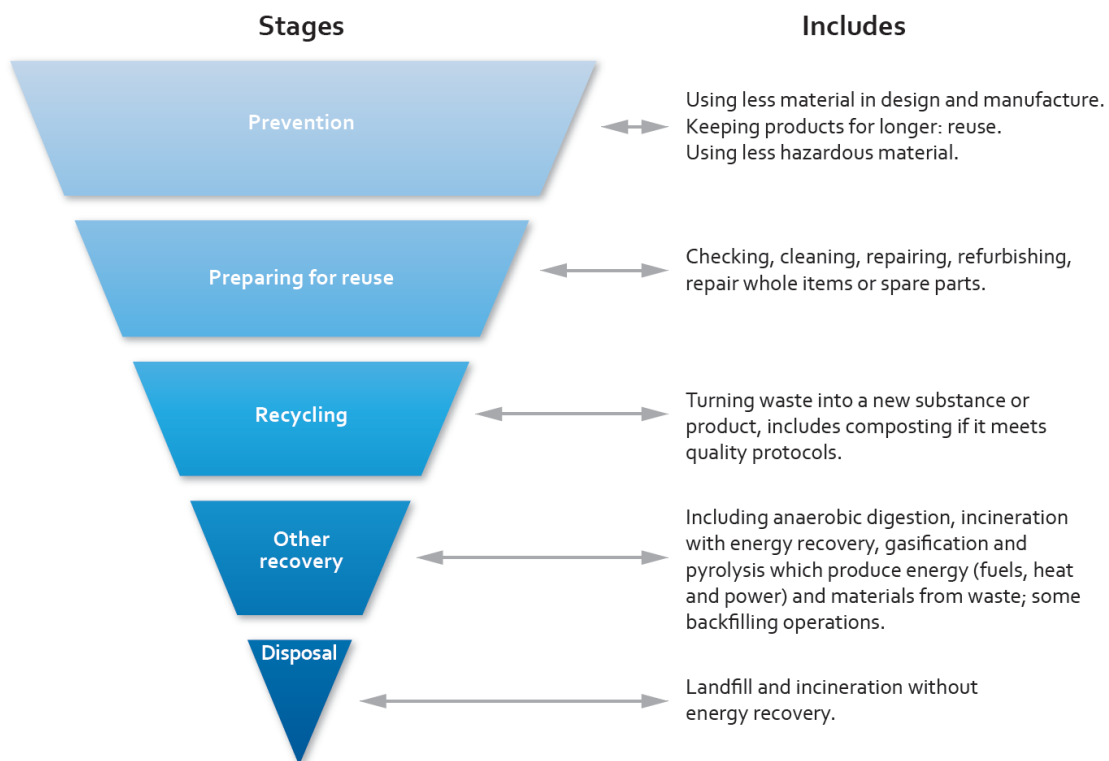
regard to the separate collection of waste types and the need to take account of waste that may need to be imported from other areas for treatment and disposal.

- 15.1.7 For this reason, waste planning has traditionally been undertaken on a county, and until early 2013, regional level basis that takes account of the need for the inter-regional movement of waste within England.
- 15.1.8 To reflect this broader county and regional-based approach to waste planning and management, an assessment of the likely significant environmental effects associated with the off-site disposal to landfill of solid waste that would be generated by the Proposed Scheme, has been undertaken on a route-wide basis.
- 15.1.9 This route-wide approach takes into account waste arisings and waste infrastructure capacity data available at county and regional levels. Comprehensive waste data at district level is often limited and so has not been considered for use in this assessment.

Environmental effects of waste management

- 15.1.10 The waste hierarchy²²⁵ (Figure 13) sets out the preferred approach to the management of waste from waste prevention, to reuse, recycling, energy recovery and landfill as a last resort.

Figure 13: The waste hierarchy



- 15.1.11 The waste hierarchy supports the need to achieve efficient use of material resources, minimise the amount of waste produced (or otherwise increase its value as a resource) and reduce, as far as possible, the amount of waste that is disposed to landfill.

²²⁵ Adapted from: Defra (2011), *Government Review of Waste Policy in England 2011*. Her Majesty's Stationary Office, London.

- 15.1.12 The waste hierarchy advocates the use of landfill disposal only as a last resort due to a range of potential adverse effects associated with its use. This includes natural resource depletion, methane production and nuisance effects (e.g. dust and odour). There is also a need to conserve existing landfill capacity for wastes for which there is currently no alternative treatment option that can be used to recover material resources and/or energy.
- 15.1.13 In England and Wales, waste producers have a legal duty to apply the waste hierarchy to decisions concerning the generation and management of waste²²⁶. The availability of waste management infrastructure capacity is also important in light of national policy that supports implementation of the proximity principle to manage waste as close as possible to the point of production without reliance on other communities to do so²²⁷.
- 15.1.14 For this reason, the assessment sets out the likely significant environmental effects associated with the off-site disposal to landfill of solid waste that will be generated by construction and operation of the Proposed Scheme.

Design approach and mitigation

- 15.1.15 An integrated design approach has been developed that seeks to reuse excavated material to satisfy the necessary engineering and environmental mitigation earthworks requirements for the Proposed Scheme including restoration of borrow pits. It seeks to minimise the quantity of surplus excavated material generated and minimise off-site disposal to landfill. This includes reuse of all topsoil and agricultural subsoil as close to the point of excavation as practicable.
- 15.1.16 A Materials Management Plan will be drafted in accordance with the CL:AIRE Code of Practice²²⁸ in anticipation of implementing the integrated design approach. This will enable suitable excavated material to be used as a resource within the construction of the Proposed Scheme with the additional benefit of reducing the quantity of imported fill required.
- 15.1.17 For the excavated material that cannot be beneficially reused for the earthworks of the Proposed Scheme, which would potentially be surplus, the nominated undertaker will, where regulation allows, seek to provide this excavated material for:
- use in other construction projects where opportunities arise at the time of construction; and/or
 - use for restoration of mineral sites.
- 15.1.18 This only applies to cases where the transportation of that material does not result in significant environmental effects.

²²⁶ *The Waste (England and Wales) Regulations 2011 (SI 2011 No. 988) (as amended)*. Her Majesty's Stationary Office, London. Available online at: http://www.legislation.gov.uk/ukSI/2011/988/pdfs/ukSI_20110988_en.pdf

²²⁷ Department for Communities and Local Government (October 2014), *National Planning Policy for Waste*.

²²⁸ Contaminated Land: Applications in Real Environments (2011), *The Definition of Waste: Development Industry Code of Practice - Version 2*. Available online at: <http://www.claire.co.uk/projects-and-initiatives/dow-cop/28-framework-and-guidance/111-dow-cop-main-document>

15.2 Policy framework

General

- 15.2.1 The assessment and mitigation of the likely significant environmental effects associated with the off-site disposal to landfill of solid waste has been considered with respect to relevant waste planning and management policies. Those of relevance to this assessment are summarised within this section.

National policy framework

- 15.2.2 The National Planning Policy Framework (NPPF²²⁹) does not contain any specific policies on waste planning. The National Planning Policy for Waste²³⁰, published in October 2014, sets out detailed waste planning policies, which all local planning authorities must follow when discharging their responsibilities associated with waste management. The policy aims to:

- deliver sustainable development through the provision of modern infrastructure, which aims to drive waste management up the waste hierarchy;
- consider other spatial planning concerns while recognising the positive contribution that waste management can make to the development of sustainable communities;
- provide a framework for communities to take more responsibility for their waste;
- secure the reuse, recovery or disposal of waste without endangering human health or the environment; and
- ensure that the design and layout of new development supports sustainable waste management.

- 15.2.3 The Waste Management Plan for England²³¹ provides an analysis of the waste management situation in England, as at the end of 2013, and a framework to support a more sustainable and efficient approach to resource use and management. Its purpose is to consolidate a number of existing policies within the context of a single national waste management plan.

- 15.2.4 The Government's Review of Waste Policy in England²³², published in 2011, contains the main policies of relevance to the Waste Management Plan for England. It sets out the Government's overarching approach to work towards a zero waste economy, to value waste as a resource (both financially and environmentally) and to work towards zero waste to landfill.

²²⁹ Department for Communities and Local Government (2012), *National Planning Policy Framework*. Available online at: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

²³⁰ Department for Communities and Local Government (2014), *National Planning Policy for Waste*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/364759/141015_National_Planning_Policy_for_Waste.pdf

²³¹ Defra (2013), *Waste Management Plan for England*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/265810/pb14100-waste-management-plan-20131213.pdf

²³² Defra (2011), *Government Review of Waste Policy in England 2011*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69401/pb13540-waste-policy-review110614.pdf

- 15.2.5 The Government's Waste Prevention Programme for England²³³ was published in December 2013 as a requirement of the revised EU Waste Framework Directive²³⁴. The programme establishes the Government's framework on measures to minimise the quantity of waste generated. It also develops the key roles and actions that need to be carried out during the transition towards a more resource efficient economy.
- 15.2.6 The Strategy for Sustainable Construction²³⁵ is a joint Government and industry initiative that aims to promote the concept of sustainability within the construction industry by specifying actions to be taken by both parties. It recognises that outputs from the construction industry have a major effect on both the economy and the environment. There are a number of mitigation measures included in the document with a view to halving construction, demolition and excavation waste (CDEW) to landfill.
- 15.2.7 Government policy on hazardous waste is contained within the National Policy Statement for Hazardous Waste: A Framework Document for Planning Decisions on Nationally Significant Hazardous Waste Infrastructure²³⁶. This document sets out the need for large-scale hazardous waste infrastructure, and the framework for decision making on relevant development consent applications within England.

Local policy framework

Staffordshire and Stoke-on-Trent

- 15.2.8 The Staffordshire and Stoke-on-Trent Joint Waste Local Plan 2010–2026²³⁷ sets out the vision, objectives and spatial strategy for waste management, and the development of waste management facilities up to 2026.
- 15.2.9 Strategic Objective 1 supports new waste management related development that reduces the effects of greenhouse gas emissions and climate change impacts, helps to maximise waste as a resource, increases diversion from landfill and supports renewable energy supplies where recycling is not viable.
- 15.2.10 Policy 1.2 (Waste as a Resource: Make Better Use of Waste Associated with Non-Waste Development) places an emphasis on developers to incorporate sustainable design techniques and demonstrate resource efficiency to minimise waste and use of raw materials. Building design should take into account end-of-life management to facilitate ease of reuse and recycling and include provision for appropriate waste segregation and storage when in use. CDEW recovery should also be maximised and be supported by a site waste management plan.

²³³ HM Government (2013), *Prevention is Better Than Cure: The Role of Waste Prevention in Moving to a More Resource Efficient Economy*.

²³⁴ The revised EU Waste Framework Directive was adopted on 20 October 2008, signed on behalf of the European Parliament and the Council on 19 November 2008, and published in the Official Journal of the European Union on 22 November (L312/3) as Directive 2008/98/EC. The revised EU Waste Framework Directive entered into force on 12 December 2008. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN>

²³⁵ HM Government (2008), *Strategy for Sustainable Construction*. Available online at: <http://webarchive.nationalarchives.gov.uk/http://www.bis.gov.uk/files/file46535.pdf>

²³⁶ Defra (2013), *National Policy Statement for Hazardous Waste: A Framework Document for Planning Decisions on Nationally Significant Hazardous Waste Infrastructure*.

²³⁷ Staffordshire County Council & City of Stoke-on-Trent (2013), *Staffordshire and Stoke-on-Trent Joint Waste Local Plan 2010–2026*. Available online at: <https://www.staffordshire.gov.uk/environment/planning/policy/thedevelopmentplan/wastelocalplan/Staffordshire-and-Stoke-on-Trent-Joint-Waste-Local-Plan-2010-to-2026-adopted-March-2013.pdf>

- 15.2.11 Policy 1.3 (Construction, Demolition and Excavation Waste) supports CDEW recycling and favours the use of inert waste for restoration purposes over landfill and land raising proposals.
- 15.2.12 Where inert waste is to be used for landscaping, screening and engineering purposes and/or for the improvement of agricultural or forestry land, proposals must comply with criteria set out within Policy 1.4 (Use of Waste for Landscaping, Screening, Engineering Purposes or for the Improvement of Agricultural or Forestry Land).
- 15.2.13 Landfill diversion targets are set out for both CDEW, and commercial and industrial (C&I) waste in Policy 2.1 (Landfill Diversion Targets). These targets include:
- 70% landfill diversion of CDEW by 2020/21; and
 - 95% landfill diversion of C&I waste by 2015/16 rising to 100% by 2020/21.

Cheshire East

- 15.2.14 The Cheshire East Council (CEC) Municipal Strategy of 2030²³⁸ sets out the strategic policy framework adopted by the council in 2014 and the council's provisions for future waste collection, treatment and disposal strategies up to 2030. The council recognises the need to review the strategy at least every five years; a requirement that was also included in the Cheshire Joint Municipal Strategy of 2007–2020²³⁹ (which should currently be used only as a historical reference).
- 15.2.15 The CEC Municipal Strategy of 2030 does not contain any specific policies on waste and material resources, instead defining high level strategic objectives. One of the objectives ('Working together'), emphasises the need for a reinforcement of partnerships with the commercial and charitable sectors, as well as the development of waste education and awareness schemes, in order to promote waste reduction, reuse and recycling.

15.3 Scope, assumptions and limitations

- 15.3.1 The scope of this assessment includes waste generated during construction and operation of the Proposed Scheme. It does not include material inputs to construction i.e. waste associated with the manufacture of material inputs. The scope is set out in further detail within Volume 1 and Section 20 of the Scope and Methodology Report (SMR)²⁴⁰ and the SMR Addendum²⁴¹.
- 15.3.2 Assumptions and limitations relevant to this assessment are set out in Volume 1.

15.4 Environmental baseline

General

- 15.4.1 The baseline comprises environmental conditions with respect to the types, quantities and management routes of waste generated in England, and within each of the

²³⁸ Cheshire East Council (2014), *Municipal Waste Management Strategy 2030*. Available online at: http://www.cheshireeast.gov.uk/PDF/FINAL_REPORT_WEBpdf.pdf

²³⁹ Cheshire Waste Partnership (2007), *Cheshire Consolidated Joint Municipal Waste Management Strategy*. Available online at: <http://consult.cheshirewestandchester.gov.uk/file/2923198>

²⁴⁰ Volume 5: Appendix CT-001-001, *Environmental Impact Assessment Scope and Methodology Report*.

²⁴¹ Volume 5: Appendix CT-001-002, *Environmental Impact Assessment Scope and Methodology Report Addendum*.

counties and former regional planning areas through which the route of the Proposed Scheme will pass.

15.4.2 The types of waste described in this context are:

- CDEW that will be generated during the overall construction phase of the Proposed Scheme (2020 to 2026);
- C&I waste that will be generated from worker accommodation sites during the overall construction phase of the Proposed Scheme (2020 to 2026); and
- C&I waste that will be generated during the first year of operation of the Proposed Scheme (2027).

15.4.3 The baseline also comprises the availability (types and capacity) of waste infrastructure within each of the county and former regional planning areas through which the route of the Proposed Scheme will pass.

15.4.4 Baseline conditions are presented as existing environmental conditions (based on latest available published data) and then as future baseline conditions for the period 2020 to 2026 (construction period) and 2027 (first full year of operation).

15.4.5 The spatial scope and study area for this assessment is defined as the two regions shown in Table 18. These regions comprise the former regional planning areas through which the route of the Proposed Scheme will pass. The two regions also represent the administrative areas for which waste arisings and waste infrastructure data is available²⁴² and within which the various waste streams are likely to be managed.

15.4.6 Reference is also made in this assessment to specific local areas (shown in Table 18) within the two regions. Local areas comprise local authority administration areas through which the route of the Proposed Scheme will pass.

Table 18: Study area for assessment

Regional area	Local area
West Midlands	Staffordshire and Stoke-on-Trent
North West	Cheshire East

15.4.7 Baseline and future baseline information is presented by both local and regional area, as there is often a need to manage waste outside of the immediate administrative area in which it is generated. This is dependent upon the type of waste infrastructure required and the available capacity of such facilities to receive and manage the type(s) of waste generated.

²⁴² Comprehensive data for waste arisings and waste infrastructure capacity is not available on a community area basis.

Waste arisings and management

Construction, demolition and excavation waste

National construction, demolition and excavation waste

- 15.4.8 In 2012, the Department of Environment, Food and Rural Affairs (Defra) ceased publication of national estimates for the recycling and recovery of CDEW. However, latest available data shows that a total of 107,557,676 tonnes of CDEW²⁴³ was generated in England in 2014²⁴⁴. Of this amount, 49,109,236 tonnes comprised of non-hazardous waste, of which 44,886,516 tonnes (approximately 91%) were recovered.
- 15.4.9 Based on the estimated proportion of CDEW sent to landfill in 2010²⁴⁵, the last year for which data is available, it has been forecast that of the 107,557,676 tonnes of CDEW generated in England in 2014, 27,577,137 tonnes (approximately 26%) were sent to landfill.
- 15.4.10 Comprehensive information on the likely future growth of CDEW arisings across England is limited. The Staffordshire and Stoke-on-Trent Joint Waste Local Plan 2010-2026²⁴⁶ suggests that the quantity of CDEW generated in the Staffordshire and Stoke-on-Trent areas will fall by 2% between 2015/16 and 2025/26. In contrast, the CEC Waste Management Needs Assessment²⁴⁷ predicts a 23% increase in CDEW generated in the Cheshire East area between 2015 and 2030.
- 15.4.11 Slow and stable growth is also expected based on trend data (2004 to 2014) for the UK, published by Eurostat²⁴⁸ (shown in Table 19).

Table 19: UK CDEW generation trend data

Area	2004	2006	2008	2010	2012	2014
United Kingdom	99,234,124	109,545,987	100,999,493	102,231,321	100,230,495	120,356,253

Regional construction, demolition and excavation waste

- 15.4.12 Regional CDEW arisings and management data have not been published by Defra in the UK since 2007. The latest available data is shown in Table 20²⁴⁹, and is based on the latest available comprehensive dataset for regional CDEW arisings in England.

²⁴³ European Competition Commission (undated). CDEW is defined as NACE Code F (Construction category). Available online at: http://ec.europa.eu/competition/mergers/cases/index/nace_all.html. The UK Government report to the EU using the NACE classification system (NACE: Nomenclature générale des activités économiques dans les Communautés Européennes; equivalent in English is General Industrial Classification of Economic Activities within the European Communities).

²⁴⁴ Defra (2016), *UK Statistics on Waste – December 2016 update*. Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/577737/UK_Statistics_on_Waste_dataset_Dec_2016_update.xlsx;

²⁴⁵ Defra (2012), *Construction, Demolition and Excavation Waste Generation Estimate: England, 2008 to 2010*. Document now archived.

²⁴⁶ Staffordshire County Council (2013), *Staffordshire and Stoke-on-Trent Joint Waste Local Plan 2010-2026 - Appendix 6: Waste Data Tables, Adopted March 2013*.

²⁴⁷ LRS Consultancy Limited (2014), *Cheshire East Borough Council - Waste Management Needs Assessment*.

²⁴⁸ Eurostat (2016), *Generation of waste*. Available online at: <http://ec.europa.eu/eurostat/data/database>

²⁴⁹ Defra (2007), *Estimated reuse, recycling and disposal of hard construction & demolition and excavation waste by region in 2005*. Available online at: <http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/evidence/statistics/environment/waste/download/xls/wrtb08.xls>

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Table 20: Baseline CDEW arisings by region, 2005

Regional area	Total arisings (tonnes)	Recycled aggregate and soil (tonnes)	Used on exempt sites (tonnes)	Landfill (tonnes)
West Midlands	9,839,688	4,917,624	2,910,592	2,011,472
North West	11,345,222	6,720,814	1,958,148	2,666,260
Total	21,184,911	11,638,438	4,868,740	4,677,732

Local construction, demolition and excavation waste

15.4.13 Forecast CDEW arisings and waste management methods for the local authority areas of Staffordshire and Stoke-on-Trent, and Cheshire East (the study area) are shown in Table 21 for the year 2017 (baseline).

15.4.14 The baseline local CDEW arisings have been extrapolated from annual forecasts using the latest available information published by the relevant waste planning authorities.

Table 21: Baseline CDEW arisings and management methods by local authority area, 2017

Area	Total arisings (tonnes)	Overall diversion from landfill		Disposal to landfill	
		(tonnes)	(proportion) ²⁵⁰	(tonnes)	(proportion)
Staffordshire and Stoke-on-Trent	1,339,750	938,150	70%	401,600	30%
Cheshire East	119,000	36,200	30%	82,800	70%

15.4.15 Further details regarding the sources of information used are presented in Volume 5: Appendix WM-001-000.

Commercial and industrial waste

National commercial and industrial waste

15.4.16 A 2011 survey by Defra²⁵¹ represents the most recently published set of detailed national data regarding the national treatment and disposal routes for C&I waste. However, latest available information²⁵² reports that, in 2012, a total of 38,976,000 tonnes of C&I waste were produced in England according to returns made under the EU Waste Statistics Regulation. Based on the waste management methods identified in the 2011 Defra survey, it is expected that of this amount:

- 20,295,527 tonnes (52%) was reused, recycled or composted;
- 6,556,991 tonnes (17%) was diverted from landfill via various treatment and recovery methods;

²⁵⁰ 'Proportion data' presented in table in percentage was calculated from tonnage projections, and rounded to two significant figures.

²⁵¹ Defra (2011), *Survey of Commercial and Industrial Waste Arisings 2010 - Revised Final Results*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/400595/ci-statistics-release.pdf

²⁵² Defra (2016), *Digest of Waste and Resource Statistics – 2016 Edition (revised)*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/567502/Digest_waste_resource_2016_rev4.pdf

- 9,173,120 tonnes (24%) was disposed to landfill; and
- the fate of 2,950,362 tonnes (7%) was unknown.

Regional commercial and industrial waste

15.4.17 Regional C&I waste arisings and management data has not been published by Defra in the UK since 2011. The latest available regional C&I waste arisings data and management methods are shown in Table 22 and are based on last available data from 2009.

Table 22: Baseline C&I waste arisings by region, 2009

Regional area	Total arisings (tonnes)	Reuse, recycling or composting (tonnes)	Energy recovery (tonnes)	Other treatment, recovery and transfer (tonnes)	Landfill (tonnes)	Unknown (tonnes)
West Midlands	5,248,000	2,739,000	100,000	737,000	1,202,000	470,000
North West	7,529,000	4,527,000	54,000	931,000	1,584,000	433,000
Total	12,777,000	7,266,000	154,000	1,668,000	2,786,000	903,000
Proportion	100%	57%	1%	13%	22%	7%

15.4.18 Table 22 indicates that approximately 57% of all C&I waste generated regionally is reused, recycled or composted, a further 14% is diverted from landfill via various treatment and recovery methods, and 22% is sent to landfill. The fate of 7% of C&I waste generated is reported as unknown.

15.4.19 In line with the outlook for national C&I waste arisings, reasonably stable growth is expected based on forecasts for England published by Defra²⁵³.

Local commercial and industrial waste

15.4.20 Forecast C&I waste arisings and waste management methods for the local study areas are shown in Table 23 for the year 2017 (baseline).

15.4.21 Further details regarding the sources of information used are presented in Volume 5: Appendix WM-001-000.

²⁵³ Defra (2011), *The Economics of Waste and Waste Policy*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf

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Table 23: Baseline C&I waste arisings and management methods by local authority area, 2017

Local area	Total arising (tonnes)	Overall diversion from landfill		Disposal to landfill	
		(tonnes)	(proportion) ²⁵⁴	(tonnes)	(proportion)
Staffordshire and Stoke-on-Trent	1,926,500	1,864,073	97%	62,428	3%
Cheshire East	527,749	316,650	60%	211,100	40%

Waste infrastructure

General

- 15.4.22 Latest available information published by the Environment Agency has been used to inform the baseline and future baseline with respect to waste infrastructure capacity within each of the county and former regional planning areas through which the route of the Proposed Scheme will pass. Waste infrastructure capacity is not provided on a national basis since it is not required for use in this assessment.
- 15.4.23 Whilst information on waste infrastructure is also available from waste planning authorities, this information may not always be presented in a way that is directly and easily comparable. Environment Agency data provides both a credible and reliable source of information that is consistent and comparable across all counties and regions. Permitted landfill capacity data from the Environment Agency has also been used to inform the significance criteria used in this assessment²⁵⁵.

Current baseline

- 15.4.24 Table 24 provides baseline waste infrastructure capacity data for the two regions through which the route of the Proposed Scheme will pass²⁵⁶.
- 15.4.25 The baseline information presented is based on permitted capacity for all types of waste treatment and disposal facilities for the year 2015, published by the Environment Agency. Waste infrastructure capacity for all types of treatment and disposal facility (including incineration, transfer and treatment) is reported in the baseline to provide context for this assessment.
- 15.4.26 Baseline waste infrastructure capacity data for the relevant counties within each of the regions is shown in Volume 5: Appendix WM-001-000.

Table 24: Baseline waste infrastructure capacity by region, 2015

Facility type	West Midlands	North West	Total
	Capacity (tonnes)	Capacity (tonnes)	Capacity (tonnes)
Inert waste landfill	22,810,722	9,438,047	32,248,769
Non-hazardous waste landfill	37,311,121	32,964,015	70,275,136

²⁵⁴ 'Proportion data' presented in table in percentage was calculated from tonnage projections, and rounded to two significant figures.

²⁵⁵ See the Significance criteria section of the Waste and material resources chapter of the SMR.

²⁵⁶ Environment Agency (2015), *Waste Management Information 2015*. Available online at: <https://www.gov.uk/government/statistics/waste-management-for-england-2015>

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Facility type	West Midlands	North West	Total
	Capacity (tonnes)	Capacity (tonnes)	Capacity (tonnes)
Hazardous waste landfill	802,572	7,248,477	8,051,049
<i>Sub-total landfill</i>	60,924,415	49,650,539	110,574,954
Municipal solid waste, C&I waste incineration	1,770,000	977,100	2,747,100
Other incineration	425,960	489,312	915,272
<i>Sub-total incineration</i>	2,195,960	1,466,412	3,662,372
Waste transfer	4,400,150	5,649,640	10,049,790
Waste treatment	5,420,981	12,209,677	17,630,658
Metal recycling	1,801,931	2,147,043	3,948,974
<i>Sub-total treatment and waste transfer</i>	11,623,062	20,006,361	31,629,422
Total	74,743,437	71,123,312	145,866,748

15.4.27 In relation to the information presented in Table 24, landfill capacity information is published by the Environment Agency in cubic metres but has been converted to tonnes using the following landfill density conversion factors²⁵⁷:

- 1.5 tonnes per cubic metre for inert waste landfill;
- 0.83 tonnes per cubic metre for non-hazardous waste landfill; and
- 1.5 tonnes per cubic metre for hazardous waste landfill.

15.4.28 The capacity of waste transfer, waste treatment and metal recycling facilities presented in Table 24 is based on the annual input rates provided by the Environment Agency, as separate capacity information is not published (i.e. capacity assumed to be at least equivalent to the input rates specified by the Environment Agency).

Future baseline

15.4.29 It is expected that various types of waste infrastructure capacity will continue to be available during the period 2020 to 2026 (for construction) and in 2027 (for operation).

15.4.30 Landfill will experience some draw-down of available capacity as void space is used up. Government policy measures to divert waste from landfill will also result in less waste being sent to landfill overall. Taking into account the purpose and scope of this

²⁵⁷ Department of the Environment (1995), *Waste Management Paper 26B, Landfill Design, Construction and Operational Practice*.

assessment, the future baseline for waste infrastructure capacity is limited to information on landfill disposal capacity only.

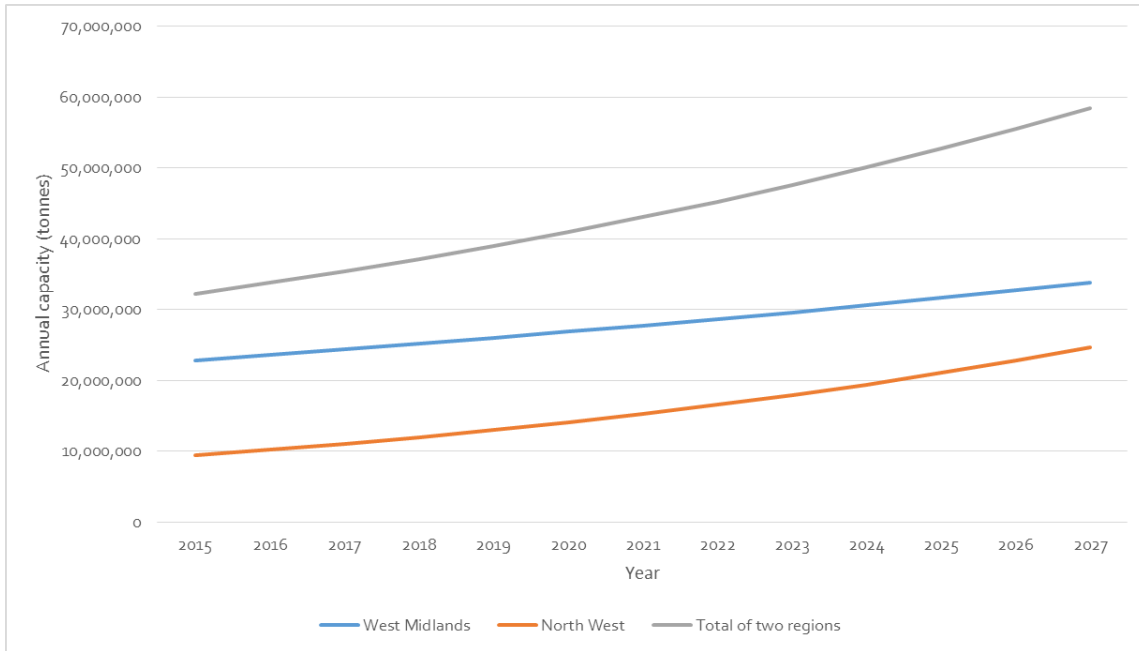
- 15.4.31 Permitted capacity data published by the Environment Agency has been used to provide an indication of projected landfill capacity for the future baseline. This method provides an indication of projected landfill disposal capacity for each class of landfill as defined by Council Directive 1999/31/EC²⁵⁸ (the Landfill Directive). This relates to the capacity of inert, non-hazardous and hazardous waste landfill that will be available during the period 2020 to 2026 (for construction) and 2027 (for operation) within each of the regional areas through which the route of the Proposed Scheme will pass. Projected landfill capacity data for the relevant counties within each of the regions is shown in Volume 5: Appendix WM-001-000.
- 15.4.32 Projected landfill capacity is based on the average percentage change in permitted landfill capacity for the years 2000 to 2015 (for inert and non-hazardous waste landfills) and for the years 2006 to 2015 (for hazardous waste landfill) as reported by the Environment Agency. The average percentage change has then been applied to the reported 2015 permitted landfill capacity and projected forward to 2027.
- 15.4.33 This method assumes that the average percentage change in permitted capacity for each class of landfill remains constant. Use of an average value taken from historical data provides a reasonable allowance for potential future increases in permitted capacity for each class of landfill, and takes account of waste generation trends driven by development in the respective regional areas. Committed developments of sufficient scale, to have the potential to disrupt the general trend in available landfill capacity, are assessed separately in the cumulative effects sections.
- 15.4.34 Waste planning authorities have a responsibility to make provision for sufficient waste infrastructure capacity based on projected waste arisings (over a defined time period), targets to divert waste from landfill and the need to take account of waste that may need to be imported from other areas for treatment and disposal. Subject to receipt of planning permission and other criteria stipulated by waste planning authorities, new permitted landfill capacity is likely to be provided to meet any future gaps in inert, non-hazardous and hazardous waste landfill capacity.
- 15.4.35 The information presented is, therefore, considered to be a reasonable scenario with respect to future landfill capacity within the two regions that form the scope of the study area. This approach takes account of future draw-down and increases in permitted capacity, as well as government policy measures to divert waste from landfill and the requirement for waste planning authorities to provide for future landfill capacity needs.

Inert waste landfill capacity

- 15.4.36 Using the latest available published data for the year 2015 as a starting point, Figure 14 shows projected inert waste landfill capacity for the future baseline period 2020 to 2026 (for construction) and the year 2027 (operation). Detailed source data, and local level projections, are presented in Volume 5: Appendix WM-001-000.

²⁵⁸ Council of the European Union (1999), *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

Figure 14: Projected (future baseline) inert waste landfill capacity by region

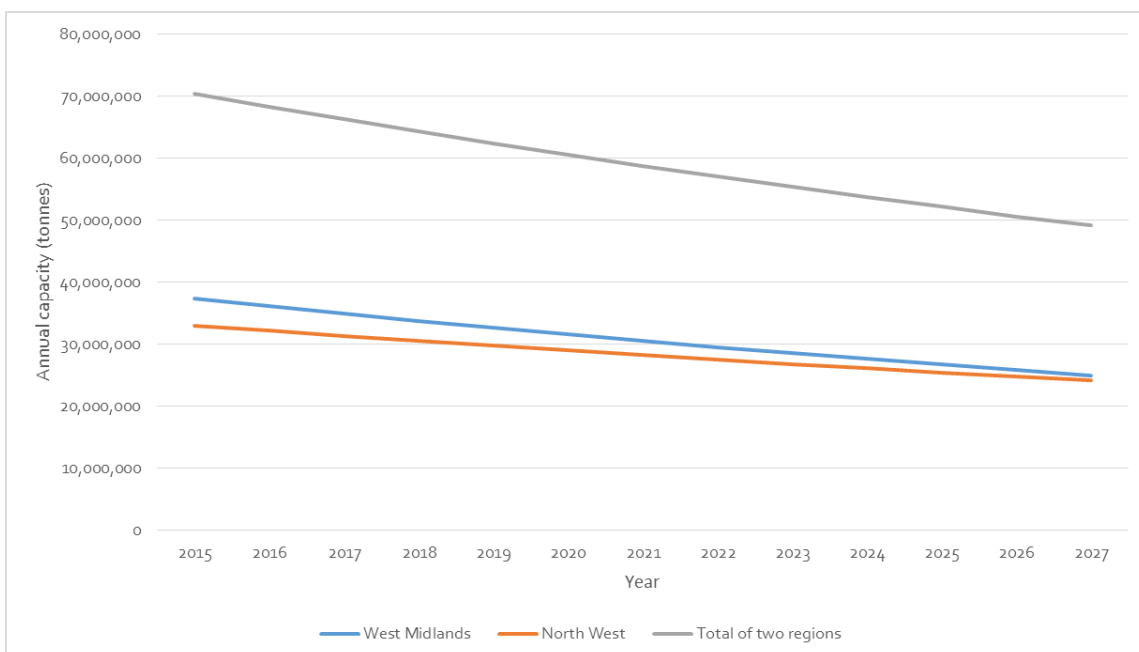


15.4.37 Figure 14 shows that, by 2027, there will be a combined total of approximately 59 million tonnes of inert waste landfill capacity remaining in the two regions through which the route of the Proposed Scheme will pass. This is a projected increase from approximately 32 million tonnes of inert waste landfill capacity in 2015, which reflects a gradual increase in inert waste landfill capacity in both regions during the period.

Non-hazardous waste landfill capacity

15.4.38 Using latest available published data for the year 2015 as a starting point, Figure 15 shows projected non-hazardous waste landfill capacity for the future baseline period 2020 to 2026 (for construction) and the year 2027 (operation). Detailed source data, and local level projections, are presented in Volume 5: Appendix WM-001-000.

Figure 15: Projected (future baseline) non-hazardous waste landfill capacity by region

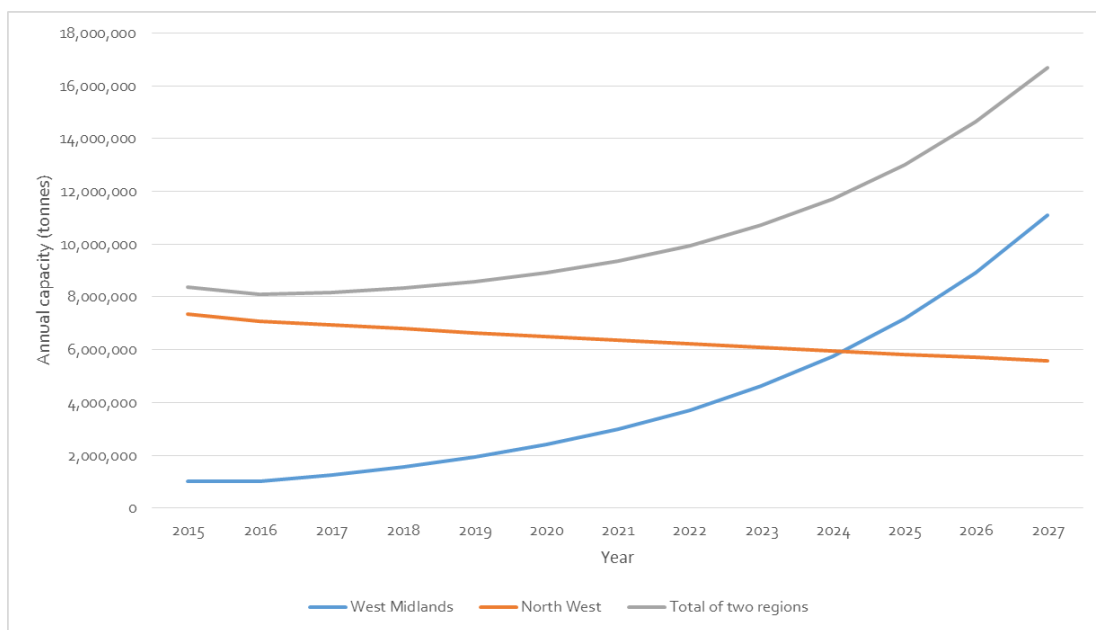


15.4.39 Figure 15 shows that, by 2027, there will be a combined total of approximately 49 million tonnes of non-hazardous waste landfill capacity remaining in the two regions through which the route of the Proposed Scheme will pass. This is a reduction from approximately 70 million tonnes of non-hazardous waste landfill capacity in 2015, which reflects a gradual decline in non-hazardous waste landfill capacity in both regions.

Hazardous waste landfill capacity

15.4.40 Using the latest available published data for the year 2015 as a starting point, Figure 16 shows projected hazardous waste landfill capacity for the future baseline period 2020 to 2026 (for construction) and the year 2027 (operation). Detailed source data, and local level projections, are presented in Volume 5: Appendix WM-001-000.

Figure 16: Projected (future baseline) hazardous waste landfill capacity by region



15.4.41 Figure 16 shows that, by 2027, there will be a combined total of approximately 17 million tonnes of hazardous waste landfill capacity remaining in the two regions through which the Proposed Scheme will pass. This is an increase from approximately 8 million tonnes of hazardous waste landfill capacity in 2015, which reflects a substantial increase in hazardous waste landfill capacity in the West Midlands but a gradual decrease in the North West.

15.5 Assessment of the effects of construction

Avoidance and mitigation measures

15.5.1 In accordance with the draft CoCP the nominated undertaker and its contractors will be responsible for managing the waste generated from construction activities.

- 15.5.2 The nominated undertaker and its contractors will comply with the requirements of the borrow pit restoration strategy²⁵⁹ which relates to the excavation, operation and restoration of borrow pits.

Assessment of impacts and effects

Excavated material

- 15.5.3 Table 25 presents a route-wide summary of the forecast excavated material quantities for the Proposed Scheme. This is based on the calculated figures for the integrated earthworks design and reflects the balance of excavated material arising from the proposed construction arrangements. A detailed excavated material quantity forecast is provided in Volume 5: Appendix WM-001-000. For the purpose of this assessment, it has been assumed as a worst-case scenario that all surplus material will be disposed off-site to landfill.

Table 25: Forecast excavated material quantities for the Proposed Scheme, 2020 to 2026

Excavated material management methods	Total quantity (tonnes)	Proportion of Proposed Scheme total
Quantity of excavated material reused for engineering and environmental mitigation earthworks (including all topsoil and agricultural subsoil)	39,009,449	98%
Quantity of surplus excavated material for off-site disposal to landfill ²⁶⁰	680,485	2%
Total	39,689,934	100%

- 15.5.4 The Proposed Scheme will generate approximately 39,689,934 tonnes of excavated material during the period 2020 to 2026.
- 15.5.5 It is estimated that 98% of the excavated material generated by the Proposed Scheme will be used to satisfy the necessary requirements for fill on a route-wide basis. The fill requirement of the Proposed Scheme is comprised predominantly of engineering fill for rail and highways use, environmental mitigation fill for bunds and landscaping, and backfill for restoration of borrow pits to previous land levels and grade. Excavated material used as engineering fill material and for environmental mitigation earthworks within the Proposed Scheme will include classes of material as defined by the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials²⁶¹:
- Class 1 and Class 3 general railway fill;

²⁵⁹ Volume 5: Appendix CT-009-000, Borrow pit restoration strategy.

²⁶⁰ All topsoil and agricultural subsoil generated by the Proposed Scheme is considered as a valuable material resource. The surplus excavated material reported for off-site disposal to landfill, does not include the quantity of topsoil and agricultural subsoil, which is not currently proposed for reuse in the design of the Proposed Scheme. It is expected that beneficial reuse opportunities will be found for surplus topsoil and agricultural subsoil, either within the Proposed Scheme, or off-site in nearby development projects.

²⁶¹ Department for Transport (2014 and as amended), *Manual of Contract Documents for Highway Works, Volume 1 – Specification for Highways Works*. Available online at: <http://www.standardsforhighways.co.uk/ha/standards/mchw/vola/index.htm>

- Class 2 general railway fill and general highway fill;
- Class 4 environmental mitigation earthworks fill;
- Class 6 selected fill;
- unacceptable material classes U1A and U1B (treated)²⁶²; and
- topsoil and agricultural subsoil.

15.5.6 The estimated quantity of surplus excavated material that will not be reused within the construction of the Proposed Scheme will be less than 2% of the overall excavated material that will be generated on a route-wide basis, based on the current level of design. This will comprise of:

- 674,179 tonnes of Class 4 materials²⁶³ not required for use as borrow pit backfill, which will require off-site disposal to inert landfill; and
- 6,306 tonnes of chemically unacceptable U2 materials²⁶⁴ which will require off-site disposal to hazardous landfill.

Borrow pits

15.5.7 It is estimated that all of the excavated material generated from the borrow pits will be used to satisfy the necessary engineering and environmental mitigation earthworks quantities requirements on a route-wide basis. Based on the current level of design, and excavation to the mineral depth required to supplement any shortfall of suitable granular engineering fill material, it is forecast that 8,338,718 tonnes of material will be excavated from the borrow pits.

15.5.8 It is forecast that the same quantity of excavated material, 8,338,718 tonnes, generated from the Proposed Scheme, will be used to backfill the borrow pits.

Demolition material and waste

15.5.9 Demolition material quantities have been estimated using the Waste and Resources Action Programme 'Demolition bill of quantities estimator'²⁶⁵, which uses the basic dimensions and typology of buildings to be demolished. Using this methodology, the Proposed Scheme will generate approximately 129,676 tonnes of demolition material during the overall construction period of 2020 to 2026.

15.5.10 The quantity of demolition material that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 90%. This rate has been selected based on a review of industry good practice landfill diversion rates from other large-scale infrastructure projects in the UK (e.g. Crossrail, London 2012 Olympics and HS1).

²⁶² Unacceptable material Class U1A is 'physically' unsuitable as defined in the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clauses 2(i)(a) and 2(i)(b). Unacceptable material Class U1B is 'chemically' unsuitable as defined in the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clause 2(ii)(a).

²⁶³ As defined by the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials.

²⁶⁴ Materials that are unsuitable for reuse by virtue of an excess concentration of contaminants that render the material 'contaminated' (as defined by statutory Regulation or HS2 project requirements) at the place and environmental setting of its final deposition.

²⁶⁵ Waste & Resources Action Programme (2016), *Net Waste Tool*. Available online at: <http://nwttool.wrap.org.uk/>

- 15.5.11 The quantity of demolition waste that will require off-site disposal to landfill during the overall construction period of 2020 to 2026 will be approximately 12,968 tonnes.
- 15.5.12 The Overview of Demolition Waste in the UK²⁶⁶ uses waste data provided by the National Federation of Demolition Contractors to determine that approximately 91% of demolition waste is reused and recycled. This can be accounted for in the most part, by the inert fraction of the waste. The report states that approximately 3% of demolition waste produced in the UK is hazardous and a further 6% of demolition waste is sent to non-hazardous waste landfill. For the purpose of this assessment, it has been assumed that 60% of the quantity of demolition waste requiring off-site disposal to landfill will be non-hazardous waste and 40% will be hazardous waste.
- 15.5.13 Based on this assumption, the class of landfill to which demolition waste will be sent for disposal is shown in Table 26.

Table 26: Quantity of demolition waste requiring off-site disposal to landfill (by class of landfill), 2020 to 2026

Class of landfill	Total quantity (tonnes)	Proportion
Quantity of demolition waste for off-site disposal to inert waste landfill	0	0%
Quantity of demolition waste for off-site disposal to non-hazardous waste landfill	7,781	60%
Quantity of demolition waste for off-site disposal to hazardous waste landfill	5,187	40%
Total	12,968	100%

Construction waste

- 15.5.14 Construction waste quantities have been estimated based on a waste generation rate derived from industry-wide benchmark performance data procured from the Building Research Establishment Ltd. Using this methodology, the Proposed Scheme is forecast to generate approximately 433,802 tonnes of construction waste during the construction period of 2020 to 2026.
- 15.5.15 The quantity of construction waste that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 90%. This rate has been selected based on a review of industry good practice landfill diversion rates from other large-scale infrastructure projects in the UK (e.g. Crossrail, London 2012 Olympics and HS1).
- 15.5.16 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment that the remaining 10% of construction waste generated will be disposed of off-site to landfill. The quantity of construction waste that will require off-site disposal to landfill during the overall construction period of 2020 to 2026 will be approximately 43,380 tonnes.

²⁶⁶ Waste & Resources Action Programme (2009), *Overview of Demolition Waste in the UK*. <http://www.wrap.org.uk/sites/files/wrap/CRWP-Demolition-Report-2009.pdf>

15.5.17 It has been assumed for the purpose of this assessment that all of the construction waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill. This is based on indicative construction waste composition information published by the Building Research Establishment²⁶⁷, Strategic Forum for Construction²⁶⁸ and Waste and Resources Action Programme²⁶⁹. These sources suggest that minimal quantities of hazardous waste are generated and that construction waste to landfill is likely to comprise non-hazardous fractions, such as component packaging, insulation materials and mixed construction wastes, which are unsuitable for reuse and recycling.

Worker accommodation site waste

15.5.18 Three worker accommodation sites will be used during construction of the Proposed Scheme. These will be located at:

- the Trent South embankment main compound in the Colwich to Yarlet community area (CA2);
- the Yarnfield North embankment satellite compound in the Stone and Swynnerton community area (CA3); and
- the Basford cutting main compound in the South Cheshire community area (CA5).

15.5.19 The quantity of waste likely to be generated at these sites has been estimated based on a waste generation rate derived from the average annual household waste generation in the UK. Using this methodology, the Proposed Scheme will generate approximately 1,089 tonnes of worker accommodation site waste during the construction period of 2020 to 2026. Further detail on the waste arisings from each work accommodation site can be found in Volume 5: Appendix WM-001-000.

15.5.20 The quantity of worker accommodation site waste that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 50%. Waste generated by occupants of worker accommodation sites will be similar in composition to household waste. As such, this rate has been selected based on a review of national household waste targets for England and Wales.

15.5.21 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment that the remaining 50% of worker accommodation site waste will be disposed of off-site to landfill. The quantity of worker accommodation site waste that will require off-site disposal to landfill during the overall construction period of 2020 to 2026 will be approximately 544 tonnes.

15.5.22 It has been assumed for the purpose of this assessment that all of the worker accommodation site waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill.

²⁶⁷ Building Research Establishment (2001), *SMARTWaste case studies: reducing construction waste*. Available online at: <http://www.smartwaste.co.uk/smartaudit/downloads/chiswick.pdf>

²⁶⁸ Strategic Forum for Construction (2011), *Waste: An Action Plan for halving construction, demolition and excavation waste to landfill*. Available online at: <http://www.greenconstructionboard.org/otherdocs/10WasteActionPlan.pdf>

²⁶⁹ Waste & Resources Action Programme (2005), *Reference document on the status of wood waste arisings and management in the UK*. Available online at: <http://www.bvsde.paho.org/bvsacd/cd43/wood.pdf>

Impact of construction on future baseline waste arisings

Construction, demolition and excavation waste

- 15.5.23 Table 27 provides a summary of material and waste quantities forecast to be generated by excavation, demolition and construction works for the Proposed Scheme during the period 2020 to 2026.

Table 27: Summary of material and waste quantities that would be generated by excavation, demolition and construction works of the Proposed Scheme, 2020 to 2026

Source	Total quantity of material (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Excavation	39,689,934	39,009,449	680,485
Demolition	129,676	116,709	12,968
Construction	433,802	390,421	43,380
Total	40,253,411	39,516,579	736,833
Proportion	100%	98%	2%

- 15.5.24 Table 27 shows that the Proposed Scheme will generate approximately 40 million tonnes of excavated material, demolition material and construction waste during the period 2020 to 2026. Over 98% of this total quantity will be diverted from landfill via reuse, recycling and recovery, based on current level of design.
- 15.5.25 The impact of this material and waste generation and its off-site disposal to landfill is shown in Table 28 as the percentage difference between future baseline CDEW arisings with and without the Proposed Scheme.
- 15.5.26 Future baseline CDEW arisings are presented as the total quantity projected to be generated during the period 2020 to 2026. This is to provide a direct comparison with the total quantity of excavated material, demolition material and construction waste that will be generated during construction of the Proposed Scheme.

Table 28: Impact of material and waste quantities that would be generated by excavation, demolition and construction of the Proposed Scheme, 2020 to 2026

Future baseline scenario with and without the Proposed Scheme	National change		Regional change ²⁷⁰	
	CDEW arisings (tonnes)	CDEW arisings to landfill (tonnes)	CDEW arisings (tonnes)	CDEW arisings to landfill (tonnes)
Future baseline waste arisings 2020 to 2026 without the Proposed Scheme	752,903,732 ²⁷¹	193,039,956 ²⁷²	148,294,377 ²⁷³	32,744,124 ²⁷⁴

²⁷⁰ Based on future baseline CDEW arisings and CDEW to landfill for the aggregated two regions.

²⁷¹ Based on annual projection of 107,557,676 tonnes nationally as set out in Section 15.4 (National construction, demolition and excavation waste).

²⁷² Based on an annual projection of 27,577,137 tonnes nationally as set out in Section 15.4 (National construction, demolition and excavation waste).

²⁷³ Based on an annual projection of 21,184,911 tonnes for the aggregated two regions as set out in Table 20.

²⁷⁴ Based on an annual projection of 4,677,732 tonnes for the aggregated two regions as set out in Table 20.

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Future baseline scenario with and without the Proposed Scheme	National change		Regional change ²⁷⁰	
	CDEW arisings (tonnes)	CDEW arisings to landfill (tonnes)	CDEW arisings (tonnes)	CDEW arisings to landfill (tonnes)
Proposed Scheme material and waste arisings 2020 to 2026	40,253,411	736,833	40,253,411	736,833
Future baseline waste arisings 2020 to 2026 with the Proposed Scheme	793,157,143	193,776,789	188,547,788	33,480,957
Increase in future baseline waste arisings with the Proposed Scheme	+5%	+0.4%	+27%	+2%

15.5.27 Table 28 shows that the total quantity of excavated material, demolition material and construction material generated by the Proposed Scheme will be equivalent to approximately 5% of national and 27% of regional future baseline CDEW arisings during the period 2020 to 2026.

15.5.28 The total quantity of surplus excavated material, demolition waste and construction waste generated by the Proposed Scheme that will require off-site disposal to landfill is equivalent to approximately 0.4% of national and 2% of regional future baseline CDEW arisings to landfill during that time.

Commercial and industrial waste

15.5.29 The impact of worker accommodation site waste generation and off-site disposal to landfill is shown in Table 29 as the percentage difference between future baseline C&I waste arisings with and without the Proposed Scheme.

15.5.30 Future baseline C&I waste arisings are presented as the total quantity projected to be generated during the period 2020 to 2026. This is to provide a direct comparison with the total quantity of C&I waste that will be generated during construction of the Proposed Scheme.

Table 29: Impact of C&I waste arisings generated by the Proposed Scheme, 2020 to 2026

Future baseline scenario with and without the Proposed Scheme	National change		Regional change ²⁷⁵	
	C&I arisings (tonnes)	C&I arisings to landfill (tonnes)	C&I arisings (tonnes)	C&I arisings to landfill (tonnes)
Future baseline waste arisings 2020 to 2026 without the Proposed Scheme	272,832,000 ²⁷⁶	64,211,840 ²⁷⁷	89,439,000 ²⁷⁸	19,502,000 ²⁷⁹
Proposed Scheme material and waste arisings 2020 to 2026	1,089	544	1,089	544

²⁷⁵ Based on future baseline C&I waste arisings and C&I waste to landfill for the aggregated two regions.

²⁷⁶ Based on annual projection of 38,976,000 tonnes nationally as set out in Paragraph 15.4.16 (National commercial and industrial waste).

²⁷⁷ Based on an annual projection of 9,173,120 tonnes nationally as set out in Paragraph 15.4.16 (National commercial and industrial waste).

²⁷⁸ Based on an annual projection of 12,777,000 tonnes for the aggregated two regions as set out in Table 22.

²⁷⁹ Based on an annual projection of 2,786,000 tonnes for the aggregated two regions as set out in Table 22.

Future baseline scenario with and without the Proposed Scheme	National change		Regional change ²⁷⁵	
	C&I arisings (tonnes)	C&I arisings to landfill (tonnes)	C&I arisings (tonnes)	C&I arisings to landfill (tonnes)
Future baseline waste arisings 2020 to 2026 with the Proposed Scheme	272,833,089	64,212,384	89,440,089	19,502,544
Increase in future baseline waste arisings with the Proposed Scheme	+0.0004%	+0.0008%	+0.0012%	+0.0028%

- 15.5.31 Table 29 shows that the total quantity of worker accommodation site waste generated by the Proposed Scheme will be equivalent to less than 0.01% of national and regional future baseline C&I waste arisings during the period 2020 to 2026.
- 15.5.32 The total quantity of worker accommodation site waste that will require off-site disposal to landfill will be equivalent to less than 0.01% of national and regional future baseline C&I waste arisings to landfill during that time.

Likely significant environmental effects

Inert waste landfill capacity

- 15.5.33 Subject to waste acceptance criteria set out in the Landfill Directive²⁸⁰ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills, the total quantity of inert waste arising from the construction of the Proposed Scheme that will require off-site disposal to landfill during the period 2020 to 2026 is approximately 674,179 tonnes (see Table 30). This quantity represents approximately 92% of the total CDEW requiring off-site disposal to landfill.

Table 30: Quantity of waste requiring off-site disposal to inert waste landfill, 2020 to 2026

Waste source	Total quantity (tonnes)	Proportion
Excavation	674,179	100%
Demolition	0	0%
Construction	0	0%
Worker accommodation sites	0	0%
Total	674,179	100%

- 15.5.34 Off-site disposal of inert surplus excavated material to landfill will result in an overall reduction of inert waste landfill void space of 674,179 tonnes.

²⁸⁰ Council of the European Union (1999), *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

- 15.5.35 The draw-down of inert waste landfill void space as a result of the Proposed Scheme will occur over a period of several years, starting initially with enabling works followed by earthworks such as tunnelling. It is assumed that the generation of surplus excavated material will take place primarily over a four year period during the construction of the Proposed Scheme.
- 15.5.36 This will be equivalent to a 1% reduction in inert waste landfill capacity void space across the aggregated two regions according to the amount of capacity projected to be available at the end of construction in 2025 (approximately 53 million tonnes).
- 15.5.37 On this basis, it is considered that there will be sufficient inert waste landfill capacity available in the aggregated two regions to accept the forecast quantity of inert surplus excavated material for off-site disposal to landfill.
- 15.5.38 All of the inert waste forecast to arise will be surplus excavated material and assuming that the earthworks take place primarily over a four year period at a fairly constant rate of generation throughout this period, the total quantity of inert surplus excavated material requiring off-site disposal to landfill will be approximately 168,545 tonnes per annum.
- 15.5.39 Significance criteria for inert waste landfill capacity, state that a local-scale reduction in inert waste landfill void space capacity of up to two million tonnes per annum may be of low importance in the decision-making process, but relevant to the detailed design and mitigation of a project.
- 15.5.40 In accordance with these significance criteria, the likely environmental effects associated with the off-site disposal to landfill of inert surplus excavated material generated by construction of the Proposed Scheme will be minor adverse and not significant.

Non-hazardous waste landfill capacity

- 15.5.41 Subject to waste acceptance criteria set out in the Landfill Directive²⁸¹ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²⁸², the total quantity of non-hazardous waste arising from the construction of the Proposed Scheme that will require off-site disposal to landfill during the period 2020 to 2026 is approximately 51,705 tonnes (see Table 31). The majority (approximately 84%) would comprise of construction waste. Other quantities of non-hazardous waste will be generated by demolition and worker accommodation activities.

Table 31: Quantity of waste requiring off-site disposal to non-hazardous waste landfill, 2020 to 2026

Waste source	Total quantity (tonnes)	Proportion
Excavation	0	0%

²⁸¹ Council of the European Union (1999), *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

²⁸² 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/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>

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Waste source	Total quantity (tonnes)	Proportion
Demolition	7,781	15%
Construction	43,380	84%
Worker accommodation sites	544	1%
Total	51,705	100%

- 15.5.42 Off-site disposal of non-hazardous surplus excavated material, demolition and construction waste will result in an overall reduction of non-hazardous waste landfill void space of 51,705 tonnes throughout the four years and five months construction period.
- 15.5.43 This will be equivalent to a 0.1% reduction in non-hazardous waste landfill capacity void space across the aggregated two regions according to the amount of capacity projected to be available at the end of construction in 2026 (approximately 51 million tonnes).
- 15.5.44 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the aggregated two regions to accept the forecast quantity of non-hazardous surplus excavated material, demolition and construction waste for off-site disposal to landfill.
- 15.5.45 Table 31 shows that non-hazardous waste will be generated by a range of construction activities that will occur throughout the four years and five months duration of construction of the Proposed Scheme.
- 15.5.46 Consequently, the draw-down of non-hazardous waste landfill void space as a result of the Proposed Scheme will occur over a period of several years and is unlikely to draw-down projected capacity to an extent where there is an immediate, significant need for additional non-hazardous waste landfill capacity to be made available in these areas.
- 15.5.47 Assuming a constant rate of waste generation throughout the construction period, the total quantity of non-hazardous waste requiring off-site disposal to landfill will be approximately 11,707 tonnes per annum.
- 15.5.48 Significance criteria for non-hazardous waste landfill capacity state that a regional-scale reduction in non-hazardous waste landfill void space capacity of up to 50,000 tonnes per annum may be judged to be of low importance in the regional planning context.
- 15.5.49 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous surplus excavated material, construction and demolition waste generated by the Proposed Scheme will be minor adverse and not significant.

Hazardous waste landfill capacity

- 15.5.50 Subject to waste acceptance criteria set out in the Landfill Directive²⁸³ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²⁸⁴, the total quantity of hazardous waste arising from the construction of the Proposed Scheme requiring off-site disposal to landfill during the period 2020 to 2026 is approximately 11,493 tonnes (see Table 32). This quantity comprises of Unacceptable Class U2 surplus excavated material that will be unsuitable for use in the construction of the Proposed Scheme due to its hazardous properties, and hazardous waste generated by demolition activities.

Table 32: Quantity of waste requiring off-site disposal to hazardous waste landfill, 2020 to 2026

Waste source	Total quantity (tonnes)	Proportion
Excavation	6,306	55%
Demolition	5,187	45%
Construction	0	0%
Worker accommodation sites	0	0%
Total	11,493	100%

- 15.5.51 Off-site disposal of hazardous waste will result in an overall reduction of hazardous waste landfill void space of approximately 11,493 tonnes throughout the Proposed Scheme construction period of four years and five months.
- 15.5.52 This will be equivalent to a 0.08% reduction in hazardous waste landfill void space across the aggregated two regions according to the amount of capacity projected to be available at the end of construction in 2026 (approximately 15 million tonnes).
- 15.5.53 Assuming a constant rate of waste generation throughout the construction period, the total quantity of hazardous waste requiring off-site disposal to landfill will be approximately 2,602 tonnes per annum.
- 15.5.54 Significance criteria for hazardous waste landfill capacity state that a regional-scale reduction in hazardous waste landfill void space capacity of up to 20,000 tonnes per annum may be judged to be of low importance in the regional planning context.
- 15.5.55 According to the significance criteria applicable to hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of hazardous surplus excavated material, construction and demolition waste generated by the Proposed Scheme will be minor adverse and not significant.

²⁸³ Council of the European Union (1999), Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

²⁸⁴ 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/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>

Other mitigation measures

- 15.5.56 Management of CDEW and worker accommodation site waste generated by the Proposed Scheme will be subject to the Environmental Minimum Requirements (EMR), as discussed within Volume 1.
- 15.5.57 Some of the non-hazardous waste generated by the construction of the Proposed Scheme will be suitable for incineration (with energy recovery). This will reduce reliance on non-hazardous waste landfill capacity.
- 15.5.58 A reasonable worst-case approach has been taken in determining the quantity of hazardous waste for off-site disposal to landfill. However, detailed chemical sampling and laboratory analysis, as part of future ground investigation works, may allow the hazardous waste to be reclassified as non-hazardous waste. This will reduce reliance on hazardous waste landfill capacity.
- 15.5.59 It is likely that a large proportion of the hazardous demolition waste will comprise asbestos containing materials. This material could be disposed of at non-hazardous landfill sites within a separate cell for Stable Non-Reactive Hazardous Waste (SNRHW)²⁸⁵ providing it meets SNRHW waste acceptance criteria in accordance with the Landfill Directive²⁸⁶ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²⁸⁷. This will reduce reliance on hazardous waste landfill capacity.

Summary of likely residual significant environmental effects

- 15.5.60 On the basis of the other mitigation measures proposed, the likely residual significant environmental effects from construction will be:
- minor adverse and not significant in relation to inert waste landfill capacity;
 - minor adverse and not significant in relation to non-hazardous waste landfill capacity; and
 - minor adverse and not significant in relation to hazardous waste landfill capacity.

Cumulative effects

Phase 2a and Phase One

- 15.5.61 The cumulative effects assessment has taken account of any Phase One construction works necessary to connect Phase One to the Proposed Scheme that will be constructed at the same time as the Proposed Scheme (i.e. between the years 2020

²⁸⁵ A non-hazardous waste landfill with a SNRHW cell allows for hazardous waste that has been stabilised and thus has a low leaching potential to be deposited in cells with a standard of containment consistent with non-hazardous wastes and in accordance with Council Decision 2003/33/EC (Council Decision of 19 December 2002 Establishing Criteria and Procedures for the Acceptance of Waste at Landfills Pursuant to Article 16 of Annex II to Directive 1999/31/EC). For further details, see Environment Agency (2010), *Waste Acceptance at Landfills: Guidance on Waste Acceptance Procedures and Criteria*, November 2010. Available online at: <http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho1110btew-e-e.pdf>

²⁸⁶ Council of the European Union (1999), Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

²⁸⁷ 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/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>

and 2026), thus they will have a simultaneous requirement for landfill disposal capacity of any construction waste generated during that period.

- 15.5.62 A description of the Phase One construction works that have been taken into account in the cumulative effects assessment is provided in Volume 5: Appendix WM-001-000.
- 15.5.63 Cumulative effects have been considered on the basis of professional judgement according to the nature of the construction activities proposed.
- 15.5.64 These construction works will produce CDEW, a proportion of which will require disposal to landfill. In line with relevant policy, it is anticipated that these works will seek to minimise the off-site disposal of waste to landfill, and manage waste in accordance with the waste hierarchy.
- 15.5.65 It is considered that waste requiring off-site disposal to landfill, will be managed according to logistical and cost constraints regarding the availability of landfill capacity. These constraints limit the distance that waste will be transported by road. It is considered that waste generated by the Phase One scheme is only of relevance when it is generated in a geographic area in which the available landfill capacity is likely to be considered for use by both the Proposed Scheme and the Phase One scheme. In this assessment, it is considered that this area of overlap comprises the West Midlands regional area.
- 15.5.66 The following quantities of waste have been forecast to be generated by the Phase One construction works in the West Midlands regional area²⁸⁸:
- no inert waste²⁸⁹;
 - 345,660 tonnes of non-hazardous waste (38,407 tonnes per annum); and
 - 150,682 tonnes of hazardous waste (16,742 tonnes per annum).
- 15.5.67 It is considered in all classes of landfill that there will be sufficient capacity available in the West Midlands region to accept the forecast quantity of waste from both the Proposed Scheme and Phase One.
- 15.5.68 The cumulative effects on the available inert and hazardous landfill capacities are considered to be as identified for the main assessment i.e. minor adverse and not significant.
- 15.5.69 Significance criteria for non-hazardous waste landfill capacity state that a regional-scale reduction in non-hazardous waste landfill void space capacity of between 50,000 to 250,000 tonnes per annum may be judged to be of importance in the local planning context. The combined non-hazardous waste generation of the Proposed Scheme and the West Midlands section of Phase One, is forecast to be approximately 50,114 tonnes per annum.

²⁸⁸ High Speed Two (2015), *Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement - Volume 5 Technical appendices Waste and material resources WM-001-000 Annex 1*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466978/Waste_and_material_resources_WM-001-000_WM-001-000_annex_WM-002-000.pdf

²⁸⁹ High Speed Two (2015), *Supplementary Environmental Statement 3 and Additional Provision 4 Environmental Statement - Volume 3 Route-wide effects, Table 18*. Available online at: [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466703/SES3 AP4 ES Volume 3 Route-wide effects.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466703/SES3_AP4_ES_Volume_3_Route-wide_effects.pdf)

- 15.5.70 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely cumulative environmental effects associated with the off-site disposal to landfill of non-hazardous surplus excavated material, construction and demolition waste generated by the Proposed Scheme and Phase One will increase from minor adverse to moderate adverse.

Phase 2a and other committed developments

- 15.5.71 The methodology used to develop the future baseline landfill capacities during the proposed construction period, takes account of waste generation trends driven by developments in the respective regional areas. It is considered in this cumulative assessment that none of the committed developments are of sufficient scale to disrupt these trends, and are therefore considered to comprise part of the future baseline against which the Proposed Scheme has already been assessed.
- 15.5.72 No further effects on material and waste resources beyond those stated previously in the assessment have been identified.

15.6 Assessment of the effects of operation

Avoidance and mitigation measures

- 15.6.1 During operation, waste from passenger trains and rolling stock maintenance will be managed in accordance with the waste hierarchy by the train operating company (or its fleet maintenance contractor in the case of rolling stock maintenance waste). Waste generated by track maintenance and other ancillary infrastructure will also be managed in accordance with the waste hierarchy by Network Rail and/or the train operating company.

Assessment of impacts and effects

Waste forecast

Railway station and train waste

- 15.6.2 Railway station and train waste refers to waste that will arise at stations along the route of the Proposed Scheme. All stations will produce waste associated with their individual operating functions such as retail units and food and beverage outlets, but only terminus stations will produce waste from trains which is associated with their operation, such as on-board passenger litter bins and catering carriages.
- 15.6.3 The Proposed Scheme does not include any railway stations. As a result no waste will be taken off trains within the Proposed Scheme. It is recognised that waste will arise at terminal stations on or remote from the HS2 scheme from passengers travelling on the Proposed Scheme that were not considered as part of the Phase One assessment. This is described further in Volume 4, Off-route effects.

Rolling stock maintenance waste

- 15.6.4 Rolling stock maintenance waste generated by the train operating company using the route, such as worn brake pads and pantograph carbons, is accounted for in the calculation of waste arising at Washwood Heath rolling stock maintenance depot located to the south of the Proposed Scheme (constructed as part of Phase One).

Track maintenance waste

- 15.6.5 The assessment has been undertaken on the assumption of slab track²⁹⁰ as the track form for the Proposed Scheme, as set out in Volume 1, Section 5. Track maintenance waste for the slab track will comprise the steel rails and associated components (e.g. fastener clips and bolts and rubber dampener) that will be periodically replaced as part of routine maintenance activities.
- 15.6.6 Table 33 presents a route-wide summary of the forecast track maintenance waste quantities for the Proposed Scheme in 2027²⁹¹. A detailed track maintenance waste quantity forecast is provided in Volume 5: Appendix WM-001-000.
- 15.6.7 Track maintenance waste will be generated along the route of the Proposed Scheme. Quantities have been estimated based on using a waste generation rate of 0.05495 tonnes/m/year²⁹². Using this methodology, the Proposed Scheme will generate approximately 706 tonnes of track maintenance waste from slab track during the first year of operation in 2027.
- 15.6.8 In practice, the nature of the high speed track is such that very little track maintenance waste will be generated during the first few years after construction (including the operational assessment year of 2027). The largest quantity of track maintenance waste will occur as the slab track bed reaches the end of its service life and requires replacement. This is unlikely to occur until approximately 60 years after construction, which is beyond this assessment’s temporal scope.
- 15.6.9 The methodology used to forecast track maintenance waste, therefore, provides a reasonable worst-case scenario in terms of waste generation for the purpose of this assessment.

Table 33: Forecast track maintenance waste quantities by region, 2027

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
West Midlands	574	574	0
North West	132	132	0
Total	706	706	0

- 15.6.10 The quantity of track maintenance waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 100%. This rate has been selected based on the assumption that track maintenance waste consists only of steel rail, other metal components²⁹² and rubber dampeners, all of which are fully recyclable or recoverable.

²⁹⁰ Slab track will comprise precast concrete slabs supported on a continuous structural layer. A final decision on the track form will be made during the detailed design of the Proposed Scheme.

²⁹¹ It has been assumed that track maintenance waste will be largely managed within the region in which it will be generated.

²⁹² For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR and the SMR Addendum.

- 15.6.11 The quantity of track maintenance waste that will require off-site disposal to landfill in 2027 is zero tonnes.

Ancillary infrastructure waste

- 15.6.12 Ancillary infrastructure waste refers to waste that will arise from an operational support site, i.e. the proposed IMB-R in the Stone and Swynnerton area (CA3), signalling locations, operations and maintenance sites (other than those involving track maintenance).
- 15.6.13 Table 34 presents a regional and route-wide summary of the forecast ancillary infrastructure waste quantities for the Proposed Scheme in 2027²⁹³. A detailed ancillary infrastructure waste quantity forecast is provided in Volume 5: Appendix WM-001-000.
- 15.6.14 Ancillary infrastructure waste will be generated along the entire route of the Proposed Scheme. Quantities have been estimated based on a waste generation rate of 0.692 tonnes per kilometre of track per year²⁹². Using this methodology, the Proposed Scheme will generate approximately 92 tonnes of ancillary infrastructure waste during the first year of operation in 2027.

²⁹³ It has been assumed that ancillary infrastructure waste will be largely managed within the region in which it will be generated.

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Table 34: Forecast ancillary infrastructure waste quantities by region, 2027

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
West Midlands	74	44	30
North West	18	11	7
Total	92	55	37

- 15.6.15 The quantity of ancillary infrastructure waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 60%. This rate has been selected based on the Network Rail target to divert 60% of operational waste from landfill by 2014.
- 15.6.16 It has been assumed that, as a reasonable worst-case scenario for the purpose of this assessment, the remaining 40% of ancillary infrastructure waste will be disposed of off-site to landfill. The quantity of ancillary infrastructure waste that will require off-site disposal to landfill in 2026 will be approximately 37 tonnes.
- 15.6.17 It has been assumed for the purpose of this assessment that all of the ancillary infrastructure waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill.

Impact of operation on future baseline waste arisings

- 15.6.18 Table 35 provides a summary of operational waste arisings for the Proposed Scheme that will be generated in 2027. This represents the total quantity of operational waste that will be generated during the first year of operation of the Proposed Scheme, and which will be managed as C&I waste. For the Proposed Scheme, operational waste includes track maintenance waste and ancillary infrastructure waste. As set out above, there are no railway stations or rolling stock maintenance depots along the route of the Proposed Scheme, therefore this assessment does not include this type of waste.

Table 35: Summary operational waste forecast, 2027

Waste source	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Railway station and train	0	0	0
Rolling stock maintenance depot	0	0	0
Track maintenance	706	706	0
Ancillary infrastructure	92	55	37
Total	798	761	37

Waste source	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Proportion	100%	95%	5%

15.6.19 Table 35 shows that the Proposed Scheme will generate approximately 798 tonnes of operational waste in 2027. Approximately 95% of this quantity will be diverted from landfill via reuse, recycling and recovery.

15.6.20 The impact of operational waste generation and off-site disposal to landfill is shown in Table 36 as the percentage difference between future baseline C&I waste arisings with and without the Proposed Scheme.

Table 36: Impact of commercial and industrial waste arisings generated by the Proposed Scheme, 2027

	Regional change ²⁹⁴	
	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)
Future baseline waste arisings 2026 without the Proposed Scheme	12,777,000	2,786,000
Proposed Scheme waste arisings 2027	798	37
Future baseline waste arisings 2027 with the Proposed Scheme	12,777,798	2,786,037
Increase in future baseline waste arisings with the Proposed Scheme	+0.0001%	+0.00001%

15.6.21 Table 36 shows that the total quantity of operational waste generated by the Proposed Scheme in 2027 is equivalent to less than 0.001% of regional future baseline C&I waste arisings.

15.6.22 The total quantity of operational waste generated by the Proposed Scheme that will require off-site disposal to landfill in 2027 will be equivalent to less than 0.001% of regional baseline C&I waste arisings to landfill during that year.

Likely significant environmental effects

15.6.23 The total quantity of non-hazardous operational waste requiring off-site disposal to landfill in 2027 will be 37 tonnes (see Table 35). This comprises non-hazardous waste that will be generated by track maintenance and ancillary infrastructure activities.

15.6.24 Subject to waste acceptance criteria set out in the Landfill Directive²⁹⁵ and the Proposal for a Council Decision Establishing Criteria and Procedures for the

²⁹⁴ Based on an annual projection of 12,777,000 tonnes total arising for the aggregated two regions and on an annual projection of 2,786,000 tonnes to landfill for the aggregated two regions as set out in Section 15.4 (Table 22).

²⁹⁵ Council of the European Union (1999), *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

Acceptance of Waste at Landfills²⁹⁶, operational waste generated by the Proposed Scheme will be mostly non-hazardous in nature.

- 15.6.25 Off-site disposal of non-hazardous operational waste to landfill will result in an overall reduction of non-hazardous waste landfill void space of 37 tonnes in 2027. This will be equivalent to a less than 0.001% reduction in non-hazardous waste landfill capacity across the aggregated two regions according to the capacity projected to be available in 2027 (approximately 49 million tonnes).
- 15.6.26 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the aggregated two regions to accept the forecast quantity of non-hazardous operational waste for off-site disposal to landfill.
- 15.6.27 Significance criteria²⁹⁷ for non-hazardous waste landfill capacity state that there is unlikely to be any appreciable adverse effect where there is:
- an insignificant increase in waste arisings relative to the future baseline; or
 - an insignificant reduction in landfill void space capacity for non-hazardous waste.
- 15.6.28 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely significant environmental effects associated with the off-site disposal to landfill of non-hazardous operational waste generated by the Proposed Scheme will be negligible.

Other mitigation measures

- 15.6.29 Some of the non-hazardous waste generated during the operation of the Proposed Scheme will also be suitable for energy recovery (i.e. incineration). This will reduce reliance on non-hazardous waste landfill capacity.

Summary of likely residual significant effects

- 15.6.30 The likely residual significant effects associated with operation of the Proposed Scheme will be negligible.

Cumulative effects

Phase 2a and Phase One

- 15.6.31 A quantitative assessment of the effects associated with the off-site disposal to landfill of solid waste that will be generated by the operation of the Proposed Scheme and by the operation of Phase One has been undertaken.
- 15.6.32 The cumulative effects assessment takes into account the operation of the Proposed Scheme and Phase One at the time the Proposed Scheme becomes operational (i.e. in the year 2027), thus they will have a simultaneous requirement for landfill disposal capacity of any operational waste generated during that year.

²⁹⁶ 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>

²⁹⁷ Rationale for landfill significance criteria technical note, SMR and the SMR Addendum.

- 15.6.33 Table 37 provides a summary of the combined operational waste arisings from the Proposed Scheme and Phase One that is estimated to be generated in 2027. A detailed waste forecast for the combined operational waste arisings from the Proposed Scheme and Phase One is provided in Volume 5: Appendix WM-001-000.

Table 37: Summary operational waste forecast Phase 2a and Phase One, 2027

Waste source	Estimated quantity of waste per annum (tonnes)	Estimated quantity of waste for off-site disposal to landfill per annum (tonnes)
Railway station and train	3,284	1,313
Rolling stock maintenance	10,698	2,140
Track maintenance	4,151	570
Ancillary infrastructure	385	154
Total	18,518	4,177

- 15.6.34 Table 37 shows that the Proposed Scheme and Phase One will generate approximately 18,518 tonnes of operational waste in 2027. Approximately 77% of this quantity will be diverted from landfill via reuse, recycling and recovery.

- 15.6.35 The total quantity of non-hazardous operational waste from the Proposed Scheme and Phase One requiring off-site disposal to landfill in 2027 will be 4,177 tonnes (see Table 37). This comprises non-hazardous waste that will be generated by passengers and train operators, rolling stock maintenance, track maintenance and ancillary infrastructure activities.

- 15.6.36 Subject to waste acceptance criteria set out in the Landfill Directive²⁹⁸ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²⁹⁹, operational waste generated by the Proposed Scheme and Phase One will be mostly non-hazardous in nature.

- 15.6.37 Off-site disposal of non-hazardous operational waste to landfill will result in an overall reduction of non-hazardous waste landfill void space of 4,177 tonnes in 2027. This will be equivalent to a less than 0.009% reduction in non-hazardous waste landfill capacity across the aggregated two regions according to the capacity projected to be available in 2027 (approximately 49 million tonnes).

²⁹⁸ Council of the European Union (1999), *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*. Available online at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>

²⁹⁹ 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>

- 15.6.38 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the aggregated two regions to accept the forecast quantity of non-hazardous operational waste for off-site disposal to landfill.
- 15.6.39 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely significant environmental effects associated with the off-site disposal to landfill of non-hazardous operational waste generated by the Proposed Scheme and Phase One will be negligible.

Phase 2a and other committed developments

- 15.6.40 The methodology used to develop the future baseline landfill capacities for the assessment year for operation, takes account of waste generation trends driven by developments in the respective regional areas. It is considered in this cumulative assessment that none of the committed developments are of sufficient scale to disrupt these trends, and are therefore considered to comprise part of the future baseline against which the Proposed Scheme has already been assessed.
- 15.6.41 No further effects on material and waste resources beyond those stated previously in the assessment have been identified.

Monitoring during operation

- 15.6.42 Volume 1, Section 9, sets out the general approach to environmental monitoring during operation of the Proposed Scheme.
- 15.6.43 Monitoring of waste management activities will be undertaken by train operating companies and infrastructure operators in accordance with statutory requirements and corporate sustainability reporting.

16 Water resources and flood risk

16.1 Introduction

- 16.1.1 This section considers the likely significant route-wide effects on surface water and groundwater resources (quality and quantity) and flood risk. In general these effects, which relate to potential impacts on individual water bodies, springs and water supplies, are site-specific and localised in nature and have therefore been scoped out of the route-wide assessment on that basis.
- 16.1.2 The water resources and flood risk issues that have been considered on a route-wide basis relate to:
- the risk to water resources associated with accidents or spillages from trains during operation of the Proposed Scheme;
 - a summary of how the Proposed Scheme complies with the statutory requirements of the Water Framework Directive (WFD)³⁰⁰; and
 - route-wide flood risk issues related to application of the Sequential Test and Exception Test in the National Planning Policy Framework (NPPF)³⁰¹.
- 16.1.3 Any local effects are described in the Volume 2 community area 1–5 reports. Further details are provided in Volume 5, including individual community area water resources assessments (Volume 5: Appendices WR-002-001, 002, 003, 004 and 005), individual community area flood risk assessments (Volume 5: Appendix WR-003-001, 002, 003, 004 and 005) and a detailed stand-alone route-wide WFD compliance assessment report (Volume 5: Appendix WR-001-000).

16.2 Water resources assessment

- 16.2.1 General examples of management measures during operation and management of the Proposed Scheme that will avoid significant adverse effects on the quality of surface water and groundwater resources are described in the draft operation and maintenance plan for water resources and flood risk (Volume 5: Appendix WR-005-000).
- 16.2.2 There is potential for pollution of the water environment from spillages during operation of the Proposed Scheme. This risk is considered very low, as the majority of trains will be electric passenger trains, and the Proposed Scheme will not be used to transport freight. Spillages on the route are only likely following derailments, collisions, or major on board incidents, all of which are considered highly improbable. This issue is considered in Major accidents and natural disasters (Section 11).
- 16.2.3 If spillage of a pollutant does occur, it will not necessarily lead to a pollution incident, as the pollutant may not reach a receiving water body, either because of prompt

³⁰⁰ Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy, 2000. Available online at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>

³⁰¹ Communities and Local Government (2012), National Planning Policy Framework. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60772116950.pdf

action by emergency personnel or as a result of pollution control measures, such as balancing ponds.

16.2.4 Specific mitigation proposed to address the residual risk includes:

- inclusion of shut-off valves on balancing ponds which could be used to isolate pollutants before they enter the wider water environment. If the procedures for closing valves on these systems were not operated in time, the ponds would still significantly reduce the amount of pollutant entering the wider water environment; and
- the draft operation and maintenance plan for water resources and flood risk (Volume 5: WR-005-000) makes specific provision for notifying the emergency and environmental services and procedures for isolating pollutants within the drainage systems.

16.2.5 It can therefore be concluded that there are unlikely to be significant adverse effects related to route-wide accident and spillage risks during operation of the proposed scheme.

16.3 WFD compliance assessment

Introduction

16.3.1 The statutory objective of the WFD is to prevent deterioration of all water bodies at good or high status and to prevent water bodies at less than good status from deteriorating further. To ensure compliance with the WFD, decision makers must consider whether proposals for new developments have the potential to:

- cause a deterioration of a water body from its current status or potential;
- prevent future attainment of good status or potential where not already achieved;
- impact on protected or priority species and habitats; and/or
- provide opportunities to improve the water environment.

16.3.2 The statutory objectives of relevance to all surface water and groundwater bodies potentially affected by the Proposed Scheme are recorded within the relevant River Basin Management Plans (RBMPs), which are the 2015 Cycle 2 Humber RBMP³⁰² and the Cycle 2 North West RBMP³⁰³. The key water bodies with potential to be affected are those associated with the River Trent, the River Lea, Betley Mere Site of Special Scientific Interest (SSSI) and the Sherwood Sandstone aquifer.

16.3.3 A WFD compliance assessment for the Proposed Scheme, prepared on a route-wide basis, has been included in Volume 5: Appendix WR-001-000 and a summary is provided here. The risk of the Proposed Scheme resulting in long term deterioration in

³⁰² Defra and Environment Agency (2016), *Humber river basin district river basin management plan*. Available online at: <https://www.gov.uk/government/publications/humber-river-basin-district-river-basin-management-plan>

³⁰³ Defra and Environment Agency (2016), *North West river basin district river basin management plan*. Available online at: <https://www.gov.uk/government/publications/north-west-river-basin-district-river-basin-management-plan>

any element used to determine the WFD status of these water bodies has been reduced as far as is reasonably practicable during the design and environmental assessment process.

Outline methodology and key assumptions

16.3.4 Although there is no published methodology for WFD compliance assessment, the approach adopted is based on guidance from the Environment Agency and professional judgement. It has also been discussed and agreed with Environment Agency specialists. The assessment has involved a staged process, including:

- baseline assessment (scoping) to identify the relevant WFD water bodies and assess their existing condition;
- preliminary assessment (screening) to establish the likely impacts of the various scheme components on the relevant water bodies and identify those WFD status elements potentially at risk with regard to the scheme causing a deterioration in current status and/or a failure to achieve status objectives; and
- detailed impact assessment, using a traffic light rating system agreed with the Environment Agency, to establish the nature and likely magnitude of the impacts of scheme components on the WFD quality elements at the water body scale.

16.3.5 The assessment is based on the Proposed Scheme design, current Environment Agency WFD baseline data and baseline hydromorphological and ecological data derived via desk study and field surveys.

16.3.6 The assessment has taken into account the mitigation built into the design of the Proposed Scheme and has informed the other mitigation identified in the Volume 2 community area reports (Section 8, Ecology and biodiversity and Section 15, Water resources and flood risk).

WFD compliance assessment results summary

16.3.7 The WFD assessment provides an indication of the likely compliance of the Proposed Scheme at the time the assessment was prepared. The assessment has identified a total of 13 WFD surface water bodies (including 55 individual watercourses) and six groundwater bodies that have potential to be impacted by the Proposed Scheme.

Deterioration of current status or potential

16.3.8 Six surface water bodies, including Betley Mere SSSI, are anticipated to experience no measurable change.

16.3.9 Four surface water bodies, and all six of the groundwater bodies, affected by the Proposed Scheme are anticipated to experience minor, localised changes that are not anticipated to cause a deterioration in their status.

16.3.10 Three surface water bodies, including the River Lea, the River Trent and Bourne Brook, have potential to be adversely affected by excavation of the borrow pits during the construction phase. Consequently, a requirement for additional mitigation at these borrow pit sites has been identified in the relevant Volume 2 community area reports in order to appropriately manage this risk. The implementation of these

additional mitigation measures will ensure that there are no residual risks to the status of the relevant water bodies.

- 16.3.11 Construction activities are in such proximity to the public water supply abstraction near Whitmore, which is from the Staffordshire Trent Valley–PT Sandstone Staffordshire (GB4041G300500) groundwater body (part of the Sherwood Sandstone Group), that it may not be practicable to implement fully effective pollution prevention measures to safeguard the supply. Options are currently being discussed with the owner of the abstraction, Severn Trent Water, and the Environment Agency, with a view to ensuring a continuous, resilient water supply during the construction period. With the implementation of additional mitigation measures outlined in Volume 2: community area 4 report, Whitmore Heath to Madeley, the residual overall effect on the quality element status of this water body is anticipated to be negligible.
- 16.3.12 Mitigation options at Whitmore may include the temporary suspension of abstraction at this location. The Staffordshire Trent Valley–PT Sandstone Staffordshire (GB4041G300500) groundwater body is currently failing its status objective due to over abstraction. It is foreseen that the alternative water source used during construction of the Proposed Scheme will involve abstraction of the same or lower quantities of water than are currently abstracted at Whitmore. Pressure on the water resources available within this water body will therefore not be worsened by the Proposed Scheme, ensuring negligible effects.
- 16.3.13 Targeted and proportional WFD compliance monitoring will be implemented prior to, during and following construction at all sites where an effect has been identified. The WFD compliance monitoring strategy will be developed in consultation with the Environment Agency and tailored around the relevant quality elements anticipated to be affected. Monitoring outcomes will be utilised to assess the suitability and effectiveness of the embedded mitigation applied to the relevant scheme components and, where deemed necessary by the Environment Agency, inform the development of any required corrective measures and/or further mitigation measures.

Prevention of achieving status objectives

- 16.3.14 The Proposed Scheme is not considered to pose a risk to the future status objectives of the relevant surface water bodies.
- 16.3.15 A requirement for further baseline fish monitoring and field survey assessment has been identified on Filly Brook and this will be undertaken in consultation with the Environment Agency. The results will inform the detailed design of the mitigation requirements identified on this watercourse.
- 16.3.16 The temporary suspension of the abstraction from the Staffordshire Trent Valley–PT Sandstone Staffordshire (GB4041G300500) groundwater body may be required for a period exceeding three years, which has potential implications for the achievement of future objectives for this water body. However, because it is foreseen that provision of this alternative water supply will involve abstraction of the same or lower quantities of water than are currently abstracted at Whitmore, any related effects should be negligible.

Conclusions

- 16.3.17 The WFD compliance assessment has concluded that, if the additional mitigation requirements outlined in the Volume 2 community area reports are implemented, the Proposed Scheme will not cause a deterioration of the current status or potential of the relevant surface and groundwater bodies or prevent any water bodies from achieving their status objectives. The Proposed Scheme is therefore considered to be compliant with the objectives of the WFD.
- 16.3.18 No requirement for Article 4.7 exemptions, which are required in circumstances where there is potential for derogations to occur, have been identified in the WFD compliance assessment.

16.4 Route-wide flood risk assessment

- 16.4.1 Sections of the Proposed Scheme will be located in flood zones, including two crossings of the River Trent floodplain, numerous crossings of ordinary watercourses and areas at heightened risk of flooding from surface water sources.
- 16.4.2 The design of the Proposed Scheme has been developed to avoid flood hazards, wherever this is reasonably practicable, and to help ensure that the Proposed Scheme will not increase flood risk to vulnerable receptors. Volume 5: Appendices WR-003-001 to 005 contain detailed assessments of flood risk in each community area. Hydraulic modelling reports are included in Background Information and Data (BID)³⁰⁴.
- 16.4.3 The only flood risk issue considered on a route-wide basis is how the Proposed Scheme has aligned with the Sequential Test and Exception Test policies in the NPPF³⁰⁵.
- 16.4.4 NPPF states that 'the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding'.
- 16.4.5 Avoidance of areas with a high probability of flooding was a key consideration in the original route engineering assessment and appraisal of sustainability. A wide range of potential route options was considered and flood risk was one of the environmental constraints used to inform the selection of a preferred route. Consequently the route of the Proposed Scheme avoids flood zones where reasonably practicable. The route of the Proposed Scheme has therefore been selected based on application of the sequential approach advocated in NPPF.
- 16.4.6 The Proposed Scheme, which is essential infrastructure as defined by NPPF, inevitably has to pass through flood zones in order to cross rivers and surface water flow paths. In such circumstances, the Exception Test requires evidence to be provided that the development provides wider sustainability benefits to the community that outweigh flood risk. It also requires that a site specific flood risk assessment (FRA) must

³⁰⁴ HS2 Ltd (2017), High Speed Two (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data, www.gov.uk/hs2

³⁰⁵ Communities and Local Government (2012), National Planning Policy Framework. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

'demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall'³⁰⁶.

- 16.4.7 It is considered that the Proposed Scheme will provide wider sustainability benefits to the community, as demonstrated in Volume 1 of this Environmental Statement. The FRA for each community area demonstrates that the Proposed Scheme will be safe from flooding over its lifetime and outlines the proposed approach to ensure that flood risk will not be increased elsewhere. An allowance for climate change has been made in the assessments in line with latest Environment Agency guidance³⁰⁷. Whilst the potential for significant effects to occur related to flood risk has been identified at three locations along the route (two locations on the River Trent floodplain and one at the River Lea crossing), the additional mitigation proposed at these site will ensure that the flood risk issues are addressed during the detailed design of the Proposed Scheme.
- 16.4.8 The Proposed Scheme is therefore considered to align with the principles of the Sequential Test and Exception Test policies in NPPF.
- 16.4.9 The potential for the Proposed Scheme to have an adverse impact on the severity of major natural disasters, including floods, is also assessed on a route-wide basis in Section 11, Major accidents and natural disasters.

16.5 Monitoring

- 16.5.1 Volume 1, Section 9 sets out the general approach to environmental monitoring during operation of the Proposed Scheme.
- 16.5.2 Monitoring will be undertaken during and following construction at all sites where the potential for adverse impacts on the water environment has been identified. This monitoring strategy will be developed in consultation with the Environment Agency and tailored around the relevant quality elements anticipated to be affected. Monitoring outcomes will be utilised to inform the development of any corrective measures and/or further mitigation measures required to ensure compliance with the requirements of the WFD.

16.6 Conclusions

- 16.6.1 Spillage risks associated with accidental release of contaminants from trains, and the pollution risk associated with accidents, are unlikely to result in significant effects, once the relevant mitigation has been implemented in full. A draft operation and maintenance plan for water resources and flood risk, which makes specific provision for this issue, has been prepared (Volume 5: Appendix WR-005-000).
- 16.6.2 The WFD compliance assessment has concluded that, if the additional mitigation requirements outlined in Volume 2 community area reports are implemented, the

³⁰⁶ National Planning Policy Framework (2012), *Meeting the challenge of climate change, flooding and coastal change*, Department for Communities and Local Government. Available online at: <https://www.gov.uk/guidance/national-planning-policy-framework/10-meeting-the-challenge-of-climate-change-flooding-and-coastal-change#para102>

³⁰⁷ Environment Agency (2016), *Flood risk assessments: climate change allowances*. Available online at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Proposed Scheme will not cause a deterioration of the current status or potential of the relevant surface and groundwater bodies or prevent any water bodies from achieving their status objectives. The Proposed Scheme is therefore considered to be compliant with the objectives of the WFD.

- 16.6.3 This route-wide assessment outlines how the Proposed Scheme aligns with the principles of the Sequential Test and Exception Test as set out in the NPPF. Consequently, it has been assessed that the effects of the Proposed Scheme related to route-wide flood risk issues will not be significant.

17 Phase One, Phase 2a and Phase 2b combined impacts

17.1 Summary

17.1.1 A summary of the potential total impacts of Phase One, Phase 2a and Phase 2b is presented in Table 38. The Phase One data is taken from the Phase One Supplementary Environmental Statement 4 and Additional Provision Environmental Statement 5³⁰⁸. The quantification of the impacts of Phase 2b is derived from the Phase 2b Sustainability Statement³⁰⁹ which was published in November 2016.

Table 38: Combined Impacts of Phase One, Phase 2a and Phase 2b

	Phase One ³⁰⁸	Phase 2a	Phase 2b ³⁰⁹	Total
Route characteristics (km)				
Total	216 ³¹⁰	58 ³¹¹	279.3	553.3
At grade	0	1.1	19.3	20.4
Tunnel	49.5	2.2	21.7	73.4
Cutting	74.7	28.2	89.4	192.3
Viaduct	16.3	5.9	38.5	60.7
Embankment	62.5	20.6	110.4	193.5
Property and settlements				
Demolitions (residential)	326 dwellings (218 buildings)	26 dwellings	255	607
Demolitions (community)	19 community facilities	0 community facilities	4	23
Demolitions (commercial/ retail/manufacturing/industrial/ miscellaneous)	372 units (309 buildings) ³¹²	48 units ³¹³	209	629

³⁰⁸ HS2 Ltd (2015), *High Speed Rail (London-West Midlands). Supplementary Environmental Statement 4 and Additional Provision 5 Environmental Statement. Volume 3. Route-wide effects. December 2015.* HS2 Ltd, London.

³⁰⁹ Temple-RSK (2016), *High Speed Rail: Phase 2b Preferred Route. Sustainability Statement including Post Consultation Update. Volume 1: Main report of the Appraisal of Sustainability. A report by Temple-RSK for HS2 Ltd. November 2016.*

³¹⁰ Includes an additional 13km of route attributable to retaining walls and stations

³¹¹ There are also two spurs each of approximately 6km in length which run parallel to the main line of the Proposed Scheme, connecting it to the WCML south of Crewe.

³¹² This figure includes some properties which also provide community resources, e.g. public house, local services.

³¹³ Total includes outbuildings at farm holdings.

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	Phase One ³⁰⁸	Phase 2a	Phase 2b ³⁰⁹	Total
Total demolitions	546 buildings	85 buildings ³¹⁴	468	1,099
Employment				
Permanent jobs created	2,200 ³¹⁵	140	Refer to footnote ³¹⁶	2,340 ³¹⁷
Construction jobs created	14,600 ³¹⁸	2,240	Refer to footnote ³¹⁶	15,770 ³¹⁷
Jobs displaced	7,950 ³¹⁹	40	5,050	13,040
Noise				
Monetary valuation of noise impacts	n/a ³²⁰	£-3.18m ³²¹	Refer to footnote ³¹⁶	-
Landscape				
AONB crossed at surface (km)	7.6	0	0	7.6
Cultural heritage				
Scheduled Monuments directly affected	1	0	1	2
Registered Battlefields directly affected	1	0	0	1
Grade I and II* structures directly affected	2	0	0	2
Grade II structures directly affected	17	3	6	26
Registered Parks and Gardens directly affected	2	0	0	2
Conservation Areas directly affected	2	4	5	11

³¹⁴ Includes total of residential, community, commercial and miscellaneous buildings including outbuildings associated with residential properties.

³¹⁵ Indicative direct operational employment figure was estimated to the nearest 100 jobs.

³¹⁶ Value not presented in the Phase 2b Sustainability Statement.

³¹⁷ Excludes Phase 2b as not presented in the Phase 2b Sustainability Statement

³¹⁸ Number reported as an approximate equivalent of permanent full time construction jobs.

³¹⁹ Jobs displaced comprise jobs relocated elsewhere in the UK economy and jobs lost, due to land being acquired for the construction and operation of the Proposed Scheme (see Section 11 for details).

³²⁰ The assessment method has materially changed since that used for the AP5 Environmental Statement (December 2015) and hence the levels are not directly comparable.

³²¹ Total net present value of change in noise.

Environmental Statement Volume 3: Route-wide effects

	Phase One ³⁰⁸	Phase 2a	Phase 2b ³⁰⁹	Total
Biodiversity and wildlife				
Natura 2000 sites affected	0	0	0	0
SSSIs directly affected	3	0	1	4
Habitats of Principal Importance directly affected	41	65	Refer to footnote ³¹⁶	106 ³¹⁷
Ancient Woodlands directly affected	32	10 ³²²	10 ³²³	52
Water resources and flood risk				
Major rivers diverted	8	0 ³²⁴	4	12
Route through Flood Zone 3 (km)	12.0	2.4	18.2	32.6
Station/depot occupation of Flood Zone 3 (ha)	2.1	2.1 ³²⁵	Refer to footnote ³¹⁶	4.2
Cutting or tunnel through SPZ 1 or 2 (km)	6.7	1.1	0.7	8.5
Land use resources				
Active landfills crossed	0	0	6	6
Grade 1 and 2 agricultural land (km)	22.0	9.9	34.5	66.4
Waste and material resources				
Excavated material (million m ³)	63.4 ³²⁶	19.4 ³²⁷	16.0	98.8
Concrete (million tonnes)	13.04	2.10	4.65	19.79
Steel (million tonnes)	1.30	0.13	0.51	1.94

³²² Total of 10 ancient woodlands, comprising 2 Ancient Woodland Inventory sites and 8 additional ancient woodlands sites to be added to the Ancient Woodland Inventory as a result of heritage surveys undertaken

³²³ Relates to Ancient Woodland Inventory sites only.

³²⁴ There are no main river diversions in Phase 2a.

³²⁵ Includes the Stone Infrastructure Maintenance Base-Rail (IMB-R)

³²⁶ This figure is the total quantity of excavated material that will be generated from the construction of Phase One. This includes excavated material that will be reused in the construction process as well as excavated material that will be made available for use off-site or disposed of on or off site.

³²⁷ This figure is the estimated quantity of excavated material that will be generated from the construction of Phase 2a. It includes excavated material that will be reused in the construction process as well as excavated material that may require off-site disposal.

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