

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 3 | Route-wide effects

November 2013

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for Transport

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Structure of the HS2 Phase One Environmental Statement

The Environmental Statement (ES) documentation comprises:

- Non-technical summary (NTS) – which provides a summary in non-technical language of the Proposed Scheme, the likely significant environmental effects of the Proposed Scheme, both beneficial and adverse, and the means to avoid or reduce the adverse effects;
- Volume 1: Introduction to the ES and the Proposed Scheme – this describes High Speed Two (HS2), and the Environmental Impact Assessment (EIA) process, the approach to consultation and engagement, details of the permanent features and generic construction techniques as well as a summary of main strategic and route-wide alternatives and local alternatives (prior to 2012) considered;
- Volume 2: Community Forum Area (CFA) reports and map books – 26 reports and associated map books providing a description of the Proposed Scheme and of environmental effects in each area;
- Volume 3: Route-wide effects – provides an assessment of the effects of the Proposed Scheme where it is not practicable to describe them within the CFA descriptions in Volume 2;
- Volume 4: Off-route effects – provides an assessment of the off-route effects of the Proposed Scheme;
- Volume 5: Appendices and map books – contains supporting environmental information and associated map books; and
- Glossary of terms and list of abbreviations – contains terms and abbreviations, including units of measurement, used throughout the ES documentation.

1 Introduction

1.1 Purpose of this report

1.1.1 This report presents the likely significant environmental effects of the construction and operation of Phase One of HS2 (the Proposed Scheme) that have been identified on a route-wide basis.

1.1.2 This report should be read in conjunction with CFA reports 1-26 of Volume 2 and their corresponding map books. The CFA reports present the elements of the Proposed Scheme and alternatives within each area, and the likely significant environmental effects of the construction and operation of the Proposed Scheme, as well as mitigation measures for those significant effects that are adverse, as appropriate to the respective study area.

1.1.3 Phase Two of HS2 comprises new lines between the West Midlands, Leeds and Manchester, completing what is known as the 'Y network'. Section 16 of this report provides a summary of the potential total impacts of both Phase One and Phase Two on a range of environmental receptors. The selection of receptors addressed and the figures provided for Phase Two draw on the HS2 Phase Two Sustainability Statement¹.

1.2 Introduction to HS2

1.2.1 HS2 is a new high speed railway proposed by the Government to connect major cities in Britain. Stations in London, Birmingham, Leeds, Manchester, South Yorkshire and the East Midlands will be served by high speed trains running at speeds of up to 360kph (225mph).

1.2.2 HS2 is proposed to be built in two phases. Phase One, the subject of this ES, will involve the construction of a new railway line of approximately 230km (143 miles) between London and Birmingham. Construction will begin in 2017 (though some early works are planned for 2015 and 2016, subject to any necessary agreements or consents) and the line will become operational by 2026; with a connection to the West Coast Main Line (WCML) near Lichfield and to the existing HS1 railway line in London.

1.2.3 During Phase One high speed trains will connect with and run on the existing WCML to serve passengers beyond the HS2 network to destinations in the north. A connection to HS1 will also allow some services to access that high speed line through east London and Kent and connect with mainland Europe via the Channel Tunnel.

1.2.4 Phase Two will involve the construction of lines from West Midlands to Leeds and Manchester; with construction commencing approximately in 2023, and planned to be operational around 2032/33.

¹ Temple, ERM (July 2013), *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*.

² Her Majesty's Stationery Office (2000), *Countryside and Rights of Way (CRoW) Act*.

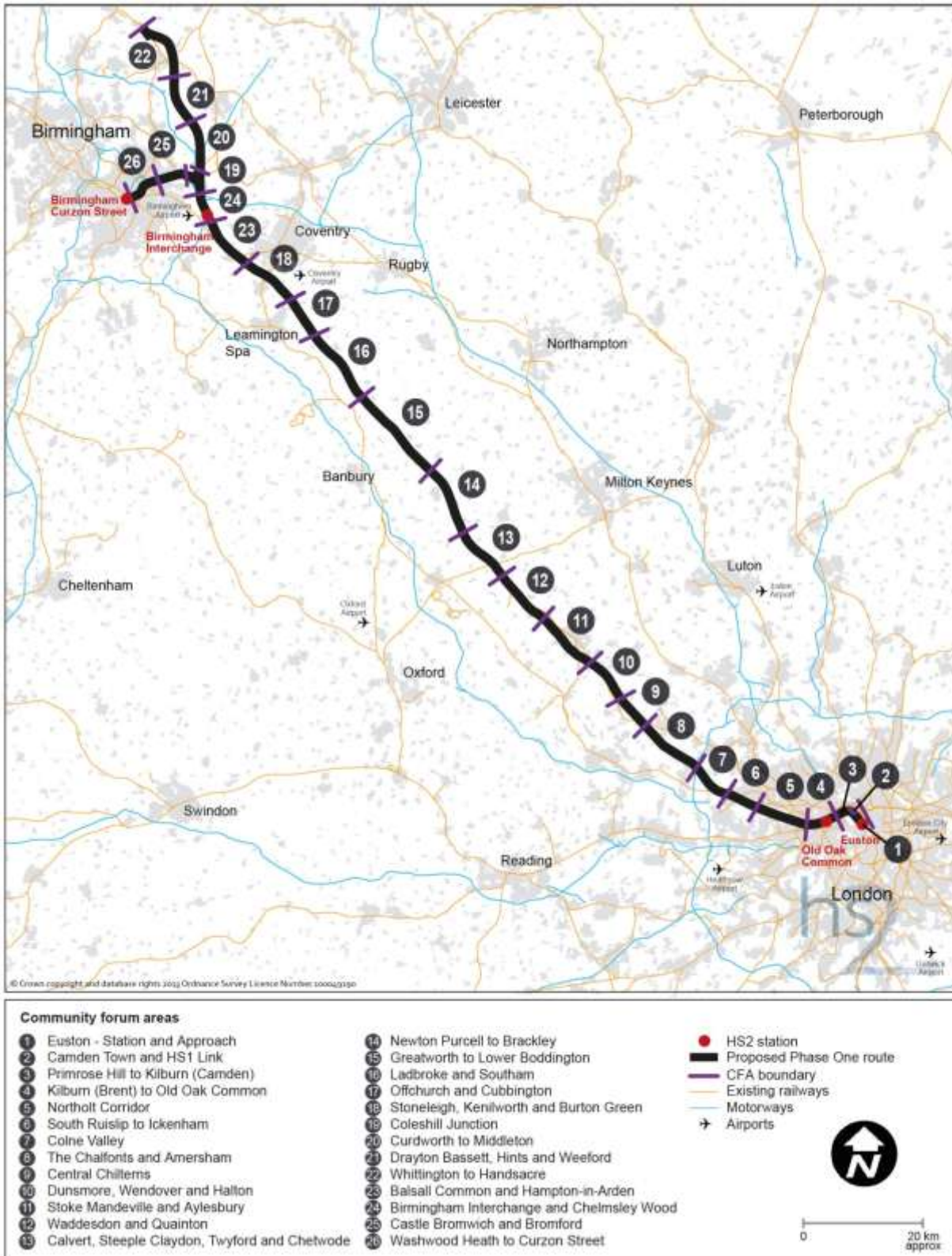
³ Department for Communities and Local Government (2012), *National Planning Policy Framework*.

- 1.2.5 Section 4 of Volume 1 describes the anticipated operational characteristics of HS2, including the anticipated frequency of train services. As Volume 1 shows, the frequency of trains is expected to increase over time and to increase further upon opening of Phase Two.
- 1.2.6 The Government believes that the HS2 network should link to Heathrow and its preferred option is for this to be built as part of Phase Two. However, the Government has since taken the decision to pause work on the Heathrow link until after 2015 when it expects the Airports Commission to publish its final report on recommended options for maintaining the country's status as an international aviation hub.
- 1.2.7 For consultation and environmental assessment purposes, the proposed Phase One route has been divided into 26 CFA, as shown in Figure 1.

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 CFA reports. These include:
- an assessment of effects on the special landscape qualities of the Chilterns Area of Outstanding Natural Beauty (AONB);
 - overall effects on the agricultural, forestry and soil resource;
 - climate, including greenhouse gas (GHG) emissions;
 - effects on ecological resources of at least national importance and on protected species;
 - socio-economic effects;
 - traffic and transport effects;
 - effects associated with the generation of solid waste during construction and operation; and
 - effects on water resources.
- 1.3.2 For some topics, effects are localised in extent and no additional significant route-wide effects have been identified. These topics include air quality, community, cultural heritage, land quality, and sound, noise and vibration.
- 1.3.3 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 assessment is described in Volume 1, which in turn refers to the Scope and Methodology Report (SMR) (Volume 5: CT-001-000/1) and the SMR Addendum (CT-001-000/2) as appropriate.

Figure 1 HS2 Phase One route and community forum areas



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 CFA reports, while including three additional sections which describe the effects on the special landscape qualities of the Chilterns AONB as a whole; climate; 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.

1.4.2 This report is structured as follows:

- introduction (Section 1);
- the Chilterns Area of Outstanding National Beauty (Section 2);
- agriculture, forestry and soils (Section 3);
- air quality (Section 4);
- climate (Section 5);
- community (Section 6);
- cultural heritage (Section 7);
- ecology (Section 8);
- land quality (Section 9);
- landscape and visual assessment (Section 10);
- socio-economics (Section 11);
- sound, noise and vibration (Section 12);
- traffic and transport (Section 13);
- waste and material resources (Section 14);
- water resources and flood risk assessment (Section 15); and
- Phase One and Phase Two combined impacts (Section 16).

2 The Chilterns Area of Outstanding Natural Beauty

2.1 Introduction

2.1.1 This section presents an assessment of effects on the special landscape qualities of the Chilterns AONB, during both construction and operation of the Proposed Scheme. Designation as an AONB under the National Parks and Access to the Countryside Act 1949 affords statutory protection to an area of high scenic quality in order to conserve and enhance the natural beauty of the landscape. This Act is supported by the Countryside and Rights of Way (CROW) Act 2000², which:

- clarifies the procedure and purpose of designating AONB;
- enables the creation of Conservation Boards in order to assume responsibility for AONB;
- requires Conservation Boards (or local authorities where there is no board) to produce management plans for each AONB; and
- requires all relevant authorities to have regard to the purpose of conserving and enhancing the natural beauty of AONB when performing their functions.

2.1.2 The Chilterns AONB was designated in 1965 for its distinctive landscapes of steep chalk scarp slopes and clay vales, and for containing the country's most extensive areas of beech woodland.

2.1.3 National planning policy regarding AONB is set out in paragraphs 115 and 116 of the National Planning Policy Framework (NPPF)³, which outlines that great weight should be given to conserving landscape and scenic beauty in AONB, with the conservation of wildlife and cultural heritage being important considerations. The NPPF goes on to state that planning permission should be refused for major developments within AONB except in exceptional circumstances, where a demonstrable need in the public interest must be presented.

2.1.4 The assessment of effects addresses the natural beauty and special landscape qualities of the Chilterns AONB (hereinafter referred to as the AONB) as referenced in the Chilterns AONB Management Plan 2008 - 2013⁴. The Management Plan provides the framework for the conservation and management of the AONB and is supported by a position statement on development affecting the setting of the AONB⁵. This assessment should be read in combination with the following reports, which describe the baseline and assessment of effects on individual landscape character areas within the AONB:

- Chalfonts and Amersham (Volume 2, CFA report 8, Section 9 and Volume 5:

² Her Majesty's Stationery Office (2000), *Countryside and Rights of Way (CROW) Act*.

³ Department for Communities and Local Government (2012), *National Planning Policy Framework*.

⁴ The Chilterns Conservation Board (2008), *Management Plan 2008 - 2013: A Framework for Action*.

⁵ The Chilterns Conservation Board (2011), *Position Statement: Development affecting the setting of the Chilterns AONB*.

Appendix LV-001-008);

- Central Chilterns (Volume 2, CFA report 9, Section 9 and Volume 5: Appendix LV-001-009); and
- Dunsmore, Wendover and Halton (Volume 2, CFA report 10, Section 9 and Volume 5: Appendix LV-001-010).

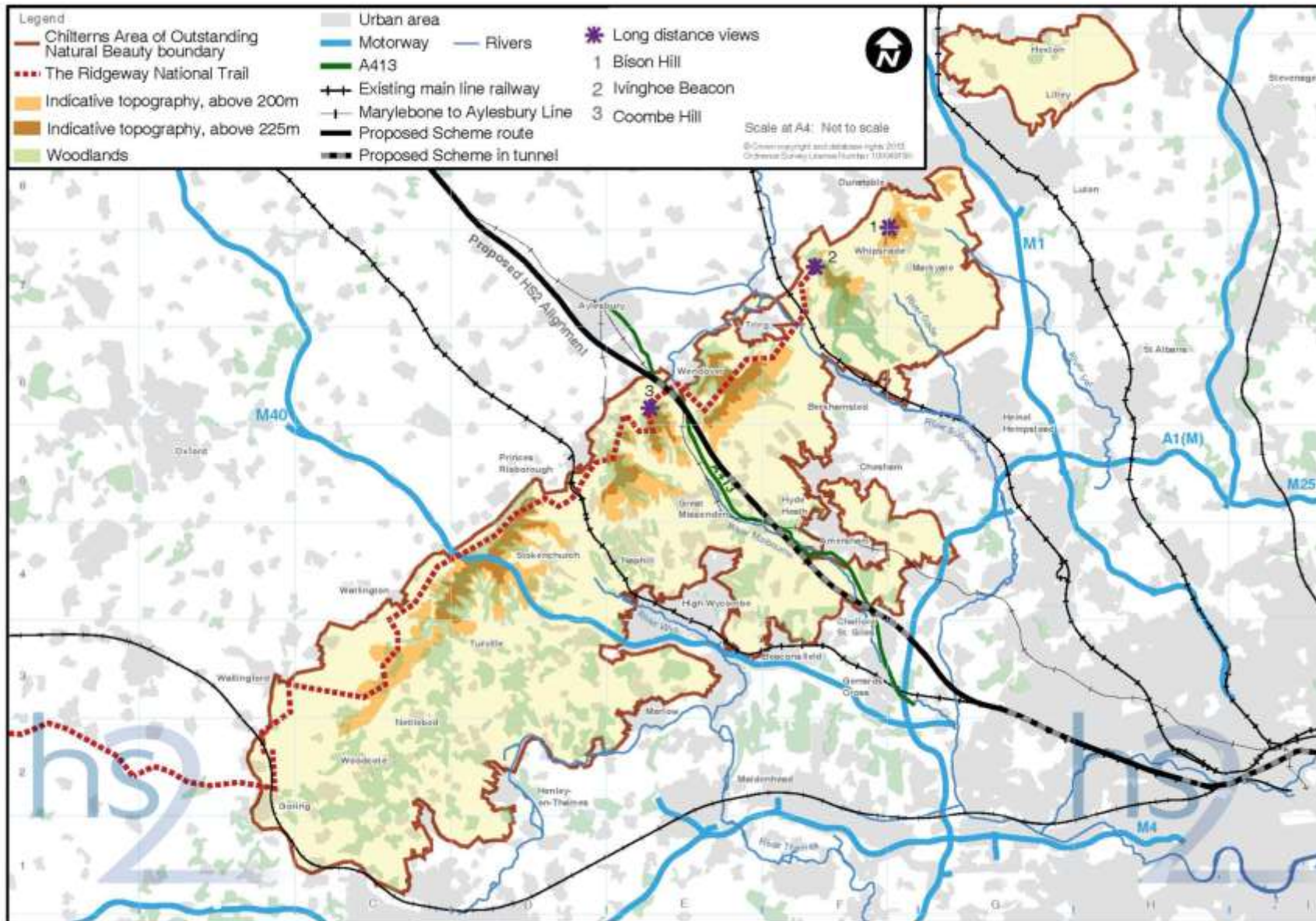
2.2 Assessment scope

- 2.2.1 Stakeholder engagement relating to the assessment of effects on landscape character areas within the AONB is reported in Volume 5: Appendix LV-001-008, Appendix LV-001-009 and Appendix LV-001-010 for CFA8, CFA9 and CFA10 respectively.
- 2.2.2 Field surveys were undertaken between July 2012 and July 2013 to establish the baseline landscape character of the AONB.
- 2.2.3 The study area is defined as the boundaries of the AONB. The assessment has been aided by the construction and operational phase zones of theoretical visibility (ZTV), which are shown on Maps LV-07-027 to LV-07-039 and LV-08-027 to LV-08-039 (Volume 5, Landscape and Visual Assessment Map Book). The ZTV have been produced in line with the methodology described in the SMR Addendum (Volume 5: Appendix CT-001-000/2), and are an indication of the visibility of the Proposed Scheme. In some locations, lack of data on vegetation cover may mean the actual visibility is substantially less than that shown in the ZTV. Tall construction plant (e.g. cranes and piling rigs) are excluded from the ZTV for the construction phase and overhead line equipment is excluded from the ZTV for the operational phase, but these are described and taken in to account in this assessment (see Volume 1, Section 8.7).

2.3 Landscape baseline

- 2.3.1 The landscape of the AONB is described in this section. Figure 2, also provided as Map LV-13 (Volume 5, Landscape and Visual Assessment Map Book for CFA 8, 9 and 10), illustrates the route of the Proposed Scheme within the context of the AONB.
- 2.3.2 The AONB comprises an extensive wooded and farmed landscape underlain by chalk bedrock, covering an area of more than 800km² (80,000ha). It rises up from the London Basin to form a north-west facing escarpment stretching from Goring in the south-west to Hexton in the north-east. The 80km-long chalk dip slope known as the Chilterns escarpment varies in character from the gentler hills in Oxfordshire rising north-east to a distinctive steep scarp slope above the Aylesbury Vale, providing long-distance views across the lower-lying vales to the north and west. The northern part of the AONB is generally more open with larger fields and less woodland, whilst the central and southern parts are dominated by heavily wooded countryside with mixed farming and a large number of scattered small settlements. Much of this woodland is classified as ancient woodland. The agricultural landscape in the valleys is dominated by arable fields surrounded by a dense network of ancient hedgerows. There are 15 registered parks and gardens (RPG) within the AONB, including Tring Park, Shardeloes and Missenden Abbey.

Figure 2: Landscape baseline



- 2.3.3 The characteristic landscape pattern of the AONB is a contrast of open ridge tops that afford long-distance views, and enclosed intimate landscapes in gently sloping valley bottoms. Although the scale varies and the valleys have their own features, a strong sense of enclosure predominates. Views from the ridge tops allow large swathes of the landscape to be experienced and the natural beauty and unique character of the area to be viewed. Panoramic long-distance views include those from Bison Hill, Ivinghoe Beacon and Coombe Hill.
- 2.3.4 The landscape of the AONB presents traces of many eras and previous settlement throughout history. The wider farmed landscape of today and its character are derived from its historic origins, with remnant historic field patterns remaining in place. The name of the Chilterns itself is suggested to derive from the Cilternsætan tribe, as recorded in the Tribal Hidage in the late 7th century, who occupied the area known as the Chilterns over 1,400 years ago⁶. The elevated escarpment provided a natural crossing point through the Chilterns which today is demarcated by the route of the Ridgeway National Trail and the Icknield Way public rights of way (PRoW), commonly cited as Britain's oldest road, which provided the basis of a major communications and trading network stretching from Wessex to East Anglia.
- 2.3.5 Today, major roads (including the M40, M1 and A41) and mainline railway lines radiating out from London are established features of the AONB. There are over 80km of National Grid overhead power lines running between Aylesbury and Beaconsfield, and between Aylesbury and Whipsnade. There is an extensive network of PRoW throughout the AONB, including the Ridgeway National Trail and the long-distance Chiltern Way and Grand Union Canal Walk. The majority of the Proposed Scheme will be located within the Misbourne Valley⁷, the valley floor of which features an existing road and rail corridor connecting the settlements in the Aylesbury Vale to the south-east of England.
- 2.3.6 A number of the special landscape qualities of the AONB are located within the Misbourne Valley and contribute to the natural beauty of the area. These are summarised in the following section.

Special landscape qualities

- 2.3.7 This section presents a summary of the special landscape qualities of the AONB as outlined in the Chilterns AONB Management Plan.

Steep chalk escarpment

- 2.3.8 The chalk escarpment rises to approximately 267m above Ordnance Datum (AOD) at the highest point (Coombe Hill, see Figure 3), providing panoramic, far-reaching views across the lower-lying vale landscapes e.g. from Coombe Hill, Bison Hill and Ivinghoe Beacon. However, in many places, extensive tree planting on the slopes of the escarpment limits visibility of the wider landscape. The underlying chalk ridge is covered by layers of clay with flint, although the chalk lies near the surface along the ridge. This has led to a history of quarry sites, many of which are now largely

⁶ The Chilterns Conservation Board (2008), *Management Plan 2008 - 2013: A Framework for Action*.

⁷ The Misbourne Valley within the Chilterns AONB is defined as the valley which extends from Chalfont St Giles in the south-east to Wendover in the north-west.

redundant. The landscape is strongly unified by the steep chalk escarpment. The Proposed Scheme lies within an arterial valley which transects the elevated steep chalk escarpment between Coombe Hill and Boddington Hill.

Figure 3: Representative elevated view from the steep chalk escarpment near Coombe Hill



Flower-rich downland

- 2.3.9 Once extensive, the open, flower-rich chalk downland (predominantly associated with the steep escarpment slopes of the chalk outcrop and dry valley slopes) is fragmented and currently encompasses approximately 7km² (700ha), which is less than 1% of the AONB. The most extensive area of flower-rich downland is located to the north-east of the AONB in the vicinity of Aldbury, north-east of the Proposed Scheme. The flower-rich chalk downland contributes to the character and natural beauty of the AONB as these areas often have a high wildlife value and a high recreational value as visitors are attracted to these publically accessible open spaces. The main area of flower-rich downland close to the Proposed Scheme is located on Bacombe Hill and Coombe Hill.

Woodlands

- 2.3.10 Approximately 170km² (17,000ha) of the AONB (21%) is wooded and, of this, approximately 110km² (11,000ha) is defined as ancient woodland. Ancient woodland, particularly beech, is a distinctive and prominent feature of the hill tops. Many of the beech woodlands provide an extensive, high-quality landscape and a place for recreational enjoyment (see Figure 4). Due to the extensive PRoW network, much of the woodland in the AONB is accessible to the public. The larger expanses of woodland are commonly located on the higher ground on the valley slopes, and along the elevated plateaux in between the valleys. Towards the valley bottoms, such as in the Misbourne Valley bottom, smaller, rectilinear areas of woodland have been shaped by agricultural practices over time. The Ancient Woodland Inventory for the Chilterns⁸ indicates that within the AONB, land in the South Oxfordshire District (to the south of the Proposed Scheme) encompasses the greatest extent of ancient woodland cover.

⁸ The Chilterns Conservation Board, (2012), *Ancient Woodland Inventory for the Chilterns: Report and Inventory Maps*.

Figure 4: An extensive tract of mixed-species woodland in the vicinity of Penn



Commons, heaths and greens

- 2.3.11 There is approximately 20km² (2,000ha) of registered common land within the AONB (representing approximately 2.5% of the AONB), split between 187 individual commons. These commons are noted in the Management Plan as being amongst the most characteristic features of the AONB. They provide accessible green places for recreation and public enjoyment and a habitat for a diverse range of wildlife, as do the town and village greens interspersed throughout the landscape in the vicinity of areas of settlement. The commons and areas of lowland heath are usually located on the higher ground within the AONB and comprise areas of mixed woodland, heathland and grassland - such as at Hyde Heath Common and South Heath Common, which are in proximity to the Proposed Scheme. The most extensive area of lowland heathland is located in the vicinity of Aldbury to the north of the Proposed Scheme. The nearest village green to the Proposed Scheme is at Mill Field near Frith-hill.

Historic settlement and environment

- 2.3.12 There are traces of human settlement dating back to prehistory in the landscape of the AONB. Many villages and farmsteads, built in the local vernacular of brick and flint, are scattered throughout the AONB. The more ancient settlements are commonly located adjacent to streams, rivers or springs at the foot of the escarpment e.g. Chesham, Amersham, Wendover and High Wycombe. Other settlements within the area often comprise nucleated villages situated along the winding network of minor roads within the valleys, such as Hyde Heath, South Heath, The Lee, Dunsmore and Kingsash.
- 2.3.13 The old farmsteads are often bounded by historic hedgerows, ancient woodlands and sunken lanes. Hill forts and chalk figures, such as the Boddington Camp (hill fort) and the Whiteleaf Cross respectively, are scattered throughout the AONB on the higher ground. Country houses (such as Chequers near Ellesborough) and registered parks and gardens (RPG), such as Shardeloes near Amersham and Missenden Abbey near Great Missenden, often feature in the valley bottoms.

Network of PRow and ancient routes

- 2.3.14 The PRow network within the AONB incorporates over 2,000km of walking routes and includes two National Trails: the Ridgeway and the Thames Path. In addition,

numerous promoted paths traverse the AONB along sunken laneways and include the Aylesbury Ring, the Chiltern Way, the Chiltern Link, the Icknield Way Path, the Oxfordshire Way, Shakespeare's Way, South Bucks Way and Swan's Way. Furthermore, approximately 29km² (2,900ha) of access land⁹ resides within the AONB (representing approximately 3.5% of the AONB). A number of PRoW and ancient routes traverse or lie in the vicinity of the Proposed Scheme.

Chalk streams

- 2.3.15 The chalk dip slope of the Chilterns escarpment is incised by a series of chalk valleys running from the north-west to the south-east. A number of these valleys are associated with chalk streams which descend into the rivers Ver, Gade, Bulbourne, Misbourne and Wye, ultimately feeding into the River Colne and River Thames. Within each river valley, smaller dry chalk valleys are located along the valley sides, giving the appearance of a gently rolling landform. The Proposed Scheme lies partly within the Misbourne chalk valley.

Tranquil valleys

- 2.3.16 The AONB is a rural area and relatively tranquil compared to the surrounding towns and cities. The varied and intimate landscape of beech woodlands, chalk hills and common land, which is unified by an extensive and well-maintained PRoW network, affords a broad appeal. For the most part, the Proposed Scheme lies within a wide valley setting interrupted by existing development and, as such, it is considered to have a relatively low level of tranquillity compared with other more secluded and less developed areas of the AONB. However, occasional hidden folds in the upper valley sides offer a higher level of tranquillity and sense of seclusion, including those near Upper Bottom House Farm, Mantle's Wood and Wendover Dean, which are secluded in character and are commonly only accessible by foot.

Farmland

- 2.3.17 Farmland covers approximately 480km² (48,000ha) of the AONB (60%), in a diverse patchwork of different-sized and shaped fields, enclosed by hedgerows interspersed with woodland, common land and downland (as illustrated in Figure 5). Traditionally, farming was a mix of arable land and livestock. Currently, the majority of the farmland is arable, often comprising cereal crops, and some field amalgamation has occurred. Despite this, a wide range of habitats are supported by the farmland and include arable field margins, ancient and species-rich hedgerows, trees, ponds and traditional orchards. The route of the Proposed Scheme traverses a predominantly arable landscape with a varied field pattern interspersed with areas of woodland, many of which are present as geometric blocks shaped over time by farming practice.

⁹ For the purpose of this assessment, *access land* is defined in accordance with Part 1 of the CRoW Act 2000 as: land mapped in conclusive form as open country; land mapped in conclusive form as registered common land; and land dedicated under Section 16 of the CRoW Act 2000, with the exception of *excepted land* described under Schedule 1 of the CRoW Act 2000, and land with existing open access rights described under Section 15 of the CRoW Act 2000.

Figure 5: Farmed landscape near Hampdenleaf Wood



Condition

- 2.3.18 The overall landscape condition of the AONB is considered to be good, with the landscape features and special landscape qualities of the AONB generally well maintained. Within the Misbourne Valley, there are some detracting elements present in the landscape, including the existing road and rail routes and National Grid high voltage power lines. However, generally within the Misbourne Valley, the landscape is in a good state of repair and is therefore considered to be in a good condition. This accords with the information presented in the State of the Chilterns Environment¹⁰.

Tranquillity

- 2.3.19 Tranquillity varies greatly across the AONB, as does the influence of light pollution, the sense of seclusion afforded by dense vegetation, land use, traffic, aircraft movements and extent of built development. The large areas of woodland and extensive network of hedgerows, often on higher ground on the valley sides, have helped to retain a comparatively secluded and enclosed character. The largest areas that are considered to have a high level of tranquillity are in the south-west of the AONB, furthest from the Proposed Scheme. On higher ground, the landscape is more exposed and prominent National Grid high-voltage power lines, road infrastructure and flight paths are an influence in the landscape. The busy road network in the valleys also influences tranquillity in the open land on the ridges. There are small pockets of high tranquillity in parts of the escarpment and in the valleys without major roads, but due to the influences of infrastructure, the overall AONB is assessed as having a medium level of tranquillity. This judgement accords with the Campaign to Protect Rural England map of relative tranquillity¹¹.
- 2.3.20 The majority of the areas in the immediate vicinity of the Proposed Scheme vary from low to medium tranquillity due to influences from the settlement of Amersham, the A413, M25, and the Marylebone to Aylesbury Line. However, there are extensive areas of high tranquillity within the elevated chalk escarpment, such as in the vicinity of Bacombe Hill, as well as in locations on the upper valley sides such as near The Lee, due to the presence of extensive public open spaces, high levels of woodland cover,

¹⁰ The Chilterns Conservation Board (2012), *State of the Chilterns Environment*.

¹¹ The Countryside Agency (revised edition 2007), *Map of Relative Tranquillity*.

and the enclosed nature of the landscape. Localised areas of high tranquillity are also associated with the dry valley folds in the landscape at Upper Bottom House Farm, Mantle's Wood and Wendover Dean.

Value

- 2.3.21 As the landscape of the AONB contains large blocks of ancient woodland, many areas of registered common land, RPG, National Trust properties and National Trails, and given the statutory national designation, this landscape is of national value.

Sensitivity

- 2.3.22 Given that the landscape condition is good, the tranquillity is medium, and the character is of national value, the resulting sensitivity to change of the AONB is considered to be high.

Future baseline

- 2.3.23 Developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme, are listed in Volume 5: Appendix CT-004-000. Except where noted otherwise in Appendix CT-004-000, it has been assumed that these committed developments will have been completed by 2017.
- 2.3.24 For the purpose of this assessment, relevant committed developments comprise developments that have the potential to affect the landscape character and special landscape qualities of the AONB within the wider corridor of the Proposed Scheme. These developments are shown on Map LV-13 (Volume 5, Landscape and Visual Assessment Map Book for CFA 8, 9 and 10)¹².

Construction (2017)

- 2.3.25 Two committed developments are located just beyond the southern boundary of the AONB in the vicinity of the Proposed Scheme and include a development comprising 198 new dwellings within the urban area of Chalfont St Peter (CFA8/4) and the redevelopment of a site to provide community care at the eastern edge of Chalfont St Peter (CFA8/8). These projects are located in the context of existing development and the setting of the AONB to the south will not be discernibly altered.
- 2.3.26 Three committed developments are located within the Misbourne Valley within the AONB and include a residential development comprising 264 dwellings adjacent to Buckinghamshire New University (CFA8/11) east of Chalfont St Giles, a Waste Transfer Station on London Road south of Amersham (CFA8/13), and the redevelopment of the Chiltern Way Federation (CFA10/1) within Wendover. Whilst the introduction of these developments in the AONB will result in the slight loss of existing vegetation and farmland, this will not be of a sufficient scale to appreciably alter the character, natural beauty and special landscape qualities of the AONB.
- 2.3.27 An additional committed development is located just beyond the northern boundary of the AONB in the vicinity of the Proposed Scheme, which comprises a dairy complex in the vicinity of the settlement of Buckland (11/00965/AOP Dairy Complex). This

¹² One development, 11/00965/AOP Dairy Complex, is not included within Appendix CT-004-000. However, in the interests of providing a robust assessment, it has been deemed appropriate to be considered as part of the future baseline for the AONB.

committed development is located in the context of existing development and the setting of the AONB to the north will not be discernibly altered.

Operation (2026)

- 2.3.28 By 2026, landscape mitigation proposals established as part of the relevant committed developments identified will have matured, although they will not discernibly alter the character, natural beauty, special landscape qualities or setting of the AONB.

2.4 Description of the Proposed Scheme

- 2.4.1 The Proposed Scheme will pass through the AONB between Chalfont St Giles and Wendover, a distance of over 20km. The Proposed Scheme will be in tunnel (the Chiltern tunnel) for 9.6km between Chalfont St. Peter and Hyde Heath. Within the AONB, the Chiltern tunnel will be served by vent shafts proposed at Chalfont St Giles, Amersham and Little Missenden. Auto-transformer stations will be located adjacent to the vent shafts at Chalfont St Giles and Little Missenden.
- 2.4.2 Beyond the Chiltern tunnel north portal, the Proposed Scheme will comprise the following features as it runs northwards:
- the Chiltern tunnel north cutting (1.4km);
 - the South Heath green tunnel (1.2km);
 - the South Heath cutting (3.1km) including the adjacent Hunt's Green Farm sustainable placement area¹³, for the permanent storage of approximately 1,000,000m³ of surplus excavated material approximately 5m high, 1.3km long and up to 450m wide (as described in Volume 2, CFA report 10, Section 2.2);
 - the Wendover Dean viaduct and adjacent earthworks (1.2km overall, including the approximately 500m long viaduct);
 - the Small Dean viaduct and adjacent earthworks (2.1km overall, including the approximately 500m long viaduct);
 - the Wendover green tunnel (1.3km); and
 - the Wendover north cutting which crosses the northern edge of the AONB after approximately 1km.
- 2.4.3 Further details of the elements previously outlined are provided in Volume 2, CFA reports 8, 9 and 10, Section 2.

2.5 Temporary effects arising during construction

- 2.5.1 The following section outlines the likely temporary effects which will arise as a result of the Proposed Scheme during construction.

¹³ This feature is to allow on-site placement of compatible materials from the South Heath cutting directly onto adjacent farmland to avoid the environmental impacts that would otherwise occur as a result of the transportation of that material via the road network through the Chiltern Hills. The material will be regraded and integrated into the landscape and returned to agricultural use.

- 2.5.2 Building and preparing the railway for operation will comprise the following general stages:
- advance works, including: site investigations further to those already undertaken; preliminary mitigation works; preliminary enabling works;
 - civil engineering works, including: establishment of construction compounds; site preparation and enabling works; main earthworks and structure works; site restoration;
 - railway installation works, including: establishment of construction compounds; infrastructure installation; connections to utilities; changes to the existing rail network; and
 - system testing and commissioning.
- 2.5.3 As is commonplace with major infrastructure works, the scale of the construction activities means that works will be visible in many locations and will have the potential to give rise to significant temporary effects which cannot be mitigated practicably. Such effects are temporary and vary over the construction period depending on the intensity and scale of the works at the time. The assessment of landscape and visual effects has been based on the activities occurring during the peak construction phase, which is defined as the period during which the civil engineering works will take place, including establishment of compounds, tunnelling, main earthworks, structure works and works at vent shafts.
- 2.5.4 Main engineering works in the AONB will be undertaken between the start of 2017 and the end of 2022, with rail systems installation commencing in 2023. Construction compounds associated with construction within the AONB will include:
- the Chiltern tunnel main construction compound, which will be located to the south of the M25 and outside the AONB, will be in place for approximately five and a half years during the civil engineering works phase. The construction of the Chiltern tunnel under the AONB, including handling of the material from the Chiltern tunnel, will be managed from this compound;
 - the Small Dean viaduct main construction compound, which will be located at Small Dean (near Wendover) and will be in place for approximately four years during the civil engineering works phase; and
 - other satellite compounds, covering both civil engineering and rail systems installation work, located within the AONB for particular aspects of the construction.
- 2.5.5 The civil engineering works at most individual sites along the Proposed Scheme within the AONB will occur for a period of between approximately two and three years, although as noted previously the Chiltern tunnel main construction compound which is located outside the AONB, will be in place for approximately six years. Effects during other phases of works are likely to be less due to less construction equipment being required and a reduced intensity of construction activity.

- 2.5.6 Details of construction activities and duration at specific locations within the AONB are contained in Volume 2, CFA 8, 9 and 10, Section 2. The construction details are illustrated on Maps CT-05-023 to CT-05-040 (Volume 2, CFA 8, 9 and 10 Map Books).

Avoidance and mitigation measures

- 2.5.7 Measures that have been incorporated into the draft Code of Construction Practice (CoCP) (Volume 5: Appendix CT-003-000) to avoid or reduce landscape effects during construction include the retention and protection of existing trees and vegetation where reasonably practicable. Account has been taken of these measures in the assessment of construction effects.
- 2.5.8 With the exception of the three vent shafts and the northern portal of the Chiltern tunnel, the construction of the bored tunnel will avoid disturbance to existing vegetation and other landscape features.
- 2.5.9 These measures have been taken into account in the assessment of the construction effects on the natural beauty and special landscape qualities of the AONB.

Description of impacts

Overview

- 2.5.10 The most apparent changes to the special landscape qualities and landscape character of the AONB will arise from the temporary presence of construction plant, temporary worksites and site compounds, the demolition of properties, the removal of existing landscape features, the reduction in tranquillity, the temporary disruption to the PRow network and areas of access land, and the emergence of new earthworks and structures in the landscape. Other notable changes will also arise as a result of earthworks which will bring about changes to the local topography, including the area of sustainable placement.
- 2.5.11 Impacts will largely be limited to the north-west extent of the Misbourne Valley within the AONB, although impacts on the setting of the AONB will arise from construction in the Aylesbury Vale to the north-west. A detailed assessment of the effects on individual landscape character areas within the AONB is provided in Volume 2, CFA Report 8, 9 and 10, Section 9. The impacts on the special landscape qualities of the AONB during construction are described in this section.

Steep chalk escarpment

- 2.5.12 The presence of construction plant will affect the setting of parts of the steep chalk escarpment, particularly within the characteristic long distance views from Coombe Hill, Bacombe Hill and Boddington Hill. From these elevated locations, construction activity will be visible against a backdrop of the extensively settled Aylesbury Vale to the north-west. In addition, the presence of construction plant at the Wendover Dean and Small Dean viaducts in the Misbourne Valley will be noticeable from Bacombe Hill. However, much of the setting of the steep chalk escarpment will remain largely unaffected by the Proposed Scheme.

Flower-rich downland

- 2.5.13 The construction of the Proposed Scheme will not require the removal of areas of flower-rich downland. However, construction activities will be visible from isolated open areas on the chalk escarpment featuring flower-rich downland, such as that at Coombe Hill and Bacombe Hill. The setting of these distinctive areas, being accessible to the public, will be temporarily affected during construction.

Woodlands

- 2.5.14 Construction activities will result in the removal of approximately 15ha of woodland, of which approximately 10.2ha is defined as ancient woodland. Principal woodland losses include approximately 6.2ha (31%) at Mantle's Wood, 0.5ha (15%) at Farthings Wood, 3ha (33%) at Hedgemoor Wood, 2.5ha (31%) at Sibley's Coppice and 1ha (57%) at Jones' Hill Wood. Although these losses represent a small proportion (less than 0.1%) of the woodland in the AONB, they are nonetheless a characteristic feature and, in the case of ancient woodland, irreplaceable. The combination of these woodland losses, in particular the ancient woodland (approximately 1% of the total ancient woodland in the AONB) and the severance of Mantle's Wood, will noticeably alter the character of the Misbourne Valley. However, these losses will not be perceived beyond the confines of the valley due to the enclosed nature of the valley and widespread presence of intervening vegetation. Furthermore, the overall wooded character of the AONB will remain as one of the key characteristics, and the overall change will be imperceptible in the majority of locations.

Commons, heaths and greens

- 2.5.15 The construction of the Proposed Scheme will not cause loss of common areas, heaths or greens within the AONB. The setting of these areas will also be largely unaffected, as intervening vegetation and built-form will visually screen construction activities along the Proposed Scheme.

Historic settlement and environment

- 2.5.16 Construction activities and earthworks along the Proposed Scheme will result in vegetation losses and severance of historic field patterns. In particular, the South Heath cutting construction activities will result in the removal of up to 150m of the Grim's Ditch scheduled monument and associated mature vegetation, substantially altering this feature in the landscape. Furthermore, sunken lanes at Leather Lane and Bowood Lane will be realigned, resulting in the removal of additional historic features from the landscape.
- 2.5.17 Several properties will be demolished to facilitate construction of the Proposed Scheme, including at Hyde Lane, Chesham Road, Kings Lane and Frith Hill, Mulberry Park Hill off Potter Row, Durham Farm in the vicinity of Wendover Dean, Road Barn Farm in the vicinity of Small Dean and properties on Ellesborough Road. The remaining properties along Hyde Lane will be separated by the cutting from this once-secluded hamlet. The setting of areas of settlement (such as at Amersham Old Town, South Heath and Wendover) in the vicinity of the Proposed Scheme will also be perceptibly impacted by the presence of additional vehicle movements in the landscape associated with the construction phase.

- 2.5.18 Construction activities will also be perceptible within specific locations of the grounds of the Shardeloes RPG within the AONB. The temporary alteration to the setting of Shardeloes during construction will be noticeable, although it will be in the context of the location of the vent shaft construction activities adjacent to the existing transport network. Construction activity will not be perceptible from Missenden Abbey due to intervening topography and vegetation.
- 2.5.19 Overall, the loss of these historic landscape features and properties and the impact of vehicular movements will be limited to the Misbourne Valley and will not be perceived over the wider AONB; therefore the impact on the historic settlement and environment will be limited.

Network of PRow and ancient routes

- 2.5.20 The construction of the Proposed Scheme will necessitate the temporary and permanent realignment of a number of PRow. These realignments will noticeably affect the recreational value of the AONB landscape in the immediate vicinity of the Proposed Scheme. In particular, the temporary realignment of the Icknield Way Path and the Ridgeway National Trail south-west of Wendover will represent a change within the historic fabric of the landscape. Visual effects on users of PRow during construction are described in Volume 2, CFA reports 8, 9 and 10, Section 9; however these will be localised in nature and will not occur outside the Misbourne Valley. During the construction phase, in some instances, PRow will require a temporary diversion which will result in a temporary disruption to access. The longest temporary diversion will occur at PRow Bridleway WEN/57 at Small Dean, with an approximate additional length of 2.2km for a period of approximately six to nine months; however, access will be maintained.

Chalk streams

- 2.5.21 The construction of the Proposed Scheme will not directly impact the chalk streams within the AONB in landscape terms, although construction activity associated with the Little Missenden vent shaft will be perceptible from a PRow following the course of the River Misbourne. Whilst this will locally affect enjoyment of this landscape feature, the overall character of chalk streams will remain unchanged.

Tranquil valleys

- 2.5.22 Construction activity at the Chalfont St Giles vent shaft will be apparent on the setting of a small secluded and tranquil valley fold to the north-west of Chalfont St Giles. In addition, the character of a dry valley coombe in the vicinity of Wendover Dean, located at distance from the A413 in the valley bottom, will also be affected by the presence of construction activities associated with the Wendover Dean viaduct. Given the generally enclosed nature of these tranquil valleys, the impact from construction activity will be largely limited to the immediate folds in the landscape, although the activity at Wendover Dean will be perceived over a wider area due to the scale of the construction activities taking place. The majority of tranquil valleys in the AONB, including in the areas considered to have the highest levels of tranquillity, will be unaffected.

Farmland

2.5.23 Construction activities will result in the temporary removal or severance of approximately 4km² (400ha) of agricultural land and the removal of approximately 40km of hedgerow vegetation with associated mature trees. In particular, the construction activities associated with the Hunt's Green Farm sustainable placement area will result in the temporary severance and loss of use of approximately 37ha of agricultural land pending reinstatement for a future return to agricultural use. However, overall this represents a small proportion of the farmland and hedgerow vegetation within the AONB and, as such, the changes will be at a slight variance with this special quality.

Assessment of effects during construction

2.5.24 Overall, the construction activity will substantially but temporarily alter the character and appearance of the landscape in the immediate vicinity of the Proposed Scheme to the north of the Chiltern tunnel. Construction activity will be apparent and audible from the areas of open farmland in the immediate vicinity of the Proposed Scheme and visible from some of the ridge tops and elevated areas overlooking the Misbourne Valley. In particular, construction activities along the eastern side of the valley stretching from South Heath towards Kingsash will be apparent from the upper slopes of the western side of the valley. The intensive activities associated with the Wendover green tunnel will be apparent from Ellesborough Road and the elevated escarpment at Coombe Hill, Bacombe Hill and Boddington Hill. Localised impacts will also be apparent in the farmland adjacent to the proposed vent shafts locations.

2.5.25 The key impacts on the landscape of the AONB during construction will include:

- the removal of woodland including 10.2ha of ancient woodland (including 6.2ha at Mantle's Wood, 0.5ha at Farthings Wood, 2.5ha at Sibley's Coppice and 1ha at Jones' Hill Wood), substantially altering the character of parts of the Misbourne Valley but only slightly altering the overall wooded character of the AONB;
- the loss and severance of agricultural land, including the loss of mature hedgerows, locally altering the rural agricultural character; and
- the removal of small areas of historic sunken laneways at Bowood Lane and Leather Lane, and a section of Grim's Ditch scheduled monument.

2.5.26 Those areas of the AONB with a high level of tranquillity will not be noticeably affected by the construction of the Proposed Scheme due to their distance from the Proposed Scheme, with the exception of the localised impact in the vicinity of the hidden fold in the landscape at Wendover Dean. Areas of low and medium tranquillity closer to the Proposed Scheme will be temporarily affected by the presence and operation of construction plant, construction activity and construction traffic. This is not considered likely to give rise to a substantial effect on tranquillity.

2.5.27 The changes in the immediate vicinity of the Proposed Scheme will be at considerable variance with the landscape character and special landscape qualities of the AONB, resulting in substantial local impacts and a major adverse effect locally (see Volume 2, CFA reports 8, 9 and 10, Section 9) during the peak construction phase.

2.5.28 However, given that changes to the character and appearance of the landscape will be temporary and limited to the landscape in the vicinity of the Misbourne Valley, the magnitude of change to the AONB is considered to be medium. The medium magnitude of change, assessed alongside the high sensitivity of the AONB, will result in a moderate adverse effect on the AONB during construction.

2.5.29 The assessment of effects has been based on the activities occurring during the peak construction phase, which is defined as the period during which the main civil engineering works will take place, including establishment of compounds, main earthworks and structure works. Effects during other phases of works are likely to be reduced due to less construction equipment being required at the time and a reduced intensity of construction activity.

2.6 Permanent effects arising during operation

2.6.1 The following section outlines the likely permanent effects which will arise as a result of the Proposed Scheme during operation.

Avoidance and mitigation measures

2.6.2 The operational assessment of impacts and effects is based on year 1 (2026), year 15 (2041) and year 60 (2086) of the Proposed Scheme. A process of iterative design and assessment has been employed to avoid or reduce adverse effects during the operational phase of the Proposed Scheme. Measures that have been incorporated into the design are documented in Volume 2, CFA reports 8, 9 and 10, Section 9; and those of particular relevance to the wider landscape assessment of the AONB include:

- an approximately 9.6km long bored tunnel for the southern portion of the Proposed Scheme within the AONB, with only vent shafts and associated infrastructure visible above ground;
- two green tunnels (total length 2.5km), allowing the reinstatement of the landscape above the Proposed Scheme adjacent to the South Heath and Wendover communities;
- presence of the majority of the remainder of the Proposed Scheme in cutting north of the Chiltern tunnel;
- the use of earthworks to integrate the Proposed Scheme into the landscape through the AONB, providing visual screening and noise attenuation;
- integration of embankment landforms into the natural topography, including earthworks associated with road diversions, and road and pedestrian bridges;
- the reinstatement and introduction of hedgerow planting to reconnect severed lengths of hedgerows and to break up the linear alignment of the Proposed Scheme, integrating it into existing vegetation patterns;
- the use of approximately 50ha of planting to replace areas of lost woodland and to introduce new areas of woodland to break up the linear alignment of the Proposed Scheme, integrating it into the existing vegetation patterns; and

- the use of approximately 0.5ha planting and sensitive earthworks design to replicate the alignment of the Grim's Ditch scheduled monument, establishing a link to the historic landscape and integrating the Proposed Scheme into the landscape.

Description of impacts

Overview

- 2.6.3 Approximately 3km² (300ha) of the landscape of the AONB (less than 0.5%) will be altered as a result of the surface changes associated with the Proposed Scheme during operation, through the introduction of rail infrastructure, highway infrastructure, balancing ponds and the Hunt's Green Farm sustainable placement area. However, in many instances, earthworks will be returned to agriculture, including those at the sustainable placement area, and will be indiscernible from the existing landscape. The most apparent changes to the character of the AONB include:
- the presence of new engineered landforms cutting across the eastern side of the Misbourne Valley towards the Aylesbury Vale, east of the A413 and Marylebone to Aylesbury Line;
 - the presence of two new viaducts of approximately 18m and 12m in height and 500m each in length with associated infrastructure;
 - the presence of noise fence barriers that will create man-made linear features;
 - the permanent severance of land;
 - the presence of new highway infrastructure in the rural environment, including road bridges;
 - the presence of overhead line equipment;
 - the presence of regular high speed trains; and
 - the noticeable loss of vegetation, in particular at Mantle's Wood, Sibley's Coppice and Jones' Hill Wood, opening up the landscape and altering the vegetation pattern.
- 2.6.4 These impacts will be limited to the Misbourne Valley, with much of the wider AONB largely unaffected. An assessment of effects on landscape character areas identified within the AONB is provided in Volume 2, CFA reports 8, 9 and 10, Section 9. The impacts on the special landscape qualities and natural beauty of the AONB during operation are described in this section.

Steep chalk escarpment

- 2.6.5 During year one of operation there will be indirect impacts on the setting of parts of the steep chalk escarpment due to the visibility of the Proposed Scheme in the lower-lying landscape. However, in the characteristic long-distance views where the Proposed Scheme will be visible, such as from Coombe Hill, Bacombe Hill and Boddington Hill, it will be seen against a backdrop of the Aylesbury Vale, which features existing settlement, transport corridors and infrastructure routes. The majority of the wider setting of the distinctive chalk escarpment will be unaffected. A

description of effects on these specific views is presented in Volume 2, CFA reports 8, 9 and 10, Section 9.

- 2.6.6 By year 15 of operation and beyond to year 60 of operation, the Proposed Scheme will be further integrated into the lower-lying landscape as a result of the maturing of established vegetation and mitigation planting. Visibility of the Proposed Scheme from the elevated landscape framing the Misbourne Valley will be reduced, and will be seen in the context of a landscape containing existing infrastructure development on the valley bottom against a backdrop of unaltered hillsides.

Flower-rich downland

- 2.6.7 During year one of operation there will be a minimal impact on the setting of the landscapes on the chalk escarpment, which feature areas of flower-rich downland, mainly in the vicinity of Coombe Hill and Bacombe Hill. The presence of the Proposed Scheme in the setting of these limited areas will be at slight variance with the character of this special quality. Overall, the impact on the character of the flower-rich downland within the AONB will be barely perceptible in year one of operation.
- 2.6.8 By year 15 of operation and beyond to year 60 of operation, the Proposed Scheme will be better integrated into the landscape through the maturity of established planting. Visibility of the Proposed Scheme will be reduced compared to year 1 of operation as a result of the maturing planting. Therefore, the Proposed Scheme will not perceptibly alter the character of the flower-rich downland by year 15 and beyond to year 60 of operation.

Woodlands

- 2.6.9 During year one of operation, the loss of areas of woodland, in particular that at Sibley's Coppice, Mantle's Wood and Jones' Hill Wood, will still be apparent in the Misbourne Valley, as the newly established mitigation planting will be immature. As a result of these vegetation losses, localised areas in the landscape will be less enclosed, affording more open views across the wider landscape. The valley will retain its generally farmed character, interspersed with areas of woodland; however, the loss of ancient woodland (approximately 10.8ha) will result in changes to the existing vegetation pattern thereby altering the historic landscape and character of the valley. The alteration in woodland cover will not be perceived beyond the landscape in the vicinity of the Misbourne Valley.
- 2.6.10 By year 15 of operation, the woodland planting mitigation (comprising approximately 50ha) will have begun to mature and will better integrate the Proposed Scheme into the Misbourne Valley in the vicinity of Mantle's Wood (at the site of the Chiltern tunnel north portal and northern approach cutting) and in the vicinity of the South Heath green tunnel and cutting. Additional areas of woodland and hedgerow mitigation planting, including that at Leather Lane and Bowood Lane, will provide visual screening of the Proposed Scheme from the wider valley landscape. This planting will introduce a new vegetation pattern, which will break up a perceived linearity of the Proposed Scheme and will resemble the character of vegetation patterns in the surrounding landscape. The extent and location of woodland losses will be less

apparent in the Misbourne Valley during year 15 of operation and will not be perceived further afield.

- 2.6.11 By year 60 of operation, the woodland planting will have matured to a greater extent, which will further integrate the Proposed Scheme into the local landscape and will reinforce the wooded farmland character of the AONB. The matured planting will screen views towards the Proposed Scheme and supplement the existing woodland characteristics of the AONB, albeit resulting in an altered vegetation pattern adjacent to the Proposed Scheme.

Commons, heaths and greens

- 2.6.12 During year one of operation, there will be no impact on commons, heaths or greens within the AONB. Any change in views towards the Proposed Scheme from these areas within the AONB, for example at South Heath, will be barely perceptible, being almost entirely obscured by the intervening vegetation and built-form.
- 2.6.13 There will be no impacts on the commons, heaths and greens within the AONB at years 15 and 60 of operation.

Settlement and historic environment

- 2.6.14 During year one of operation, the setting of settlements such as South Heath, Hyde Heath and Wendover will be affected as new highway infrastructure, in combination with the noticeable absence of buildings demolished during the construction phase, will be apparent in the vicinity of the green tunnels. In these areas there will also be a permanent alteration in the natural landform, with tunnel portals also visible in the landscape. In the vicinity of Wendover Dean and Kingsash, the presence of the Proposed Scheme, including passing high speed trains and overhead line equipment, will also noticeably alter the setting of these settled areas. The impact on villages and on properties built in the local style of brick and flint will be limited to the landscape in the vicinity of the Misbourne Valley and will not be perceived over the wider AONB. The loss of several brick and flint properties will also be apparent, though the effect of these losses will be highly localised. The absence of a section of the Grim's Ditch scheduled monument will still be apparent, as at this stage the proposed planting will not mitigate the impact on the historic landscape character. The wider severance of hedgerows and the historic field pattern will also be apparent as reinstated planting will not yet be mature and the landscape pattern will be altered as a result of the presence of the Proposed Scheme. In addition, the loss of ancient woodland and the presence of the Proposed Scheme will partially alter the composition of the landscape in the vicinity of the Misbourne Valley and further erode the historic landscape. The Proposed Scheme will not alter the setting of Shardeloes RPG, nor will it have an impact on the setting of the Missenden Abbey RPG.
- 2.6.15 By year 15 of operation, the reinstated hedgerows will have matured, reinforcing the historic field patterns present in the landscape, although these will still be severed by the Proposed Scheme in places.
- 2.6.16 By year 60 of operation, planting proposals will have matured and will better integrate the Proposed Scheme into the landscape, partially screening views from areas of settlement and individual properties. The planting in the vicinity of the Grim's Ditch scheduled monument will have matured and will aid the understanding of the historic

landscape at this location. However, the partial loss of this feature where severed by the route of the Proposed Scheme will remain apparent.

Network of PRow and ancient routes

- 2.6.17 During year one of operation, there will be impacts on a number of PRow and ancient routes. In particular, evidence of the sunken laneway partial realignments associated with the construction phase will be apparent at Bowood Lane and Leather Lane. Visibility of the Proposed Scheme from many of the ancient routes will also occur, including from notable routes such as the Ridgeway National Trail and the Icknield Way Path south-west of Wendover. This will affect the recreational value of the AONB landscape in the immediate vicinity of these PRow. However, these views will be transient and intermittent in nature and will often be partially screened by intervening vegetation. Visual effects on users of PRow during operation are described in Volume 2, CFA reports 8, 9 and 10, Section 9. Visual effects from PRow will not occur beyond the Misbourne Valley. The longest permanent diversion will occur at PRow Footpath GMI/13 with an approximate additional length of 750m near Great Missenden; however the extent of access by PRow will be maintained.
- 2.6.18 By year 15 of operation and beyond to year 60 of operation, the direct impact on the network of ancient routes will remain the same as in year one of operation. However, the indirect impacts on PRow, through visibility of the Proposed Scheme, will be reduced due to the increased screening effect of maturing planting associated with the Proposed Scheme.

Chalk streams

- 2.6.19 During year one of operation, there will be no impacts on chalk streams within the AONB. Whilst the setting and recreational value of the River Misbourne and adjacent PRow will be affected to a limited extent by the presence of the Proposed Scheme through visibility of the Little Missenden vent shaft, the character of the chalk stream landscape will remain largely unaltered.
- 2.6.20 During year 15 of operation and beyond to year 60 of operation, visibility of the Proposed Scheme will likely be reduced due to the screening effect of maturing planting. There will be no landscape impact on the chalk streams within the AONB.

Tranquil valleys

- 2.6.21 During year one of operation, the presence of and visibility of new structures associated with the Proposed Scheme, including passing high speed trains, will have impacts on the setting of a small number of the tranquil hidden folds within the AONB. The local reductions in tranquillity in these areas will lead to substantial impacts on the character of this special quality. In the vicinity of the Chalfont St Giles vent shaft, the presence of a new structure will alter the perception in the valley. In the vicinity of the Chiltern tunnel north portal and the Wendover Dean viaduct, the presence of new structures and passing high speed trains, will impact these hidden folds in the landscape. Given the nature of these tranquil valleys, these impacts will generally be localised and will only occur in a small number of areas. An exception to this however, is the change which will occur within the vicinity of Wendover Dean where the influence of the Wendover Dean viaduct will extend across much of the

northern part of the Misbourne Valley due to the scale of this newly introduced structure. Tranquil valleys in the wider AONB, outside of the Misbourne Valley, will remain unaltered.

- 2.6.22 By year 15 of operation and beyond to year 60 of operation, impacts from the Proposed Scheme on the tranquil valleys will likely be reduced due to the screening effect of maturing planting, restricting visibility of elements of the Proposed Scheme.

Farmland

- 2.6.23 During year one of operation, farmland and hedgerow vegetation reinstated following the construction phase will still be immature and will contribute little to the characteristic farmland of the AONB. There will be a loss of approximately 1.8km² (180ha) of farmland, although this will largely only be discernible at a local level, with the existing wooded farmland character retained in the valley. In addition, some of the farmland lost during operation will be as a result of areas of new planting. In the context of the wider AONB, the impact on farmland biodiversity during year one of operation will be limited.
- 2.6.24 By year 15 of operation and beyond to year 60 of operation, approximately 2.2km² (220ha) of reinstated farmland will have taken on an appearance similar to that formerly present in the landscape. Hedgerow vegetation will have matured, replicating the existing character of farmland in the AONB. Newly introduced wooded areas will also complement the existing landscape mosaic and provide a habitat for wildlife. Although there will be a loss of farmland as a result of the Proposed Scheme, the impact on farmland biodiversity will be limited and localised in nature. Although evident locally, the loss of farmland will not be perceived across the wider AONB.

Assessment of effects during operation

- 2.6.25 Impacts arising during year 1 of operation of the Proposed Scheme will be limited to the landscape in the vicinity of the Misbourne Valley. In the immediate vicinity of the Proposed Scheme, they will be at variance with the existing character and will discernibly alter the special landscape qualities, natural beauty, pockets of tranquillity, landscape character and setting of the AONB, resulting in a major adverse effect locally during year one of operation. These local effects are described for individual landscape character areas within the AONB in Volume 2, CFA reports 8, 9 and 10, Section 9.
- 2.6.26 Whilst the mitigation earthworks and planting will serve to integrate the Proposed Scheme into the landscape, remaining impacts on the special landscape qualities and natural beauty of the landscape will be associated with highly visible structures including viaducts and the changes to the existing vegetation pattern.
- 2.6.27 The specific impacts on the special landscape qualities and landscape character of the AONB during operation will include:
- the presence of new infrastructure along the Proposed Scheme including viaducts, tunnel portals, road and pedestrian overbridges, noise fence barriers, fencing, high speed trains and overhead line equipment; affecting the character of the landscape in the vicinity of the Misbourne Valley and the setting of the chalk escarpment, flower rich downland and localised tranquil

valleys;

- the noticeable absence of woodland including 10.2ha of ancient woodland as a result of vegetation removal during the construction phase, substantially altering the character of parts of the Misbourne Valley but only slightly altering the overall wooded character of the AONB. In year one, new planting will be immature and provide minimal mitigation for this loss. However, by year 15 and more noticeably by year 60, this planting will largely mitigate this loss of woodland character;
- the loss and severance of agricultural land including the loss of mature hedgerows, locally altering the rural agricultural character. In year one of operation, mitigation planting will be immature and provide minimal contribution to the character of the landscape. However, by year 15 and beyond to year 60, this planting will have matured thereby largely reinstating these lost features of the rural agricultural landscape; and
- the permanent loss of small areas of historic sunken laneways and a section of Grim's Ditch scheduled monument.

2.6.28 Whilst the presence of the Proposed Scheme will substantially alter the character of the landscape in the immediate vicinity of the Proposed Scheme, impacts on the special landscape qualities and natural beauty of the AONB have been avoided and reduced where practicable through the implementation of mitigation measures. However, direct and indirect impacts will remain.

2.6.29 Taking into account the partial alteration to the special landscape qualities in one of the valleys within the AONB and the permanent alterations to landscape character and natural beauty, the magnitude of change is considered to be medium.

2.6.30 The medium magnitude of change, assessed alongside the high sensitivity of the AONB, will result in a moderate adverse effect during year one of operation, which is considered to be significant.

2.6.31 By year 15 of operation, planting proposals will have matured and will further integrate the Proposed Scheme into the landscape, including the planting adjacent to Mantle's Wood, reinstatement of hedgerows and planting along the alignment of Grim's Ditch. The 2.2km² (220ha) of reinstated farmland, representing 55% of the agricultural land temporarily lost during construction, will also have taken on a similar appearance to that formerly present in the landscape. Although the impacts of the Proposed Scheme on the special landscape qualities, natural beauty and landscape character of the AONB will be reduced, the reduction in impact will not be of a sufficient scale to alter the overall assessment findings. Therefore, a moderate adverse effect will remain in year 15 of operation, which is considered to be significant.

2.6.32 By year 60 of operation, the mitigation planting will have matured to a greater extent and will further integrate the Proposed Scheme into the AONB. In particular, the woodland planting will reinforce the existing character and special landscape qualities of the AONB and; although there will be a net loss of farmland and direct impacts on

ancient woodland, local style properties and sunken laneways; this will only be perceived at a local scale largely within the Misbourne Valley. A moderate adverse effect will be experienced locally during year 60 of operation. Some wider impacts on the setting of special landscape qualities of the AONB will also remain, such as visibility of the Proposed Scheme from the steep chalk escarpment, which will discernibly alter the setting of this special quality in localised areas within the Misbourne Valley.

- 2.6.33 Taking into account the above, the effects of the Proposed Scheme on the special landscape qualities, natural beauty and landscape character and setting of the wider AONB during year 60 of operation will reduce such that it is not considered to be significant.

3 Agriculture, forestry and soils

3.1 Introduction

- 3.1.1 This section provides an assessment of the route-wide impacts and likely significant effects on agriculture, forestry and soils arising from the construction of the Proposed Scheme. Since it is considered that during operation there will be no effects that become significant through accumulation across the Proposed Scheme, this is not considered further.
- 3.1.2 At the national level, paragraph 109 of the NPPF 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.
- 3.1.3 Paragraph 112 of the NPPF states 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. Where significant development of agricultural land is demonstrated to be necessary, poorer quality land in Grades 3b, 4 and 5 should be used in preference to higher quality land.
- 3.1.4 Efforts have been made (particularly during the HS2 London to the West Midlands Appraisal of Sustainability (AoS) process¹⁴) in selecting the route alignment to avoid the highest quality agricultural land, but this has not always been possible given the need to satisfy or balance a number of other important environmental and engineering considerations.

3.2 Assessment of effects during construction

- 3.2.1 The agricultural land required for the Proposed Scheme and its construction will amount to approximately 4,800ha, of which approximately 2,500ha (52%) will be the BMV agricultural land in Grade 2 and Subgrade 3a, and 2,300ha (48%) will be poorer quality land in Subgrade 3b and Grade 4. The Proposed Scheme will not affect Grade 1 (excellent quality) land or, at the other end of the scale, Grade 5 (very poor quality) land.
- 3.2.2 Adopting the methodology employed in Volume 2, CFA reports 1-26, Section 3 to establish the significance of the effect of the requirement for BMV land, would place BMV land as a resource of medium sensitivity (with 42% of farmland in England estimated to be of this quality) that would be subject to an impact of medium magnitude (with 52% of the land required being BMV), giving rise to a moderate adverse effect. Whilst the temporary requirement for about 2,500ha of BMV agricultural land during the construction phase will be significant, it represents a very small percentage (about 0.07%) of the BMV agricultural land in England.

¹⁴ Booz & Co. Temple (2011), *HS2 London to the West Midlands Appraisal of Sustainability, Volume 1: Main Report*.

- 3.2.3 Following construction, the land required temporarily will be primarily reinstated to its pre-existing agricultural condition by following good practice guidance on the sustainable use of soils, as set out in the draft CoCP (Volume 5: Appendix CT-003-000). 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. It is estimated that there will not be any significant surplus of the displaced agricultural topsoil or subsoil material arising from the Proposed Scheme.
- 3.2.4 Following construction and restoration to agricultural land, the area of land that will remain permanently removed from agricultural use will be approximately 2,800ha, of which 1,500ha (or 54%) will be BMV land in Grades 2 and 3a, and 1,300ha (46%) in Subgrade 3b and Grade 4.
- 3.2.5 Whilst the permanent requirement for BMV agricultural land represents a very small percentage (approximately 0.04%) of the BMV agricultural land in England, it will be an impact of medium magnitude on a resource of medium sensitivity, giving rise to a moderate adverse effect which is significant in the context of the Proposed Scheme.
- 3.2.6 The residual permanent requirement for all grades of agricultural land for the construction of the Proposed Scheme is likely to represent about 0.03% of the utilised agricultural land in England.
- 3.2.7 An area of approximately 250ha of forestry land will be permanently removed but will be offset by the replanting of approximately 650ha of woodland for landscape mitigation and ecological habitat creation or replacement.

¹⁵ Defra (2011), *The Natural Choice: securing the value of nature*.

4 Air quality

4.1 Assessment of effects during construction

- 4.1.1 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. 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. Construction dust can be carried a few hundred metres from construction sites. Whilst dust generation from HS2 sites will be strictly controlled by application of best practice measures set out in the draft CoCP (Volume 5: Appendix CT-003-000). The result will be that significant effects from dust should not occur at properties and other receptors outside the construction sites.
- 4.1.2 The emissions from fixed sources and vehicle movements on 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 effects on air quality will generally be negligible.
- 4.1.3 Construction traffic and changes in the volume and location of traffic on the highway network will result in impacts further from the construction sites (up to a few tens of kilometres away). The geographic extent of these impacts is assessed within Volume 2, CFA reports 1-26, Section 4; and there are no significant route-wide effects. Consequently, there will be no significant air quality effects on a route-wide basis associated with construction of the Proposed Scheme.

4.2 Assessment of effects during operation

- 4.2.1 There will be no route-wide air quality impacts arising directly from the operation of the trains. There are minor emissions from some stations and other buildings arising from heating plant and other activities, but these will have only local effects.
- 4.2.2 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 at some locations along the route as recorded within the relevant Volume 2, CFA reports, Section 4. The traffic changes on the road network have been screened and assessed in these specific locations where a significant local air quality effect is possible.
- 4.2.3 The Department for Transport (DfT) has provided estimates of grammes of NO_x emissions per passenger kilometre (pkm) in 2030 as follows: intercity rail¹⁶ (0.180); all domestic flights (0.749); domestic flights to/from London (0.605); inter-urban car journeys (0.140). HS2 is predicted to have lower emission rates than each of these at 0.031g NO_x per pkm, the emission being from the power stations supplying the electricity grid.

¹⁶ 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.

5 Climate

5.1 Summary

- 5.1.1 This section presents the assessment of the GHG emissions¹⁷ of the Proposed Scheme during construction and operation. This issue was considered in detail in the AoS of Phase One, where a range for the carbon footprint was presented¹⁸. This assessment updates and refines the GHG assessment with design, operation and travel demand information.
- 5.1.2 A bespoke carbon model has been developed for the GHG assessment of the Proposed Scheme. In developing the approach to the assessment, which is set out in the SMR Addendum (Volume 5: Appendix CT-001-000/2), the GHG assessment referred to national and international standards and guidance¹⁹. In addition, benchmarking has been used to provide context for the carbon footprint.
- 5.1.3 Furthermore, the assessment approach has been informed by wider policy context including the Climate Change Act 2008²⁰, which sets a target for at least an 80% reduction in 1990 levels of carbon dioxide (CO₂) emissions by 2050, and the European Union Emissions Trading System (EU ETS), which covers most of the Proposed Scheme's emissions.
- 5.1.4 The Proposed Scheme includes use by two types of service: those operating between London and Birmingham using standard European-sized high speed trains (referred to as 'captive' trains), and those running between London and destinations north of the West Midlands, using specially designed high speed trains that are also capable of running on the existing UK rail network (referred to as 'classic compatible' trains). The GHG assessment is based upon 252.5km of track, as it includes sidings. The assessment is based on the following sources from the Proposed Scheme (see Figure 6 and Figure 7):
- construction - embedded emissions in construction materials, associated construction activities (such as site energy use and movements of excavated material) and land use change/clearance;
 - operational - electricity from the National Grid used to power the Proposed Scheme's trains, stations and tunnel fans;
 - modal shift of passengers during operation - the Proposed Scheme will attract users from road, the classic network and aviation;
 - surface access during operation - new journeys to access the Proposed Scheme's stations;

¹⁷ The term emissions can be associated with the release of GHGs from the burning of fossil fuels to generate electricity to drive the train sets in the operation of the Proposed Scheme; or the release of GHGs in the manufacture of materials for construction such as steel or cement known as embedded emissions in the construction of the Proposed Scheme.

¹⁸ Booz & Co. Temple (2011), *HS2 London to the West Midlands Appraisal of Sustainability, Volume 1: Main Report*.

¹⁹ For example, World Resources Institute (WRI), Greenhouse gas protocol; <http://www.ghgprotocol.org/>; Accessed: 24 September 2013; and the European Commission's Report Integrating Climate Change and Biodiversity into Environmental Impact Assessment (2013); <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf>; Accessed 11 September 2013.

²⁰ HM Government, (2008), *Climate Change Act 2008*. The Stationery Office Limited.

- modal shift of freight during operation - released capacity on the classic network will allow additional freight to move from road to rail; and
 - carbon sequestration - from planting 2 million trees.
- 5.1.5 The assessment covers the construction period (2017-2026) and 60 years (2026-2085)²¹ of operation, although the design life of the Proposed Scheme is 120 years. The 60-year operational assessment period is consistent with the assessment period used in the Economic Case for HS2²².
- 5.1.6 An assessment covering such a long timescale requires a number of assumptions to be made, including: the rate of replacement of fossil fuel electricity generation with low-carbon generation capacity, the ability of the steel and cement industries to implement greater efficiencies, the rate of uptake of electric cars and changes in aviation policy around fuels and airport capacity. Consequently, the carbon footprint is presented as a range to take account of these uncertainties. This range is represented by two scenarios based largely on projections for the replacement of fossil fuel electricity generation with low-carbon alternative electricity generation and electric vehicle uptake forecasts. Scenario A uses many of the same assumptions that are used by, and reflected in, the Economic Case for HS2. Scenario B uses assumptions contained within the Fourth Carbon Budget²³ produced by the Committee on Climate Change (CoCC).
- 5.1.7 The key assumptions adopted to calculate the carbon footprint of the Proposed Scheme are set out in Table 5, Section 5.8, and Volume 5: Appendix CL-002-000. HS2 Ltd cannot directly influence all of these assumptions (see Figure 8) as many are dependent on commercial decisions and Government policy²⁴. Volume 5: Appendix CL-002-000 also includes a list of what is not included in the carbon footprint of the Proposed Scheme.
- 5.1.8 The results of the operational carbon footprint of the key components of the Proposed Scheme are summarised in Table 1.
- 5.1.9 Table 1 shows that there is a large carbon saving associated with the operation of the Proposed Scheme. The Proposed Scheme represents one of the lowest carbon transport solutions compared to other modes such as road, air and classic rail (network average). Based on projected carbon emissions in 2030²⁵, the Proposed Scheme has lower emissions per passenger kilometre (8gCO₂e/pkm) than interurban cars (67gCO₂e/pkm); intercity rail²⁶ (22gCO₂e/pkm) and UK domestic flights (170gCO₂e/pkm).

²¹ Six months of testing the trains is not included.

²² HS2 Ltd (2013), *The Economic Case for HS2*.

²³ Committee on Climate Change, (2010), *The Fourth Carbon Budget. Reducing emissions through the 2020s*; <http://www.theccc.org.uk/publication/the-fourth-carbon-budget-reducing-emissions-through-the-2020s-2/>; Accessed: 1 October 2013.

²⁴ Such as Government policy on aviation.

²⁵ Comparisons based on Department for Transport estimates for HS2 Ltd.

²⁶ 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.

Table 1. The Proposed Scheme's carbon footprint by scenario (tonnes of carbon dioxide equivalent (tCO₂e))

	Scenario A (tCO ₂ e)	Scenario B (tCO ₂ e)
Operational emissions	2,800,000	1,750,000
Mode shift ²⁷	-3,200,000	-2,340,000
Freight uptake of released capacity	-2,070,000	-2,070,000
Tree planting	-500,000	-500,000
Total	-2,970,000	-3,160,000

- 5.1.10 There are also potential secondary carbon benefits that arise from the construction of a wholly new rail transport scheme such as HS2. Since the Proposed Scheme would increase the total carrying capacity of the rail transport system, it would provide a means to free up capacity on existing rail networks. If this 'released capacity' can then be used to transfer freight or passenger traffic from higher-carbon modes (such as road or aviation) to the existing rail network, a further carbon benefit arises. This benefit is unlikely to arise from alternative rail schemes that add no significant new strategic capacity.
- 5.1.11 The construction carbon footprint is calculated to be a range between 5,300,000 and 6,460,000 tCO₂e, assuming that the construction industry is able to implement its research on carbon efficiency (5,300,000 tCO₂e) and assuming no improvement from 2013 in the efficiency of the manufacture of materials such as steel and their use in construction (6,460,000 tCO₂e) (see Section 5.5). A central figure based on likely improvements by 2020 is estimated to be 5,590,000 tCO₂e; and has been used in the preparation of a total carbon footprint for scenario A, whereas the lower figure of 5,300,000 is used for scenario B.
- 5.1.12 A significant proportion of the construction footprint is associated with the construction of earthworks, bridges, viaducts, tunnels and underpasses; some of which help to mitigate other significant environmental impacts, such as noise and visual amenity. The adopted approach to carbon minimisation is to promote opportunities to reduce the carbon footprint of the Proposed Scheme through appropriate design and procurement practices.
- 5.1.13 Phase Two of HS2 is planned to extend the high speed line to Leeds and Manchester from 2033 and derive further carbon benefits from the Phase One lines.
- 5.1.14 The total carbon footprint of the Proposed Scheme over the 60 year assessment period is between 2,140,000 tCO₂e and 2,620,000 tCO₂e²⁸. If the same assumptions are applied across the Proposed Scheme's 120 year design life, the total carbon footprint is between 360,000 and 230,000 tCO₂e.
- 5.1.15 As a comparison to the carbon footprint of the Proposed Scheme, the construction footprint of a hypothetical new motorway between London and the West Midlands to

²⁷ The surface access component of the mode shift operation footprint is 372,000 tCO₂e for scenario A and 74,000 tCO₂e for scenario B

²⁸ This includes emissions from construction and operation as well as all mitigating factors such as modal shift, tree planting and freight benefits from released capacity on the classic network. Figures in the report have been rounded.

carry the same amount of people is estimated to be slightly smaller, but within the same range as that predicted in the earlier Phase One AoS. The operational footprint, however, would be significantly larger, ranging between 23 and 25 million tCO₂e over the 60 year appraisal period (see Volume 5: Appendix CL-002-000 for more details on assumptions).

- 5.1.16 Compared to the UK's projected carbon footprint in 2030, the Proposed Scheme's total carbon emissions represent a very small proportion of the UK's total annual emissions (0.15%). In addition, the Proposed Scheme's operational emissions will represent only 2% of the UK's current operational rail emissions.
- 5.1.17 The EU ETS is a European cap-and-trade system with a decreasing cap over time. It provides a significant policy tool for implementing the UK's Carbon Plan²⁹. The emissions of the UK's electricity generation sector used to power the Proposed Scheme will be regulated by the EU ETS, as will EU cement and steel industries, which are likely to be used in the construction of the Proposed Scheme. The emissions associated with the carbon footprint of the Proposed Scheme will therefore be largely regulated through the EU ETS. This means that, overall, most of the Proposed Scheme's carbon emissions will not contribute to an increase in Europe-wide carbon emissions.
- 5.1.18 Additionally, GHG 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 be taken on the Proposed Scheme through mode shift, will become tradable within the EU ETS cap.
- 5.1.19 GHG 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 carbon emissions both in the traded and non-traded sectors by implementation of its Sustainability Policy (see Volume 1, Section 1.5).
- 5.1.20 The structure of this GHG assessment is as follows. Section 5.2 sets the context for the assessment. Section 5.3 highlights the policy context for reducing carbon emissions and the associated potential role of the transport sector. Section 5.4 presents the scope of the assessment and the limitations associated with creating a baseline. The results of the carbon modelling are presented in Section 5.5, in the form of two carbon footprints for the construction and operation of the Proposed Scheme. Section 5.6 presents a discussion of the possible significance of the total carbon footprint (construction and operation). The conclusions of the assessment are presented in Section 5.7.

5.2 Introduction

- 5.2.1 This section presents the approach, context and results of the GHG assessment of the Proposed Scheme. The assessment presents the GHG emissions in the form of the 'carbon footprint' (see Box 1 for further information) of the Proposed Scheme and a

²⁹ HM Government, (2011), The Carbon Plan: Delivering our Low Carbon Future; <https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2>; Accessed 11 September 2011.

discussion of its potential significance. This matter was considered in the AoS for Phase One³⁰, where a range for the carbon footprint was presented. This section presents an update to the AoS and refines the carbon footprint based on design, operation and travel demand information available³¹.

- 5.2.2 The GHG assessment includes the calculation of emissions associated with the construction, operation and maintenance of the Proposed Scheme for 60 years from scheme opening (as advised by the Department for Transport's (DfT) Transport Analysis Guidance). It includes land use and land use change factors (as detailed in the SMR Addendum in Volume 5: Appendix CT-001-000/2). An assessment is also made of the carbon footprint for the 120 year design life of the Proposed Scheme.
- 5.2.3 Figure 6 and Figure 7 set out the key sources of emissions within the assessment of the construction and operation of the Proposed Scheme respectively.
- 5.2.4 Figure 6 shows the sources of construction emissions which include (from left to right):
- embedded carbon in the extraction and processing of raw materials;
 - energy use in construction processes, such as vehicles delivering building materials to the site;
 - site clearance and land use change;
 - waste from site, recycling and landfill gas emissions; and
 - worker commuting.

Figure 6: Emissions associated with the construction phase of the Proposed Scheme



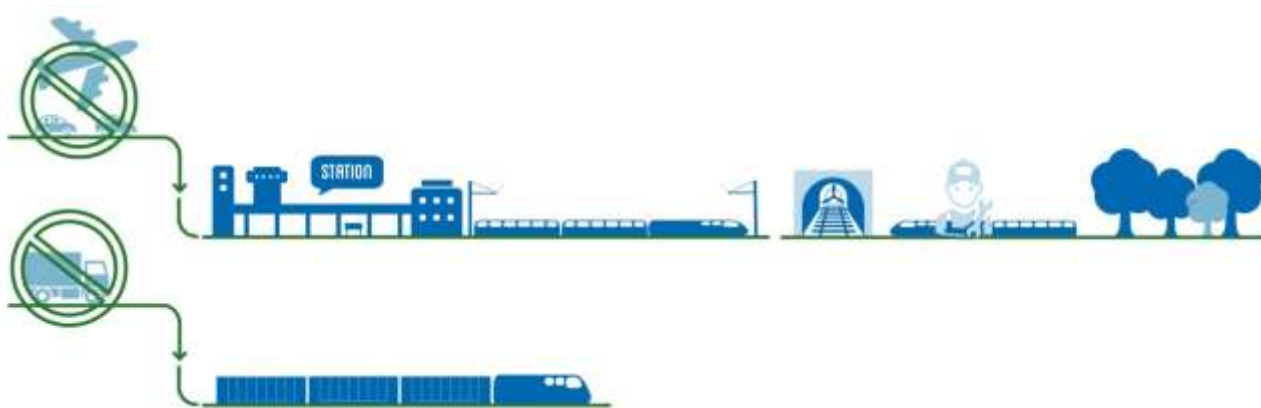
- 5.2.5 Figure 7 shows the operational emissions which will arise from the Proposed Scheme. The operational emissions include consideration of:
- modal shift of passengers onto the Proposed Scheme or released capacity on the classic rail network;
 - modal shift of freight onto the classic rail network also due to released capacity;
 - direct emissions from trains, stations and interchanges;

³⁰ Booz & Co. Temple, (Feb 2011), *HS2 London to the West Midlands Appraisal of Sustainability – Appendix 2: Greenhouse gas emissions*.

³¹ Details of the data used are contained in Volume 5: Appendix CL-002-000.

- tunnel fan operation;
- maintenance, which includes embedded emissions in replacement parts and energy consumption in routine activities (such as cleaning); and
- tree planting carbon sequestration benefits.

Figure 7: Emissions associated with the operational phase of the Proposed Scheme



- 5.2.6 The carbon footprint is reported as metric tonnes of CO₂ equivalent (see Box 1). Where assumptions have been used in the prediction of the footprint, such as estimating the potential benefits of growth in rail freight from released capacity on the classic network, the assessment has adopted a conservative approach. The key assumptions used to create the carbon footprint are presented in Table 5 in Section 5.8 and Volume 5: Appendix CL-002-000.
- 5.2.7 The carbon footprint assesses the change in emissions between a scenario 'with the Proposed Scheme' and a scenario 'without the Proposed Scheme'. Both scenarios include same committed transport schemes, such as further electrification of the classic network. These schemes on their own do not provide a step change in transport infrastructure capacity between London, the West Midlands and beyond.
- 5.2.8 To assist in understanding the scale of the carbon footprint of the Proposed Scheme, an approximate carbon footprint of a hypothetical new motorway has been prepared, which would be able to deliver the same capacity as HS2.

Greenhouse gas emissions

- 5.2.9 The International Organisation for Standardization (ISO) defines a GHG as a "Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds"³².
- 5.2.10 There are six GHG covered by the Climate Change Act 2008:
- carbon dioxide (CO₂);
 - methane (CH₄);

³²ISO 14064 Greenhouse Gas Accounting and Verification is concerned with quantifying, monitoring, reporting and verifying greenhouse gas emissions; http://www.iso.org/iso/catalogue_detail?csnumber=38381; Accessed: 11 September 2013.

- nitrous oxide (N₂O);
- hydrofluorocarbons (HFC);
- perfluorocarbons (PFC); and
- sulphur hexafluoride (SF₆).

5.2.11 The GHG emissions of the Proposed Scheme are reported in tCO₂e, where data is available, which standardises the six GHGs listed above into one index based on CO₂. In practical terms, emissions from construction and operation of the Proposed Scheme will mostly be CO₂ with some CH₄.

Box 1: GHG and carbon footprinting

GHG emissions result from both human activities and natural processes. The main contributions from human activities arise from the combustion of fossil fuels for energy generation and transportation. Some industrial processes and land use changes also produce emissions. The Proposed Scheme will result in the emission of GHG, principally CO₂, through construction and operational activities, including the manufacture and transport of construction materials and operation and maintenance of the railway over its lifetime, among other sources.

The GHG emissions resulting from the Proposed Scheme are presented as a **carbon footprint**. A carbon footprint is the total GHG emissions associated with a particular scheme, policy or development. The GHG emissions are converted into tCO₂e which standardises the global warming potential of the six GHG regulated under the Kyoto protocol (see Section 5.3.3 for more information) into one index based on the global warming potential of CO₂. For the Proposed Scheme, the carbon footprint has been created by combining the units of quantity of materials, distance and land area with the appropriate emission factors, and then subtracting the benefits of emission reductions due to modal shift from road and air onto the Proposed Scheme, carbon sequestration associated with tree planting and benefits from released capacity on the classic network allowing additional freight to move from road to rail.

The **GHG assessment** involves an analysis and discussion of the potential significance of the carbon footprint of the Proposed Scheme.

5.3 Climate change policies and greenhouse gas targets

International

5.3.1 The latest Intergovernmental Panel on Climate Change Assessment Report (AR5)³³ was published on the 27th September 2013. It strengthened its statement on human-induced climate change from being 90% certain in the last assessment report in 2007, to 95% certain in AR5. It now also states that it is extremely likely that humans have

³³ IPCC Working Group 1, (2013), *Summary for Policy Makers*; http://www.climatechange2013.org/images/uploads/WGIAR5-SPM_Approved_27Sep2013.pdf; Accessed: 30 September 2013.

been the dominant cause of observed warming since the mid-20th century. AR5 states that atmospheric CO₂ has increased by 40% to 391 parts per million (ppm) (2011) since pre-industrial times.

- 5.3.2 The United Nations Framework Convention on Climate Change (UNFCCC) (1992) established an overall framework for intergovernmental efforts to address global climate change.
- 5.3.3 The Kyoto Protocol to the UNFCCC, adopted in 1997, provided legally binding limits on GHG emissions for 37 Annex 1 countries³⁴ originally up until 2012. Recent negotiations at the 18th Conference of the Parties (COP) of the UNFCCC in Doha on the future of international cooperation on climate change have resulted in the European Union (EU), Australia, Switzerland and Norway agreeing to a second commitment period of the Kyoto Protocol from January 2013 to the end of 2020. The EU's current pledge of a 20% cut in emissions from 1990 levels by 2020 under the Protocol may be extended to 30%³⁵. It was agreed at COP 17 (Durban, 2011) that a new international treaty³⁶ will come into force after 2020.

Europe

- 5.3.4 The EU ETS is an EU-wide cap-and-trade mechanism whereby a total amount of allowable annual GHG emissions for electricity generation, large energy-intensive industries (such as steel and aluminium production) and commercial flights to and from the EU and the three European Economic Area European Free Trade Association states (Norway, Lichtenstein and Iceland) has been agreed at the EU level. This will also include Croatia from January 2014³⁷. Those installations covered by the cap are allowed to trade emission allowances³⁸ with one another. Owners of the affected installations can also buy limited amounts of international credits from emission-saving projects around the world through a scheme known as the Clean Development Mechanism.
- 5.3.5 The emissions cap for 2013 from power stations and other activities covered by the EU ETS (excluding aviation) is set provisionally at 2,039,152,882 allowances³⁹ (tCO₂e). In each subsequent year after 2013, the total number of allowances issued will decrease by 1.74% of the average number of allowances issued between 2008 and 2012. This will mean that each year there will be an absolute reduction of 37,435,387 allowances. This will result in there being 21% less emissions (within the cap) in 2020 than in 2005.

³⁴Annex I Parties include the industrialised countries that were members of the Organisation for Economic Co-operation and Development in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States; http://unfccc.int/parties_and_observers/items/2704.php; Accessed: 11 November 2013.

³⁵ UNFCCC Appendix I - Quantified economy-wide emissions targets for 2020; http://unfccc.int/meetings/copenhagen_dec_2009/items/5264.php; Accessed: 11 November 2013.

³⁶ This new comprehensive international treaty is to be negotiated no later than 2015. <https://www.gov.uk/government/policies/taking-international-action-to-mitigate-climate-change/supporting-pages/negotiating-for-a-comprehensive-global-climate-change-agreement>; Accessed: 11 November 2013.

³⁷In October 2013 the International Civil Aviation Organization Assembly agreed to develop a global market based mechanism by 2016 to address international aviation emissions and apply it by 2020. To give momentum to global discussions the European Commission has proposed amendments to the EU ETS including: from 1 January 2014 emissions taking place within EEA airspace from flights to and from countries outside the EEA would be covered; http://ec.europa.eu/clima/policies/transport/aviation/index_en.htm; Accessed: 22 October 2013.

³⁸One allowance equals one tonne of CO₂e allowances can either be allocated freely or auctioned by governments; <https://www.gov.uk/eu-ets-carbon-markets>; Accessed: 22 October 2013.

³⁹ European Commission, *Allowances and Caps*; http://ec.europa.eu/clima/policies/ets/cap/index_en.htm; Accessed: 11 November 2013.

The annual reduction in the cap is set to continue after 2020, but will be revised before the end of 2025.

- 5.3.6 The current price of allowances is very low due to slower economic growth in the EU leading to lower demand, combined with member states largely allocating allowances at zero cost rather than auctioning them. In order to address the exceptionally low price of allowances, the European Parliament's Environment Committee has adopted a position called 'backloading' which involves postponing the auctioning of new allowances by one year (2014-2015). This should reduce some of the supply and thus slightly increase the price. This proposal was approved by the European Parliament in July 2013. Talks with the European Council have now been opened to progress the implementation of the backloading proposal⁴⁰.
- 5.3.7 The European Commission has issued pilot guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment⁴¹ to improve the systematic integration of both biodiversity and climate change within EIA. It states that the direct GHG emissions from construction, operation and perhaps decommissioning should be considered, as well as from land use, land-use change and forestry. Indirect impacts might include increased energy demand, supporting infrastructure/activities and personal travel and freight transport.
- 5.3.8 The 2011 White Paper Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system⁴², 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

The Climate Change Act

- 5.3.9 The Climate Change Act 2008⁴³ establishes a framework for the UK to achieve its long-term goals of reducing GHG emissions by at least 80% from 1990 levels by 2050 and to ensure that steps are taken towards adapting to the impact of climate change. An interim target of 34% reduction from 1990 by 2020 has also been agreed.

⁴⁰ European Commission, *Structural reform of the European carbon market*; http://ec.europa.eu/clima/policies/ets/reform/index_en.htm; Accessed: 11 September 2013.

⁴¹ European Commission, (2013), *Integrating Climate Change and Biodiversity into Environmental Impact Assessment*; <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf>; Accessed: 11 September 2013.

⁴² European Commission, (2011), *White Paper Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52011DC0144:EN:NOT>; Accessed: 11 November 2013.

⁴³ Her Majesty's Stationery Office, (2008), *Climate Change Act 2008*, London.

The Carbon Plan

5.3.10 The Carbon Plan (2011)⁴⁴ sets out the Government's plans for achieving the GHG emissions reductions committed to in the Climate Change Act and the first four carbon budgets. Low carbon transport is an essential part of the Carbon Plan. The Plan states that rail travel will become substantially decarbonised through increasing electrification and the use of more efficient trains and lower carbon fuels. The Plan also mentions that the high speed rail network being developed by HS2 "will transform rail capacity and connectivity to promote long term and sustainable economic growth". Furthermore, the Plan notes that further electrification of the rail network will support low carbon modal shift in the future. In addition, the freight sector will have found lower carbon ways of working, such as modal shift to rail and water.

5.3.11 In 2011 (the latest figures available), the UK's progress against its Climate Change Act targets was a reduction of 29.1% (i.e. 549,200,000 tCO₂e) from 1990 levels excluding the effects of emissions trading⁴⁵. In terms of overall UK emissions, transport accounted for 134,800,000 tCO₂e (25%) and rail for 4,400,000 tCO₂e (less than 1%).

The Fourth Carbon Budget

5.3.12 Carbon budgets were introduced as part of the Climate Change Act 2008. The first four, five-year budgets have been set in law from 2008-2027. The budgets are split into traded and non-traded carbon. A limit on UK carbon emissions is imposed for each five-year period. The budgets are prepared by the CoCC who were set up under the Climate Change Act as an independent evidenced advisory body to the UK Government and parliament. The Fourth Carbon Budget (2010) was accepted by parliament and covers the period 2023-2027, which includes the Proposed Scheme's opening year (2026). The key recommendations for this budget include:

- the need for the UK to be on a pathway to at least an 80% cut in GHG below 1990 levels by 2050, with maximum 2050 emissions of 160,000,000 tCO₂e; and
- by 2025, annual UK emissions should be reduced to around 390,000,000 tCO₂e (a 50% reduction relative to baseline levels).

5.3.13 Although domestic aviation and shipping emissions are included in the budget, international aviation and shipping are currently not.

5.3.14 The Government legislated for the fourth budget in June 2011 with a budget for 2023-27 of 1,950,000,000 tCO₂e.

5.3.15 In its supporting evidence for the Fourth Carbon Budget submission, the CoCC views HS2 as being an important part of the UK's low carbon transport strategy as it has the potential to replace domestic and short-haul aviation.

⁴⁴ HM Government, (2011), *The Carbon Plan: Delivering our Low Carbon Future*, <https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2>; Accessed: 11 September 2011.

⁴⁵ DECC, (2013), *2011 UK greenhouse gas emissions: Final figures*; <https://www.gov.uk/government/publications/final-uk-emissions-estimates>; Accessed: 11 November 2013.

Construction 2025 Industrial Strategy: government and industry in partnership

- 5.3.16 The Industrial Strategy⁴⁶ 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 GHG emissions in the built environment⁴⁷. 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.

5.4 Greenhouse gas assessment scope

- 5.4.1 Full details of the assessment scope and methodology are presented in the SMR Addendum, and details of the factors and assumptions used are included in Section 1.7, Table 1 of Volume 5: Appendix CL-002-000. Key assumptions are presented in Table 5.
- 5.4.2 The Proposed Scheme includes approximately 230km of railway (143 miles), to be used by two types of service, namely those operating between London and Birmingham using standard European-sized high speed trains (referred to as ‘captive’ trains); and those running between London and destinations north of the West Midlands, using specially designed high speed trains that are also capable of running on the existing UK rail network (referred to as ‘classic compatible’ trains). The assessment is based on the following sources from the Proposed Scheme (see Figure 6 and Figure 7):
- construction - embedded emissions in construction materials, associated construction activities (such as site energy use and movements of excavated material) and land use change/clearance;
 - operational - electricity from the national grid used to power the Proposed Scheme's trains, stations and tunnel fans;
 - modal shift of passengers during operation - the Proposed Scheme will attract users from road, the classic network and aviation;
 - surface access during operation - new journeys to access the Proposed Scheme's stations ;
 - modal shift of freight during operation - released capacity on the classic network will allow additional freight to move from road to rail; and
 - carbon sequestration - from planting two million trees.

⁴⁶ HM Government, (2013), *Construction 2025 Industrial Strategy: government and industry in partnership*; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf; Accessed: August 2013.

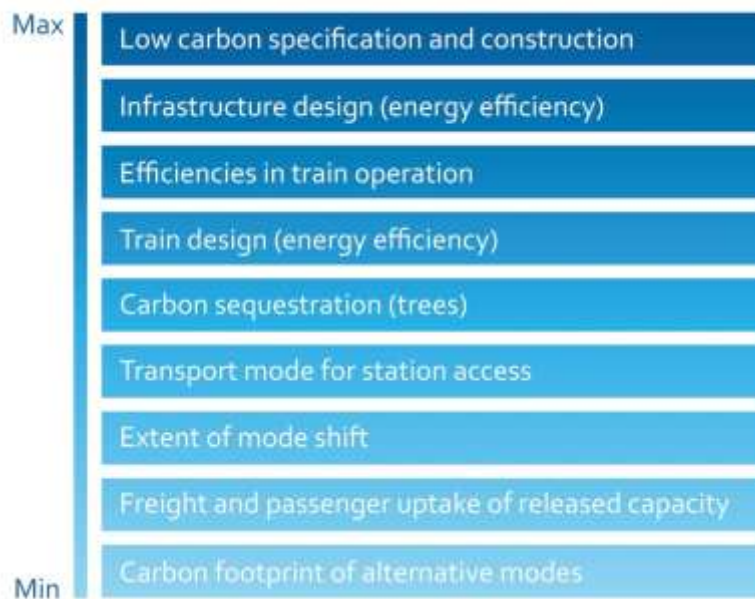
⁴⁷ Versus a 1990 baseline. This is set out in the Green Construction Board's Low Carbon Route map for the Built Environment (2013); <http://www.greenconstructionboard.org/otherdocs/Routemap%20ofinal%20report%2005032013.pdf>; Accessed: September 2013.

- 5.4.3 The assessment period covers 10 years of construction (2017–2026) and 60 years (2026–2085) of operation, although the design life of the Proposed Scheme is 120 years.
- 5.4.4 An assessment covering such a long timescale requires a number of assumptions to be made including 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, the rate of uptake of electric cars and changes in aviation policy around fuels and airport capacity. Consequently, the carbon footprint is presented as a range to take account of these uncertainties. In addition, consultations have been carried out with industry and Government to identify assumptions. This responds to the consultation on the draft ES, where a number of responses requested a single figure for the footprint or at least a reduction in the range of emissions reported in the AoS for Phase One. Volume 5: Appendix CL-002-000 includes a list of that which is not included in the carbon footprint of the Proposed Scheme.

HS2 Ltd's influence on the Proposed Scheme's carbon footprint

- 5.4.5 Figure 8 illustrates the varying degrees of HS2 Ltd's influence over each of the carbon footprint's contributing factors. Each factor has the potential to affect the Proposed Scheme's carbon footprint.
- 5.4.6 The factors at the top of the figure are those over which HS2 Ltd has direct influence, such as low carbon specification and construction. Those towards the middle are factors which are more likely to be influenced by Government policy and have a strong indirect impact on the carbon footprint of the Proposed Scheme, such as transport mode for station access. The bottom of the figure includes factors outside the direct influence of Government policy and HS2 Ltd, such as the carbon footprint of alternative transport modes. For example, the extent of modal shift is dependent on the attractiveness of the Proposed Scheme (within HS2 Ltd's direct control) and the attractiveness of alternative modes of travel (influenced both by Government policy and independent transport operator policies).

Figure 8: HS2 Ltd's degree of influence on factors affecting the Proposed Scheme's carbon footprint



Environmental baseline

- 5.4.7 An environmental baseline provides a reference point against which the impact of a new project can be compared. The environmental baseline for the construction of the Proposed Scheme is based on a 'without the Proposed Scheme' scenario (i.e. the Proposed Scheme is not built, so all the construction emissions are counted in the construction footprint). This approach is not an accurate reflection of reality, as without the Proposed Scheme some other transport infrastructure would be constructed to address the future predicted infrastructure capacity constraints. However, at the time of this assessment there was insufficient detailed data to calculate the construction carbon footprint of alternative infrastructure options⁴⁸. As a result, the construction carbon footprint as presented is an overestimate⁴⁹.
- 5.4.8 The calculation of the carbon emission reductions associated with the operation of the Proposed Scheme is based on the shift in travel patterns from other transport modes to the Proposed Scheme. The PLANET Framework Model⁵⁰, which is used to estimate this modal shift, does not model all trips with and without the Proposed Scheme; rather, it calculates only the difference between the Proposed Scheme and the without the Proposed Scheme scenario. In estimating the modal shift as a result of the Proposed Scheme, the model does account for anticipated future upgrades to the existing road and rail network⁵¹.

⁴⁸ DfT, (2012), *High Speed Alternatives Study: Update following consultation*; <https://www.gov.uk/government/publications/high-speed-rail-strategic-alternatives-study-update-following-consultation>; Accessed: 25 October 2013.

⁴⁹ The GHG assessment has created an artificial motorway alternative to help explore the significance of the Proposed Scheme carbon footprint.

⁵⁰ PLANET is a multimodal transport model which estimates the numbers of passengers that will use the Proposed Scheme.

⁵¹ Some of the other transport models held by DfT would theoretically be able to help develop a baseline of future trips without the Proposed Scheme, or DECC Energy Model projections could help develop a baseline level of transport CO₂ impact without the Proposed Scheme. However, these would not provide a baseline that would be directly comparable with the incremental impact estimated by the PLANET Framework Model. Hence, the aforementioned models have not been used in determining the future baseline for the operational assessment.

5.5 Carbon footprint

5.5.1 This section presents the carbon footprint of the Proposed Scheme. Since detailed design of the Proposed Scheme will continue after the submission of the hybrid Bill, certain detailed design data is not yet available. As such, the assessment is based on a number of assumptions. As previously discussed, there are a number of inherent uncertainties in preparing a carbon footprint based on the current data available and the influence of external factors.

5.5.2 The operation and construction phase carbon footprints of the Proposed Scheme, together with the different construction and operation scenarios, explore the potential range of the carbon footprint. This section also includes a summary of the carbon footprint of the Proposed Scheme taking into account both construction and operation, and including modal shift, tree planting and freight benefits from released capacity on the classic network.

Construction phase

5.5.3 The construction of any large infrastructure project will result in emissions of GHG. The European Commission⁵² acknowledges that mitigation measures can help to reduce GHG emissions, but may not result in the project having an overall positive impact on emissions. In terms of a transport project, as well as identifying material with lower embedded carbon and using appropriate sustainable design and construction principles, the extent to which construction emissions may be offset will be largely dependent on modal shift from more carbon intensive forms of transportation and the rate of decarbonisation of the grid, electric car uptake and freight released capacity.

5.5.4 The central estimate of the Proposed Scheme's construction carbon footprint is 5,590,000 tCO₂e. Figure 9 presents the breakdown of the Proposed Scheme's construction phase carbon footprint. The elements contributing the largest proportion to the embedded carbon footprint are the construction of tunnels including ancillary rail electrification and telecommunications equipment, tunnels, Tunnel Boring Machines (TBMs) and dive-unders (1,200,000 tCO₂e). In many cases, tunnels have been included in order to mitigate other significant environmental impacts such as noise and visual amenity.

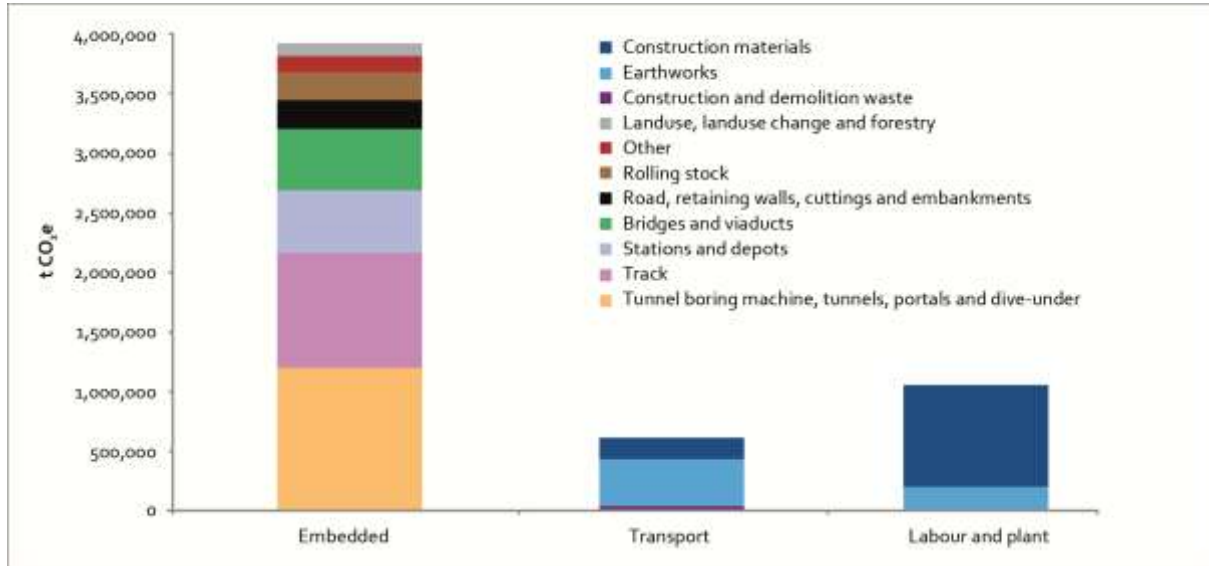
5.5.5 The next most carbon intensive element of the scheme is the track (970,000 tCO₂e) followed by bridges and viaducts (520,000 tCO₂e). For the purpose of this assessment, slab track rather than a more traditional ballast option has been assumed for the whole route as it has the largest amount of embedded carbon, although a final decision is yet to be made on this issue. Construction material transport emissions contribute 610,000 tCO₂e to the total construction emissions; and labour, plant and waste contribute 1,060,000 tCO₂e.

5.5.6 The structures in Figure 9 (and previously discussed) require significant quantities of steel and concrete. Consequently, reductions in the carbon intensity of concrete and

⁵² European Commission, (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment*; <http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf>; Accessed: 11 September 2013.

steel would have a significant impact on reducing the total construction carbon footprint. A sensitivity test has been conducted to explore the effect of procuring more carbon efficient concrete and steel on the carbon footprint.

Figure 9: The Proposed Scheme's construction emissions (tCO₂e) by element and scope



Concrete and Steel

5.5.7 In order to provide some understanding of the range of potential future construction footprints, the construction carbon footprint range has been based on three scenarios (namely, 2020 central, 2020 stretching and no change). The scenarios apply different carbon factors for concrete and steel as these materials are calculated to contribute approximately 80% of the total embedded construction emissions. The details of the three scenarios are as follows:

- 2020 central - this scenario, represented by the middle bar within Figure 10, is considered to represent the most likely scenario and is presented as the "central case" for the Proposed Scheme's construction footprint. This scenario is based on anticipated carbon reduction targets for concrete⁵³ and steel⁵⁴ that are likely to be achieved at the time of construction of the Proposed Scheme. The embedded carbon footprint for this scenario is 3,800,000 tCO₂e (note: total construction carbon footprint is 5,590,000 tCO₂e);
- 2020 stretching - this scenario, represented by the left-hand bar within Figure 10, presents the construction footprint based on future 'stretching' concrete and steel carbon factors derived from anticipated carbon reduction trajectories to achieve the UK 2050 carbon reduction target. Should these targets be achieved, this would result in an embedded construction carbon footprint of 3,540,000 tCO₂e and result in a reduction in the construction footprint of 260,000 tCO₂e compared to the 2020 central scenario (note: total

⁵³ MPA the Concrete Centre, (2012), *Concrete Industry Sustainability Performance Report - 5th report: 2011 performance data*; http://www.sustainableconcrete.org.uk/pdf/MB_Fifth_Concrete_Industry_Sustainability_Performance_Report_Final.pdf; Accessed: September 2013.

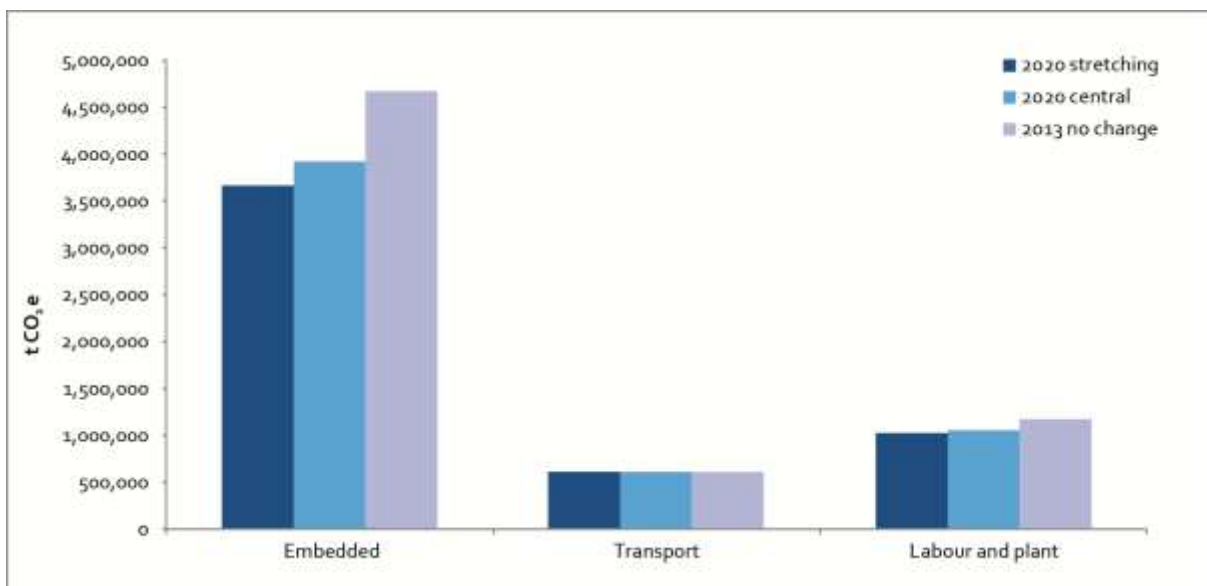
⁵⁴ Eurofer, (2012), *A steel roadmap for a low carbon Europe 2050*; <http://www.eurofer.org/News%26Media/PublicationsLinksList/2013-Roadmap.pdf>; Accessed: September 2013.

construction carbon footprint is 5,300,000 tCO₂e); and

- 2013 no change - this scenario, represented by the right-hand bar within Figure 10, presents the upper range of the construction carbon footprint of the Proposed Scheme and is based on known 2013 carbon factors. This scenario essentially presents a worst case and assumes there will be no carbon reduction improvements within the concrete and steel industries between the time of this assessment and construction of the Proposed Scheme. Applying these factors results in an embedded construction carbon footprint of 4,550,000 tCO₂e (note: total construction carbon footprint is 6,460,000 tCO₂e).

5.5.8 Consequently, the total construction carbon footprint up to 2026 (year one of operation) for the Proposed Scheme is calculated as being between 5,300,000 tCO₂e and 6,460,000 tCO₂e based on the stretching and no change (see Figure 10). See Table 5 in Section 5.8 for further information on the carbon factors applied for materials other than concrete and steel.

Figure 10: Construction emissions (tCO₂e) of the Proposed Scheme per scenario



Construction carbon efficiency opportunities

5.5.9 One of the themes of HS2 Ltd's Sustainability Policy is to "minimise the carbon footprint of HS2 as far as practicable". To help achieve this, HS2 Ltd has set up a low carbon focus group to explore sustainable construction options and to help define HS2 Ltd's design approach to ensure efficient delivery, innovation and the realisation of carbon savings. The low carbon focus group will also act as a forum for sharing good practice and lessons learnt.

5.5.10 The approach adopted with regards to carbon aims to minimise the carbon footprint of the Proposed Scheme as far as practicable. Specifically, 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, energy requirements of the Proposed Scheme will be reduced and energy efficiency of

operations will be maximised; low carbon energy, if practicable, will be used and/or generated. Further opportunities for efficiencies would include:

- increased use of recycled materials (particularly steel);
- use of less carbon-intensive concrete blends;
- improved design and construction of rolling stock to reduce weight where possible;
- maximum management and 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;
- adoption of construction workforce travel to reduce travel impact;
- maximisation of 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.

Operational phase

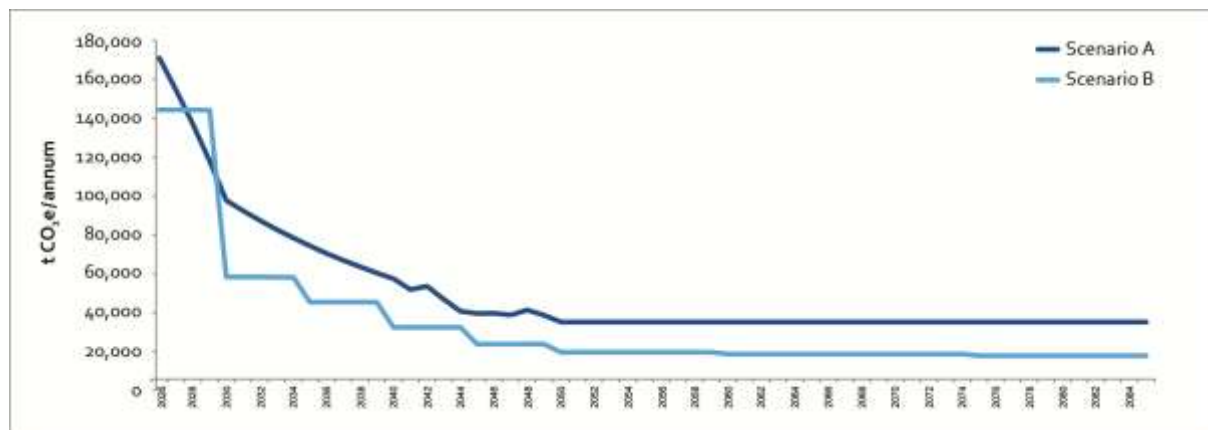
- 5.5.11 This section presents the emissions associated with the operation and maintenance phase of the Proposed Scheme including the likely reductions in operational emissions due to modal shift as a result of the Proposed Scheme. One of the key determinants of the operational carbon footprint of the Proposed Scheme is the rate and extent of replacement of fossil fuels with low carbon alternative electricity generation (the UK must achieve at least an 80% reduction in its emissions from 1990 levels due to the Climate Change Act, 2008). The Carbon Plan⁵⁵ also states that, by 2050, all power will be generated from either renewables, coal or gas fitted with carbon capture and storage, and nuclear power resulting in a power generation sector that has very low GHG emissions.
- 5.5.12 The CoCC has produced a projection of how the carbon intensity of the grid will reduce in the future in order to achieve the 2050 target set in the Climate Change Act. Guidance from DfT WebTAG also provides a projection of how fast fossil fuel based electricity generation capacity will be replaced before 2050 (otherwise known as grid decarbonisation) by 2050. The WebTAG projection is based on work undertaken by the Department of Energy and Climate Change (DECC) / Interdepartmental Analysis Group (IAG).
- 5.5.13 As the operational footprint is very sensitive to the projections for future electricity generation fuel sources and rates of electric car uptake, two scenarios have been prepared to show the possible range of the operational footprint based on two

⁵⁵ DECC, (2011), *The Carbon Plan*; <https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2>; Accessed: 11 September 2013.

different credible sources of projections (See Figure 11 for a graphic representation of these two scenarios):

- scenario A - uses many of the same assumptions that are used by, and reflected in, the Economic Case for HS2. It is based on grid emission factor and electric car uptake projections from DECC/IAG and WebTAG; and
- scenario B - based on grid emission factor and electric car uptake projections from the CoCC.

Figure 11: Projected annual operational emissions of the Proposed Scheme in tCO₂e/annum⁵⁶



5.5.14 Table 2 sets out the key components of the operational carbon footprint. Further information on assumptions can be found in Section 5.8 and Volume 5: Appendix CL-002-000.

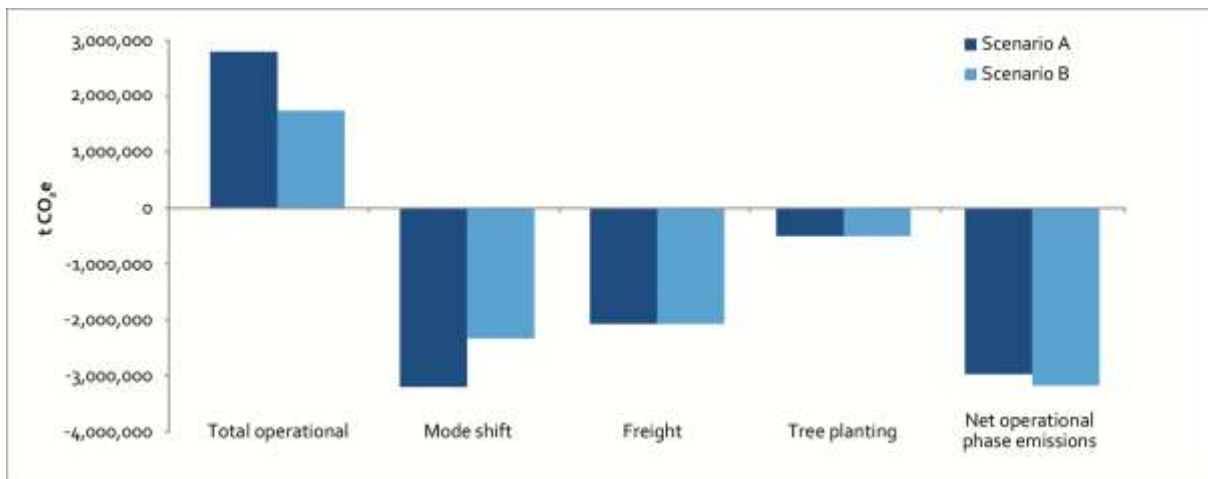
Table 2 Breakdown of the operational footprint for the Proposed Scheme (tCO₂e)

	Scenario A (tCO ₂ e)	Scenario B (tCO ₂ e)
Train operation	1,980,000	1,040,000
Train maintenance	290,000	280,000
Station operation	530,000	420,000
Tunnel fans	5,000	3,000
Tree planting	-500,000	-500,000
Mode shift ⁵⁷	-3,200,000	-2,340,000
Freight uptake of released capacity	-2,070,000	-2,070,000
Total net operational emissions	-2,970,000	-3,160,000

5.5.15 Figure 12 shows a breakdown of operational components and, in particular, the large contribution of passenger and freight modal shift to the total footprint.

⁵⁶ The calculation has been based on five-year averages which explain the step-like nature of the graph.

⁵⁷ The surface access component of the mode shift operation footprint is 372,000 tCO₂e for scenario A and 74,000 tCO₂e for scenario B.

Figure 12: Contribution of different components of the total operational footprint (tCO₂e)

- 5.5.16 The total operational carbon footprint associated with the operation and maintenance of the Proposed Scheme including mode shift, freight from released capacity and tree planting is -2,970,000 tCO₂e (scenario A) and -3,160,000 tCO₂e (scenario B) over the 60 year assessment period. This footprint includes emissions associated with: the generation of electricity for rolling stock operation; tunnel fan operation; station energy use as well as emissions associated with the maintenance of the rolling stock and emission reductions associated with the modal shift from more carbon intensive modes (such as aviation and car travel) to the Proposed Scheme.
- 5.5.17 The majority of emissions from the operation of the Proposed Scheme over the 60 year assessment period, based on the scenario A decarbonisation scenario, are the result of the energy consumption of the rolling stock (1,980,000 tCO₂e), followed by station operation (530,000 tCO₂e), rolling stock maintenance (290,000 tCO₂e) including embedded emissions of the rolling stock and general maintenance, and tunnel fan operation (5,000 tCO₂e).
- 5.5.18 The marginal grid emission factors have been chosen as they take account of the need for construction of new cleaner generating plant over the next 60 years⁵⁸. A sensitivity test with the alternative long run average factors (also contained within the DECC/IAG work), shows that there is a small difference of approximately 50,000 tCO₂e over 60 years.

Modal shift

- 5.5.19 Reductions in operational emissions due to modal shift and freight from released capacity as a result of the Proposed Scheme are calculated to be 5,270,000 tCO₂e (scenario A) over the 60 year assessment period. This equates to an average saving of 86,000 tCO₂e per annum from 2026 to 2036, and 88,000 tCO₂e per annum from 2036

⁵⁸ Grid emission factors are based on a yearly average and do not take account of differences in daily peaks. The Proposed Scheme will run during peak hours as well as off-peak hours. Any further refinement of daily and seasonal differences in grid emission factors are assumed to be unnecessary as the potential scale of difference and associated uncertainty over a 60 year period of how the generation mix may change is assumed to be within the margin of error.

to 2085⁵⁹. This is based on the following key data sources and assumptions (see Table 5, Section 5.7 and Table 3 of Volume 5: Appendix CL-002-000):

- the PLANET Framework Model which estimates the change in vehicle kilometres for classic rail, aviation and associated surface access modes (e.g. highway) for the with the Proposed Scheme and without the Proposed Scheme scenarios;
- passenger kilometre carbon factors for air travel are based on DfT TR13⁶⁰ Central scenario projections for London airports to 2050⁶¹. An uplift factor for radiative forcing, otherwise known as the non-CO₂ climate change effects of aviation (e.g. water vapour, contrails, nitrogen oxides (NO_x) etc.) has been applied to the carbon factors from TR13 to ensure its consistency with the Defra Company reporting guidelines⁶²;
- the percentage uptake of electric vehicles is based on the DECC/IAG and CoCC projections in scenario A and scenario B; and
- the increase of rail freight on the classic network due to released capacity on the WCML as passenger services on WCML are changed and passengers shift to the high speed alternative (see Table 5 for assumptions).

5.5.20 It should be noted that there are two factors outside of HS2 Ltd's direct influence (apart from the issue of grid decarbonisation considered in scenarios A and B) that potentially have the most significant impact on the operational carbon footprint:

- freight mode shift through released classic rail capacity; and
- the released capacity at airports.

5.5.21 These two factors are discussed in the following sections.

Freight and the released capacity on the classic network

5.5.22 While the PLANET Framework Model does not consider the Proposed Scheme's impact on freight, there is the potential for an increase in rail freight on the classic network due to released capacity resulting from the Proposed Scheme. According to Network Rail predictions⁶³, an average annual growth in rail freight of 5.5% is expected to 2033 in terms of the amount of weight transported and distance travelled (tonne kilometres).

5.5.23 Released capacity on the classic network is likely to occur because of changes in train services as passengers shift to the high speed alternative: the assumption for the Economic Case for HS2 is that the majority of these freed paths on the classic network

⁵⁹ The transport modelling for the economic case assumes that Phase One would reach capacity by 2037 and that from this date there would be no further increase in passenger numbers.

⁶⁰ DfT UK Aviation Forecasts, January 2013

⁶¹ DfT, (2013), *UK aviation forecasts 2013*; <https://www.gov.uk/government/publications/uk-aviation-forecasts-2013>; Accessed 30 September 2013.

⁶² Defra, (2013), Government GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224437/pb13988-emission-factor-methodology-130719.pdf ; Accessed: September 2013.

⁶³ Network Rail, (2013), *Long Term Planning Process: Freight Market Study Draft for Consultation*.

<http://www.networkrail.co.uk/improvements/planning-policies-and-plans/long-term-planning-process/market-studies/freight/>; Accessed September 2013.

will be used for passenger services. The data and assumptions used to estimate the released capacity for the carbon footprint assessment are presented in Table 5. In summary, there are at least 20 more freight paths between London and the West Midlands each day⁶⁴.

- 5.5.24 As well as the uncertainty associated with the assumptions over the number of freight paths, there are also a number of options associated with the selection of appropriate carbon factors. For example, research by the Chartered Institute of Logistics and Transport, and the Transport and Logistics University of Kühne⁶⁵ suggests that the conversion factors set out in Defra's company reporting guidelines may overestimate gross weight of freight and underestimate locomotive fuel efficiency. Within the current DECC/IAG factors, a difference arises when estimating the carbon benefits of released capacity using the tonne kilometre or fuel efficiency factors, with the latter resulting in less carbon savings from a shift of freight from road to rail⁶⁶.
- 5.5.25 The calculation of the released capacity benefits from freight presented here has largely relied upon more conservative assumptions such as 20 freight paths each day and favouring the DECC/IAG factors over the freight industry research (more freight paths may become available during the course of timetable development, and would provide further benefits). As data has been provided in tonne kilometres, this factor has been selected, rather than fuel efficiency. Consequently, the emissions savings associated with released capacity as a result of the Proposed Scheme over the 60 year assessment period are estimated to be 2,070,000 tCO₂e. However, it is recognised that additional freight paths may become available once the timetable has been finalised, which would provide further carbon benefits.

Released capacity and slot allocation at airports

- 5.5.26 The Phase One AoS reported a large range for the carbon footprint. Much of this uncertainty was due to whether the assessment should take account of liberated airport slots used for domestic flights at Heathrow as air passengers transfer to the Proposed Scheme, and the likelihood that this would bring about an increase in long-haul (more carbon emitting) flights. This GHG assessment has not included the emissions from additional long-haul flights associated with possible released capacity for three reasons:
- the reallocation of slots is a commercial matter, primarily for the airlines. Factors that might influence the future use of slots could include passenger demand, airport capacity issues, agreements with airport operators and other local commercial considerations at the time;
 - due to capacity shortages, short-haul and particularly domestic flights are

⁶⁴ Network Rail, (2007), *Freight Route Utilisation Strategy*;

<http://www.networkrail.co.uk/browse%20documents/rus%20documents/route%20utilisation%20strategies/freight/freight%20rus.pdf>; Accessed: 23 September 2013.

⁶⁵ Nick Gazzard and Alan McKinnon, (2013), *The use of weight impact modelling to derive carbon intensity factors for UK rail freight operations*. Logistics Research Network annual conference 2013

⁶⁶ Nick Gazzard and Alan McKinnon (2013) argue that rail freight tonne kilometre carbon factors applied to this carbon footprint should be lower than the published factors from Defra/DECC (2013). "The current UK Defra railfreight CO₂ emission factor is set at 28.5 grams per tonne km. This is presented as a single, average emission factor for all UK railfreight operations. As the emission factor is sensitive to the density of the goods and loading of the wagon, this average figure may misrepresent the actual carbon intensity of many rail freight operations."

gradually being eroded from London Heathrow, with some relocating to other airports in the south-east. This is increasing the slots available for long-haul flights, regardless of the presence of the Proposed Scheme. The impact of the Proposed Scheme may be limited to simply speeding up what is already happening; and

- if a small number of domestic flights are liberated at Heathrow (in the context of its total number) and substituted by long-haul flights, it is more likely to slightly increase Heathrow's relative market share of long-haul flights compared to other airports, including competitor European hub airports. Therefore, there is unlikely to be any significant overall change in total European long-haul flights or emissions due to the Proposed Scheme⁶⁷.

Operation carbon efficiency measures

- 5.5.27 There are a number of areas where HS2 Ltd could have direct influence on the Proposed Scheme's operational carbon emissions (see Figure 8). These include: train design, attractiveness of HS2 to generate modal shift, support to low-carbon road vehicles (belonging to HS2); and efficiencies in train operation. There has been no sensitivity testing undertaken regarding these issues, as they are either potentially minor (e.g. support to low-carbon vehicles owned by HS2 Ltd) or insufficient information is available. It has also not been possible to identify to what extent local low-carbon energy generation could affect the operational carbon footprint of the Proposed Scheme.
- 5.5.28 As part of the Proposed Scheme's mitigation, 2 million trees will be planted. This planting is calculated to capture approximately 500,000 tCO₂e over the 60 year operational assessment period; equivalent to an average of 8,366 tCO₂e per year. The calculation of the carbon sequestration is based on factors from the Woodland Carbon Code⁶⁸.
- 5.5.29 Other carbon efficiency opportunities include:
- investigation of the feasibility to procure low carbon energy supplies for the operation of the Proposed Scheme;
 - improved aerodynamic design of HS2 rolling stock;
 - reduction of rolling stock weight;
 - drive style management and/or automatic train operation (consistent, optimal use of energy throughout journey);
 - better management and control of infrastructure and rolling stock auxiliary (non-traction) power usage;
 - changes to speed profiling / improved fleet operation control and timetabling; and

⁶⁷ Greengauge 21, (2012), *The Carbon Impacts of HS2*; <http://www.greengauge21.net/publications/the-carbon-impacts-of-hs2/>; Accessed: 1 October 2013.

⁶⁸ UK Woodland Carbon Code; <http://www.forestry.gov.uk/carboncode>; Accessed: 11 November 2013.

- opportunities for local renewable energy generation associated with stations and depots.

5.5.30 There are also three key drivers of impacts that are largely out of HS2 Ltd's control, which could indirectly affect the operational carbon footprint of the Proposed Scheme. These are the reduction in carbon intensity of the national grid, train speed and land use planning policy. These three factors are discussed in the following sections.

Carbon intensity of the grid

5.5.31 The carbon intensity of the national grid is dependent on the extent to which fossil fuel electricity generation is replaced with a greater share of renewables and low carbon energy. A sensitivity analysis using grid decarbonisation projections from the Government (DECC/IAG) and its key advisory body (CoCC) has identified a significant difference in the Proposed Scheme's carbon footprint (approximately 1,000,000 tCO₂e). This demonstrates that the actual rate of grid decarbonisation will have a significant impact on the overall operational phase carbon footprint.

Train speed

5.5.32 The faster the average speed along the route, the greater the energy requirement. Table 3 sets out the sensitivity of the Proposed Scheme's operational carbon footprint to changes on average speed on the track. It shows that reducing the average speed to 300km/h from 330-360km/h⁶⁹ makes an approximately 7% difference to the operational carbon footprint (an even smaller proportion of the total footprint). It is important to note that energy consumption data for the Proposed Scheme's train sets is based on today's technology and does not include expected improvements in system efficiency and management. Furthermore, changing the line speed would affect the timetabling and the economic benefits of the Proposed Scheme.

Table 3: Line speed sensitivity testing

Assumed maximum speed (km/h)	Total operational footprint (tCO ₂ e)	Variance to 330/360km/h
360	2,380,000	4.8%
330-360	2,270,000	N/A
330	2,250,000	-0.9%
300	2,110,000	-7%

Land use planning and transport interchanges

5.5.33 The actual operational carbon footprint will depend greatly on a number of national and local Government policy decisions on issues such as land use planning and

⁶⁹ The Proposed Scheme will run on an average of 330km/hr with the option to increase speed to 360km/hr to regulate the service.

transport. A report by Greengauge 21 stated that it would be more sustainable to construct city centre rather than parkway stations wherever possible⁷⁰.

5.5.34 The construction of the Proposed Scheme will represent a significant investment in public transport in the UK. The benefits of this investment could be maximised by promoting the integration of the Proposed Scheme with other transport modes (especially other forms of public transport such as rail lines and buses) for connecting journeys; and through maximising walking and cycling facilities at stations as well as ensuring energy efficiency is designed into stations from the outset.

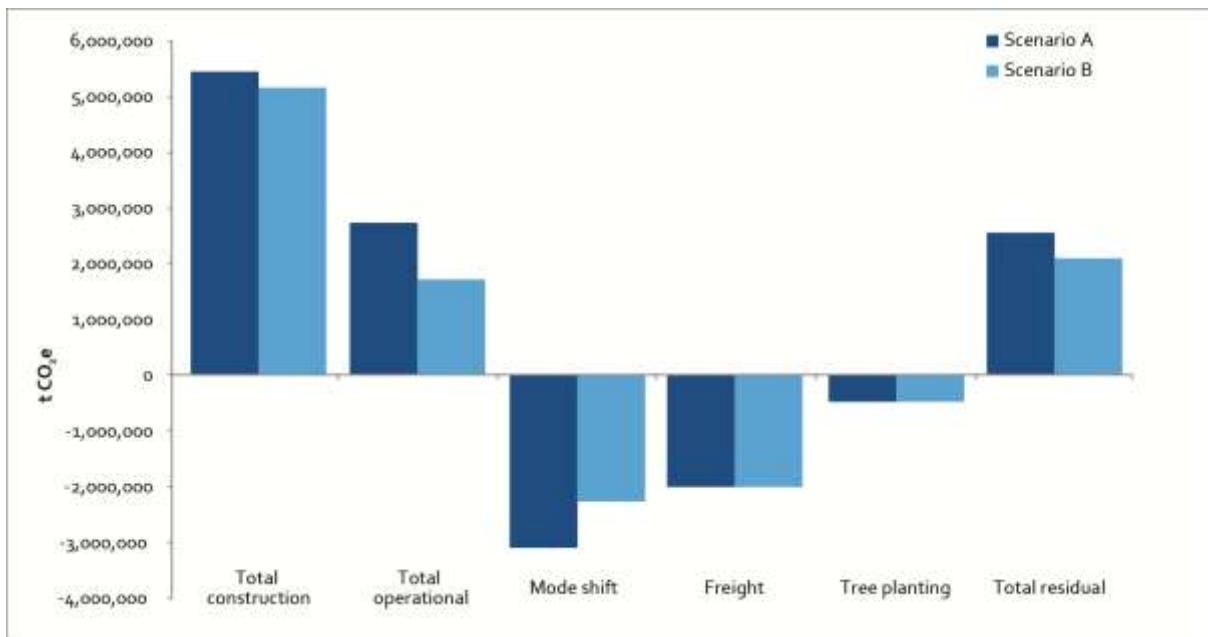
5.6 The total carbon footprint

5.6.1 The total carbon footprint for the Proposed Scheme is based upon total emissions from the construction and operation of the Proposed Scheme including the emissions reductions from modal shift, carbon sequestration from tree planting and freight benefits from released capacity on the classic network. The total carbon footprint of the Proposed Scheme is presented as a range between 2,140,000 tCO₂e and 2,620,000 tCO₂e over the 60 year assessment period. This range is based on the following two scenarios:

- scenario A (total) - based on the central case construction scenario (anticipated concrete and steel factors for 2020), the DECC/IAG grid decarbonisation scenario, and WebTAG electric car uptake projections; and
- scenario B (total) - based on the stretching case construction scenario (industry and governments targets for decarbonisation) and the CoCC grid decarbonisation scenario and electric car uptake projections.

5.6.2 Figure 13 shows the breakdown in components of the total carbon footprint according to the two scenarios (A and B) and, in particular, which components increase and reduce the carbon footprint.

⁷⁰ Greengauge 21, (2012), *The Carbon Impacts of HS2*; <http://www.greengauge21.net/publications/the-carbon-impacts-of-hs2/>; Accessed: 1 October 2013.

Figure 13: Contribution of different components of the total carbon footprint (tCO₂e)

- 5.6.3 An assessment based on the 120 year design life of the Proposed Scheme - by simply carrying forward the same assumptions for another 60 years, as there are no projections that cover this length of period - results in either a small residual amount of emissions (scenario A), or a positive GHG savings under scenario B (360,000 tCO₂e (scenario A) and -230,000 tCO₂e (scenario B)).
- 5.6.4 A final element of the total footprint is to include a future baseline. The without Proposed Scheme scenario does not include an alternative infrastructure option for increasing capacity on the WCML, other than the committed schemes, which are common to both the with and without the Proposed Scheme scenarios.
- 5.6.5 A hypothetical new motorway between London and Birmingham would provide similar capacity as the Proposed Scheme. There has been no detailed analysis of a motorway option. Nevertheless, as means to illustrate the potential difference between similar capacity alternatives, a very high level footprint has been prepared.
- 5.6.6 Under the motorway option, construction would result in 2,000,000 tCO₂e; and operation would result in between 23,000,000 tCO₂e and 25,000,000 tCO₂e depending on whether operation scenario A or B is used (see Volume 5: Appendix CT-001-000/2 for more information on the assumptions used). Under this option, the construction footprint would be smaller than that of the Proposed Scheme. Early high level footprints of the construction of HS2, including the Phase One AoS and initial footprints during early design development, showed smaller footprints than the one using more detailed design data reported here. See Volume 5: Appendix CT-001-000/2 for more information on the reasons behind the difference between the construction carbon footprints reported in the Phase One AoS and in this section for the Proposed Scheme.
- 5.6.7 The operational emissions associated with a hypothetical motorway are significantly more carbon intensive (about 10 times more, ranging between 23 and 25 million tonnes of CO₂e over a 60 year appraisal period). In summary, if carbon associated

with a hypothetical motorway delivering a similar capacity was taken into account, the Proposed Scheme could be considered carbon beneficial over the 60 year appraisal period.

Benchmarking the Proposed Scheme's carbon footprint

5.6.8 It is useful to benchmark the Proposed Scheme's performance against other significant transport modes and within the construction sector, as well as within the UK's overall GHG footprint, to put the Proposed Scheme's GHG emissions in context and understand its scale.

Carbon efficiency of transport modes

5.6.9 Table 4 sets out the carbon emissions per passenger kilometre for the Proposed Scheme at the key assessment years. This is based on the Proposed Scheme's power supply modelling outputs for the rolling stock, combined with projected grid decarbonisation figures from DECC/IAG. Table 4 shows the significant improvement in the efficiency of the Proposed Scheme as the grid becomes less dependent on fossil fuels. The emission per passenger kilometre reduces from 15.33 grams of CO₂ in 2026, to 2.88 grams in 2041 and 1.57 grams from 2050 onwards.

Table 4: The Proposed Scheme's projected carbon emissions per passenger kilometre (gCO₂e/pkm)

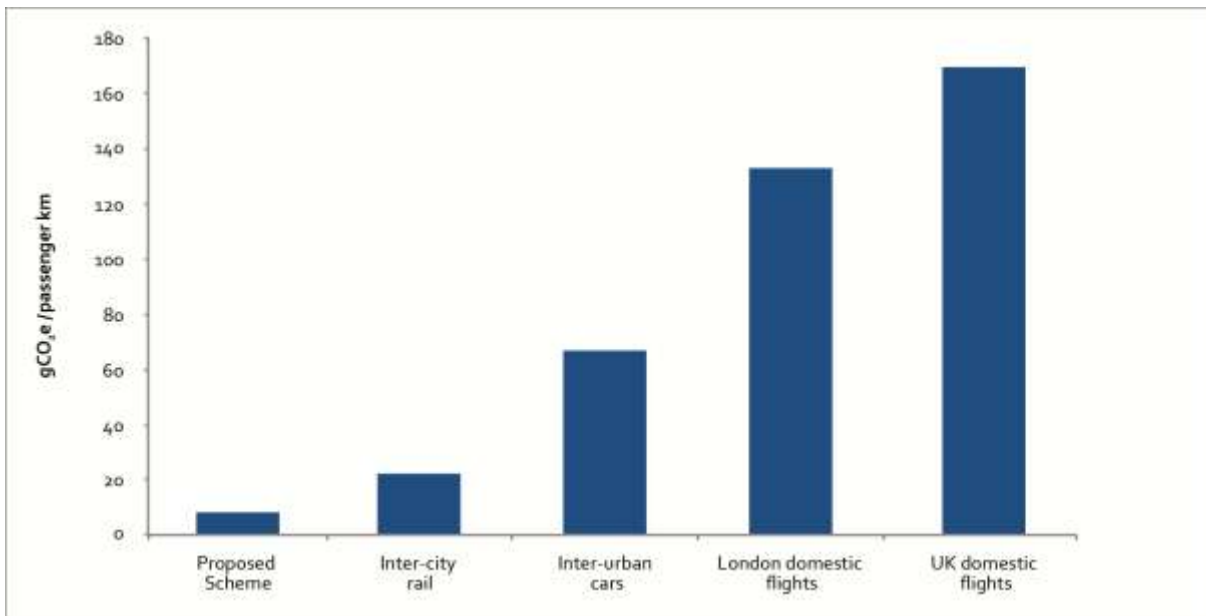
Year	2026	2041	2050	2086
gCO ₂ e/pkm	15.33	2.88	1.57	1.57

5.6.10 Figure 14 presents average carbon emissions per passenger kilometre (gCO₂e/pkm) for road, rail and air emissions for 2030⁷¹. The figure shows that the Proposed Scheme offers a significant carbon efficiency benefit in terms of gCO₂e/pkm (the Proposed Scheme is 8 gCO₂e/pkm as compared to interurban cars 67 gCO₂e/pkm; intercity rail 22 gCO₂e/pkm⁷² and UK domestic flights 170 gCO₂e/pkm, based on projected carbon emissions in 2030). The increasingly low-carbon traction system, the large capacity of each train and the dedicated new line give the Proposed Scheme a significant advantage as a high-volume, low-carbon form of transport.

⁷¹ 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.

⁷² 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.

Figure 14: Carbon emissions per passenger kilometre by mode in 2030



Sector comparisons

- 5.6.11 While there are very few comparable infrastructure projects to the Proposed Scheme, published data for the carbon footprint for Crossrail, a £14.5 billion, 118km railway between the east and west of London, states that its emissions are estimated to be between 9,600,000 tCO₂ and 14,900,000 tCO₂ during its lifetime for construction and 120 years of operation. The range is dependent on assumptions on rolling stock and future grid mix projections. The operation of Crossrail is expected to comprise the majority of these emissions, with the construction emissions estimated to contribute approximately 1,500,000 tCO₂⁷³. Modal shift is estimated to save 1,300 tCO₂ per year⁷⁴. This compares with an anticipated total construction footprint of 5,600,000 tCO₂e for the Proposed Scheme and modal shift savings of over 5,270,000 tCO₂e over the 60 year assessment period.
- 5.6.12 To provide context to the significance of the Proposed Scheme's carbon footprint, it has also been presented in relation to the UK's total GHG emissions, as well as compared to the transport, rail and construction sector's GHG emissions.
- 5.6.13 In terms of construction emissions, a report by the Green Construction Board⁷⁵ reported that all UK construction emissions in 2010 were 33,650,000 tCO₂e⁷⁶. By 2026, the same report estimates that total UK construction emissions will have decreased to 30,290,000 tCO₂e. In comparison, the Proposed Scheme's annual construction emissions represent approximately 1.9% of this 2026 figure.

⁷³ Transport for London Safety health and Environment Committee, (2011), Sustainability and Crossrail; <http://www.tfl.gov.uk/assets/downloads/Item08-SHEAC-9-March-2011-Sustainability-Crossrail.pdf>; Accessed: September 2013.

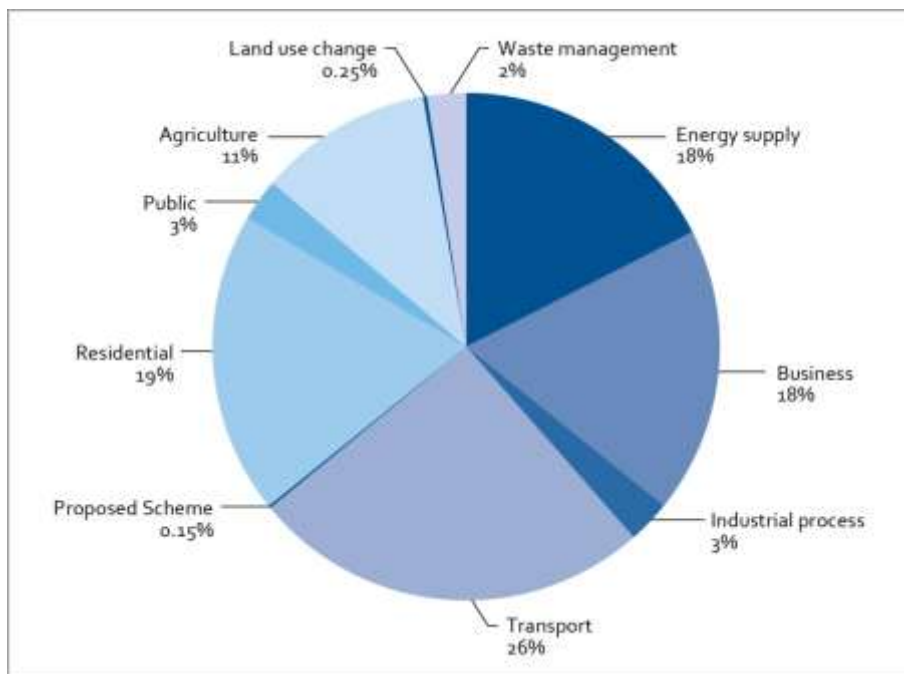
⁷⁴ Ian Lindsey, (2012), Crossrail and the Future of London's Transport; http://www.ucl.ac.uk/sustainable-cities/results/2062presentations/transport2062_Lindsay.pdf; Accessed: August 2013.

⁷⁵ Green Construction Board, (2013), *Low carbon route map for the UK built environment*; <http://www.greenconstructionboard.org/otherdocs/Routemap%20ofinal%20report%2005032013.pdf>; Accessed: August 2013.

⁷⁶ The Green Construction Board (2013) presents three scenarios for the UK's Built Environment carbon trajectory. The figures presented here are for the 'Central Case' scenario where strategies are technically feasible and financially viable over their lifetime.

5.6.14 Figure 15 presents the Proposed Scheme's carbon footprint for construction and operation (annualised), compared to annual emissions in related sectors. This shows that the Proposed Scheme will comprise a small fraction of UK transport emissions in that year, even when the construction emissions are included.

Figure 15: The Proposed Scheme's annualised total emissions compared to annual emissions in other sectors expressed as a percentage, 2030⁷⁷



5.6.15 In the context of UK rail emissions, the emissions of the Proposed Scheme in 2030 (operation only) represents 2% of the UK's total operational rail emissions in 2011 (calculated based on end user emissions for railways in 2011, as this data is not available for 2030).

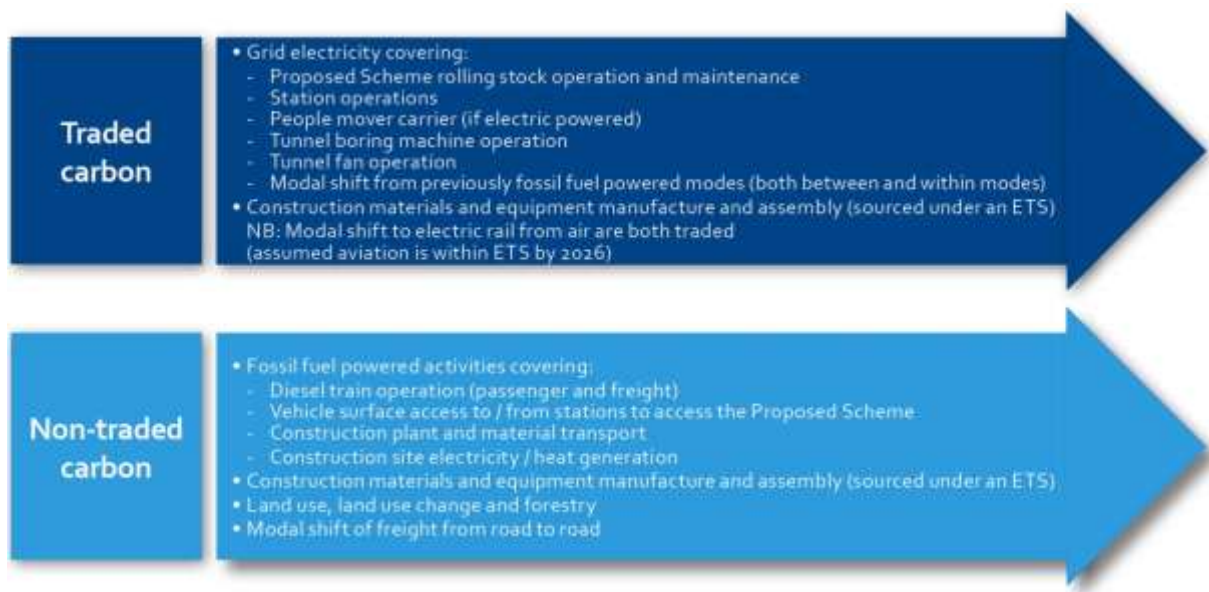
Traded versus non-traded carbon

5.6.16 Figure 16 shows which sources of GHG emissions associated with the Proposed Scheme are traded (i.e. in the EU ETS) and non-traded. This shows that the majority of GHG emissions from operation the Proposed Scheme, which arises from the generation of electricity for traction power, will fall under the EU ETS cap. The potential modal shift from road and classic diesel rail to the Proposed Scheme will mean that GHG emissions that are currently in the non-traded sector (combustion of petrol and diesel in cars) will then be included in the traded sector.

5.6.17 The Proposed Scheme could play a role in helping to meet the Climate Change Act target by wherever possible, bringing the non-traded emissions mentioned above into the ETS (one of the key policy tools for meeting the Climate Change Act budgets).

⁷⁷ DECC, (2012), *Updated energy and emissions projections 2012*; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65717/6660-updated-emissions-projections-october-2012.pdf; Accessed: September 2013.

Figure 16: Traded versus non-traded carbon



5.6.18 Figure 16 does not include embedded carbon in materials such as concrete and steel, as it is unclear at this stage whether construction materials will be sourced from EU manufacturers. If materials are sourced from outside the EU, then the embedded carbon in those materials would be non-traded. However, there are a growing number of cap-and-trade systems being set up outside the EU, perhaps most significantly in China. If steel came from another cap-and-trade system from outside the EU (such as China), then the benefit of it being part of an overall target associated with traded carbon would still be relevant.

5.6.19 The experience from Crossrail suggests that it is probable that much of the material will come from the UK/EU, as cement and aggregates all came from either the UK or the rest of the EU. Some steel came from the UK and EU sources, while the rest came from China and Turkey⁷⁸. Therefore, most of the emissions should fall within the EU ETS.

5.7 Conclusions

5.7.1 The GHG assessment supports the view of the Government's Carbon Plan that the Proposed Scheme can form an important part of the UK's low carbon future, transforming its "rail capacity and connectivity to promote long term and sustainable economic growth"⁷⁹.

5.7.2 The Proposed Scheme's operational emissions are anticipated to result in between -2,970,000 tCO₂e and -3,160,000 tCO₂e over the 60 year operational assessment period, once modal shift, carbon mitigation from tree planting and freight benefits from released capacity on the classic network is taken into account. There is also a wider benefit associated with the increase in the total carrying capacity of the rail transport system; since the Proposed Scheme would increase the total capacity of the

⁷⁸ Crossrail (2013), Personal Communication. Statement does not include track and overhead lines as this is still to be procured.

⁷⁹ HM Government, (2011), *The Carbon Plan: Delivering our Low Carbon Future*; <https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2>; Accessed: 11 September 2011.

rail transport system, it would provide a means to free up capacity on existing rail networks. This benefit is unlikely to arise from an alternative rail scheme that adds no strategic capacity.

- 5.7.3 The significant passenger capacity of the Proposed Scheme, combined with its ability to draw power from an increasingly decarbonised National Grid, means that it would be one of the most effective low carbon transport solutions for travel between London and the West Midlands in 2030. In terms of emissions per passenger kilometre, the Proposed Scheme is 8 gCO₂e/pkm as compared to interurban cars (67 gCO₂e/pkm); intercity rail (22 gCO₂e/pkm⁸⁰) and UK domestic flights (170 gCO₂e/pkm), based on projected carbon emissions in 2030.
- 5.7.4 Nevertheless, the GHG emissions associated with the construction of the Proposed Scheme are significant, as might be expected from a national level infrastructure scheme. The construction carbon footprint is estimated to be between 5,300,000 tCO₂e and 6,460,000 tCO₂e⁸¹. This is mostly a result of the construction of tunnels, earthworks, bridges, viaducts and underpasses, of which many of these elements have been included in order to mitigate other significant environmental noise and visual amenity.
- 5.7.5 When the operational and construction footprints of the Proposed Scheme are combined to form a total carbon footprint over the 60 year assessment period (plus the 10 years of construction), the residual carbon ranges between 2,140,000 tCO₂e and 2,620,000 tCO₂e. This includes all emissions associated with construction, operation and maintenance of the Proposed Scheme, as well as modal shift, carbon mitigation from tree planting and freight benefits from released capacity on the classic network. If the same assumptions for the first 60 years of assessment are extended for another 60 years to align with the 120 year design life of the Proposed Scheme, the footprint ranges from a small surplus to a small saving of 230,000 tCO₂e resulting in a reduction in carbon.
- 5.7.6 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 London and the West Midlands. As a comparison the construction of a new motorway would have a smaller construction footprint (based on a very simple high-level design); however its operational footprint would be significantly higher ranging between 23 and 25 million tCO₂e over a 60 year appraisal period.
- 5.7.7 The benchmarking of the Proposed Scheme's annualised construction and operation emissions against the UK's projected carbon footprint in 2030 shows that it represents a small contribution to the UK's annual emissions (0.15%) as well as its operational emissions, being only 2% of the UK's operational rail emissions. If the residual emissions after 60 years were annualised, then the proportion would be even smaller.

⁸⁰ 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.

⁸¹ With a central case scenario of 5,590,000 tCO₂e.

- 5.7.8 The EU ETS, a cap-and-trade system with a decreasing cap over time is a significant policy tool available for implementing the UK Carbon Plan. 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 emissions associated with the total carbon footprint 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.
- 5.7.9 Additionally, GHG 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 be taken on the Proposed Scheme through mode shift, will become tradable within the EU ETS cap.
- 5.7.10 GHG 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 carbon emissions both in the traded and non-traded sectors by implementation of its Sustainability Policy.
- 5.7.11 HS2 Ltd cannot directly influence all of the elements that underpin the carbon footprint (see Figure 8). 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.

5.8 Assumptions

- 5.8.1 The geographical scale of the Proposed Scheme and the duration of its construction and operation, means that a number of assumptions have been made in this assessment. These assumptions have been sensitivity tested and result in a 20% difference in the range of the carbon footprint. The eventual carbon footprint of the Proposed Scheme will depend on HS2 Ltd's design and procurement decisions (particularly around construction material and possible sources of low carbon energy), future policy decisions around land use planning and transport, and private sector investment.

Table 5: Key assumptions used in completing the carbon footprint of the Proposed Scheme

Components of the Footprint	Assumption used
Construction scenarios - factors used for material other than concrete and steel	SimaPro LCA software 7.3.3, the University of Bath, (2011) ⁸² and other industry sources including MPA The Concrete Centre, (2012) ⁸³ , Cemex and ARUP's CO2ST Tool; Transport emissions are based on factors from Defra DECC, (2013) ⁸⁴ and DECC/IAG (2013)
Released capacity for freight	<p>Currently, on the WCML, there are three standard off-peak freight paths per hour; although currently, approximately 1.5 paths an hour are used. The Government wishes to encourage more freight to shift from road to rail. Coupled with the rising costs of road transport, demand for rail freight paths is expected to increase over the next 15 years. Therefore, it is reasonable to assume that there may be insufficient capacity to meet the total demand for rail freight by the time the Proposed Scheme is due to open in 2026. Based on a number of assumptions, many of which are the same as those used for the Economic Case for HS2, and its presumption for passenger services, there is still the potential for one to two additional freight paths in each direction between London and the Midlands, outside the peak periods of 07:00 – 10:00 and 16:00 – 19:00. This means that 10 of the 16 operational hours of the Proposed Scheme (06:00 – 22:00) could accommodate two to four freight paths an hour, making a total of up to 20 - 40 additional freight paths a day (300 days a year).</p> <p>The carbon footprint has assumed 20 paths per day, released linearly from two in year 2026 to 20 in 2035, from which point there are 20 freed up paths per day to 2085.</p> <p>Each freight train carries 36 containers and each heavy goods vehicle (HGV) carries one container.</p> <p>Each container weighs 20 tonnes.</p> <p>Rail freight and road haulage is for 300 days per year.</p> <p>Emissions saving are calculated based on the same distance travelled for both HGVs and trains, i.e. 124km which represents a trip from Wembley to Rugby via Northampton.</p>
Aviation	<p>Passenger kilometre carbon factors for air travel are based on DfT UK Aviation Forecasts TR13 Central Scenario data for London airports to 2050.⁸⁵</p> <p>Due to lack of any other data, carbon factors for 2050 are projected forward and unchanged to 2085.</p> <p>The emissions associated with aviation include a distance uplift factor and radiative forcing, otherwise known as the other non-CO₂ climate change effects of aviation (water vapour, contrails, NOx etc.). This approach is consistent with the latest UK Government conversion factors for Company Reporting (Defra / DECC 2013) which states "Users should generally include the distance uplift of 8% and the radiative forcing increase of 90% in the emissions reporting".</p>
Operation of the Proposed Scheme	<p>Maximum speed of 330-360 km/hr.</p> <p>Train lengths of 200m and 400m.</p> <p>Energy consumption figures of: 24.65 kWh/km for the 200m trains, and 47.32 kWh/km for the 400m trains moving on the HS2 network and 15.27 kWh/km for the 200m train moving on the classic network. The true consumption of the train is expected to be less</p>

⁸² University of Bath, (2011), Inventory of Carbon & Energy (ICE) Version 2.0

⁸³ MPA the Concrete Centre, (2012), *Concrete Industry Sustainability Performance Report - 5th report: 2011 performance data*; http://www.sustainableconcrete.org.uk/pdf/MB_Fifth_Concrete_Industry_Sustainability_Performance_Report_Final.pdf; Accessed: September 2013.

⁸⁴ University of Bath, (2011), Inventory of Carbon & Energy (ICE) Version 2.0.

⁸⁵ Department for Transport, (2013), *UK Aviation Forecasts*; <https://www.gov.uk/government/publications/uk-aviation-forecasts-2013>; Accessed: September 2013.

Components of the Footprint	Assumption used
	<p>than these figures.</p> <p>200m trains: Weekdays and Saturdays - 290 movements per day; Sundays - 286 movements per day.</p> <p>400m trains: Weekdays and Saturdays - 40 movements per day; Sundays - 0 movements per day.</p>
Construction footprint: 2020 central scenario	<p>Concrete, is based on the Mineral Products Association projection that the UK concrete industry will achieve a 62% reduction in emissions by 2050 based on 1990 levels. This reduction was plotted and the 2020 concrete carbon factor (73.20 kgCO₂/t) was chosen for the "central case" assessment. The steel scenario was based on Eurofer's⁸⁶ report on a roadmap for low carbon in Europe. Various scenarios were presented here, but the "central case" assessment assumes the implementation of best-practice sharing and increased scrap availability in the steel sectors. This was projected to reduce steel's embedded carbon by 24% based on 1990 levels. Similar with concrete, this trajectory was plotted and the 2020 factor (1,293 kgCO_{2e}/t) was adopted for the "central case" carbon assessment.</p>
Construction footprint: 2020 stretching scenario	<p>The concrete 2020 stretch scenario is based on the Mineral Products Association's optimistic assumption that carbon in concrete could be reduced by 81% by 2050 based on 1990 levels. By plotting this trajectory, the embodied carbon within concrete by 2020 is estimated to be 68.33 kgCO₂/t. Similarly, Eurofer's more optimistic scenario would involve "maximum theoretical abatement without Carbon Capture and Storage". Under this scenario, the embedded carbon of steel would be reduced by 48% by 2050 based on 1990 levels (equivalent to 1,157 kgCO_{2e}/t).</p>

⁸⁶ Eurofer, (2012), A steel roadmap for a low carbon Europe 2050; <http://www.eurofer.org/News%26Media/PublicationsLinksList/2013-Roadmap.pdf>; Accessed: September 2013.

6 Community

- 6.1.1 Community impacts arising from both the construction and operation of the Proposed Scheme are considered to be of no more than local significance and have accordingly been assessed in Volume 2, CFA reports 1-26, Section 5. Impacts on PRoW which run through multiple CFA are considered to be localised and therefore appropriately reported in Volume 2, CFA reports 1-26, Section 5.
- 6.1.2 Construction worker impacts on community resources are considered at a route-wide level in Appendix CM-002-000. The assessment takes into account the number of workers, the type and location of accommodation, working hours, facilities provided on construction compounds, experience from other large projects (such as HS1) and the measures contained in the draft CoCP. On this basis it is concluded that there will be no significant effects associated with construction worker accommodation.
- 6.1.3 Localised effects on amenity are reported at CFA level for both construction and operation in the relevant Volume 2 CFA report, Section 5.

7 Cultural heritage

- 7.1.1 Heritage assets can be affected through the physical removal of the asset or changes to its setting due to development. The loss of individual heritage assets and effects on setting, are not considered to be of route-wide importance and are therefore reported within Volume 2, CFA reports 1-26, Section 6.
- 7.1.2 The Proposed Scheme will not have a direct physical effect on any World Heritage Site and will not require the demolition of any Grade I or Grade II* listed building.
- 7.1.3 Across the entire route of the Proposed Scheme, a number of designated assets will be significantly affected through direct physical impact, including:
- Heritage assets comprising:
 - one registered battlefield;
 - one scheduled monument;
 - 18 Grade II listed buildings entries; comprising six which will be demolished, four which will be altered and eight which will be removed and relocated; and
 - alteration to a curtilage wall to a Grade I listed building.
 - Historic landscape assets comprising:
 - two Grade II* registered parks and gardens;
 - 81 lengths of historic hedgerow; and
 - 19 areas of ancient woodland.
- 7.1.4 Heritage assets physically affected by the Proposed Scheme will be subject to a programme of archaeological and built heritage investigation, recording, analysis, reporting and archiving. Although such a programme contributes to advancing our understanding, it will not fully mitigate the loss of the heritage assets and consequently each effect is considered on an individual basis within Volume 2, CFA reports 1-26, Section 6.

8 Ecology

- 8.1.1 This section 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.
- 8.1.2 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, CFA reports 1-26, Section 7. This section considers both significant effects at the regional and national level, and in combination effects that are not discussed within the Volume 2 CFA reports.
- 8.1.3 Local/parish level effects for each CFA are listed within Volume 5: Appendices EC-005-001, EC-005-002, EC-005-003 and EC-005-004. This section considers the scope for local/parish level effects identified in the aforementioned appendices to, in combination, result in significant effects (i.e. effects at a district/borough level or above).

Designated sites

- 8.1.4 No sites designated as being of international value for nature conservation will be significantly affected by construction or operation of the Proposed Scheme. Detailed consideration was given to the potential for effects on the South West London Waterbodies Special Protection Area and Ramsar site which is located 12.3km to the south of the Proposed Scheme. A Habitat Regulations Assessment (HRA) screening (Volume 5: Appendix EC-009-002) concluded that no likely significant effects on the conservation status of the features for which the site is designated.
- 8.1.5 A HRA screening report (Volume 5: Appendix EC-010-002) was also prepared for the Chilterns Beechwoods Special Area of Conservation after air quality modelling identified that a small increase in air pollution will occur at this site during the construction period. The HRA concluded that there will be no likely significant effect on the conservation status of the features for which the site is designated.
- 8.1.6 The Proposed Scheme will result in habitat loss to, and fragmentation of, two sites of special scientific interest (SSSI), namely the Mid Colne Valley SSSI and Helmdon Disused Railway SSSI. SSSI are of national value for nature conservation.
- 8.1.7 Mitigation and compensation measures incorporated into the design to address impacts at the Mid Colne Valley SSSI (see Volume 2, CFA Report 7, Section 7) will address potential adverse effects, including habitat loss and disturbance to breeding and wintering birds, and no significant residual⁸⁷ effect is likely.
- 8.1.8 The effect of habitat loss and fragmentation on Helmdon Disused Railway SSSI will be addressed through creation of approximately 7ha of lowland calcareous grassland and scrub. This habitat will be created north of land required for the construction of the Proposed Scheme, on the eastern side of the Helmdon Disused Railway SSSI (see

⁸⁷ For the purpose of this ES, 'residual' is defined as the effects that remain following consideration of both mitigation and compensation measures. Such effects may be regarded as 'net' effects.

Volume 2, CFA report 14, Section 7). As a consequence, no significant residual effect is likely.

- 8.1.9 Several other SSSI lie in the vicinity of the Proposed Scheme and the potential for significant adverse effects has been considered as part of the assessment, as reported in the relevant Volume 2 CFA reports. No significant effects on other SSSI are expected.
- 8.1.10 Non-statutory Local Wildlife Sites⁸⁸ (LWS) will be affected by the Proposed Scheme, as summarised in Table 6. LWS vary in value and are considered to be either of county/metropolitan or district/borough value.
- 8.1.11 As with all receptors, the aim has been to avoid impacts on LWS where reasonably practicable, and then reduce impacts that cannot be avoided. The Proposed Scheme will result in habitat loss and/or fragmentation of 89 LWS. At 61 of these LWS, the impacts will result in a significant adverse effect on the integrity of the site. A number of other LWS 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 CFA reports, Section 7.
- 8.1.12 Table 6 shows a breakdown of LWS affected by the construction or operation of the Proposed Scheme in the context of the resource by county.

Table 6: Local Wildlife Sites affected by county

County	LWS type	Number of LWS affected by construction and/or operation of Proposed Scheme	Number of LWS type in county ⁸⁹	% of total LWS in county (all types) affected by Proposed Scheme
Greater London	Site of Metropolitan Importance (SMI)	4	140	1.5
	Site of Biological Importance (Grade I & Grade II)	14	800	
	Site of Local Importance (SLI)	3	460	
Hertfordshire	LWS	1	1930	<1
Buckinghamshire	LWS	14	392	6
	Biological Notification Site (BNS)	11		
Oxfordshire	LWS	1	362	<1
Northamptonshire	LWS	4	750	<1

⁸⁸ LWS is the generic term given for non-statutory sites designated on the basis of their nature conservation value. LWS are designated by the local authority or local Wildlife Trust and a range of different names are used by these bodies including Site of Local Importance for Nature Conservation, Site of Local Importance etc.

⁸⁹ The numbers of LWS in each county represent the most recent available figures taken from the websites of the respective designating bodies.

County	LWS type	Number of LWS affected by construction and/or operation of Proposed Scheme	Number of LWS type in county ⁸⁹	% of total LWS in county (all types) affected by Proposed Scheme
Warwickshire	LWS	18	431	4
Birmingham and Black Country	Site of Importance for Nature Conservation (SINC)	1	141	<1
	Site of Local Importance for Nature Conservation (SLINC)	1	270	
Staffordshire	Site of Biological Importance (SBI)	13	850	2
	Biodiversity Alert Site (BAS)	4		

8.1.13 LWS form an important component of ecological networks⁹⁰. They provide 'core habitat'⁹¹ and/or 'stepping stones'⁹² which are likely to be important to maintaining the conservation status of a range of habitats and species, including those which are not identified as formal reasons for the designation of these sites. In addition to the adverse effects on LWS identified in the Volume 2 CFA reports, it is possible that, without mitigation, the construction of the Proposed Scheme will lead to additional adverse effects on other features of the ecological networks of which they form a part.

8.1.14 Where a significant adverse effect on the integrity of a LWS is expected, sufficient compensation has been incorporated into the Proposed Scheme to address effects on the conservation status of the habitats and species for which that LWS 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 report⁹³ principles of 'bigger, better, more joined up'. In so doing, compensatory habitat creation will seek to maintain and enhance existing ecological networks (see Volume 1, Section 9 and the methodology for demonstrating no net loss in biodiversity set out in the SMR Addendum (Volume 5: Appendix CT-001-000/2), by enhancing existing core habitats, providing new core habitats, and/or promoting connectivity between habitat fragments. In so doing, it is likely that route-wide effects on ecological networks will be reduced to a level where they are unlikely to be significant.

⁹⁰ 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.

⁹¹ 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.

⁹² 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.

⁹³ Lawton, J (2010), *Making space for nature: A review of England's wildlife sites and ecological network*, Defra, London.

- 8.1.15 Where a significant effect would occur at a LWS, 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 criteria. Once ecological compensation areas are of sufficient ecological value to meet LWS criteria then, where reasonably practicable, HS2 Ltd will encourage the formal designation of these areas as part of the LWS network.
- 8.1.16 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.

Habitats

- 8.1.17 The Proposed Scheme will result in loss of areas of a range of habitats, including many which represent habitats of principal importance (as identified under Section 41 of the Natural Environment and Rural Communities Act, 2006)⁹⁴.
- 8.1.18 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.
- 8.1.19 32ha of ancient woodland will be lost to the Proposed Scheme, with 19 woodlands directly affected. Ancient woodland is an irreplaceable resource and this loss is considered to be a permanent adverse residual effect, which is significant at national level. However, the loss of woodland will be 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. In addition, planting of compensatory areas of lowland mixed deciduous woodland will be undertaken to boost the extent of woodland in the local area, or to enhance connectivity between existing fragments.
- 8.1.20 The most notable habitat losses which will occur as a consequence of the construction of the Proposed Scheme are:
- broadleaved woodland: loss of approximately 310ha across the Proposed Scheme, of which 195ha is semi-natural woodland. The loss represents less than 0.1% of the resource in England⁹⁵;
 - neutral grassland: loss of 170ha of unimproved and semi-improved neutral

⁹⁴ *Natural Environment and Rural Communities Act (2006)*, Her Majesty's Stationery Office.

⁹⁵ *Natural England (2008), State of the Natural Environment 2008 (NE85)*.

grassland across the Proposed Scheme. Due to the variation in systems of categorising grasslands, it has not been possible to compare this figure directly with the total resource in England; however, it is likely to be around 0.1%; and

- fen, marsh and swamp: loss of 19ha across the Proposed Scheme; although this loss is relatively small, this is an uncommon habitat type and this represents loss of 0.07% of the resource in England.

- 8.1.21 The loss of small areas of woodland, scrub, tall ruderal, and ephemeral/short perennial communities (which often appear closely associated as part of a mosaic) associated with the existing railway corridors in central London and central Birmingham, are individually local/parish level effects. While similar habitats are likely to establish naturally following completion of construction, there is the potential for a temporary adverse effect (up to seven years) that is significant up to the county/metropolitan level.
- 8.1.22 There will be an overall loss of up to approximately 490km of hedgerows. This figure represents a worst case, which is based on the assumption that all hedgerows within the land required for the construction of the Proposed Scheme will be lost (actual losses are expected to be significantly lower as a result of detailed design refinements). This loss will be compensated through a range of measures, including translocation of some important hedgerows, creation of new hedgerows and linear planting features, and tree and shrub planting for 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 have been taken wherever practicable, including the planting of hedges across green tunnels and green bridges. 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, no permanent significant residual effect is likely to occur.
- 8.1.23 During construction, the loss and severance of hedgerows will result in a temporary adverse effect on the hedgerow network that is significant at the regional level. In accordance with the ecological principles of mitigation (Volume 5: Appendix CT-001-000/2), efforts will (where reasonably practicable) be made to limit effects on species by minimising habitat loss and through the early creation of replacement features.
- 8.1.24 Once restoration of arable farmland and compensatory habitat creation is taken into account, the loss of arable field margins and ponds do not give rise to significant adverse residual effects at a route-wide level.
- 8.1.25 Where reasonably practicable, the design of the Proposed Scheme is such that watercourses have been crossed by bridges or viaducts; elsewhere, the lengths of culverts have been designed to be as short as possible. In compensation for culverts, and also where stretches of watercourses have been realigned, the ecological quality of the new lengths have been enhanced with the introduction of meanders, natural bank features etc. Overall, no significant residual effect on watercourses (as ecological receptors) is likely.

- 8.1.26 The results of a separate Water Framework Directive⁹⁶ (WFD) compliance assessment undertaken to consider the Proposed Scheme's compliance against WFD objectives⁹⁷ are presented in Volume 5: Appendix WR-001-000, with a summary provided in Section 15.5 of this report.
- 8.1.27 Where habitats of principal importance will be lost, opportunities for the creation of compensatory habitat have been explored. Overall, approximately 330ha of habitats of principal importance will be lost as a result of construction of the Proposed Scheme, including up to 195ha of lowland mixed deciduous woodland and 60ha of lowland meadows.
- 8.1.28 Where reasonably practicable, ecological compensation areas will be created to provide habitats of principal importance. A total of approximately 520ha of habitats of principal importance will be created, including approximately 280ha of lowland mixed deciduous woodland and 165ha of lowland meadow. Further details of habitat loss and gain will be provided within additional documentation to be produced (following submission of the hybrid Bill) in support of the no-net loss calculation described later in this section.

Species

Bats

- 8.1.29 Thirteen of England's 17 resident bat species have been recorded along the route of the Proposed Scheme, including Bechstein's bat which is very rare⁹⁸ in the UK, and barbastelle which is rare^{99,100}.
- 8.1.30 A population of Bechstein's bat comprising of at least three colonies, is associated with a network of woodlands located either side of the Proposed Scheme in the Waddesdon and Quainton (CFA12) and Calvert, Steeple Claydon, Twyford and Chetwode (CFA13) areas. These woodlands collectively form remnants of the former Bernwood Forest. Field survey has confirmed that the Bechstein's bat population commutes both across and along the route of the Proposed Scheme. The Bechstein's bat population, which is associated with the Bernwood Forest, is of national value.
- 8.1.31 Up to six barbastelle populations have been recorded at scattered locations along the route of the Proposed Scheme. However, the numbers of records are low in all cases, and there are no known barbastelle roosts in the vicinity of the Proposed Scheme.
- 8.1.32 Some of the barbastelle populations may interact with each other, for example those identified in Buckinghamshire and to the south-east of Birmingham; and in each case, could potentially represent single populations. Hence the number of populations may

⁹⁶ 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*

⁹⁷ To secure compliance with WFD, decision makers, must consider whether proposals for new developments have the potential to cause a deterioration of water body from its current status or potential, and/or prevent future attainment of good status or potential where not already achieved.

⁹⁸ Bat Conservation Trust (2011), *The state of the UK's bats. National Bat Monitoring Programme Population Trends 2012*. Bat Conservation Trust, London.

⁹⁹ Bat Conservation Trust (2011), *The state of the UK's bats. National Bat Monitoring Programme Population Trends 2012*. BCT, London.

¹⁰⁰ Both species are identified to be amongst the rarest species in England within Wray, S., Wells, D., Long E., Mitchell-Jones, T. (2010), *Valuing bats in Ecological Impact Assessment. In Practice*, (pp. 23-25).

be less than six. The individual populations are evaluated as being of up to regional value.

- 8.1.33 Other notable bat populations that occur along the route of the Proposed Scheme include a large maternity colony of Natterer's bat associated with houses and a church to the north of the route at Radstone within the Newton Purcell to Brackley (CFA14) area. This population is of regional value. Several other diverse assemblages of bat species identified along the route are of up to regional value.
- 8.1.34 Key impacts on bats will be those associated with the loss and disturbance of roost sites and the severance of existing habitat. 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.
- 8.1.35 There is also a risk of bat mortality due to collision with passing trains and associated turbulence from trains. However, when travelling at high speed, trains will pass quickly (approximately 4 seconds), and therefore exposure to the risk of collision will be intermittent and not continual. The point at which these impacts would result in a significant adverse effect on the bat population concerned would differ depending on a number of factors including: the size, status, and flight characteristics of the bat species, and the design of the Proposed Scheme at the point the impact occurs (i.e. whether the railway is in cutting, on embankment, on viaduct or at grade).
- 8.1.36 The loss of active roosts located within the land required will be compensated through the provision of suitable replacement features in accordance with the ecological principles of mitigation identified in the SMR Addendum in Volume 5: Appendix CT-001-000/2. All replacement provision for loss of active roosts will be provided within land identified as required in support of the Proposed Scheme.
- 8.1.37 At the route-wide level, the loss of trees and buildings identified as having high potential to support roosting bats (but that currently show no evidence of confirmed use), will result in a reduction in the availability of a roosting resource in the immediate vicinity of the Proposed Scheme until compensatory planting establishes (approximately 50 years from planting). 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 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 comprise the provision of bat boxes and other methods, such as tree surgery, to provide artificial roosting features within retained trees as appropriate.
- 8.1.38 With a view to maximising the benefit for the local bat population concerned, the provision of some of the required mitigation within the wider local area (as an alternative to providing it entirely within the confines of the Proposed Scheme) will be considered where agreement can be reached with local landowners. If such

agreements are not possible, then all necessary measures will be provided within the ecological compensation area to be created within the Proposed Scheme.

- 8.1.39 Site specific measures to address the effects of habitat severance, such as the provision of green bridges and underpasses, have been provided 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.
- 8.1.40 Proposed planting will not be sufficiently mature to provide habitat linkages immediately, and therefore, there is the potential for 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 that are included within the SMR Addendum (Volume 5: Appendix CT-001-000/2).
- 8.1.41 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.
- 8.1.42 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, hop-overs¹⁰¹, and viaducts will provide safe crossing points at discrete locations where the route of the Proposed Scheme crosses key bat foraging and commuting routes. Adjacent to Sheephouse Wood in Buckinghamshire, where there is considered to be a particularly high risk of collision of Bechstein's bat with passing trains, a structure forming a physical barrier to bats, will be provided. At other locations along the route, where a high risk of mortality has been identified, fencing and planting will be used to force bats to fly over the route of the Proposed Scheme above the height of passing trains and associated catenary. Existing vegetation close to the route of the Proposed Scheme will be removed at high risk locations; and parallel alternative flight lines (comprising new planted vegetation) will be provided to promote the use of an alternate route at a safe distance from the route.
- 8.1.43 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 incidental. An appropriate monitoring programme will be developed in consultation with Natural England, and

¹⁰¹ The use of planting or other artificial measures such as fences to encourage bats to maintain height as they cross the Proposed Scheme.

implemented during operation in order to assist in meeting relevant government requirements under the European Communities Habitats Directive¹⁰².

- 8.1.44 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 Bechstein's bat and barbastelle populations), will be reduced to the local/parish level 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

- 8.1.45 The Proposed Scheme passes through areas within the core geographical range of great crested newt and, with the exception of urban areas, both great crested newt and other more common amphibians are widespread throughout the route. 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 newt.
- 8.1.46 Compensatory habitat, to address impacts on great crested newt and other amphibian populations, will be provided in accordance with the ecological principles of mitigation identified 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.
- 8.1.47 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 (as identified in the SMR Addendum) in close 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.
- 8.1.48 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

- 8.1.49 Otter is frequent in some parts of the route and the assessment assumes that it is likely to have spread to all suitable watercourses by the date 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. Thus, 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.

¹⁰² The Council of the European Communities (1992), *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.*

- 8.1.50 The potential for temporary adverse effects on otter populations as a consequence of disturbance of watercourses during construction will be avoided through the implementation of measures within the draft CoCP and through the implementation of the ecological principles of mitigation (Volume 5: Appendix CT-001-000/2). Following mitigation, no significant residual effects on individual otter populations are likely to occur.

Hazel dormouse

- 8.1.51 Once well distributed across England, hazel dormouse is no longer commonly found north of London¹⁰³. There are scattered remnant populations in Northamptonshire, and the species has been reintroduced to Buckinghamshire, Warwickshire and Staffordshire. Hazel dormouse has not been recorded within the land required for the construction of the Proposed Scheme, although there are records in nearby woodlands in a number of locations.
- 8.1.52 As part of the precautionary assessment, compensatory habitat has been designed in these areas to ensure that there will not be a significant effect on the conservation status of this species.
- 8.1.53 No significant adverse effects on dormouse are likely to occur. However, in the event that surveys conducted between Royal Assent and construction identify adverse effects, then mitigation would be provided within the ecological compensation areas (which form part of the Proposed Scheme) in accordance with the ecological principles of mitigation identified in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

Water vole

- 8.1.54 Whilst water vole is found throughout England, it has however, undergone significant contraction in range during recent years due to habitat loss and increased predation by North American mink. Evidence of water vole was found on watercourses in the vicinity of the Proposed Scheme. However, there has been no confirmed use of land required for the construction and operation of the Proposed Scheme.
- 8.1.55 In the event that surveys conducted prior to construction confirm the presence of water vole within the land required for the construction of the Proposed Scheme, then mitigation will be provided within the ecological compensation areas (which form part of the Proposed Scheme) in accordance with the principles of ecological mitigation identified in the SMR Addendum.

Birds

- 8.1.56 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/metropolitan level,

¹⁰³ Natural England, *Standing Advice Species Sheet - Hazel dormouse*; http://www.naturalengland.org.uk/Images/Dormice_tcm6-21704.pdf; Accessed 23 October 2013.

are likely to occur for the duration of construction (up to 7 years). In particular, whilst effects are generally at district/borough level for yellow wagtail, the route-wide effect will be significant at the county/metropolitan level, as numerous smaller populations along the route will be affected. There is also the potential during construction for in-combination losses to result in temporary adverse effects on urban populations of widespread breeding bird species due to widespread loss of semi-natural habitat in areas that have limited alternative suitable habitat. This temporary effect will be significant up to the district/borough level.

- 8.1.57 Barn owl will be subject to significant adverse effects due to loss of nesting sites and foraging habitat during construction. In addition, during operation, there is the potential for mortality due to train strike; resulting in further significant adverse effects. Overall, on a precautionary basis, there may be loss of up to 52 pairs of barn owl due to these combined effects, which is equivalent to approximately 1% of the UK population¹⁰⁴. Route-wide, these losses will result in a permanent residual adverse effect, which is significant at the national level.
- 8.1.58 To offset the likely loss of barn owl from the vicinity of the Proposed Scheme, opportunities to provide barn owl nesting boxes in areas greater than 1.5km 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 owl 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.
- 8.1.59 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 songs. 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 effects.

Common reptiles

- 8.1.60 The Proposed Scheme does not pass through areas that are known to support the rarer reptiles found in England. All four of the more common species of reptile (adder, grass snake, common lizard and slow worm) were recorded within the land required for the construction of the Proposed Scheme. Compensatory habitat 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. Sufficient provision has been included to deal with a reasonable worst case.
- 8.1.61 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

¹⁰⁴ Current UK population estimated at 4,000 pairs. Barn Owl Trust (2013); *About the Barn Owl - Current distribution and numbers*; <http://www.barnowltrust.org.uk/infopage.html?id=115>; Accessed 23 October 2013.

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. No cumulative effects are anticipated.

Badger

- 8.1.62 Badger is common throughout much of lowland England and numerous badger setts were found within the land required for the construction of the Proposed Scheme.
- 8.1.63 Mitigation measures to address the potential killing, injury and disturbance of badgers during construction of the Proposed Scheme will be provided in accordance with the principles of mitigation identified within the SMR Addendum. This will include the provision of badger-proof fencing and replacement setts where necessary.
- 8.1.64 Adverse effects on badger will occur. However, due to the widespread nature of the species and the fact that the species is not of conservation concern; where in-combination effects occur, these are unlikely to be significant.

Other species

- 8.1.65 A single white-clawed crayfish population will be affected by the Proposed Scheme. Given that this is the only occurrence of this species, no in-combination effects are anticipated.
- 8.1.66 Potential effects on terrestrial invertebrate populations (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.
- 8.1.67 However, there is the potential for in-combination adverse effects resulting from impacts on multiple local/parish value populations and assemblages of terrestrial invertebrates associated with the habitats found within existing railway land in London and central Birmingham. Construction of the Proposed Scheme is likely to result in a temporary (up to seven years) reduction in the availability of scrub, ruderal and ephemeral communities, which in turn, is likely to result in a temporary adverse effect on the abundance and distribution of associated terrestrial invertebrate communities that is significant up to the county/metropolitan level. Following construction, similar habitat will be reinstated or will develop naturally; therefore no permanent adverse effect is likely to occur.
- 8.1.68 In order to prevent in-combination effects on aquatic invertebrate populations, replacement habitats will (where 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.

Climate change

- 8.1.69 Over the timeframe considered by the EIA, it is unlikely that ecological baseline conditions will change markedly as a consequence of climate change, although future climate change scenarios have been considered. However, 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 England), 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 and by de-fragmenting the landscapes through which it passes.

8.1.70 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. Review of relevant documents¹⁰⁵ suggests that potential changes in the baseline could arise from projected changes and trends for climate averages 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;
- 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.

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

8.1.72 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 landscaping and habitat creation within the Proposed Scheme has been heavily influenced by this imperative (as discussed in Volume 1, Section 9.6). The aims of maintaining and enhancing habitat connectivity within the landscape and of increasing the size of areas of core habitat have clear advantages for the future resilience of biodiversity in response to climate change¹⁰⁶.

¹⁰⁵ Such as Morecroft, M and Speakman, L (eds.) (2013), *Terrestrial Biodiversity Climate Change Impacts Summary Report, Living with Environmental Change*, Natural England, London.

¹⁰⁶ 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*.

8.1.73 Thus, the avoidance, mitigation, compensation and enhancement measures 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;
- protected areas and areas managed for biodiversity have been enlarged;
- strong linkages have been created between habitat fragments and islands to ensure that the landscape is permeable to species which move in response to climate change;
- the amount, quality and distribution of suitable habitat have been enhanced in order to allow robust and sustainable colonies to establish as species move in response to climate change;
- varied landscapes have been created with a diversity of features and structure; and
- measures to avoid the spread of invasive aliens (which may be competitively favoured by climate change) will be implemented, mainly through the implementation of measures within the CoCP and associated documents.

8.1.74 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 which establish alongside the Proposed Scheme will provide areas of suitable habitat for a wide range of species, and will minimise the extent of unsuitable habitat to the extent of the operational railway.

Seeking no net loss

8.1.75 The UK Government is committed to halting overall loss in biodiversity by 2020¹⁰⁷. In line with government policy, HS2 Ltd is seeking to achieve no net loss in biodiversity at the route-wide level. In support of this objective, the methodology used for the Defra biodiversity offsetting^{108,109} pilot has been adapted to allow losses and gains in biodiversity that will occur as a consequence of the Proposed Scheme, to be robustly compared.

8.1.76 Details of the methodology that will be used are provided in the SMR Addendum. The approach involves scoring each area of habitat present before and after development against pre-defined scales based on a range of variables including habitat distinctiveness, condition and position within ecological networks. The scores obtained are then multiplied to give a number of biodiversity units per hectare, and

¹⁰⁷ Defra (2011), *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*.

¹⁰⁸ Defra (2012), *Biodiversity Offsetting Pilots: Technical Paper: the metric for the biodiversity offsetting pilot in England*.

¹⁰⁹ Biodiversity offsets are conservation activities designed to deliver biodiversity benefits in compensation for losses in a measurable way. Offsetting methodologies compare the losses resulting from the impact of a development with the gains achieved through the provision of offsets, thus aiming to provide a transparent mechanism by which the impacts of a development can be quantified, and an appropriate level of compensation agreed.

adjusted on the basis of the extent of that habitat type present. The results of the biodiversity offsetting analysis will be presented in a separate report following submission of the hybrid Bill.

9 Land quality

- 9.1.1 Land quality encompasses issues relating to existing land contamination, to mineral or mining resources and to geological conservation resources.
- 9.1.2 For most of the route in predominantly rural areas, potentially contaminative land uses will be found only at isolated locations, and its remediation will give rise essentially to local effects. Even through more urban areas, where the incidence of potentially contaminative land uses will be more widespread, the effects will again be essentially local in nature due to the limited area over which contamination can spread. Although landfill gases, leachate and contaminated groundwater can migrate some distance from their source, such migration is unlikely to lead to any regional effects (for example, involving two or more CFAs). Where either groundwater 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.
- 9.1.3 It is intended to deal with contamination by treatment of contaminated soils and reuse of the treated material wherever practicable. Off-site disposal of contaminated soils is normally considered to be the least sustainable method of dealing with contamination, and will be restricted to those soils which cannot be made suitable for reuse through treatment or reallocation to appropriate locations. The likely incidence of such materials is considered to be low, and therefore the route-wide disposal of contaminated soils is not considered to be a significant issue in the context of the off-site void space available (see Section 14).
- 9.1.4 The incidence of current mining or mineral deposits affected by the Proposed Scheme is generally small. Whilst the route crosses a variety of Mineral Safeguarding Areas (MSA) for minerals such as sand and gravel, building stone, brick clay and coal, mostly prevalent in the Warwickshire, Staffordshire and Northamptonshire areas, it will affect only a small part of the total extent of the MSA. Where construction does occur within an MSA, any pre-extraction of surface minerals, at least under landscaping areas adjacent to the route, will assist in minimising the sterilisation of a local mineral supply. The pre-extraction of minerals will need to be discussed with the landowner, the Mineral Planning Authority and other relevant stakeholders to assist in achieving an effective management of minerals. With this mitigation, it is considered that on a regional or route-wide basis, the effects on mineral resources will not be significant.
- 9.1.5 There are only three geological conservation resources identified within the vicinity of the Proposed Scheme. Of these, two are considered to be at sufficient distance from construction works that they will not be affected. The third, Hartwell Walls in Buckinghamshire, lies within a construction area and will be affected during construction of the Proposed Scheme. However, this local affect to Hartwell Walls is not significant (see Volume 2, CFA report 11, Section 8). It is not considered that there are any regional or route-wide effects on geological conservation areas.
- 9.1.6 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 Depot at Calvert and the Rolling Stock Maintenance Depot at Washwood Heath. The operations at both depots will be controlled by

environmental protocols, with storage of potentially polluting materials according with good practice and any discharges operated under consents or permits from the regulatory authorities. Therefore, the potential for pollution to occur will be minimal, and inadvertent contamination, if any, will be localised.

- 9.1.7 Auto-transformer station sites are located at intervals along the track. An auto-transformer station can, in principle, be a source of contamination through accidental discharge or leakage of coolant. However, the proposed substations, in common with other modern substations, will use secondary containment appropriate to the level of risk.
- 9.1.8 There exists the potential for minor leakage of oils from the trains. However, such leakage or spillage is expected to be very small and is highly unlikely to lead to any significant contaminative effects on a route-wide basis. Therefore, it is considered that no significant route-wide land quality issues will arise.

10 Landscape and visual assessment

- 10.1.1 Within Volume 2, CFA reports 1-26, Section 9, landscape effects are reported against LCA which have been defined with reference to available published documents and professional judgement, where no published information is available. It is not considered that there are any significant route-wide effects on landscape and visual receptors arising from the construction or operation of the Proposed Scheme.
- 10.1.2 Due to its national importance, the effects of the Proposed Scheme on the Chilterns AONB are assessed in their own right. This assessment is provided in Section 2.

11 Socio-economics

11.1 Introduction

11.1.1 Direct socio-economic effects of the Proposed Scheme are reported at a route-wide and CFA level. The potential overall changes to employment levels, i.e. both the wider socio-economic benefits and those that arise from construction and operation of the Proposed Scheme, are reported in this section at a route-wide level. Significant localised effects on employment are reported in Volume 2, CFA reports 1-26, Section 10.

11.2 National policy and guidance

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

- the UK Government's commitment to sustainable development presented in the Defra publication 'Mainstreaming sustainable development'¹¹⁰. 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 NPPF 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 which typically identifies areas and issues of environmental sensitivity and economic opportunity;
- 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 plan¹¹¹ 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 2012¹¹² in which the Government announced its decision to proceed with HS2, and a further update published in 2013¹¹³ which set out the progress made on priority infrastructure investments; and
- the January 2012 Command Paper¹¹⁴ 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 on-going economic growth.

¹¹⁰ Department for Environment, Food and Rural Affairs (Defra) (2011), *Mainstreaming sustainable development - the government's vision and what this means in practice*.

¹¹¹ HM Treasury (November 2011), *National Infrastructure Plan* (2011).

¹¹² HM Treasury (December 2012), *Infrastructure UK National Infrastructure Plan: update 2012* (2012).

¹¹³ HM Treasury (2013), *Infrastructure delivery update* (2013).

¹¹⁴ Department for Transport (DfT) (2012), No. Cm.8247 *High Speed Rail: Investing in Britain's Future – Decisions and Next Steps*.

11.3 Key themes of assessment

11.3.1 This section presents the three types of impacts considered in the route-wide socio-economic assessment, using the methodology described in the SMR Addendum (see Volume 5: Appendix CT-001-000/2).

Impacts on employment associated with construction

11.3.2 Two types of impact are defined:

- direct employment opportunities: the number of jobs that the Proposed Scheme expects to be directly generated throughout the construction phase; and
- indirect employment opportunities: the number of jobs that the Proposed Scheme expects to be indirectly generated throughout the construction phase through multiplier effects.

Existing businesses and organisations

11.3.3 Three types of impact are defined:

- businesses and organisations (socio-economic resources) that will be relocated 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 organisations¹¹⁵;
- socio-economic resources affected by a change in amenity as a result of construction and operation of the Proposed Scheme. Amenity of resources may be affected by a combination of factors such as: sound, noise and vibration; air quality/construction dust; HGV traffic flows; and visual impacts. An adverse change in amenity could lead to a possible decline in trade for the affected resources; and
- socio-economic resources affected by isolation 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

11.3.4 Two types of impact are defined:

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

11.3.5 Socio-economic effects are presented as either gross or net employment effects. Gross effects refer to the total effect of the Proposed Scheme including direct effects

¹¹⁵ Judgements were made on the extent to which business resources could be grouped together. Where business or organisation resources were geographically close or of a similar use, class or industrial sector, individual businesses were grouped for assessment.

(such as jobs required to lay the track in the construction phase or train crew 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). In calculating effects, economic adjustments such as leakage, displacement and substitution are applied to reflect the interrelated nature of the economy. Net effects take into account those effects that will occur regardless of the presence of the Proposed Scheme. These effects can be beneficial or adverse.

11.4 Wider socio-economic benefits

11.4.1 Wider socio-economic benefits are generated by businesses, property developers, communities and local authorities responding to economic and regeneration opportunities brought about by the Proposed Scheme. Key benefits will include:

- wider economic benefits identified in the Economic Case for HS2 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 £4.3bn (present value, 2011 prices¹¹⁶). These 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 demand for property development around the four Proposed Scheme stations (London Euston, Old Oak Common, Birmingham Interchange and Birmingham Curzon Street), which will provide substantial new employment space and new homes. Overall, it has been forecast that the Proposed Scheme could accommodate and attract some 30,000 jobs¹¹⁷, thereby contributing to the planned growth in employment for London and the West Midlands, especially in the areas around the proposed stations; and
- freeing up capacity on the classic rail network as a consequence of passengers transferring from the classic rail network to long distance services provided by the Proposed Scheme. This will allow the provision of more local passenger services and freight services on the WCML.

11.5 Socio-economic baseline

Key economic indicators

11.5.1 This section summarises key economic indicators for England and the two major economies of London and the West Midlands, which the Proposed Scheme will serve.

11.5.2 Gross Value Added (GVA) measures the contribution to the economy of each individual producer, industry or sector. England generated a GVA of £1,125,000 million in 2011, of which London contributed £283,000 million (25%) and the West

¹¹⁶ HS2 Ltd (2013), *The Economic Case for HS2*.

¹¹⁷ HS2 Ltd (2011), *HS2 London to the West Midlands Appraisal of Sustainability Main Report Volume 1*.

Midlands £96,000 million (9%)¹¹⁸. GVA per person per year is higher in London (£35,600) than the West Midlands (£17,500) and the England average (£21,300). The long term trend has been for both total GVA and GVA per person per year to grow¹¹⁹.

- 11.5.3 There are 23.1 million employees in England, of which 4.3 million (19%) are located in Greater London and 2.3 million (10%) in the West Midlands¹²⁰. The majority of employment in England is in the service sector (85%)¹²¹. London's employment is more heavily concentrated in services than the West Midlands (94% compared with 81%, respectively). The proportion of employees in the public sector is also significantly lower in London compared with the West Midlands. A sector breakdown by industry in London and the West Midlands, benchmarked against England, is shown in Figure 17.
- 11.5.4 Figure 17 shows some clear differences between the employment profile of London and the West Midlands compared to the England average. London has higher proportions of employment in business administration and support services and professional, scientific and technical activities and a low proportion in manufacturing. The West Midlands has an employment profile more similar to the England average but shows higher proportions of employment in health and manufacturing.
- 11.5.5 The average employment rate¹²² for those aged 16-74 is 65% in London and 62% in the West Midlands, compared with 65% for England as a whole¹²³.

¹¹⁸ Office for National Statistics (ONS) (2012), *Regional Gross Value Added (Income Approach), December 2012. Provisional estimates for headline GVA at current basic prices*, ONS, London.

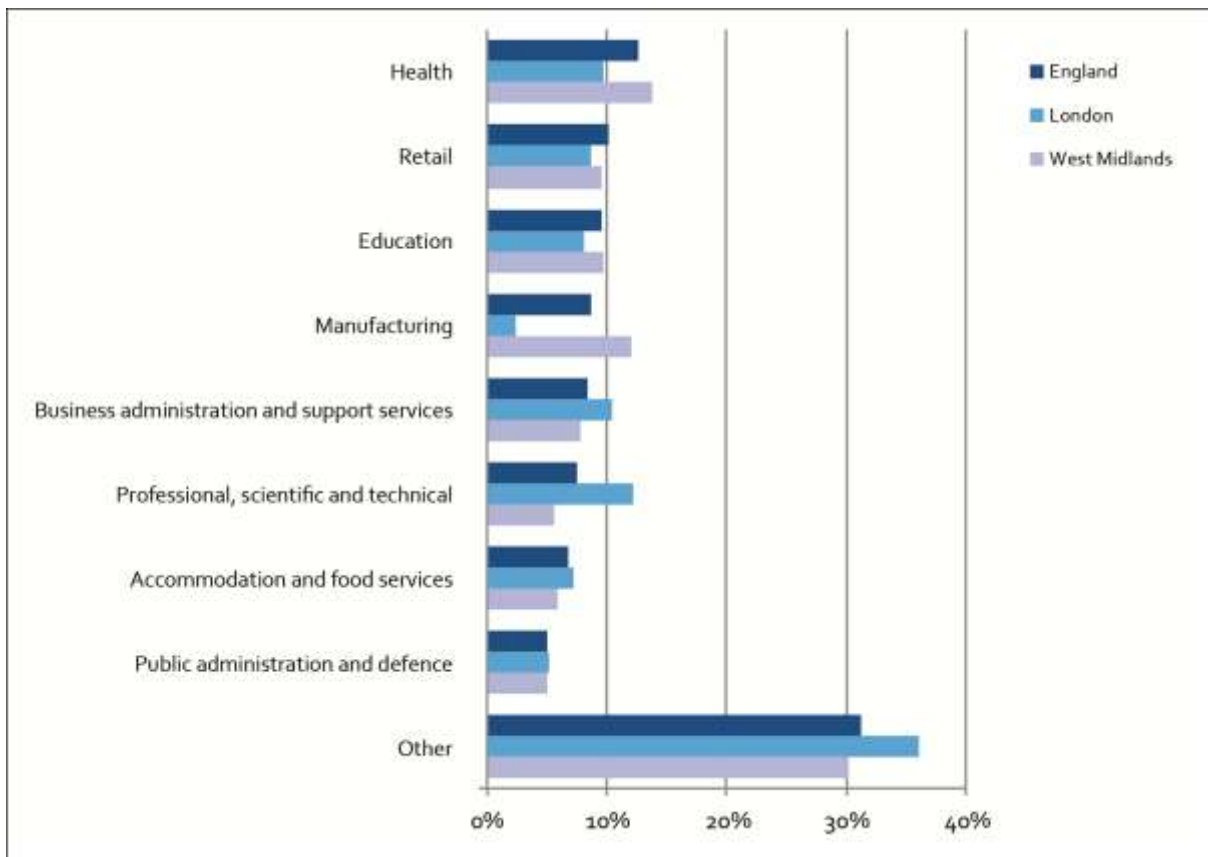
¹¹⁹ Between 1997 and 2011 England's average annual rate of change in GVA per person is 3.7% in nominal terms (unadjusted for inflation).

¹²⁰ ONS (2012), *Business Register and Employment Survey 2011*, ONS, London.

¹²¹ Defined by the broad sector groupings of: wholesale and retail trade; repair of motor vehicles and motorcycles; transport and storage; accommodation and food services; information and communication; financial and insurance; property; professional, scientific and technical; business administration and support services; public administration and defence; education; health; and arts, entertainment, recreation and other services.

¹²² The proportion of working age (16-74 year olds) residents in employment. Employment comprises the proportion of total resident population who are 'in employment' and includes full-time students who are employed.

¹²³ ONS (2012), *Census 2011*, ONS, London.

Figure 17: Proportion of employment by industry in London, the West Midlands and England^{124 125}

Construction sector

- 11.5.6 The construction sector is expected to remain an important and sizeable sector of the UK, London and West Midlands economies. In 2010, the UK construction sector generated £70,400 million GVA, of which £12,300 million was created in London and £6,300 million in the West Midlands¹²⁶. Construction workplace employment¹²⁷ measured 126,500 jobs in London and 106,200 jobs in the West Midlands, which implies a gross productivity rate per workplace job of £97,500 and £50,100 for London and the West Midlands respectively (by comparison, the figure for England as a whole is £68,200 per workplace job).
- 11.5.7 Given the large demand for construction workers required for the Proposed Scheme, it is relevant to consider other large projects which could impact on the availability of construction workers, especially those which will demand similar skill sets such as mechanical, electrical and civil engineering.
- 11.5.8 There are several large construction projects occurring at a similar time to the Proposed Scheme:
- Northern Line extension, London: Transport for London (TfL) is currently

¹²⁴ 'Other' includes transport and storage; arts, entertainment, recreation and other services; construction; wholesale; information and communication; financial and insurance; motor trades; property; mining, quarrying and utilities; agriculture, forestry and fishing.

¹²⁵ ONS (2012), *Business Register and Employment Survey 2011*, ONS, London.

¹²⁶ ONS (2012), *Regional Gross Value Added (Income Approach)*, December 2012. *Provisional estimates for headline GVA at current basic prices*, ONS, London using Table 3.4, *Headline GVA by 10 industries at current basic prices*.

¹²⁷ ONS (2012), *Business Register and Employment Survey 2011*, ONS London.

taking forward a proposal through a public inquiry to build and operate the extension. Planning, design and public consultation have been undertaken. The programme is estimated to begin in 2016 and finish in 2020;

- development associated with the Olympics Legacy: Policy 2.4 of the Mayor's London Plan¹²⁸ identifies the potential of the Olympic Games to deliver fundamental economic, social and environmental change in east London. The Mayor estimates that the Olympics Legacy area has the potential to provide around 32,000 new homes and 1.35 million m² of new and improved commercial floorspace. At the heart of the area is the Olympic Legacy Communities Scheme, for which the Olympic Park Legacy Company submitted the Legacy Communities Scheme planning applications in September 2011. The project will regenerate the Lea Valley and Stratford area. The construction period is due to begin in 2013 and complete in 2031, peaking in 2023 at 2,600 jobs¹²⁹;
- Thames Tideway Tunnel: The tunnel is to be constructed over a six-year period beginning in 2016; at its peak it is expected there will be 4,250 direct construction workers and a further 5,100 indirect jobs; and
- nuclear power station build programme: In 2019-2021, according to the Nuclear Energy Skills Alliance a maximum of seven nuclear new build station programmes could overlap. Across the seven programmes, demand is estimated to be between 11,000 to 14,000 permanent full time construction jobs¹³⁰, with a peak (excluding manufacturing) in employment of 14,000 jobs in the period 2020-2022 (coinciding with the Proposed Scheme's peak demand for construction jobs), the electrical, mechanical and construction workforce being the ones in most demand. It is likely that demand for construction workers will represent new jobs, with a significant proportion of employment being drawn from those currently in education and training¹³¹. These proposed power stations are in remote geographical locations, so it is anticipated that the construction workforce catchment areas will not overlap significantly with that of the Proposed Scheme.

11.5.9 For these major projects, it is anticipated that education and training programmes will be planned and rolled out in advance to ensure sufficient provision of suitable skills and workforce availability. There could also be a legacy effect of other major infrastructure projects such as Crossrail and Thames Tideway Tunnel, on the provision of suitably skilled construction workers, for example, the Tunnelling and Underground Construction Academy was established specifically for Crossrail to support the key skills required to work in tunnel excavation, underground construction and infrastructure. Based on the above, there is not envisaged to be a shortage of construction labour for the Proposed Scheme.

¹²⁸ Mayor of London (2011), *The London Plan: Spatial Development Strategy for Greater London*, Greater London Authority, London.

¹²⁹ Olympic Park Legacy Company (2012), *Legacy Communities Scheme, Regulation 22 and additional information submission, Employment Statement Addendum*.

¹³⁰ Assuming a ratio of ten construction person years to one full time permanent job.

¹³¹ The Nuclear Energy Skills Alliance (2010), *Renaissance Nuclear Skills Series 2, Next Generation - Skills for New Build Nuclear*, Cogent SSC Ltd., Warrington.

11.6 Assessment of effects during construction

- 11.6.1 There are broadly two types of impacts considered in the construction phase of the Proposed Scheme: employment associated with construction of the Proposed Scheme and employment associated with businesses affected by construction of the Proposed Scheme.

Construction employment

- 11.6.2 The Proposed Scheme will support employment in the construction industry over the construction period. Overall, it is estimated that the construction phase will generate 146,000 person years of construction employment opportunities¹³², or approximately the equivalent of 14,600 permanent full time construction jobs¹³³ which will be a major beneficial effect and is therefore considered to be significant.
- 11.6.3 Of these an estimated 75,900 persons years of construction jobs (or approximately the equivalent of 7,590 permanent full-time construction jobs will be based at worksites along the route), as described in the relevant Volume 2, CFA reports, Section 10. 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.
- 11.6.4 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.
- 11.6.5 It is estimated that construction of the Proposed Scheme could provide opportunities for around 1,000 apprenticeships in the construction workforce. 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.
- 11.6.6 The construction works will generate additional indirect demand for goods and services through the business supply chain and expenditure effects of workers which could deliver business opportunities and generate further employment¹³⁴. As a consequence, a further 54,750 person years of employment could be created or approximately the equivalent of 5,480 full-time jobs, which will be a major beneficial effect and is therefore considered to be significant.

¹³² 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.

¹³³ Based on the total construction person years generated by the Proposed Scheme and a ratio of ten construction person years to one full time permanent job.

¹³⁴ 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 English Partnerships (2008), *English Partnership Additionality Guide: A standard approach to assessing the impact of interventions (3rd Edition)*.

Businesses affected

- 11.6.7 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 the relevant Volume 2, CFA reports, Section 10. In most cases, it is concluded that the majority of businesses affected in this way will be able to relocate¹³⁵, given the availability of alternative premises and the payment of compensation, and therefore continue to operate. It is also concluded that a large proportion of employees who may lose their jobs as a consequence of their employer closing or relocating and contracting, will be able to re-enter the workforce relatively quickly given the size and strength of the relevant local labour market.
- 11.6.8 The construction phase will also result in some proposed developments not being implemented as a consequence of land required for the construction and/or operation of the Proposed Scheme. It is assumed that, in the majority of cases, these developments will instead come forward elsewhere in the region.
- 11.6.9 Route-wide, there is estimated employment of 12,700 jobs attributable to developments, which will be unable to proceed due to the Proposed Scheme. These include proposed developments at Old Oak Common, Curzon Street and Washwood Heath. There is substantial capacity at development sites within these areas and the surrounding sub-regions, which could accommodate additional demand for employment uses from the developments no longer considered viable due to the Proposed Scheme.
- 11.6.10 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 in this area. The London Development Agency (LDA) carried out research into the relocation of companies and jobs on account of the London 2012 Games. This research¹³⁶ indicated that the majority of businesses (88%) relocated while 12% of businesses did not continue to trade.
- 11.6.11 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 lost¹³⁷. There is a total relocation of 8,430 jobs from businesses as a result of land required for construction of the Proposed Scheme. This figure includes the loss of 55 agricultural jobs (full time equivalent) as a consequence of the permanent loss of land required for the Proposed Scheme.

¹³⁵ 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.

¹³⁶ 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*.

¹³⁷ 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, we are assuming a worse-case figure of 12% to represent total employment lost as a result of the Proposed Scheme.

- 11.6.12 If an assumption is made that 12% of all jobs associated with directly affected businesses as a result of the Proposed Scheme, will be lost route-wide, then approximately 1,010 jobs will be lost.
- 11.6.13 The direct loss of businesses and employment will have knock-on effects through the business supply chain and expenditure effects, and other economic adjustment factors¹³⁸. As a consequence, it is estimated an additional 380 jobs will be lost through indirect effects, route-wide.
- 11.6.14 Businesses displaced by the Proposed Scheme will be fully compensated within the provisions of the Compensation Code. HS2 Ltd recognises the importance of displaced businesses being able to relocate to new premises and will therefore provide additional support over and above statutory requirements to facilitate this.
- 11.6.15 For those socio-economic resources affected by land required for construction of the Proposed Scheme, there is a total relocation of employment of approximately 8,430 jobs. It is considered that the route-wide impact will be of high magnitude. The route-wide sensitivity of businesses is assumed to be medium. As such, there will be a major adverse effect, which is considered to be significant.
- 11.6.16 Business amenity and isolation effects have been assessed and reported within the relevant Volume 2, CFA reports, Section 10. Route-wide, there are approximately 60 businesses across the length of the route that may experience significant amenity 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 significantly affected are in the hospitality, leisure and recreation sectors, retail sector and industrial and manufacturing sectors. In total, these businesses support approximately 1,100 jobs¹³⁹ of which 90¹⁴⁰ jobs could potentially be lost or displaced. As a result of knock on effects through the business supply chain and expenditure effects, an additional 30 jobs could be lost or displaced. Route-wide, there is not considered to be a significant employment effect as a result of business amenity and isolation.
- 11.6.17 In total, approximately 1,510 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 that have lost their jobs, and have been unable to find work, come forward. As outlined in the Economic Case for HS2, 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 London and the West Midlands, which provide over six million jobs, the potential level of job loss is

¹³⁸ 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 English Partnerships (2008), *English Partnership Additionality Guide: A standard approach to assessing the impact of interventions (3rd Edition)*. Please refer to Volume 1 assumptions for further details on multipliers.

¹³⁹ Employment within businesses has been estimated through employment floor space and the Homes and Communities Agency (HCA) (2010), *Employment Density Guide (2nd edition)*, HCA, London. The estimate is calculated using standard employment density ratios and estimates of floor areas and may vary from actual employment at the sites.

¹⁴⁰ Employment loss has been estimated by first estimating the total employment of the business(es) affected; then, based on the business activity/sector type, by applying a percentage to represent the likely proportion of employment which could be significantly affected by changes in amenity.

a relatively small proportion of total employment. Table 7 provides a summary of this assessment of construction effects.

Table 7: Summary of the construction 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	High
Sensitivity	Medium
Overall significance	Major adverse

11.7 Assessment of effects during operation

11.7.1 There are two types of impact considered in the operational phase of the Proposed Scheme: employment associated with operation of the service, and employment associated with businesses affected by operation of the Proposed Scheme.

Operational employment

11.7.2 The Proposed Scheme will create direct operational employment at locations along the route including stations and maintenance depots, as well as employment associated with train crew facilities. The key locations of employment will be the four railway stations of the Proposed Scheme (London Euston, Old Oak Common, Birmingham Interchange and Birmingham Curzon Street); and at the Washwood Heath rolling stock maintenance depot in Birmingham and the Calvert infrastructure maintenance depot north-east of Bicester. The Proposed Scheme will also create employment at other stations located north of the Proposed Scheme on the existing classic rail network namely Manchester, Preston, Liverpool and Glasgow.

11.7.3 Retail floorspace will be built at London Euston station as part of the Proposed Scheme. This will result in an overall net gain of approximately 830m² of retail floorspace, creating an estimated 50 additional employment opportunities. There is also potential for over-site development to include employment generating uses, which would create direct employment opportunities. The hybrid Bill does not seek approval for over-site development.

11.7.4 Route-wide there will be an estimated 2,200 direct operational jobs created. This figure includes train crews on the classic compatible trains. Table 8 presents the demand for operational jobs by location.

Table 8: Proposed Scheme: direct operational employment¹⁴¹

Location of operational employment	Total employment (estimated)
London Euston	500
Old Oak Common	100
Calvert infrastructure maintenance depot	300
Birmingham Interchange	100
Birmingham Washwood Heath rolling stock maintenance depot	500
Birmingham Curzon Street	200
North of Handsacre to Glasgow (classic route network)	500
Total	2,200

- 11.7.5 The route-wide impact will be of medium magnitude while the sensitivity is considered to be high given the benefit that individuals will derive from employment. Route-wide the 2,200 direct operational jobs will be a major beneficial effect and is therefore considered to be significant.
- 11.7.6 The Proposed Scheme will create indirect employment opportunities at locations along the route associated with stations and maintenance depots, as well as employment associated with train crew facilities. 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 as part of operations on the Proposed Scheme and by workers employed by suppliers contracted to the Proposed Scheme. It is estimated that 830 jobs will be created route-wide through indirect effects as a result of the operational phase. Route-wide, the indirect employment impact will be a moderate beneficial effect and is therefore considered to be significant.
- 11.7.7 In addition, the anticipated increased footfall at and around stations is likely to generate demand for new retail and office floorspace, and generate wider employment opportunities during the operational phase. The new development at stations is also likely to encourage investment in their surrounding areas as businesses seek to capture transport user benefits and footfall.

Effects on existing business employment

- 11.7.8 Route-wide, the socio-economic assessment has not identified any adverse significant effects on employment due to operation of the Proposed Scheme beyond those already covered in the construction phase assessment.

¹⁴¹ Operational employment is estimated to the nearest 100 jobs and the figures are indicative and subject to change.

Table 9: Summary of the operational phase assessment

Direct operational employment created:	
Magnitude	Medium
Sensitivity	High
Overall significance	Major beneficial
Indirect operational employment created:	
Magnitude	Low
Sensitivity	High
Overall significance	Moderate beneficial

12 Sound, noise and vibration

12.1 Assessment of effects during construction

- 12.1.1 Noise and vibration effects from construction activities will be confined to local areas around construction operations. Construction noise and vibration effects have been assessed on a local basis and are described for each area within the relevant Volume 2, CFA reports, Section 12.
- 12.1.2 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.

12.2 Assessment of effects during operation

- 12.2.1 Noise and vibration effects from passing trains and fixed operational noise sources will occur locally on people and other sensitive receptors. Operational noise and vibration effects have been assessed on a local basis and are described for each area within the relevant Volume 2, CFA reports, Section 12.
- 12.2.2 No potentially significant noise or vibration effects arising from changes to existing roads have been identified.
- 12.2.3 It is considered that there will be no significant noise or vibration effects on a route-wide basis associated with operation of the Proposed Scheme

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13 Traffic and transport

13.1 Introduction and scope

13.1.1 This section provides an overview of the approach to and conclusions from the route-wide traffic and transport assessment (Volume 5: Appendix TR-001-000). It considers those impacts that may occur over a wide area due to changes in travel patterns. Location specific impacts that are remote from the route are considered separately in Volume 4. Impacts directly related to activities within an individual CFA (or combined CFA for those in London) are considered in the relevant Volume 2, CFA reports, Section 12, even if the impacts extend well beyond the route of the Proposed Scheme. This includes the onward travel of workers and movement of materials, to and from compounds in the CFAs.

13.2 Wider traffic and transport effects

13.2.1 Continued growth in demand is forecast for long distance rail travel to 2026 and beyond. Without the Proposed Scheme, the WCML, East Coast Main Line and Midland Main Line and other routes will become increasingly congested. The Proposed Scheme is expected to bring beneficial effect to transport users across a variety of trip types including commuter, business and leisure passengers. Key effects include:

- new additional rail capacity to accommodate future growth in demand for rail travel;
- reduced journey times between key destinations;
- increased capacity and reduced congestion on WCML medium distance and local services;
- increased capacity for freight services; and
- new travel opportunities for previously suppressed trips.

13.2.2 These effects are described in more detail below.

13.3 Effects arising during construction

13.3.1 The primary potential route-wide impacts during construction will result from:

- the collective impacts of traffic and rail movements (specifically those associated with the movement of excavated and fill materials); and
- the impacts of engineering works and possessions on the classic rail network as a result of the construction of the Proposed Scheme.

13.3.2 The collective impacts associated with the movement of excavated and fill materials has been scoped out of further consideration at the route-wide level given the expected small impact on the wider network. The impacts of construction traffic are focused on the road network close to the Proposed Scheme, which includes the principal corridors for bulk material movements. These are considered within Volume

2, CFA reports 1-26, Section 12. The sustainable placement of material adjacent to the Proposed Scheme and the use of rail to transport bulk materials, where reasonably practicable, will help to reduce wider traffic impacts of such movements. Consequently, construction traffic movements represent a very small proportion of total traffic on the strategic highway network.

- 13.3.3 Rail movements of bulk material will use spare train paths on the rail network and the balance of how to handle this between road and rail movements has been developed taking into account likely availability of train paths. As a result, the movement of materials by rail will be planned so that it can be accommodated within available capacity and not have significant transport impacts or effects.
- 13.3.4 Engineering works required on the classic rail network, and expected rail possessions during construction of the Proposed Scheme, will have the potential to cause disruption to services on the rail network. The assessment of such impacts has been based on analyses to identify works to the rail network. This has enabled the likely number, location and nature of works, as well as how they will be implemented to be established.
- 13.3.5 A number of works on the classic rail network are required, including:
- remodelling station layouts and track alignment to accommodate the HS2 tracks;
 - protection of existing rail assets where the route crosses over, adjacent to or under existing rail infrastructure;
 - the use of existing rail sidings to support the construction and operation of the Proposed Scheme; and
 - the linkage of temporary construction sidings to the rail network to support the construction process.
- 13.3.6 The potential scale of effect from these works 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, rail sidings and asset protection works will not have a direct impact on the operation of the classic rail network as they can be implemented without the need for disruptions to the railway and delay to passenger journeys. However, major track re-modelling has greater potential to affect services. In addition, 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.
- 13.3.7 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 individually. These are outlined below by CFA:
- Euston – Station and Approach area (CFA1): Removal, modification and re-instatement of existing Network Rail infrastructure at Euston station and its approaches;

- Camden Town and HS1 Link area (CFA2): Other works in North London which will interact with the existing railway on the North London Line and the freight only Primrose Hill Line;
- Kilburn (Brent) to Old Oak Common area (CFA4): Construction of Old Oak Common Station to provide an interchange between HS2 and Great Western Main Line services, HS1 services, Crossrail services and express services between Heathrow Airport and Paddington;
- Stoke Mandeville and Aylesbury area (CFA11): A realignment of the Aylesbury to Princes Risborough Line will be required just south of Aylesbury;
- Calvert, Steeple Claydon, Twyford and Chetwode area (CFA13): Works will be required at Calvert to create a number of proposed facilities including an infrastructure maintenance depot, a construction railhead and off-line realignment of the Oxford Branch Line that will all require amendment to the Network Rail infrastructure;
- North of the Whittington to Handsacre area (CFA22): The connection of the Proposed Scheme onto the WCML south of Colwich Junction will require crossover structures of the WCML, track works to tie the HS2 line into the WCML and alterations to power and signalling equipment;
- Washwood Heath to Curzon Street area (CFA26): Extensive remodelling of the mainline and sidings will be required to accommodate the Proposed Scheme on its approach into Birmingham, where it will run in close proximity to the Water Orton Line at Castle Bromwich Junction, through Washwood Heath infrastructure maintenance depot, under the Stechford to Aston Line, under Aston Church Road and Saltley viaduct before rising up and crossing the Water Orton Line at Duddeston Junction; and
- Curzon Street station (CFA26) will be constructed in close proximity to the Rugby to Birmingham Line and Moor Street station which is served by the Didcot to Chester Line.

13.3.8 These works have been considered in the relevant CFA reports in Volume 2. They are all relatively localised and short-term in duration and are not expected to have route-wide effects except as discussed in this section.

13.3.9 The method for implementing works will be through a series of planned possessions of the classic rail network. This is a standard technique widely used for the maintenance of the railway. A number of standard possessions will be used that, depending on the scale and complexity of the works required, will in almost all locations be restricted to mid-week night possessions, weekend 54 hour possessions and bank holiday weekend 100 hour possessions.

13.3.10 The type and scale of works proposed will be consistent with those adopted for current 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, but these will be

of short duration and, in isolation, are not considered to result in significant environmental effects.

- 13.3.11 The works at Euston station and its approaches will require a large number of possessions. The great majority of these will be non-disruptive possessions that will be of short duration and will take place during times as included above. These will not have any significant effects on passengers. Euston station will remain open during construction of the Proposed Scheme. It is expected that there will be only approximately 20 possessions that would have the potential to cause significant disruption to passengers. Some of these possessions will restrict either the operation of part of the station or its approaches. In particular, works to realign platform 15 will require a 16 day possession of the platform; works to permanently remove platforms 9 and 10 and extend platforms 8 and 11 will require a series of six 54 hour possessions; and works to accommodate the Proposed Scheme's platforms will permanently remove platforms 16 to 18.
- 13.3.12 Despite the scale of the works during construction, overall station capacity will be maintained through efficient use of available platform space and there will be only a relatively short period during which train frequency will reduce (with a loss of two peak trains to/from Watford). Once construction is complete, the total of platforms at Euston station will increase from the current 18 to 24, comprising 13 classic rail platforms and 11 HS2 platforms.
- 13.3.13 However, all of these activities during construction will place pressure on the available capacity and will have a potential impact on network performance and consequent delays to services and passengers on the WCML. The extent of change during construction at Euston station could result in some level of disruption to the services which run on the WCML.
- 13.3.14 The following are measures that HS2 Ltd will explore to reduce the impacts and effects on passengers from the disruptive possessions:
- the current access requirements reflect the present development of the design, and as the development progresses so too will the maturity of the access requirements;
 - any access to the operational railway will follow the recognised industry planning process controlled by Network Rail (NR);
 - HS2 Ltd will seek to optimise the access to the operational railway across all HS2 works by planning works in association with the NR enhancement and renewals plans eliminating possessions where possible and use existing railway access where applicable. This harmonisation includes using existing disruptive possessions and maximising the use of published NR track access availability;
 - HS2 Ltd will work with NR to minimise works on routes which would cause disruption to the travelling public on national holidays and on days when major leisure/sporting events are occurring;
 - due to programme constraints, concurrent works at the location will occur. However HS2 Ltd will seek to programme the works in such a way as to

eliminate as far as reasonably practicable concurrent works requiring major possessions of the railway affecting routes into major conurbations e.g. works at Euston concurrent with works affecting the GWML at Old Oak Common and NR;

- where total closure is necessary HS2 Ltd will work with NR to keep passengers on trains, albeit with extended journey times via different routes that ultimately reach the original final destination, e.g. if WCML is closed then re-routing passenger trains via the Chiltern Lines into Euston as is done today on occasions;
- where the final destination is not achievable a similar alternative will be offered e.g. as above but diverted into Paddington or Marylebone;
- provide rail replacement services where necessary when rail possessions are in place; and
- provide effective notification of disruption to the travelling public so that non-essential trips can be avoided or alternative routes are easily established.

13.3.15 Since these measures will mitigate the wider impacts described above, it has been assessed that there will be no significant route-wide effects arising as a result of the required railway possessions.

13.3.16 The localised impacts and effects at Euston station are assessed in Volume 2, CFA report 1, Section 12.

13.4 Effects arising during operation

Introduction and methodology

13.4.1 During operation, there will be substantial changes to train patterns and frequencies on the classic network both as a direct result of the Proposed Scheme services and also to take advantage of the capacity released on the classic network. This includes the potential for new services to take up classic rail network train paths released by HS2 services taking over the role of providing for long distance travel. These changes will provide journey time and accessibility benefits and are likely to reduce crowding and congestion on the classic network. This, in turn, has the potential to result in substantial changes in overall use of rail services and mode shift from the private car, long distance coach and air during the operation of the Proposed Scheme.

13.4.2 The expected changes to frequencies, routes and calling patterns on the classic rail network have been determined from the current assumptions embodied in the Economic Case for HS2. The analysis is presented for 2026 when the Proposed Scheme is scheduled to become operational, and for 2036 with the Proposed Scheme's network in operation.

13.4.3 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 the new stations of the Proposed Scheme). Stations that are forecast to

experience a substantial increase or decrease in daily weekday passenger numbers (greater than 5% and the change being more than 500 passengers) have been identified and are reported in this section.

The HS2 Phase One proposal

- 13.4.4 The Proposed Scheme will introduce a new high speed and high capacity route between London Euston and Birmingham Curzon Street with intermediate stations at Old Oak Common and Birmingham Interchange. The Proposed Scheme will also allow for onward running of classic compatible high speed trains north of Birmingham on the existing WCML to serve Manchester, Liverpool and Glasgow and selected intermediate stations (Phase Two will add further to the high speed network and locations served). At Old Oak Common station, the Proposed Scheme will also provide a link to the HS1 network that will accommodate international trains.
- 13.4.5 The assumed operational timetable for the Proposed Scheme is shown in Volume 1, and provides for ten trains per hour to serve Euston station. It assumes that all trains will call at Old Oak Common, with three trains per hour calling at Birmingham Interchange and terminating at Birmingham Curzon Street; two trains per hour terminating at Liverpool Lime Street; three trains per hour terminating at Manchester Piccadilly; one train per hour terminating at Preston and one train per hour terminating at Glasgow Central. Intermediate stations served will be: Stafford, Crewe, Warrington Bank Quay, Wigan North Western, Runcorn, Preston, Wilmslow and Stockport.
- 13.4.6 The passenger seating capacity for HS2 trains operating solely on the high speed line will be 1,100 in the peak and 550 in the off-peak. This will result in a daily capacity of 39,600 passengers in each direction on the London Euston to Birmingham Curzon Street route. Since this uses the dedicated HS2 route, the new additional capacity and its contribution towards accommodating future growth in rail use, represents a major beneficial effect which is significant.
- 13.4.7 On services travelling north of Birmingham on the high speed line and the WCML, the seating capacity on each train is currently expected to be 550. This will result in a daily HS2 capacity in each direction of 17,600 between London Euston and Liverpool; 26,400 between Euston and Manchester; and 8,800 between London Euston and Glasgow.
- 13.4.8 Journey time benefits will be achieved by the introduction of the Proposed Scheme. Expected journey times and the comparison with existing times are shown in Table 10.

Table 10 Journey times between key destinations 'without' and 'with' the Proposed Scheme in operation (Phase 1)

Origin / destination	Journey time	
	Without the Proposed Scheme (i.e.current)	With the Proposed Scheme
London Euston - Birmingham Interchange/International	1 hour 14 minutes	38 minutes
London Euston - Birmingham Curzon Street	1 hour 24 minutes	49 minutes
London Euston - Manchester Piccadilly	2 hours 8 minutes	1 hour 40 minutes
London Euston - Liverpool Lime Street	2 hours 8 minutes	1 hour 50 minutes
London Euston - Glasgow Central	4 hours 8 minutes	4 hours

13.4.9 Table 10 shows the substantial journey time benefits provided by the Proposed Scheme. The biggest proportionate benefits are achieved where the service uses just the HS2 route. Journey times between London and Birmingham are reduced by some 35 minutes, almost halving the current journey time. Similarly, journey time savings will also be achieved where the HS2 route will be used in combination with the WCML to serve locations north of Birmingham, with the journey time between London and Manchester reducing by 28 minutes, a 22% reduction. The resultant travel time savings for forecast rail users represents a major beneficial effect which is significant.

13.4.10 The subsequent introduction of Phase Two will further substantially reduce journey times, with the journey time between London and Manchester reducing to 1 hour 8 minutes; and travel time between London and Leeds reducing from 2 hours 12 minutes to 1 hour 23 minutes.

Released capacity

13.4.11 The transfer of long distance passengers from the classic WCML rail network to the Proposed Scheme will create the opportunity to provide additional services and to stop services at more locations on the classic network. The actual service patterns, including the use of released capacity, will be determined nearer to the time of opening of the Proposed Scheme.

13.4.12 A released capacity timetable specification has been developed for the Economic Case for HS2 and used in this assessment. The general principles underpinning the use of the released capacity have been to increase capacity in corridors with high demand; and to address some of the reliability and overcrowding issues that currently exist and that are otherwise forecast to intensify as a result of increased demand for rail travel. The general approach in the use of released capacity has been to reduce long distance WCML services and replace them with enhancement of the medium distance and local commuter routes into London and into Birmingham.

13.4.13 The assessed timetable in the 2026 base case includes 157 long distance services departing per day on the classic rail network from London Euston and 96 additional medium distance and local services. With the Proposed Scheme in operation, there will be 86 longer distance trains and 173 medium distance and local trains on WCML. In total, the number of classic rail services serving London Euston will remain largely unchanged, with 253 trains per day expected in the 2026 base case and 259 expected when the Proposed Scheme is operational. This data is summarised in Table 11.

Table 11 2026 Base case / with Proposed Scheme comparison of number of trains leaving London on the WCML

Service type (excluding HS2 trains)	Number of trains per day in assessed timetable	
	2026 Base case	2026 with the Proposed Scheme
Long distance trains	157	86
Medium distance and local trains	96	173
Total	253	259

13.4.14 Similar changes are envisaged along the WCML including in the West Midlands. Along the WCML from London to Birmingham, the introduction of the Proposed Scheme will result in the removal of some long distance trains as they are no longer needed. The combination of HS2 trains and WCML trains running on the classic rail network will result, in most cases, in an increase in the service level and capacity at main line stations. For instance, with the timetable assumptions, daily stopping WCML services at Watford will increase by some 20%. Milton Keynes will see stopping services increase by 6%. Also, the transfer of some passengers to HS2 trains will reduce loadings on classic rail services through these locations. These service enhancements and reduced loadings can be expected to provide net increases in capacity and reduced crowding with the Proposed Scheme compared to the base case without the Proposed Scheme.

13.4.15 Of particular note, given the extent of crowding on commuter routes into London, are improvements to the commuter services by providing more capacity on busy routes and by more stopping services. Both enhancements will contribute to less congestion and crowding. However, there will be some reductions in service levels at a limited number of stations but these will generally reflect the reduced loadings on trains (either users of the station itself or through passengers from other origins) resulting from a number of the users transferring to HS2 services.

13.4.16 Overall, the use of the released long distance train paths by medium distance and local services, coupled with the reduction in long distance passenger numbers using trains on the WCML, will increase capacity and reduce congestion and passenger crowding, thereby providing a major beneficial effect which is significant.

13.4.17 It is also expected that an additional ten train paths each way on the WCML will be available for freight services running between London and the Midlands (each train path is equivalent to 50 HGV per day per direction). This is considered a minor beneficial effect.

13.4.18 This assessment has assumed that there will be no changes to the Proposed Scheme’s services between 2026 and 2036. Therefore, the effects presented here apply generally to both 2026 and 2036 (Phase One). However, it should be noted that, as rail use continues to grow between 2026 and 2036, the need for and the benefits of increased capacity will continue to increase. In addition, with the introduction of Phase Two in 2033, further changes to services could be expected.

Passenger demand

13.4.19 The increased capacity and improved journey times that will result from the Proposed Scheme and the additional services provided to take advantage of released capacity will generate increased demand for rail travel. The Proposed Scheme will provide an attractive substitute for many users of the long distance rail services that would operate in the absence of HS2. The improvements will also encourage changes in mode share from car and potentially air trips. As well as generating new rail trips and attracting users of car and air to use HS2 services.

13.4.20 The PLANET Framework Model has been used to forecast demand for rail, car and air and to establish the extent of changes in mode share. Forecasts for 2026 and 2036 have been considered for the future base cases and for the Proposed Scheme scenarios. The PLANET Framework Model reports on a national basis and estimates for the base case that there will be over two million daily long distance trips in 2026, with 74% undertaken by highway, 24% by rail and 2% by air modes. By 2036, long distance travel in the base case is forecast to have increased by 10%, with the majority of these new trips being made by rail.

13.4.21 The impact of the Proposed Scheme’s capacity and reduced journey times results in HS2 use for over 112,000 passenger trips (combined flow from both directions) on a typical day in 2026, rising to approximately 142,000 by 2036.

13.4.22 Table 12 shows these forecast numbers of HS2 passenger trips for 2026 and 2036, the numbers of generated new trips and, for the remainder, the mode of travel that they will have transferred from.

Table 12 Origin mode of HS2 passenger trips – typical day

From mode	Origin of trips (average day, combined both directions)	
	2026 with the Proposed Scheme	2036 with the Proposed Scheme
Classic rail	86,900 (77%)	107,200 (75%)
Generated by the Proposed Scheme	22,100 (19%)	30,600 (21%)
Air	800 (1%)	1,000 (1%)
Car	3,000 (3%)	3,700 (3%)
Total	112,700	142,500

13.4.23 When expressed in annual terms, Table 13 shows that there will be 34.8 million passenger trips per annum in 2026, rising to approximately 44 million in 2036.

Table 13 Origin mode of HS2 passenger trips – annual

From mode	Origin of trips (average day, combined both directions)	
	2026 with the Proposed Scheme	2036 with the Proposed Scheme
Classic rail	26,840,000 (77%)	33,127,400 (75%)
Generated	6,821,500 (19%)	9,440,000 (21%)
Air	249,000 (1%)	312,400 (1%)
Car	923,300 (3%)	1,136,000 (3%)
Total	34,833,800	44,015,800

13.4.24 The PLANET Framework Model has been used to identify increases and decreases of daily passenger use at stations. To illustrate the wide spread of these changes, those stations where there is forecast to be a 5% change in passenger numbers (and this is more than 500 per day) are shown in Table 14. These show the extent of the benefits in rail accessibility. Stations within London are considered within Volume 2, CFA reports 1-4, Section 12.

Table 14 Percentage changes in passenger numbers arriving/departing at stations in 2026 and 2036

Station	2026	2036
	% change	% change
Increase		
Runcorn	32%	36%
Wilmslow	16%	18%
Watford Junction	15%	16%
Stafford	12%	15%
Wolverhampton	12%	13%
Crewe	12%	12%
Rugby	10%	11%
Northampton	10%	10%
Manchester Airport	8%	8%
Decrease		
Wellingborough	-7%	-7%
Cheltenham Spa	-8%	-7%
Lancaster	-8%	-8%
Coventry	-8%	-8%
Leamington Spa	-14%	-11%
Worcester Shrub Hill	-14%	-14%

Station	2026	2036
	% change	% change
Salford Central	-21%	-22%

- 13.4.25 The stations where growth is shown are either stations that will be served by the Proposed Scheme or those that benefit from additional services as a result of released capacity and less crowded trains. Stations where there are reductions are generally relatively close to HS2 services and it is expected that a number of passengers will use an HS2 station for convenience and other benefits. These changes provide supporting evidence to demonstrate the significant beneficial effect previously identified.
- 13.4.26 The impacts and effects that individual changes in station flows will have on the surrounding transport networks are further considered in Volume 4: Off-route effects.
- 13.4.27 The introduction of the Proposed Scheme will increase the number of annual long distance rail passenger trips and reduce the long distance vehicle trips. This is quantified in Table 15 which shows an increase in rail trips in 2026 of approximately eight million rising to 10.9 million in 2036. There is a corresponding fall in long distance car trips of approximately 900,000 in 2026 rising to 1.1 million in 2036.

Table 15 Changes in annual long distance trips

	2026 with the Proposed Scheme	2036 with the Proposed Scheme
Annual change in rail passenger trips as a result of the Proposed Scheme	+ 8 million	+10.9 million
Annual change in car trips as a result of the Proposed Scheme	- 0.9 million	- 1.1 million

- 13.4.28 The transfer of passengers from the classic rail network and from mode transfer from car will result in benefits through reducing forecast future congestion on both the strategic highway and the classic rail network. The extent of reduction in vehicle kilometres as a result of the Proposed Scheme is shown in Table 16.

Table 16 Reduction in vehicle-kilometres resulting from mode shift

	Reduction in vehicle-kilometres travelled	
	2026 with the Proposed Scheme	2036 with the Proposed Scheme Highway
Annual reduction in vehicle kilometres as a result of mode shift to the Proposed Scheme	181.7 million	211.9 million

- 13.4.29 The extent of change in annual vehicle kilometres on strategic long distance highway routes will result in some limited relief of congestion and improvement in traffic speeds (or provide the opportunity to accommodate growth in overall travel demands), particularly on the West Midlands to London highway corridor. This

reduction in vehicle kilometres excludes any consideration of the transfer of freight from road to rail.

- 13.4.30 The overall change in rail travel, with some 20% of HS2 trips being generated as new travel, demonstrates the levels of travel suppressed by current capacity constraints and journey times. The overall change in rail travel shows the substantial travel opportunities and aspirations that the Proposed Scheme and the released capacity services will realise. This is a major beneficial effect.

14 Waste and material resources

14.1 Introduction

General

- 14.1.1 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.
- 14.1.2 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. These are considered in the appropriate sections of Volume 2 and Volume 3.¹⁴²
- 14.1.3 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 waste.
- 14.1.4 An overview of the types and quantity of waste that will be generated within each CFA is presented within Volume 2 as follows:
- Section 2.3 of each CFA report for construction waste and material resources; and
 - Section 2.4 of each CFA report for operational waste and material resources.
- 14.1.5 Further details of the types and quantities of waste that will be generated within each CFA are presented within Volume 5: Appendix WM-001-000.
- 14.1.6 Other supporting information specific to this route-wide assessment is also presented in Volume 5: Appendix WM-002-000. This information includes:
- the local policy framework applicable to this assessment;
 - environmental baseline information comprising the types, quantities and management routes of waste generated in London boroughs and in counties along the route of the Proposed Scheme;
 - environmental baseline information comprising waste infrastructure capacity data for London boroughs and counties along the route of the Proposed

¹⁴² For liquid waste, see Volume 2: CFA Reports, Section 13 (water resources and flood risk assessment). For the direct and indirect effects of waste-related transport, see Volume 2: CFA Reports, Section 13 (traffic and transport assessment), Section 4 (air quality assessment) and Section 12 (sound, noise and vibration assessment) and Volume 3: Route-wide effects, Section 5 (climate assessment). For mineral resources, see Volume 2: CFA Reports, Section 8 (land quality assessment).

Scheme; and

- a schedule of developments for cumulative assessment.

Context

Need for route-wide assessment

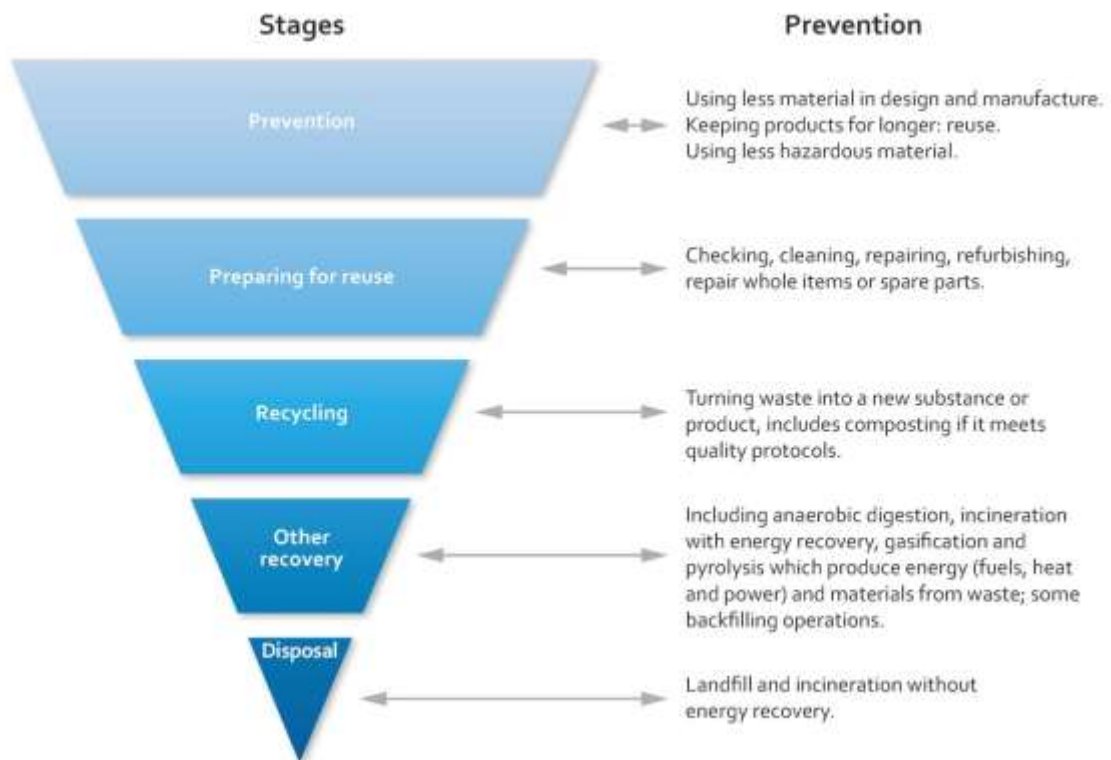
- 14.1.7 The movement of waste from source to final destination is a complex process as waste is often transferred across waste planning authority boundaries for treatment and disposal according to the type of waste and the nature of the waste management facility required.
- 14.1.8 Waste planning authorities 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 and the need to take account of waste that may need to be imported from other areas for treatment and disposal.
- 14.1.9 For this reason, waste planning has traditionally been undertaken on a county and, until recently, regional level basis that takes account of the need for the inter-regional movement of waste within England.
- 14.1.10 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 will be generated by the Proposed Scheme, has been undertaken on a route-wide basis.
- 14.1.11 This route-wide approach takes into account waste arisings and waste infrastructure capacity data available at county and regional level. Comprehensive waste data at district and borough level is often limited and so has not been considered for use in this assessment.

Environment effects of waste management

- 14.1.12 The waste hierarchy¹⁴³ (see Figure 18) sets out the preferred approach to the management of waste from waste prevention, to reuse, recycling, energy recovery and landfill as a last resort.

¹⁴³ Adapted from Defra (2011), *Government Review of Waste Policy in England 2011*. London, HMSO.

Figure 18: Waste hierarchy



- 14.1.13 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.
- 14.1.14 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.
- 14.1.15 In England and Wales, waste producers are legally required to apply the waste hierarchy to decisions concerning the management of waste¹⁴⁴. 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 so¹⁴⁵.
- 14.1.16 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.

¹⁴⁴ *The Waste (England and Wales) Regulations 2011 (SI 2011 No. 988) (as amended)*. London, HMSO.

¹⁴⁵ DCLG (2011), *Planning Policy Statement 10: Planning for Sustainable Waste Management*. London, HMSO.

Design approach and mitigation

- 14.1.17 An integrated design approach has been developed that seeks to minimise the quantity of surplus excavated material generated, reuse that which is generated to satisfy the necessary engineering and environmental mitigation earthworks requirements for the Proposed Scheme 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.
- 14.1.18 A CL:AIRE Code of Practice Materials Management Plan¹⁴⁶ will also be prepared in advance of the implementation of 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.
- 14.1.19 For the surplus excavated material which cannot be beneficially reused for the earthworks of the Proposed Scheme, the nominated undertaker will seek to provide surplus excavated material for:
- use in other local construction projects where opportunities arise at the time of construction; and/or
 - use for restoration of mineral sites, where the transportation of that material does not result in significant environmental effects.
- 14.1.20 Where the transportation of that material would result in significant environmental effects, sustainable placement will be used.
- 14.1.21 Sustainable placement is the on-site placement for disposal of surplus excavated material to avoid causing environmental effects (e.g. transport) that would otherwise be associated with the off-site disposal of that material.
- 14.1.22 Sites for sustainable placement have been selected on the basis of their suitability for the disposal of surplus excavated material.

14.2 Policy framework

General

- 14.2.1 The assessment and mitigation 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 have 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

- 14.2.2 The NPPF does not contain any specific policies on waste planning. Waste planning policy is currently retained within Planning Policy Statement 10 (PPS10): Planning for

¹⁴⁶ Contaminated Land: Applications in Real Environments (2011), *The Definition of Waste: Development Industry Code of Practice (Version 2, March 2011)*.

Sustainable Waste Management¹⁴⁷. PPS10 will be replaced by the Updated National Waste Planning Policy: Planning for Sustainable Waste Management following the end of consultation in September 2013¹⁴⁸.

- 14.2.3 PPS10 sets out the Government's approach to delivery of sustainable waste management including:
- the promotion of the waste hierarchy and use of waste as a resource;
 - the use of landfill as a least preferred waste management option but one that must still be adequately provided for;
 - provision of a framework for communities to take more responsibility of their waste; and
 - ensuring that the design and layout of new development supports sustainable waste management.
- 14.2.4 The Waste Management Plan for England¹⁴⁹, released for consultation in July 2013, provides an analysis of the current waste management situation in England and a framework to support further implementation of the objectives and provisions of the European Waste Framework Directive (2008/98/EC)¹⁵⁰. Its purpose is to consolidate a number of existing policies within the context of a single national waste management plan.
- 14.2.5 The Government Review of Waste Policy in England 2011 contains the main policies of relevance to the Waste Management Plan for England¹⁵¹. 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.
- 14.2.6 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 Infrastructure¹⁵². 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.
- 14.2.7 Government strategy for halving construction, demolition and excavation waste (CDEW) to landfill is set out within the Government's Strategy for Sustainable Construction¹⁵³.

¹⁴⁷ DCLG (2011), *Planning Policy Statement 10: Planning for Sustainable Waste Management*. HMSO.

¹⁴⁸ DCLG (2013), *Planning for Sustainable Waste Management (Consultation)*. London, HMSO.

¹⁴⁹ Defra (2013), *Waste Management Plan for England*. London, HMSO.

¹⁵⁰ *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives*. Strasbourg, European Parliament and European Council.

¹⁵¹ Defra (2011), *Government Review of Waste Policy in England 2011*. London, HMSO.

¹⁵² Defra (2013), *National Policy Statement for Hazardous Waste: A Framework Document for Planning Decisions on Nationally Significant Hazardous Waste Infrastructure*. London, HMSO.

¹⁵³ HM Government (2008), *Strategy for Sustainable Construction*. London, HMSO.

Regional policy framework

- 14.2.8 Regional spatial strategies applicable to areas along the route outside of Greater London were revoked early in 2013 and have not been replaced by other equivalent policy measures¹⁵⁴. The London Plan: Spatial Development Strategy for Greater London (The London Plan) is the only remaining regional spatial strategy applicable to the Proposed Scheme¹⁵⁵.
- 14.2.9 Chapter 5 of the London Plan (London's Response to Climate Change) outlines policy on resource and waste management within the context of a fully integrated economic, environmental, transport and social framework for the development of London to 2031.
- 14.2.10 Within Chapter 5 of the London Plan, policy provisions are made with respect to waste self-sufficiency (i.e. managing as much as possible of Greater London's waste within the regional boundary) and use of the planning regime to drive implementation of the waste hierarchy on major development sites. The latter is also intended to help support the supply of recycled secondary aggregates for use in construction activities in London.
- 14.2.11 The London Plan sets targets of 95% reuse and recycling of CDEW, and 70% reuse and recycling of commercial and industrial (C&I) waste in London by 2020. Making Business Sense of Waste: The Mayor's Business Waste Management Strategy for London provides specific policies setting out how these targets are to be met¹⁵⁶. It also refers to the London Plan Supplementary Planning Guidance on Sustainable Design and Construction that sets out the essential and preferred standards that should be taken into consideration in the design of major new development¹⁵⁷.

Local policy framework

- 14.2.12 Following abolition of the regional assemblies and revocation of regional spatial strategies, waste planning is now provided for at the regional planning level for Greater London (by the London Plan) and at the county planning level elsewhere along the route of the Proposed Scheme.
- 14.2.13 Outside of London, local development frameworks for minerals and waste planning provide the local policy framework of relevance to this assessment. Often in the form of core strategies, local plans or development plans, these frameworks set out the strategic vision and overall spatial strategy applicable to waste and material resources. This is in relation to the development of waste infrastructure and waste generation and management associated with non-waste development.
- 14.2.14 A summary of the local policy framework applicable to this assessment is set out within Volume 5: Appendix WM-002-000.

¹⁵⁴ Applicable to the East of England (revoked 3 January 2013), South East (revoked 25 March 2013), East Midlands (revoked 12 April 2013), and West Midlands (revoked 20 May 2013).

¹⁵⁵ Greater London Authority (2011), *The London Plan: Spatial Development Strategy for Greater London*.

¹⁵⁶ Greater London Authority (2011), *Making Business Sense of Waste: The Mayor's Business Waste Management Strategy November 2011*.

¹⁵⁷ Greater London Authority; *Sustainable Design and Construction: The London Plan Supplementary Planning Guidance*; http://www.london.gov.uk/the-london-plan/guides/spg/spg_04.jsp; Accessed 7 July 2013.

14.2.15 Given the route-wide nature of this assessment, district and borough-level policy provisions applicable to waste planning and non-waste development (where relevant to the generation and management of waste) have not been considered further in this section.

14.3 Scope, assumptions and limitations

14.3.1 The scope of this assessment is set out in full within Volume 1, Section 16 of the SMR (Volume 5: Appendix CT-001-000/1) and Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

14.3.2 Assumptions and limitations relevant to this assessment are as set out within Volume 1.

14.4 Assessment methodology

14.4.1 This assessment follows the methodology described in Section 16 of the SMR (Volume 5: Appendix CT-001-000/1) and Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2), along with supporting annexes¹⁵⁸.

14.5 Environmental baseline

General

14.5.1 The baseline comprises environmental conditions with respect to the types, quantities and management routes of waste generated in England, and within each of the county and former regional planning areas through which the Proposed Scheme will pass.

14.5.2 The types of waste described in this context are:

- CDEW that will be generated during the overall construction phase of the Proposed Scheme (2017 to 2025);
- C&I waste that will be generated from worker accommodation sites during the overall construction phase of the Proposed Scheme (2017 to 2025); and
- C&I waste that will be generated during the first year of operation of the Proposed Scheme (2026).

14.5.3 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 Proposed Scheme will pass.

14.5.4 Baseline conditions are presented as existing environmental conditions (based on latest available published data) and then as future baseline conditions for the period 2017 to 2025 (construction period) and 2026 (first full year of operation).

14.5.5 The spatial scope and study area for this assessment is defined as the aggregated five regions as shown in Table 17. These regions comprise of the former regional planning areas through which the Proposed Scheme will pass. The aggregated five regions also

¹⁵⁸ See waste forecast and assessment methodology technical note and Rationale for landfill significance criteria technical note.

represent the administrative areas for which waste arisings and waste infrastructure data is available¹⁵⁹ and within which the various waste streams are likely to be managed.

- 14.5.6 Reference is also made in this assessment to specific local areas (shown in Table 17) within the aggregated five regions. Local areas are the London boroughs and counties through which the Proposed Scheme will pass.

Table 17: Study area for assessment

Regional area	Local area
Greater London	City of Westminster, the Royal Borough of Kensington and Chelsea and the London boroughs of Camden, Brent, Hammersmith and Fulham, Ealing and Hillingdon
South East	Buckinghamshire and Oxfordshire
East of England	Hertfordshire
East Midlands	Northamptonshire
West Midlands	Warwickshire, Staffordshire and the metropolitan areas of Solihull and Birmingham

- 14.5.7 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.

- 14.5.8 Given the route-wide nature of this assessment, only regional-level baseline and future baseline information is presented within this section. Local-level information (i.e. for local areas within Greater London and counties) along the route of the Proposed Scheme is presented in Volume 5: Appendix WM-002-000.

Waste arisings and management

Construction, demolition and excavation waste

National construction, demolition and excavation waste arisings and management

- 14.5.9 According to the latest available national data, a total of 77,375,430 tonnes of CDEW were generated in England in 2010¹⁶⁰. Of this amount:
- 42,184,000 (55%) tonnes were recycled into aggregate;
 - 8,150,134 (10%) tonnes were used on exempt sites;
 - 7,202,705 (9%) tonnes went to waste transfer or treatment facilities; and
 - 19,838,591 (26%) tonnes entered permitted landfill.
- 14.5.10 Comprehensive information on the likely future growth of CDEW arisings nationally across England is limited. A number of existing regional and local studies, such as

¹⁵⁹ Comprehensive data for waste arisings and waste infrastructure capacity is not available on a community forum area basis.

¹⁶⁰ Defra; *Construction, Demolition and Excavation Waste Generation Estimate: England, 2008 to 2010*; <https://www.gov.uk/government/publications/construction-and-demolition-waste>; Accessed: 11 November 2013.

those used within this assessment, suggest reasonably stable growth in CDEW arisings to around 2025 and beyond to 2030 (the timeframe for most local development frameworks).

- 14.5.11 Reasonably stable growth is also expected based on trend data (2001 to 2005) for England published by Defra¹⁶¹.

Regional construction, demolition and excavation waste arisings and management

- 14.5.12 Regional CDEW arisings and management are shown in Table 18 and are based on the latest available comprehensive dataset for regional CDEW arisings in England¹⁶².

Table 18: Baseline construction, demolition and excavation waste arisings by region, 2005

Regional area	Total arisings (tonnes)	Recycled aggregate and soil (tonnes)	Used on exempt sites (tonnes)	Landfill (tonnes)
Greater London	8,030,000	4,840,000	2,040,000	1,150,000
South East	14,250,000	6,620,000	2,513,000	5,117,000
East of England	11,550,000	6,030,000	1,680,000	3,840,000
East Midlands	9,820,000	5,590,000	730,000	3,500,000
West Midlands	9,840,000	4,920,000	2,910,000	2,010,000
Total	53,490,000	28,000,000	9,873,000	15,617,000
Proportion	100%	52%	19%	29%

- 14.5.13 Table 18 indicates that over half of all CDEW generated regionally is recycled into aggregate, a further 19% is diverted from landfill through reuse at exempt sites and 29% is sent to landfill (including for engineering, capping and disposal purposes according to the data published).

- 14.5.14 In line with the outlook for national CDEW arisings, reasonably stable growth is expected based on trend data (2001 to 2005) for England published by Defra¹⁶³.

Local construction, demolition and excavation waste arisings and management

- 14.5.15 Local CDEW arisings and management for the year 2013 (baseline) and the period 2017 to 2025 (future baseline) are presented in detail in Volume 5: Appendix WM-002-000.

¹⁶¹ Defra; *Construction and Demolition Waste Management 1999 to 2005: England (Construction and Demolition Waste Management 1999 to 2005 - based on information taken from Department for Communities and Local Government, Survey of Arisings and Use in Construction, Demolition and Excavation Waste as Aggregate in England, 1999, 2001 and 2005)*;
<http://archive.defra.gov.uk/evidence/statistics/environment/waste/kf/wrkfog.htm>; Accessed 11 November 2013.

¹⁶² Defra; *Construction and Demolition Waste Management 1999 to 2005: Data Tables (Table No.8 - Estimated Re-Use, Recycling and Disposal of Hard Construction, Demolition and Excavation Waste by Region, 2005)*;
<http://archive.defra.gov.uk/evidence/statistics/environment/waste/kf/wrkfog.htm>; Accessed 11 November 2013.

¹⁶³ Defra; *Construction and Demolition Waste Management 1999 to 2005: England (Construction and Demolition Waste Management 1999 to 2005 - based on information taken from Department for Communities and Local Government, Survey of Arisings and Use in Construction, Demolition and Excavation Waste as Aggregate in England, 1999, 2001 and 2005)*;
<http://archive.defra.gov.uk/evidence/statistics/environment/waste/kf/wrkfog.htm>; Accessed 11 November 2013.

14.5.16 The local CDEW arisings and management information presented in Volume 5: Appendix WM-002-000 originates from different information sources but would otherwise contribute to the CDEW arisings and management data presented in Table 18¹⁶⁴.

Commercial and industrial waste

National commercial and industrial waste arisings and management

14.5.17 Latest available information from Defra reports that, in 2009, a total of 47,928,000 tonnes of C&I waste were produced in England¹⁶⁵. Of this amount:

- 24,957,000 tonnes (52%) was reused, recycled or composted;
- 8,063,000 tonnes (17%) was diverted from landfill via various treatment and recovery methods;
- 11,280,000 tonnes (24%) was disposed to landfill; and
- the fate of 3,628,000 tonnes (7%) was unknown.

14.5.18 The Economics of Waste and Waste Policy provides C&I waste growth forecasts for England¹⁶⁶. Using extrapolation of regional data, which Defra considers to provide a more accurate forecast¹⁶⁷, C&I waste arisings in England are projected to remain at around 50 million tonnes from 2015 to 2025¹⁶⁸.

Regional commercial and industrial waste arisings and management

14.5.19 Regional C&I waste arisings¹⁶⁹ and management methods¹⁷⁰ are shown in Table 19 and are based on latest available data from Defra.

Table 19: Baseline commercial and industrial 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)
Greater London	4,811,000	2,498,000	123,000	730,000	986,000	474,000
South East	6,250,000	3,278,000	199,000	952,000	1,308,000	512,000

¹⁶⁴ The aggregated five regions include local areas other than the London boroughs and counties directly along the route of the Proposed Scheme.

¹⁶⁵ Defra; *Survey of Commercial and Industrial Waste Arisings 2010 - Revised Final Results*; <https://www.gov.uk/government/publications/commercial-and-industrial-waste-generation-and-management>; Accessed 11 November 2013.

¹⁶⁶ Defra; *The Economics of Waste and Waste Policy, June 2011*; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf; Accessed 24 September 2013.

¹⁶⁷ Defra reports that arisings estimates from the model are much closer to those actually observed than an alternative scenario that has been considered.

¹⁶⁸ Defra; *The Economics of Waste and Waste Policy, June 2011 - Figure A.6*; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf; Accessed 24 September 2013. C&I waste arisings projections are projected at just over 50 million tonnes in 2015, around 50 million tonnes in 2020 and just less than 50 million tonnes in 2025.

¹⁶⁹ Defra; *Survey of Commercial and Industrial Waste Arisings 2010 - Revised Final Results*; <https://www.gov.uk/government/publications/commercial-and-industrial-waste-generation-and-management>; Accessed 11 November 2013.

¹⁷⁰ Defra; *Commercial and Industrial Waste Survey 2009: Final Report, May 2011*; <https://www.gov.uk/government/publications/commercial-and-industrial-waste-generation-and-management>; Accessed 11 November 2013.

Regional area	Total arisings (tonnes)	Reuse, recycling or composting (tonnes)	Energy recovery (tonnes)	Other treatment, recovery and transfer (tonnes)	Landfill (tonnes)	Unknown (tonnes)
East of England	4,507,000	2,274,000	94,000	928,000	858,000	354,000
East Midlands	6,308,000	3,073,000	94,000	885,000	1,948,000	308,000
West Midlands	5,247,000	2,738,000	100,000	737,000	1,202,000	470,000
Total	27,123,000	13,861,000	610,000	4,232,000	6,302,000	2,118,000
Proportion	100%	51%	2%	16%	23%	8%

14.5.20 Table 19 indicates that around half of all C&I waste generated regionally is reused, recycled or composted, a further 18% is diverted from landfill via various treatment and recovery methods, and 23% is sent to landfill. The fate of 8% of C&I waste generated is reported as unknown.

14.5.21 In line with the outlook for national C&I waste arisings, reasonably stable growth is expected based on forecasts for England published by Defra¹⁷¹.

Local commercial and industrial waste arisings and management

14.5.22 Local C&I waste arisings and management for the year 2013 (baseline), the period 2017 to 2025 (future baseline for construction) and the year 2026 (for operation) are shown in detail in Volume 5: Appendix WM-002-000.

14.5.23 The local C&I waste arisings and management information presented in Volume 5: Appendix WM-002-000 originates from different information sources but would otherwise contribute to the C&I waste arisings and management data presented in Table 19¹⁷².

Waste infrastructure

General

14.5.24 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 Proposed Scheme will pass. Waste infrastructure capacity is not provided on a national basis since it is not required for use in this assessment.

14.5.25 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

¹⁷¹ Defra; *The Economics of Waste and Waste Policy, June 2011*; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69500/pb13548-economic-principles-wr110613.pdf; Accessed 24 September 2013.

¹⁷² The aggregated five regions include local areas other than the London boroughs and counties directly along the route of the Proposed Scheme.

regions. Permitted landfill capacity data from the Environment Agency has also been used to inform the significance criteria used in this assessment¹⁷³.

Baseline

- 14.5.26 Table 20 provides baseline waste infrastructure capacity data for the aggregated five regions through which the Proposed Scheme will pass¹⁷⁴.
- 14.5.27 The baseline information presented is based on permitted capacity for all types of waste treatment and disposal facility for the year 2011, 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.
- 14.5.28 Baseline waste infrastructure capacity data for the relevant London boroughs and counties within each of the five regions is shown in Volume 5: Appendix WM-002-000.

Table 20: Baseline waste infrastructure capacity by region, 2011

Facility type	Greater London (tonnes)	South East (tonnes)	East of England (tonnes)	East Midlands (tonnes)	West Midlands (tonnes)	Total (tonnes)
Inert waste landfill	1,123,500	41,832,000	11,505,000	34,131,000	15,646,500	104,238,000
Non-hazardous waste landfill	7,283,250	55,520,360	42,457,820	34,766,210	42,076,850	182,104,490
Hazardous waste landfill	325,500	1,879,500	0	361,500	705,000	3,271,500
Sub-total landfill	8,732,250	99,231,860	53,962,820	69,258,710	58,428,350	289,613,990
Municipal waste, C&I waste incineration	1,863,000	1,762,000	0	260,000	1,140,000	5,025,000
Other incineration	227,000	656,000	901,000	694,000	429,000	2,907,000
Sub-total incineration	2,090,000	2,418,000	901,000	954,000	1,569,000	7,932,000
Waste transfer	6,762,000	5,441,000	4,414,000	3,144,000	3,736,000	23,497,000
Waste treatment	3,171,000	6,004,000	6,920,000	3,387,000	2,481,000	21,963,000
Metal recycling	1,229,000	2,173,000	2,415,000	1,101,000	2,395,000	9,313,000
Sub-total treatment and waste transfer	11,162,000	13,618,000	13,749,000	7,632,000	8,612,000	54,773,000
Total	21,984,250	115,267,860	68,612,820	77,844,710	68,609,350	352,318,990

- 14.5.29 In relation to the information presented in Table 20, landfill capacity information is published by the Environment Agency in cubic metres but has been converted to tonnes using the following landfill density conversion factors:

- 1.5 tonnes per cubic metre for inert waste landfill;

¹⁷³ Rationale for landfill significance criteria technical note appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

¹⁷⁴ Environment Agency; *Waste Data Table 2011*; <http://www.environment-agency.gov.uk/research/library/data/14,2773.aspx>; Accessed 11 November 2013.

- 0.83 tonnes per cubic metre for non-hazardous waste landfill; and
- 1.5 tonnes per cubic metre for hazardous waste landfill¹⁷⁵.

14.5.30 The capacity of waste transfer, waste treatment and metal recycling facilities presented in Table 20 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

- 14.5.31 It is expected that various types of waste infrastructure capacity will continue to be available during the period 2017 to 2025 (for construction) and in 2026 (for operation).
- 14.5.32 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 assessment, the future baseline for waste infrastructure capacity is limited to information on landfill disposal capacity only.
- 14.5.33 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/EC¹⁷⁶ (the Landfill Directive). This relates to the capacity of inert, non-hazardous and hazardous waste landfill that will be available during the period 2017 to 2025 (for construction) and 2026 (for operation) within each of the former regional planning areas through which the Proposed Scheme will pass.
- 14.5.34 Projected landfill capacity is based on the average percentage change in permitted landfill capacity for the years 2004 to 2011 (for inert and non-hazardous waste landfills)¹⁷⁷ and for the years 2006 to 2011 (for hazardous waste landfill)¹⁷⁸ as reported by the Environment Agency¹⁷⁹. The average percentage change has then been applied to the reported 2011 permitted landfill capacity and projected forward to 2026.
- 14.5.35 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 also provides a reasonable allowance for potential future increases in permitted capacity for each class of landfill.
- 14.5.36 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

¹⁷⁵ As used to inform significance criteria for this assessment set out in Rationale for landfill significance criteria technical note appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

¹⁷⁶ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

¹⁷⁷ Based on latest available historic datasets published by the Environment Agency.

¹⁷⁸ Due to changes in legislation concerning hazardous waste landfill in 2005, historic data for permitted hazardous waste landfill capacity pre-2006 has not been used (i.e. it is not comparable to that published since 2006).

¹⁷⁹ Environment Agency; *Waste Data and Information*; <http://www.environment-agency.gov.uk/research/library/data/34169.aspx>; Accessed 11 November 2013.

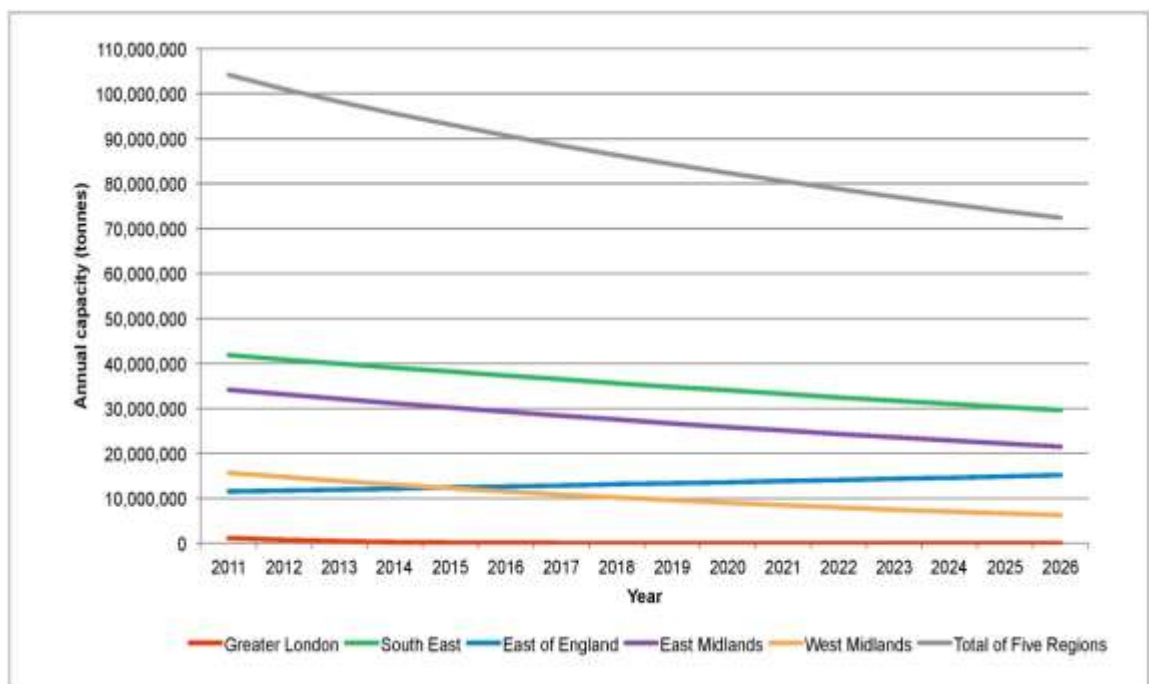
need to be imported from other areas for treatment and disposal. Subject to receipt of planning permission and other criteria stipulated by waste planning authorities, new, permitted landfill capacity is likely to be provided to meet any future gaps in inert, non-hazardous and hazardous waste landfill capacity.

14.5.37 The information presented is therefore considered to be a reasonable scenario with respect to future landfill capacity within the five regions that form the scope of the study area (see Table 17). 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

14.5.38 Using latest available published data for the year 2011 as a starting point, Figure 19 shows projected inert waste landfill capacity for the future baseline period 2017 to 2025 (for construction) and the year 2026 (operation). Detailed source data is presented in Volume 5: Appendix WM-002-000.

Figure 19: Projected (future baseline) inert waste landfill capacity by region



14.5.39 Figure 19 shows that, by 2026, there will be approximately 72 million tonnes of inert waste landfill capacity remaining in the aggregated five regions through which the Proposed Scheme will pass. This is a reduction from over 100 million tonnes of inert waste landfill capacity in 2011, which reflects a gradual decline in inert waste landfill capacity in four out of the five regions shown.

14.5.40 Inert waste landfill capacity is projected to decline in four of the five regions throughout the period to 2026. The exception is for the East of England where inert waste landfill capacity is projected to increase from approximately 11 million tonnes to 15 million tonnes by 2026.

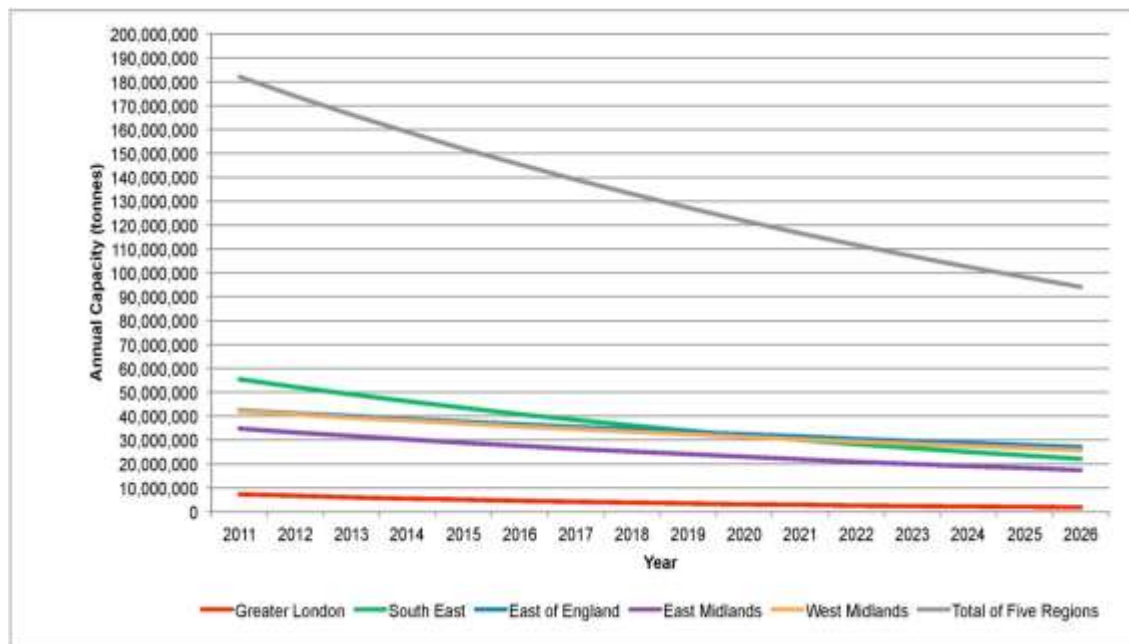
14.5.41 The greatest amount of inert waste landfill capacity will be available in the South East, with a projected capacity of approximately 30 million tonnes by 2026.

14.5.42 It is projected that Greater London will have the least amount of inert waste landfill capacity remaining by 2026.

Non-hazardous waste landfill capacity

14.5.43 Using latest available published data for the year 2011 as a starting point, Figure 20 shows projected non-hazardous waste landfill capacity for the future baseline period 2017 to 2025 (for construction) and the year 2026 (operation). Detailed source data is presented in Volume 5: Appendix WM-002-000.

Figure 20: Projected (future baseline) non-hazardous waste landfill capacity by region



14.5.44 Figure 20 shows that, by 2026, there will be approximately 94 million tonnes of non-hazardous waste landfill capacity remaining in the aggregated five regions through which the Proposed Scheme will pass. This is a reduction from over 180 million tonnes of non-hazardous waste landfill capacity in 2011, which reflects a gradual decline in non-hazardous waste landfill capacity in each of the five regions.

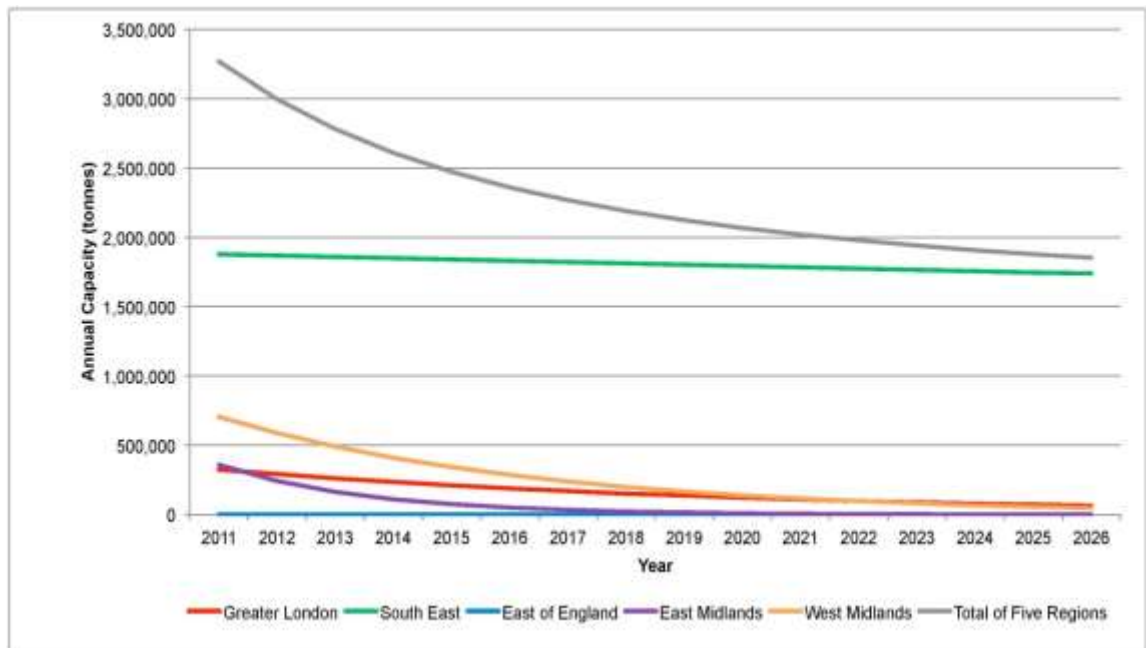
14.5.45 The greatest amount of non-hazardous waste landfill capacity will be available in the East of England and West Midlands with an average capacity of approximately 26 million tonnes between the two regions in 2026.

14.5.46 It is projected that Greater London will have the least amount of non-hazardous waste landfill capacity remaining by 2026, which is projected to decline to approximately 1.8 million tonnes.

Hazardous waste landfill capacity

14.5.47 Using latest available published data for the year 2011 as a starting point, Figure 21 shows projected hazardous waste landfill capacity for the future baseline period 2017 to 2025 (for construction) and the year 2026 (operation). Detailed source data is presented in Volume 5: Appendix WM-002-000.

Figure 21: Projected (future baseline) hazardous waste landfill capacity by region



14.5.48 Figure 21 shows that, by 2026, there will be approximately 1.8 million tonnes of hazardous waste landfill capacity remaining in the aggregated five regions through which the Proposed Scheme will pass. The majority (approximately 94%) of this available capacity will be in the South East, equivalent to approximately 1.7 million tonnes.

14.5.49 Hazardous waste landfill capacity is projected to decline to less than approximately 100,000 tonnes in each of Greater London, the East Midlands and West Midlands by 2026.

14.5.50 According to data published by the Environment Agency, as of 2011, there was no hazardous waste landfill capacity available in the East of England hence zero capacity is projected throughout the period to 2026.

14.6 Assessment of effects during construction

Avoidance and mitigation measures

14.6.1 Management of CDEW and worker accommodation site waste generated by the Proposed Scheme will be subject to the Environmental Minimum Requirements (EMR) set out within Volume 1.

14.6.2 EMR of key relevance to this assessment include:

- the draft CoCP, which sets out measures to provide effective planning, management and control during construction; and
- an environmental memorandum, which identifies the management approach to, and controls on, environmental aspects of the Proposed Scheme that have been agreed with stakeholders such as the Environment Agency and Natural England.

- 14.6.3 An integrated design approach has been developed that seeks to minimise the quantity of surplus excavated material generated, reuse that which is generated to satisfy the necessary engineering and environmental mitigation earthworks requirements for the Proposed Scheme 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.
- 14.6.4 A CL:AIRE Code of Practice Materials Management Plan will be prepared at a later stage of design to support implementation of the integrated design approach¹⁸⁰. 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.
- 14.6.5 Sustainable placement is the on-site placement for disposal of surplus excavated material to avoid causing environmental effects (e.g. transport) that would otherwise be associated with the off-site disposal of that material.
- 14.6.6 Three sustainable placement areas have been selected on the basis of their suitability for the disposal of surplus excavated material. These sustainable placement areas are detailed in Table 21. This will reduce the quantity of inert surplus excavated material to be disposed off-site to landfill by approximately 6,856,960 tonnes.

Table 21: Sustainable placement areas for the Proposed Scheme

Sustainable placement area (SPA) reference	Quantity (tonnes)	Sustainable placement region	Sustainable placement site	Map references
SPA1	2,884,487	Greater London	Four areas at Harvil Road	CT-06-019a-R1 and CT-06-019a-L1 ¹⁸¹ CT-06-019b-R1 and CT-06-019b-R2 ¹⁸²
SPA2	1,928,002	South East	South Heath	CT-06-035 ¹⁸³
SPA3	2,044,471	South East	Calvert	CT-06-055 ¹⁸⁴
Total	6,856,960	-	-	-

- 14.6.7 A site waste management plan will be prepared and maintained in line with statutory and policy requirements applicable at the time of construction of the Proposed Scheme¹⁸⁵.

¹⁸⁰ Contaminated Land: Applications in Real Environments (2011), *The Definition of Waste: Development Industry Code of Practice (Version 2, March 2011)*.

¹⁸¹ CFA 6 (South Ruislip to Ickenham).

¹⁸² CFA 7 (Colne Valley).

¹⁸³ CFA 10 (Dunsmore, Wendover and Halton).

¹⁸⁴ CFA 13 (Calvert, Steeple Claydon, Twyford and Chetwode).

¹⁸⁵ A SWMP records the amount and type of waste generated by a construction project and how it will be managed in terms of reuse, recycling, recovery and disposal. It is also used to record details of the actions taken to minimise the quantity of waste forecast to be generated through project design or as a result of the construction methods and / or materials used.

- 14.6.8 Other environmental controls stated in Section 6.4 of Volume 1 will apply to the management of CDEW and worker accommodation site waste generated during construction of the Proposed Scheme. These controls will include implementation of local environmental management plans, environmental management systems and procedures for measurement and monitoring, auditing and record-keeping.

Assessment of impacts and effects

Waste forecast

Excavated material quantities

- 14.6.9 Table 22 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 across the Proposed Scheme. A detailed excavated material quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).

Table 22: Forecast excavated material quantities for the Proposed Scheme, 2017 to 2025

Excavated material management methods	Total quantity (tonnes)	Proportion
Quantity of excavated material reused for engineering and environmental mitigation earthworks	116,649,579	91%
Quantity of surplus excavated material for sustainable placement	6,856,960	5%
Quantity of surplus excavated material for off-site disposal to landfill	4,492,557	4%
Total	127,999,096	100%

- 14.6.10 The Proposed Scheme will generate approximately 127,999,096 tonnes of excavated material during the period 2017 to 2025.
- 14.6.11 Table 22 shows that 91% of the excavated material generated by the Proposed Scheme will be used to satisfy the necessary engineering and environmental mitigation earthworks quantities required on a route-wide basis.
- 14.6.12 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 Materials¹⁸⁶:
- Class 1 and Class 3 general railway fill;
 - Class 2 general railway fill and general highway fill;
 - Class 4 environmental mitigation earthworks fill;
 - Class 6 selected fill;

¹⁸⁶ DfT; Highways Agency, *Manual of Contract Documents for Highway Works, Volume 1 – Specification for Highway Works, Series 600 Earthworks*; <http://www.dft.gov.uk/ha/standards/mchw/vol1/>; Accessed 11 November 2013.

- Unacceptable material classes U1A and U1B (treated)¹⁸⁷; and
- topsoil and agricultural subsoil.

14.6.13 The estimated quantity of surplus excavated material that will not be reused within the construction of the Proposed Scheme will be less than 10% of the overall excavated material that will be generated on a route-wide basis. This will comprise of:

- approximately 6,856,960 tonnes of surplus excavated material that will be managed via sustainable placement; and
- approximately 4,492,557 tonnes of surplus excavated material that will require off-site disposal to landfill.

14.6.14 The quantity of surplus excavated material that will be disposed off-site to each class of landfill is shown in Table 23.

Table 23: Quantity of surplus excavated material requiring off-site disposal to landfill (by class of landfill)¹⁸⁸, 2017 to 2025

Class of landfill	Total quantity (tonnes)	Proportion
Quantity of surplus excavated material for off-site disposal to inert waste landfill	3,760,937	84%
Quantity of surplus excavated material for off-site disposal to non-hazardous waste landfill	394,329	9%
Quantity of surplus excavated material for off-site disposal to hazardous waste landfill	337,291	7%
Total	4,492,557	100%

Surplus excavated material for off-site disposal to inert waste landfill

14.6.15 Table 23 shows that, subject to waste acceptance criteria set out in the Landfill Directive¹⁸⁹ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills¹⁹⁰, the majority (approximately 84%) of surplus excavated material requiring off-site disposal to landfill will be inert in nature.

14.6.16 This includes material classifications (Class 1 and Class 3 general railway fill, Class 2 general railway fill and general highway fill, Class 4 environmental mitigation earthworks fill, Class 6 selected fill and Unacceptable Class U1A materials) that will be disposed off-site to inert waste landfill under List of Wastes Code 17 05 04 (soil and

¹⁸⁷ 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)*.

¹⁸⁸ Article 4 (Classes of Landfill) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste sets out three classes of landfill: landfill for hazardous waste, landfill for non-hazardous waste and landfill for inert waste.

¹⁸⁹ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

¹⁹⁰ Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

stones other than those containing 'dangerous substances'¹⁹¹) as defined by the List of Wastes (England) Regulations 2005 (SI 2005 No. 895) (as amended)¹⁹².

- 14.6.17 Opportunities may arise at the time of construction to provide inert surplus excavated material for off-site reuse in other local construction projects, thereby increasing diversion of this material from landfill. For the purpose of this assessment, it has been assumed as a reasonable worst-case scenario that all of this material will be disposed off-site to landfill.

Surplus excavated material for off-site disposal to non-hazardous waste landfill

- 14.6.18 Subject to waste acceptance criteria set out in the Landfill Directive¹⁹³ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills¹⁹⁴, surplus excavated material that will require off-site disposal to non-hazardous waste landfill represents the quantity of Unacceptable Class U1B material that will be generated by the Proposed Scheme (approximately 394,329 tonnes). This material will not be suitable either for reuse within the Proposed Scheme or sustainable placement due to the chemical properties of this material.

Surplus excavated material for off-site disposal to hazardous waste landfill

- 14.6.19 Subject to waste acceptance criteria set out in the Landfill Directive¹⁹⁵ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills¹⁹⁶, surplus excavated material that will require off-site disposal to hazardous waste landfill represents the quantity of Unacceptable Class U2 material that will be generated by the Proposed Scheme (approximately 337,291 tonnes)¹⁹⁷.
- 14.6.20 Unacceptable Class U2 material will be unsuitable for reuse within the Proposed Scheme and for sustainable placement due to the hazardous nature of the material.

Demolition material and waste quantities

- 14.6.21 Table 24 presents a summary of the forecast demolition material and waste quantities for the Proposed Scheme. A regional and route-wide summary is shown to indicate where along the route demolition materials will be generated and managed¹⁹⁸. A detailed demolition material and waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).

¹⁹¹ 'Dangerous substance' means any substance that has been or will be classified as dangerous in Council Directive 67/548/EEC and its subsequent amendments. *The List of Wastes (England) Regulations 2005 (SI 2005 No. 895) (as amended)* refers to a substance being hazardous if it contains dangerous substances, either absolutely or above specified threshold concentrations (depending on the nature of the hazardous property).

¹⁹² *The List of Wastes (England) Regulations 2005 (SI 2005 No. 895) (as amended)*. London, HMSO.

¹⁹³ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

¹⁹⁴ Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

¹⁹⁵ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

¹⁹⁶ Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

¹⁹⁷ Unacceptable material Class U2 'hazardous waste', as described in the *Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials* sub-Clause 3(i).

¹⁹⁸ It has been assumed that demolition materials will be largely managed within the region in which they will be generated.

- 14.6.22 Demolition material quantities have been estimated using the Waste and Resources Action Programme 'Demolition bill of quantities estimator'¹⁹⁹, which uses the basic dimensions and typology of buildings to be demolished. Using this methodology, the Proposed Scheme will generate approximately 1,601,741 tonnes of demolition material during the overall construction period of 2017 to 2025.

Table 24: Forecast demolition material and waste quantities (by region) for the Proposed Scheme, 2017 to 2025

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	601,112	541,001	60,111
South East	74,510	67,059	7,451
East of England	2,478	2,230	248
East Midlands	44,308	39,877	4,431
West Midlands	879,333	791,399	87,934
Total	1,601,741	1,441,566	160,175

- 14.6.23 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 of other large-scale infrastructure projects in the UK (e.g. Crossrail, London 2012 Olympics and High Speed 1).
- 14.6.24 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment, that the remaining 10% of demolition material that will be generated will be disposed of off-site to landfill. The quantity of demolition waste that will require off-site disposal to landfill during the overall construction period of 2017 to 2025 will be approximately 160,175 tonnes. The class of landfill to which demolition waste will be sent for disposal is shown in Table 25.

Table 25: Quantity of demolition waste requiring off-site disposal to landfill (by class of landfill)²⁰⁰, 2017 to 2025

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	96,105	60%
Quantity of demolition waste for off-site disposal to hazardous waste landfill	64,070	40%
Total	160,175	100%

- 14.6.25 The nature of demolition waste requiring disposal to landfill is indicative based on information published by the Construction Resources & Waste Platform in its report,

¹⁹⁹ Waste and Resources Action Programme; *Net Waste Tool*; <http://nwtool.wrap.org.uk/>; Accessed 11 November 2013.

²⁰⁰ Article 4 (Classes of Landfill) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste sets out three classes of landfill: landfill for hazardous waste, landfill for non-hazardous waste and landfill for inert waste.

Overview of Demolition Waste in the UK²⁰¹. Using waste data provided by the National Federation of Demolition Contractors, the reports states that approximately 91% of demolition waste is reused and recycled. This would account for most of the inert fraction of the waste according to information provided in the report²⁰².

- 14.6.26 The Construction Resources & Waste Platform further states that around 3% of demolition waste is hazardous and a further 6% of demolition waste is sent to non-hazardous waste landfill.
- 14.6.27 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.

Construction waste quantities

- 14.6.28 Table 26 presents a summary of the forecast construction waste quantities for the Proposed Scheme. A regional and route-wide summary is shown to provide an indication of where along the route construction waste will be generated and managed²⁰³. A detailed construction waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).
- 14.6.29 Construction waste quantities have been estimated based on a waste generation rate of 26.4 tonnes per £100,000 of construction spend. This waste generation rate has been derived from industry-wide benchmark performance data procured from the Building Research Establishment Ltd²⁰⁴. Using this methodology, the Proposed Scheme will generate approximately 2,727,818 tonnes of construction waste during the overall construction period of 2017 to 2025.

Table 26: Forecast construction waste quantities (by region) for the Proposed Scheme, 2017 to 2025

Regional area	Total quantity of waste (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	1,315,930	1,184,337	131,593
South East	470,119	423,107	47,012
East of England	15,035	13,531	1,504
East Midlands	126,292	113,663	12,629
West Midlands	800,442	720,398	80,044
Total	2,727,818	2,455,036	272,782

- 14.6.30 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 of other

²⁰¹ Construction Resources and Waste Platform; *Overview of Demolition Waste in the UK*; <http://www.strategicforum.org.uk/pdf/10WasteActionPlan.pdf>; Accessed 30 September 2013.

²⁰² Overall diversion from landfill of 91% comprising of 17% aggregates used on-site, 25% of aggregates removed off-site, 36% of aggregates crushed for on-site re-use and 14% aggregates crushed for off-site re-use.

²⁰³ It has been assumed that construction waste will be largely managed within the region in which it will be generated.

²⁰⁴ Building Research Establishment Ltd (2013), *Construction Waste Benchmarks for Railway Projects*.

large-scale infrastructure projects in the UK (e.g. Crossrail, London 2012 Olympics and High Speed 1).

- 14.6.31 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment, that the remaining 10% of construction waste that will be 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 2017 to 2025 will be approximately 272,782 tonnes.
- 14.6.32 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 Establishment²⁰⁵, Strategic Forum for Construction²⁰⁶ and Waste and Resources Action Programme²⁰⁷. These sources suggest that 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 that are unsuitable for reuse and recycling.

Worker accommodation site waste

- 14.6.33 Table 27 presents a summary of the forecast worker accommodation site waste quantities for the Proposed Scheme. A regional and route-wide summary is shown to provide an indication of where along the route worker accommodation site waste will be generated and managed²⁰⁸. A detailed worker accommodation site waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).

Table 27: Forecast worker accommodation site waste quantities (by region) for the Proposed Scheme, 2017 to 2025

Regional area	Total quantity of waste (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	134	67	67
South East	708	354	354
East of England	71	36	35
East Midlands	281	140	141
West Midlands	723	361	362
Total	1,917	958	959

- 14.6.34 Worker accommodation site waste quantities have been forecast based on a waste generation rate of 0.031 tonnes per worker per month, according to the number of

²⁰⁵ Building Research Establishment; *Waste and Recycling*; <http://www.smartwaste.co.uk/smartaudit/downloads/chiswick.pdf>; Accessed 30 September 2013.

²⁰⁶ Strategic Forum for Construction; *Waste: An Action Plan for Halving Construction, Demolition and Excavation Waste to Landfill, June 2011*; <http://www.strategicforum.org.uk/pdf/10WasteActionPlan.pdf>; Accessed 30 September 2013.

²⁰⁷ Waste and Resources Action Programme; *Reference Document on the Status of Wood Waste Arisings and Management in the UK*; http://www2.wrap.org.uk/downloads/WOQ0041_Final_Report_June_20051_b6b12d04_3560.pdf; Accessed 30 September 2013.

²⁰⁸ It has been assumed that worker accommodation site waste will be largely managed within the region in which it will be generated.

workers to be accommodated and the duration of occupation²⁰⁹. Using this methodology, the Proposed Scheme will generate approximately 1,917 tonnes of worker accommodation site waste during the overall construction period of 2017 to 2025. Worker accommodation site waste will be managed as C&I waste.

- 14.6.35 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 and takes into account the most recently published performance data for household waste and local authority collected waste in England (i.e. for the year 2011/12).
- 14.6.36 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 2017 to 2025 will be approximately 959 tonnes²¹⁰.
- 14.6.37 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.

Impact of construction on future baseline waste arisings

Construction, demolition and excavation waste

- 14.6.38 Table 28 provides a summary of material and waste quantities that will be generated by excavation, demolition and construction of the Proposed Scheme during the period 2017 to 2025.

Table 28: Summary of material and waste quantities that will be generated by excavation, demolition and construction of the Proposed Scheme, 2017 to 2025

Source	Total quantity of material (tonnes)	Quantity diverted from landfill (tonnes)	Quantity of surplus excavated material for sustainable placement (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Excavation	127,999,096	116,649,579	6,856,960	4,492,557
Demolition	1,601,741	1,441,566	-	160,175
Construction	2,727,818	2,455,036	-	272,782
Total	132,328,655	120,546,181	6,856,960	4,925,514
Proportion	100%	91%	5%	4%

²⁰⁹ For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

²¹⁰ This figure is slightly more than 50% as described due to rounding of figures to whole numbers.

- 14.6.39 Table 28 shows that the Proposed Scheme will generate approximately 132,328,655 tonnes of excavated material, demolition material and construction waste during the period 2017 to 2025. Over 90% of this total quantity will be diverted from landfill via reuse, recycling and recovery.
- 14.6.40 The impact of this material and waste generation and its off-site disposal to landfill is shown in Table 29 as the percentage difference between future baseline CDEW arisings with and without the Proposed Scheme.
- 14.6.41 Future baseline CDEW arisings are presented as the total quantity projected to be generated during the period 2017 to 2025. 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 29: Impact of material and waste quantities that will be generated by excavation, demolition and construction of the Proposed Scheme, 2017 to 2025

Future baseline scenario with and without the Proposed Scheme	National change		Regional change ²¹¹	
	CDEW arisings (tonnes)	CDEW arisings to landfill (tonnes)	CDEW arisings (tonnes)	CDEW arisings to landfill (tonnes)
Future baseline waste arisings 2017 to 2025 without the Proposed Scheme	696,378,870 ²¹²	178,547,319 ²¹³	481,410,000 ²¹⁴	140,553,000 ²¹⁵
Proposed Scheme material and waste arisings 2017 to 2025	132,328,655	4,925,514	132,328,655	4,925,514
Future baseline waste arisings 2017 to 2025 with the Proposed Scheme	828,707,525	183,472,833	613,738,655	145,478,514
Increase in future baseline waste arisings with the Proposed Scheme	+19%	+3%	+27%	+4%

- 14.6.42 Table 29 shows that the total quantity of excavated material, demolition material and construction waste generated by the Proposed Scheme will be equivalent to approximately 19% of national and 27% of regional future baseline CDEW arisings during the period 2017 to 2025.
- 14.6.43 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 will be equivalent to approximately 3% of national and 4% of regional future baseline CDEW arisings to landfill during that time.

Worker accommodation site waste

- 14.6.44 The total quantity of worker accommodation site waste that will be generated during the overall construction period of 2017 to 2025 is shown in Table 27 (along with the

²¹¹ Based on future baseline CDEW arisings and CDEW to landfill for the aggregated five regions.

²¹² Based on annual projection of 77,375,430 tonnes nationally as set out in Section 14.5 (national construction, demolition and excavation waste arisings and management).

²¹³ Based on an annual projection of 19,838,591 tonnes nationally as set out in Section 14.5 (national construction, demolition and excavation waste arisings and management).

²¹⁴ Based on an annual projection of 53,490,000 tonnes for the aggregated five regions as set out in Section 14.5 (Table 18).

²¹⁵ Based on an annual projection of 15,617,000 tonnes for the aggregated five regions as set out in Section 14.5 (Table 18).

quantity that will be diverted from landfill via reuse, recycling and recovery and the quantity that will require off-site disposal to landfill).

- 14.6.45 The impact of worker accommodation site waste generation and off-site disposal to landfill is shown in Table 30 as the percentage difference between future baseline C&I waste arisings with and without the Proposed Scheme.
- 14.6.46 Future baseline C&I waste arisings are presented as the total quantity projected to be generated during the period 2017 to 2025. 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 30: Impact of commercial and industrial waste arisings generated by the Proposed Scheme, 2017 to 2025

Future baseline scenario with and without the Proposed Scheme	National change		Regional change ²¹⁶	
	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)
Future baseline waste arisings 2017 to 2025 without the Proposed Scheme	431,352,000 ²¹⁷	101,520,000 ²¹⁸	244,107,000 ²¹⁹	56,718,000 ²²⁰
Proposed Scheme waste arisings 2017 to 2025	1,917	959	1,917	959
Future baseline waste arisings 2017 to 2025 with the Proposed Scheme	431,353,917	101,520,959	244,108,917	56,718,959
Increase in future baseline waste arisings with the Proposed Scheme	0.0004%	0.001%	0.001%	0.002%

- 14.6.47 Table 30 shows that the total quantity of worker accommodation site waste generated by the Proposed Scheme will be equivalent to less than 0.1% of national and regional future baseline C&I waste arisings during the period 2017 to 2025.
- 14.6.48 The total quantity of worker accommodation site waste that will require off-site disposal to landfill will be equivalent to less than 0.1% of national and regional future baseline C&I waste arisings to landfill during that time.

Likely significant environmental effects

Inert waste landfill capacity

- 14.6.49 Subject to waste acceptance criteria set out in the Landfill Directive²²¹ and the Proposal for a Council Decision Establishing Criteria and Procedures for the

²¹⁶ Based on future baseline C&I waste arisings and C&I waste to landfill for the aggregated five regions.

²¹⁷ Based on an annual projection of 47,928,000 tonnes nationally as set out in Section 14.5 (national commercial and industrial waste arisings and management).

²¹⁸ Based on an annual projection of 11,280,000 tonnes nationally as set out in Section 14.5 (national commercial and industrial waste arisings and management).

²¹⁹ Based on an annual projection of 27,123,000 tonnes for the aggregated five regions as set out in Section 14.5 (Table 19).

²²⁰ Based on an annual projection of 6,302,000 tonnes for the aggregated five regions as set out in Section 14.5 (Table 19).

²²¹ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

Acceptance of Waste at Landfills²²², the total quantity of inert waste that will require off-site disposal to landfill during the construction period 2017 to 2025 is approximately 3,760,937 tonnes (see Table 31). This represents approximately 76% of the total CDEW requiring off-site disposal to landfill.

Table 31: Quantity of waste requiring off-site disposal to inert waste landfill, 2017 to 2025

Waste source	Total quantity (tonnes)	Proportion
Excavation	3,760,937	100%
Demolition	0	0
Construction	0	0
Worker accommodation sites	0	0
Total	3,760,937	100%

14.6.50 Off-site disposal of inert surplus excavated material to landfill will result in an overall reduction of inert waste landfill void space of 3,760,937 tonnes throughout the nine-year construction period.

14.6.51 This will be equivalent to a 5% reduction in inert waste landfill capacity void space across the aggregated five regions according to the amount of capacity projected to be available at the end of construction in 2025 (approximately 74 million tonnes)²²³.

14.6.52 Further to this, Table 32 shows that the majority (approximately 87%) of inert surplus excavated material will be disposed off-site to inert waste landfill in the South East and East of England.

Table 32: Locations (by regional and local area) for the off-site disposal to landfill of inert surplus excavated material, 2017 to 2025

Regional area for off-site disposal to landfill	Local area for off-site disposal to landfill	Quantity (tonnes)	Proportion
Greater London	N/A	0	0%
South East and East of England	Hertfordshire, Surrey	3,259,434	87%
South East	Buckinghamshire	0	0%
East Midlands	Northamptonshire	501,503	13%
West Midlands	Warwickshire	0	0%
Total	-	3,760,937	100%

²²² Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

²²³ Figure 19 (Section 14.5) shows that by the end of the construction period in 2025, there will be approximately 74 million tonnes of inert waste landfill capacity remaining in the aggregated five regions through which the Proposed Scheme will pass.

- 14.6.53 According to projected inert waste landfill capacity for the future baseline period 2017 to 2025 (for construction) and the year 2026 (operation) (see Figure 19, Section 14.5), it is estimated that the South East alone will have approximately 30 million tonnes of inert waste landfill capacity remaining by the end of construction in 2025. A further 15 million tonnes will be available in the East of England at that time. Together, these two regions will provide more than half of the projected amount of inert waste landfill capacity in the aggregated five regions through which the Proposed Scheme will pass.
- 14.6.54 On this basis, it is considered that there will be sufficient inert waste landfill capacity available in the aggregated five regions to accept the forecast quantity of inert surplus excavated material for off-site disposal to landfill.
- 14.6.55 Furthermore, 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 unlikely that the Proposed Scheme will draw-down projected capacity to an extent where there is an immediate, significant need for additional inert waste landfill capacity to be made available in the aggregated five regions.
- 14.6.56 Assuming a fairly constant rate of waste generation throughout the nine-year construction period, the total quantity of inert surplus excavated material requiring off-site disposal to landfill will be approximately 417,882 tonnes per annum.
- 14.6.57 Significance criteria for inert waste landfill capacity, which is appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2)²²⁴, 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.
- 14.6.58 In accordance with these significance criteria, the likely significant 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.

Non-hazardous waste landfill capacity

- 14.6.59 Subject to waste acceptance criteria set out in the Landfill Directive²²⁵ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²²⁶, the total quantity of non-hazardous waste that will require off-site disposal to landfill during the construction period 2017 to 2025 is approximately 764,099 tonnes (see Table 33).
- 14.6.60 The majority (approximately 51%) will comprise of surplus excavated material of Unacceptable Class U1B material. Other quantities of non-hazardous waste will be generated by demolition and construction activities and by occupants of worker accommodation sites.

²²⁴ Rationale for landfill significance criteria technical note appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

²²⁵ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

²²⁶ Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

Table 33: Quantity of waste requiring off-site disposal to non-hazardous waste landfill, 2017 to 2025

Waste source	Total quantity (tonnes)	Proportion
Excavation	394,329 ²²⁷	51%
Demolition	96,105	12%
Construction	272,782	36%
Worker accommodation sites	959	1%
Total	764,175	100%

- 14.6.61 Off-site disposal of non-hazardous surplus excavated material, demolition, construction and worker accommodation site waste will result in an overall reduction of non-hazardous waste landfill void space of 764,175 tonnes throughout the nine-year construction period.
- 14.6.62 This will be equivalent to a 1% reduction in non-hazardous waste landfill capacity void space across the aggregated five regions according to the amount of capacity projected to be available at the end of construction in 2025 (approximately 98 million tonnes).
- 14.6.63 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the aggregated five regions to accept the forecast quantity of non-hazardous surplus excavated material, demolition, construction and worker accommodation site waste for off-site disposal to landfill.
- 14.6.64 Table 33 shows that non-hazardous waste will be generated by a range of construction activities that will occur throughout the nine year duration of construction of the Proposed Scheme.
- 14.6.65 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.
- 14.6.66 Assuming a fairly constant rate of waste generation throughout the nine-year construction period, the total quantity of non-hazardous waste requiring off-site disposal to landfill will be approximately 84,908 tonnes per annum.
- 14.6.67 Significance criteria for non-hazardous waste landfill capacity, which is appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2)²²⁸, state that a regional-scale reduction in non-hazardous waste landfill void space capacity of between 50,000 tonnes and 250,000 tonnes per annum may be judged to be important in the regional planning context.

²²⁷ Quantity of Unacceptable Class U1B material.²²⁸ Rationale for landfill significance criteria technical note appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

14.6.68 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 surplus excavated material, construction, demolition and worker accommodation site waste generated by the Proposed Scheme will be moderate adverse.

Hazardous waste landfill capacity

14.6.69 Subject to waste acceptance criteria set out in the Landfill Directive²²⁹ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²³⁰, the total quantity of hazardous waste requiring off-site disposal to landfill during the construction period 2017 to 2025 is approximately 401,361 tonnes (see Table 34).

14.6.70 The majority (approximately 84%) will comprise 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. The remainder (approximately 16%) will be hazardous waste generated by demolition activities.

Table 34: Quantity of waste requiring off-site disposal to hazardous waste landfill, 2017 to 2025

Waste source	Total quantity (tonnes)	Proportion
Excavation	337,291 ²³¹	84%
Demolition	64,070	16%
Construction	0	0%
Worker accommodation sites	0	0%
Total	401,361	100%

14.6.71 Off-site disposal of hazardous surplus excavated material and demolition waste will result in an overall reduction of hazardous waste landfill void space of 401,361 tonnes throughout the nine-year construction period.

14.6.72 This will be equivalent to a 21% reduction in hazardous waste landfill void space across the aggregated five regions according to the amount of capacity projected to be available at the end of construction in 2025 (approximately 1.8 million tonnes).

14.6.73 Table 34 shows that the majority (approximately 84%) of the hazardous waste landfill capacity requirement will be for hazardous surplus excavated material (i.e. Unacceptable material Class U2) requiring off-site disposal to landfill (approximately 337,291 tonnes).

²²⁹ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

²³⁰ Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

²³¹ Quantity of Unacceptable Class U2 material.

- 14.6.74 This will be generated predominantly within the first two years of construction (i.e. 2017 and 2018) and will thus be equivalent to a 15% reduction in hazardous waste landfill void space across the aggregated five regions according to the amount of capacity projected to be available at the end of 2018 (approximately 2.2 million tonnes).
- 14.6.75 Hazardous surplus excavated material will be generated predominantly in the South East (approximately 141,575 tonnes, or 42% of all hazardous surplus excavated material generated)²³² and the West Midlands (approximately 114,536 tonnes, or 34% of all hazardous surplus excavated material generated)²³³, where the majority of hazardous waste landfill capacity is projected to be available (see Figure 21, Section 14.5).
- 14.6.76 Significance criteria for hazardous waste landfill capacity, which is appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2)²³⁴, state that a regional-scale reduction in hazardous waste landfill void space capacity of between 20,000 tonnes and 100,000 tonnes per annum may be judged to be important in the regional planning context.
- 14.6.77 According to the significance criteria applicable to hazardous waste landfill capacity, the likely significant environmental effects associated with the off-site disposal to landfill of hazardous surplus excavated material and demolition waste generated by the Proposed Scheme will be major adverse.

Other mitigation measures

- 14.6.78 Further opportunities to minimise CDEW and worker accommodation site waste, and increase diversion from landfill, will be investigated during the detailed design phase of the Proposed Scheme.
- 14.6.79 Opportunities may also arise at the time of construction to provide inert surplus excavated material for use in other local construction projects, thereby increasing diversion of such material from landfill.
- 14.6.80 As shown in Table 35, excavation and earthworks activities will be responsible for the majority (91%) of waste requiring off-site disposal to landfill. Of this quantity, approximately 3,760,937 tonnes (or 84% of the total quantity of surplus excavated material requiring off-site disposal to landfill - see Table 23) will be inert in nature. This represents the greatest opportunity for further diversion from landfill through provision for use in other local construction projects.

²³² 22,163 tonnes in CFA11 (Stoke Mandeville and Aylesbury), 14,772 tonnes in CFA 13 (Calvert, Steeple Claydon, Twyford and Chetwode) and 104,640 tonnes in CFA 14 (Newton Purcell to Brackley - South East region only).

²³³ 1,593 tonnes in CFA 23 (Balsall Common and Hampden-in-Arden), 2,372 tonnes in CFA 24 (Birmingham Interchange and Chelmsley Wood), 2,126 tonnes in CFA 25 (Castle Bromwich and Bromford) and 108,445 tonnes in CFA 26 (Washwood Heath to Curzon Street).

²³⁴ Rationale for landfill significance criteria technical note appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

Table 35: Quantity of waste for off-site disposal to landfill by waste type, 2017 to 2025

Waste source	Quantity for off-site disposal to landfill (tonnes)	Proportion
Excavation	4,492,557	91%
Demolition	160,175	3%
Construction	272,782	6%
Worker accommodation sites	959	Less than 0.1%
Total	4,926,473	100%

- 14.6.81 In some local areas along the route of the Proposed Scheme²³⁵, the use of inert surplus excavated material is also favoured by waste planning authorities for restoration purposes, for example, to restore landfill sites and former mineral workings. Whilst still classed as a landfill disposal activity, this is likely to provide further opportunities for the off-site management of inert surplus excavated material.
- 14.6.82 Some of the non-hazardous waste generated by the construction of the Proposed Scheme will also be suitable for energy recovery (i.e. incineration). This will reduce reliance on non-hazardous waste landfill capacity.
- 14.6.83 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.
- 14.6.84 It is likely that a large proportion of the hazardous demolition waste and hazardous surplus excavated material 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)²³⁶ providing it meets SNRHW waste acceptance criteria in accordance with the Landfill Directive²³⁷ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²³⁸. This will reduce reliance on hazardous waste landfill capacity.

²³⁵ For example, Policy 1.3 (Construction, Demolition and Excavation Waste) of the *Staffordshire and Stoke-on-Trent Local Waste Plan 2010-2026* favours the use of inert waste for restoration purposes.

²³⁶ 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; *Waste Acceptance at Landfills: Guidance on Waste Acceptance Procedures and Criteria, November 2010*; <http://ao768b4a8a31e106d8bo-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho1110btew-e-e.pdf>; Accessed 21 October 2013.

²³⁷ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

²³⁸ Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

Summary of likely residual significant effects

- 14.6.85 On the basis of the other mitigation measures proposed, the likely residual significant effects from construction will be:
- negligible in relation to inert waste landfill capacity;
 - moderate adverse in relation to non-hazardous waste landfill capacity; and
 - moderate adverse in relation to hazardous waste landfill capacity.

Cumulative effects

- 14.6.86 A qualitative assessment has been undertaken to establish the cumulative effects associated with the off-site disposal to landfill of solid waste that will be generated by the construction of the Proposed Scheme and other developments along its route.
- 14.6.87 The cumulative effects assessment takes into account developments that are likely to be under construction (in whole or in part for phased development) at the same time as the Proposed Scheme (2017 to 2025), thus they will have a simultaneous requirement for landfill of any CDEW generated during this timeframe.
- 14.6.88 A list of developments that have been taken into account in the cumulative effects assessment is provided Volume 5: Appendix WM-002-000. These developments are listed by regional area and have been identified by way of a screening exercise in line with the aforementioned rationale for screening of other developments. A list of developments that have been screened out is also provided in Volume 5: Appendix WM-002-000.
- 14.6.89 Cumulative effects have been considered on the basis of professional judgement according to the nature of the construction-related activities proposed.
- 14.6.90 Construction of these developments will produce CDEW, a proportion of which will require disposal to landfill. In line with relevant policy, also applicable to the Proposed Scheme, it is anticipated that all of these developments will seek to minimise waste to landfill and manage waste in accordance with the waste hierarchy.
- 14.6.91 The Proposed Scheme, together with the developments listed in Volume 5: Appendix WM-002-000, will add further to the need for off-site disposal of waste to landfill. The extent of this cannot be quantified accurately hence the need for a qualitative assessment. This is due to a lack of published information on forecast waste arisings and landfill disposal assumptions for these developments.
- 14.6.92 Opportunities may arise at the time of construction to provide CDEW and surplus excavated material for use in other local construction projects thereby increasing diversion of such materials from landfill.
- 14.6.93 Considering the potential for waste generation, opportunities to divert waste from landfill and the amount of inert, non-hazardous and hazardous waste landfill capacity projected to be available in the aggregated five regions at the end of construction in

2025²³⁹, it has been assessed that the cumulative effects will be as identified for the main assessment, that is:

- minor adverse in relation to inert waste landfill capacity;
- moderate adverse in relation to non-hazardous landfill capacity; and
- major adverse in relation to hazardous waste landfill capacity.

14.7 Assessment of effects during operation

Avoidance and mitigation measures

14.7.1 Outline waste segregation and storage strategies have been developed to inform the preliminary design of railway stations for the Proposed Scheme. This is to ensure that sufficient waste storage and collection access provision is incorporated early on in the design process to facilitate segregation of waste and recyclable materials during operation. Measures will include:

- provision of public realm litter and recycling bins for train passengers and other users of railway stations;
- provision of secure containers for use by train operating companies and railway station tenants; and
- use of compactors and baling equipment to improve collection payloads and facilitate opportunities to derive revenue streams for large quantities of recyclable material such as cardboard.

14.7.2 During operation, management of waste from passenger trains and rolling stock maintenance will be managed 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 be managed by Network Rail and / or the train operating company.

Assessment of impacts and effects

Waste forecast

Railway station and train waste

14.7.3 Railway station and train waste refers to waste that will arise at the four stations along the route, i.e. Euston station²⁴⁰ and Old Oak Common station²⁴¹ in Greater London, and Birmingham Interchange station²⁴² and Curzon Street station²⁴³ in the West Midlands. It will include waste from station operations and passenger waste removed from trains at the two terminating stations in London and Birmingham.

²³⁹ Approximately 74 million tonnes of inert waste landfill, 98 million tonnes of non-hazardous waste landfill and 1.8 million tonnes of hazardous waste landfill.

²⁴⁰ Euston - Station and Approach (CFA1).

²⁴¹ Kilburn (Brent) to Old Oak Common (CFA4).

²⁴² Birmingham Interchange and Chelmsley Wood (CFA24).

²⁴³ Washwood Heath to Curzon Street (CFA26).

- 14.7.4 Table 36 presents a regional and route-wide summary of the forecast railway station and train waste quantities for the Proposed Scheme in 2026²⁴⁴. A detailed railway station and train waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).
- 14.7.5 Railway station and train waste quantities have been estimated based on a waste generation rate of 0.085kg per station entry and exit²⁴⁵ to account for boardings and alightings of HS2 services only (i.e. net of other services at Euston station, which will be redeveloped as part of the Proposed Scheme). Using this methodology, the Proposed Scheme will generate approximately 3,284 tonnes of railway station and train waste during the first year of operation in 2026.

Table 36: Forecast railway station and train waste quantities by region, 2026

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	1,788	1,073	715
South East	0	0	0
East of England	0	0	0
East Midlands	0	0	0
West Midlands	1,496	898	598
Total	3,284	1,971	1,313

- 14.7.6 The quantity of railway station and train 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.
- 14.7.7 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment, that the remaining 40% of railway station and train waste will be disposed of off-site to landfill. The quantity of railway station and train waste that will require off-site disposal to landfill in 2026 will be approximately 1,313 tonnes.
- 14.7.8 It has been assumed for the purpose of this assessment that all railway station and train waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill.

Rolling stock maintenance waste

- 14.7.9 Rolling stock maintenance waste refers to waste that will be generated by the relevant train operating company at the Washwood Heath rolling stock maintenance depot²⁴⁶ and by the operator of the people mover between Birmingham Interchange

²⁴⁴ It has been assumed that railway station and train waste will be largely managed within the region in which it will be generated.

²⁴⁵ Defined as number of passengers entering and exiting through ticket barriers. For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

²⁴⁶ Washwood Heath to Curzon Street (CFA26).

station and the NEC complex, Birmingham International station and Birmingham Airport²⁴⁷. Both facilities will be located in the West Midlands region.

- 14.7.10 Maintenance of the people mover will generate similar types of solid waste to rolling stock maintenance and hence is referred to as rolling stock maintenance waste in this assessment.
- 14.7.11 Table 37 presents a regional and route-wide summary of the forecast rolling stock maintenance waste quantities for the Proposed Scheme in 2026²⁴⁸. A detailed rolling stock maintenance waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).
- 14.7.12 Rolling stock maintenance waste quantities have been estimated based on a waste generation rate of 0.3 tonnes per square metre per year applied to the gross floor area of the rolling stock maintenance and people mover depot areas²⁴⁹. Using this methodology, the Proposed Scheme will generate approximately 10,698 tonnes of rolling stock maintenance waste during the first year of operation in 2026.

Table 37: Forecast rolling stock maintenance waste quantities by region, 2026

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	0	0	0
South East	0	0	0
East of England	0	0	0
East Midlands	0	0	0
West Midlands	10,698	8,558	2,140
Total	10,698	8,558	2,140

- 14.7.13 The quantity of rolling stock maintenance waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 80%. This rate has been selected following a review of the evidence base from Network Rail and other organisations involved in train fleet maintenance in the UK²⁵⁰.
- 14.7.14 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment, that the remaining 20% of rolling stock maintenance waste will be disposed of off-site to landfill. The quantity of rolling stock maintenance waste that will require off-site disposal to landfill in 2026 will be approximately 2,140 tonnes.

²⁴⁷ Birmingham Interchange and Chelmsley wood (CFA24).

²⁴⁸ It has been assumed that rolling stock maintenance waste will be largely managed within the region in which it will be generated.

²⁴⁹ For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

²⁵⁰ For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

14.7.15 It has been assumed for the purpose of this assessment that all of the rolling stock maintenance waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill.

Track maintenance waste

14.7.16 Track maintenance waste will comprise of track ballast and other rail components (e.g. steel railway tracks, sleepers, switches and crossings) that will be replaced as part of routine maintenance activities.

14.7.17 Table 38 presents a regional and route-wide summary of the forecast track maintenance waste quantities for the Proposed Scheme in 2026²⁵¹. A detailed track maintenance waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).

14.7.18 Track maintenance waste will be generated along the entire route of the Proposed Scheme. Quantities have been estimated based on a waste generation rate of 8.23 tonnes per kilometre of track per year²⁵². Using this methodology, the Proposed Scheme will generate approximately 3,798 tonnes of track maintenance waste during the first year of operation in 2026.

14.7.19 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 2026). The largest quantity of track maintenance waste will occur as the track ballast reaches the end of its life and requires replacement. This is unlikely to occur until at least 25 years after construction, which is beyond this assessment horizon.

14.7.20 It would be equally inaccurate to incorporate an annual average quantity of track maintenance waste in the forecast for this assessment year of 2026 as this would create a forecast beyond that which would be considered a reasonable worst-case.

14.7.21 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 38: Forecast track maintenance waste quantities by region, 2026

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	544	463	81
South East	1,074	912	162
East of England	25	21	4
East Midlands	340	289	51
West Midlands	1,815	1,543	272

²⁵¹ It has been assumed that track maintenance waste will be largely managed within the region in which it will be generated.

²⁵² For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Total	3,798	3,228	570

14.7.22 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 85%. This rate has been selected based on data provided by Network Rail across a range of material types for track maintenance waste²⁵³.

14.7.23 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment, that the remaining 15% of track maintenance waste will be disposed of off-site to landfill. The quantity of track maintenance waste that will require off-site disposal to landfill in 2026 will be approximately 570 tonnes.

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

Ancillary infrastructure waste

14.7.25 Ancillary infrastructure waste refers to waste that will arise from operational support sites including depots (other than Washwood Heath rolling stock maintenance depot and the Birmingham Interchange people mover depot), signalling locations, operations and maintenance sites (other than those involving track maintenance).

14.7.26 Table 39 presents a regional and route-wide summary of the forecast ancillary infrastructure waste quantities for the Proposed Scheme in 2026²⁵⁴. A detailed ancillary infrastructure waste quantity forecast is provided in Volume 5: Appendix WM-001-000 (Annex 1).

14.7.27 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 year²⁵⁵. Using this methodology, the Proposed Scheme will generate approximately 319 tonnes of ancillary infrastructure waste during the first year of operation in 2026.

Table 39: Forecast ancillary infrastructure waste quantities by region, 2026

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Greater London	46	27	19
South East	91	55	36

²⁵³ For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

²⁵⁴ It has been assumed that ancillary infrastructure waste will be largely managed within the region in which it will be generated.

²⁵⁵ For further details, see Waste forecast and assessment methodology technical note, which can be found in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
East of England	2	1	1
East Midlands	28	17	11
West Midlands	152	92	60
Total	319	192	127

- 14.7.28 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.
- 14.7.29 It has been assumed, as a reasonable worst-case scenario for the purpose of this assessment, that 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 127 tonnes.
- 14.7.30 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

- 14.7.31 Table 40 provides a summary of operational waste arisings for the Proposed Scheme that will be generated in 2026. 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. Operational waste will comprise of railway station and train waste, rolling stock maintenance waste, track maintenance waste and ancillary infrastructure waste.

Table 40: Summary operational waste forecast, 2026

Waste source	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Railway station and train	3,284	1,971	1,313
Rolling stock maintenance	10,698	8,558	2,140
Track maintenance	3,798	3,228	570
Ancillary infrastructure	319	192	127
Total	18,099	13,949	4,150
Proportion	100%	77%	23%

- 14.7.32 Table 40 shows that the Proposed Scheme will generate approximately 18,099 tonnes of operational waste in 2026. Approximately 77% of this quantity will be diverted from landfill via reuse, recycling and recovery.
- 14.7.33 The impact of operational waste generation and off-site disposal to landfill is shown in

Table 41 as the percentage difference between future baseline C&I waste arisings with and without the Proposed Scheme.

Table 41: Impact of commercial and industrial waste arisings generated by the Proposed Scheme, 2026

	National change		Regional change ²⁵⁶	
	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)
Future baseline waste arisings 2026 without the Proposed Scheme	47,928,000 ²⁵⁷	11,280,000 ²⁵⁸	27,123,000 ²⁵⁹	6,302,000 ²⁶⁰
Proposed Scheme waste arisings 2026	18,099	4,150	18,099	4,150
Future baseline waste arisings 2026 with the Proposed Scheme	47,946,099	11,284,150	27,141,099	6,306,150
Increase in future baseline waste arisings with the Proposed Scheme	+0.04%	+0.04%	+0.1%	+0.1%

14.7.34 Table 41 shows that the total quantity of operational waste generated by the Proposed Scheme in 2026 will be equivalent to approximately 0.1% of national and regional future baseline C&I waste arisings.

14.7.35 The total quantity of operational waste generated by the Proposed Scheme that will require off-site disposal to landfill in 2026 will be equivalent to approximately 0.1% of national and regional baseline C&I waste arisings to landfill during that year.

Likely significant environmental effects

14.7.36 The total quantity of non-hazardous operational waste requiring off-site disposal to landfill in 2026 will be 4,150 tonnes (see Table 40). This comprises non-hazardous waste that will be generated in railway stations and on passenger trains, and by rolling stock maintenance, track maintenance and ancillary infrastructure activities.

14.7.37 Subject to waste acceptance criteria set out in the Landfill Directive²⁶¹ and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills²⁶², operational waste generated by the Proposed Scheme will be mostly non-hazardous in nature.

14.7.38 Off-site disposal of non-hazardous operational waste to landfill will result in an overall reduction of non-hazardous waste landfill void space of 4,150 tonnes in 2026. This will

²⁵⁶ Based on future baseline C&I waste arisings and C&I waste to landfill for the aggregated five regions.

²⁵⁷ Based on an annual projection of 47,928,000 tonnes nationally as set out in Section 14.5 (national commercial and industrial waste arisings and management).

²⁵⁸ Based on an annual projection of 11,280,000 tonnes nationally as set out in Section 14.5 (national commercial and industrial waste arisings and management).

²⁵⁹ Based on an annual projection of 27,123,000 tonnes for the aggregated five regions as set out in Section 14.5 (Table 19).

²⁶⁰ Based on an annual projection of 6,302,000 tonnes for the aggregated five regions as set out in Section 14.5 (Table 19).

²⁶¹ Council of the European Union; *Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT>; Accessed 11 October 2013.

²⁶² Commission of the European Communities; *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)*; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52002PC0512:EN:NOT>; Accessed 27 September 2013.

be equivalent to a less than 0.1% reduction in non-hazardous waste landfill void space across the aggregated five regions according to the capacity projected to be available in 2026 (approximately 94 million tonnes).

- 14.7.39 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the aggregated five regions to accept the forecast quantity of non-hazardous operational waste for off-site disposal to landfill.
- 14.7.40 Significance criteria for non-hazardous waste landfill capacity, which is appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2)²⁶³, 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.
- 14.7.41 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 operational waste generated by the Proposed Scheme will be negligible and insignificant.

Other mitigation measures

- 14.7.42 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

- 14.7.43 Based on the assessment above, the likely residual significant effects associated with operation of the Proposed Scheme will be negligible.

Cumulative effects

- 14.7.44 A qualitative assessment has been undertaken to establish the cumulative effects associated with the off-site disposal to landfill of solid waste that will be generated by the operation of the Proposed Scheme and other developments along its route.
- 14.7.45 The cumulative effects assessment takes into account developments that are assumed (based on available information presented in Volume 5: Appendix WM-002-000) to become operational at the same time as the Proposed Scheme (i.e. in the year 2026), thus they will have a simultaneous requirement for landfill disposal capacity of any operational waste generated during that year.
- 14.7.46 Developments that are assumed to become operational either before or after 2026 have been screened out of the cumulative effects assessment on the basis that they do not fall within the assessment year for operation.
- 14.7.47 A list of developments that have been taken into account in the cumulative effects assessment is provided in Volume 5: Appendix WM-002-000. These developments are

²⁶³ Rationale for landfill significance criteria technical note appended to Section 16 of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

listed by regional area and have been identified by way of a screening exercise in line with the aforementioned rationale for screening of other developments. A list of developments that have been screened out is also provided in Volume 5: Appendix WM-002-000.

- 14.7.48 Cumulative effects have been considered on the basis of professional judgement according to the nature of the operational activities proposed.
- 14.7.49 Operation of these developments will produce C&I waste and municipal solid waste, a proportion of which will require disposal to landfill. In line with relevant policy, also applicable to the Proposed Scheme, it is anticipated that all of these developments will seek to minimise waste to landfill and manage waste in accordance with the waste hierarchy.
- 14.7.50 The Proposed Scheme, together with the developments listed in Volume 5: Appendix WM-002-000 will add further to the need for off-site disposal to landfill. The extent of this cannot be quantified accurately hence the need for a qualitative assessment. This is due to a lack of published information on forecast waste arisings and landfill disposal assumptions for these developments.
- 14.7.51 Considering the potential for waste generation, opportunities to divert waste from landfill and the amount of non-hazardous waste landfill capacity projected to be available in the aggregated five regions as of 2026 (approximately 94 million tonnes), it has been assessed that the cumulative effects will be as identified for the main assessment, i.e. negligible for operation.

15 Water resources and flood risk assessment

15.1 Introduction

15.1.1 This section presents the likely significant route-wide effects on surface water and groundwater resources and flood risk.

15.1.2 It should be read in conjunction with Volume 5: Appendix WR-001-000 which contains further details on the route-wide effects, particularly:

- stakeholder engagement;
- a draft Operation and Maintenance Plan for water resources and flood risk;
- a WFD compliance assessment; and
- a route-wide Flood Risk Assessment (FRA).

15.2 Spillage risks

15.2.1 The risk that a polluting spillage may result from an accident and affect either surface water or groundwater resources has been assessed on a route-wide basis. The methodology used is given in the SMR Addendum (Volume 5: Appendix CT-001-000/2).

15.2.2 The risk of a spillage causing a significant effect on water resources will depend on the probability of an accident and the consequence of any spilt pollutant affecting a receptor. An accident will not necessarily lead to a spillage of pollutant, and should it occur, such a spillage will not necessarily lead to pollution of a water body, as:

- it may be absorbed or controlled by measures included in the design, such as the ballast and drainage systems;
- it may occur at a location where there is no pathway to a receptor; and
- prompt action by the infrastructure operator or the emergency and environmental services may prevent the pollutant affecting the receptor (for example by shutting valves, blocking outfalls, or deploying oil booms).

15.2.3 The probability of a rail accident causing a pollution incident is low, and on the Proposed Scheme, where electric passenger trains will operate, is considered extremely low. No pollution incidents have been reported on the similar HS1 route since it began operation.

15.2.4 Whilst spillage could also occur in depots and stations during operation and maintenance work, the application of a pollution incident response plan as outlined in the draft Operation and Maintenance Plan for water resources and flood risk will mitigate those spillage risks. Although the risk of a pollution incident will be affected by site specific parameters, these are not considered significant, and do not warrant site specific spillage assessments being carried out in each CFA. The only exception to

this is the risk from spillages on highways, and for this risk, site specific assessments were carried out where appropriate, and are discussed in the relevant Volume 2, CFA reports, Section 13, and corresponding Water Resources appendices in Volume 5.

- 15.2.5 There are not likely to be any significant regional or route-wide permanent adverse effects on water resources as a result of accidental spillages during the operation and maintenance of the Proposed Scheme.

15.3 Surface water resources

- 15.3.1 Surface water catchments that span several assessment areas are discussed in the relevant Volume 2, CFA reports, Section 13 and in the WFD compliance assessment (Volume 5: Appendix WR-001-000).
- 15.3.2 Temporary adverse impacts on surface water resources as a result of construction methods or materials, silt, or mobilisation of contaminants, will be avoided or mitigated locally by adopting good practices (Section 16, draft CoCP, Volume 5: Appendix CT-003-000). These practices include bunding of stored pollutants, temporary drainage of construction sites including sustainable drainage systems (SuDS) and pollution response plans and monitoring plans as required.
- 15.3.3 Permanent adverse impacts on surface water resources arising during operation will be avoided or mitigated through measures included in the design such as balancing ponds, infiltration ponds, recharge trenches and swales to control the runoff from the railway. In addition, culverts and the realignments of water courses are designed to seek to ensure compliance with the objectives of the WFD and to avoid adverse impacts on flood risk. Indicative sizes, form, and locations of drainage features, such as balancing ponds, are shown on the maps within the Volume 5: Water resources and flood risk Map Book. These will be developed further through detailed design. Features such green roofs, other forms of SuDS and other green infrastructure will also be considered during detailed design. It is considered that these measures will avoid adverse impacts wherever possible and may provide some overall benefit at given locations at the detailed design stage.
- 15.3.4 There are not likely to be significant regional or route-wide temporary or permanent adverse effects on surface water resources as a result of the construction process.
- 15.3.5 Generic examples of management measures during operation and management of the Proposed Scheme that will mitigate impacts so that there are no significant adverse effects on the quality and flow characteristics of surface water courses and groundwater bodies are described in Volume 1, Section 9 and in the draft Operation and Maintenance Plan for water resources and flood risk included in Volume 5 Appendix WR-001-000. These impacts could result from routine runoff or accidental spillage.
- 15.3.6 There are not likely to be significant regional or route-wide adverse effects on surface water resources as a result of operation and maintenance of the Proposed Scheme.

15.4 Groundwater resources

- 15.4.1 Although groundwater bodies span several assessment areas, many of the potential impacts of the Proposed Scheme can be related to local receptors and specific mitigation at the CFA level. Therefore, groundwater is discussed in Volume 2, CFA reports, Section 13. Any groundwater level reduction impacts to specific ecological receptors are also addressed in the Volume 2, CFA reports, Section 7 and their associated Volume 5 Appendices.
- 15.4.2 The WFD compliance assessment addresses route-wide impacts on groundwater bodies and associated surface water receptors and groundwater dependent terrestrial ecosystems.
- 15.4.3 Potential impacts on groundwater resources due to construction of excavations to form cuttings or tunnels, including green tunnels, will be mitigated locally wherever possible. Volume 2, CFA reports, Section 13 and their associated Volume 5 Appendices contain more detail on local impacts to groundwater.
- 15.4.4 The tunnels will be designed so that the ingress of groundwater is not significant. The assessment has demonstrated that the passage of groundwater past the tunnels is not significantly reduced. The drainage within the Proposed Scheme will be designed, where possible, to promote the recharge of groundwater bodies.
- 15.4.5 The possible adverse effects on groundwater quality due to disturbing and mobilising existing poor quality ground or groundwater, and of creating or altering pathways during construction, will be mitigated through the implementation of measures set out in the draft CoCP. Impacts to groundwater from existing land contamination are presented in the Volume 2, CFA reports, Section 8 and their associated Volume 5 Appendices.
- 15.4.6 In accordance with the draft CoCP (Section 16), monitoring will be undertaken in consultation the Environment Agency prior to, during and post-construction, if required, to establish baseline conditions for surface water and groundwater and to confirm the effectiveness of agreed temporary and permanent mitigation measures.
- 15.4.7 Within the Mid-Chilterns Chalk groundwater body, which spans several CFA, the Proposed Scheme could give rise to a significant temporary adverse effect on water supplies, including public water supplies, which depend on the groundwater in the Chalk in CFAs 6, 7, 8 and 9. As a result, the programme of monitoring will be integrated with monitoring undertaken by the owners to address these receptors. The programme will be structured taking into account all the construction processes that could have an impact on the quantity and quality of surface water and groundwater resources, and the interaction between the water resources and water supplies. The monitoring programme scope and duration will be agreed with the Environment Agency, in consultation with Affinity Water Ltd.
- 15.4.8 In respect of public water supplies, a management strategy will be agreed with the Environment Agency, in consultation with Affinity Water Ltd, that will cover timing of any physical mitigation, the scale and nature of monitoring and the thresholds at which actions are invoked (in terms of both quality and flow), the nature of other

intervention measures and the responsibilities for ensuring agreed actions occur. These mitigation options could include:

- minimising construction durations in areas of risk for groundwater impacts from turbidity;
- treatment of water at abstractions affected by turbidity; reduced amounts, or suspension, of abstraction at specific periods of construction. Reduction or suspension of abstraction will result in groundwater rebound occurring around the source in question; but since this is permitted under the existing abstraction licence, the rebound will have negligible impact;
- temporarily importing water from another source such as those in the Colne Valley that are not affected by the Proposed Scheme and those in neighbouring areas (for example CFA8). Since these other sources would operate within their abstraction licence limits, there would be negligible impacts to groundwater at these other sources;
- use of scavenger wells to intercept poor quality groundwater between the works and the public water supply abstraction points. This would require discharge of water arising from the scavenger wells; however, since higher levels of turbidity are acceptable in most watercourses compared to the standard required by the Drinking Water Inspectorate, the discharge from scavenger wells will usually be suitable for discharge to the appropriate water body with minimal additional treatment; and
- regulatory and management initiatives such as demand reduction, leakage control or, less desirably, variations to conditions for licence abstractions in the area. In the event of adverse impacts arising from the construction activities of the Proposed Scheme these initiatives could provide Affinity Water Ltd with enhanced flexibility of operations across its sources and additional supplies (in the event of an extreme drought or outage²⁶⁴) to manage the impacts from the Proposed Scheme.

15.4.9 Until such monitoring and any necessary agreed measures have been carried out, a likely significant temporary adverse effect is reported on the groundwater resources in the CFA identified above, and is therefore a likely significant effect on a regional scale during construction. In developing the management strategy for the public water supply abstractions, due regard will be given to Catchment Abstraction Management Strategies, the relevant River Basin Management Plan (RBMP) and the requirements of any necessary consents or approvals.

15.4.10 There are not likely to be any other significant regional or route-wide temporary or permanent adverse effects on groundwater resources as a result of the construction process.

15.4.11 Other operational impacts on groundwater will be negligible overall and will not be significant. Discussions will take place with the Environment Agency regarding

²⁶⁴ Outage refers to periods where there is an unavailability or decrease in the level of service or abstraction.

monitoring and any other measures required in order to confirm that this outcome will be achieved.

15.5 Water Framework Directive Compliance Assessment

Assessment Methodology

- 15.5.1 An assessment of the effects from the Proposed Scheme on objectives under the WFD was undertaken and is reported in Volume 5: Appendix WR-001-000.
- 15.5.2 Although no published methodology exists for WFD assessment, the approach adopted for this project is based on internal guidance from the Environment Agency and was agreed at stages throughout the process. The assessment is based on the baseline information available at the time the assessment was prepared.
- 15.5.3 The assessment takes into account the mitigation built into the design of the Proposed Scheme. In addition, the mitigation measures identified in the Volume 2, CFA reports, Sections 7 (ecology) and 13 (water resources), and their corresponding Volume 5 appendices have been taken into account in the WFD assessments.

Surface Water

- 15.5.4 The WFD surface water assessment is based on existing surface water body status information provided by the Environment Agency, and on ecological and river habitat survey baseline data collected for the EIA.
- 15.5.5 The assessment considered effects on water bodies which lie within the land required for the construction and operation of the Proposed Scheme, and those which lie up and downstream for which there is a potential risk of impacts. The scope and the assessment methodology were agreed with the Environment Agency.
- 15.5.6 The assessment has been undertaken on a precautionary basis given that baseline data was not available for all the affected water bodies and tributaries, and that the detailed design will be taken forward after the hybrid Bill has been enacted.
- 15.5.7 Of the 60 surface water bodies affected by the Proposed Scheme, 45 water bodies were considered to have either minor effects or no effects likely to result in deterioration of the quality elements.
- 15.5.8 The remaining 15 surface water bodies were considered to be at potential risk of deterioration as a result of effects on one or more of the quality elements. Of these, 11 water bodies are considered unlikely to experience deterioration in status or potential.
- 15.5.9 The risk of deterioration in status or potential was considered to be higher for four water bodies. These water bodies are the River Blythe (from Patrick Bridge to the River Tame), River Ouse (GB105033037880), Stoke Brook and Padbury Brook (The Twins).
- 15.5.10 Combined hydromorphological and biological effects were considered to give rise to a potential risk of deterioration in two of the four water bodies (Stoke Brook and Padbury Brook (The Twins)). In both cases, river diversions and/or culverting will occur on significant lengths of the water body or its major tributaries. Whilst the design aim for river diversions is to ensure that the existing hydromorphological regime is

maintained, where the diversion is considered to increase the length of the water body, there is a risk of reducing flow rates and disrupting stream processes. It is recognised that diversions also offer opportunities for habitat enhancement. Further refinement of the design of the diversions will be undertaken.

- 15.5.11 Similarly, long culverts (for example, temporary and permanent culverts on the Padbury Brook) have the potential to disrupt stream processes and continuity. In the case of the Padbury Brook, macroinvertebrates are at good status and fish are at high status, and are therefore considered to be sensitive receptors. For the Stoke Brook, the status of the biological receptors is unknown and therefore a precautionary approach has been adopted.
- 15.5.12 For the River Blythe (Patrick Bridge to River Tame) there will be localised impacts from culverts on tributaries of the Blythe including the Holywell Brook, Shadow Brook and un-named tributary. Although there will be enhancements to the water body from the removal of culverts and associated river diversions, there will also be dewatering impacts from the Diddington cutting on the Holywell Brook and cumulative impacts with the upstream River Blythe water body (Temple Balsall Brook to Patrick Bridge) (GB104028042571). Baseline surveys will be undertaken to determine the value of these tributaries for fish. Monitoring of groundwater levels will be undertaken to further inform the dewatering assessment and additional mitigation measures identified.
- 15.5.13 For the River Ouse (GB105033037880), effects could arise from potentially permanent flow reductions on a major tributary as a result of dewatering of the Brackley South cutting. Whilst effects on the River Ouse itself will be minimal, since water will be returned to the river, given the high status of fish in the River Ouse and the lack of certainty over the value of the tributary for migratory fish, a precautionary approach has been adopted. Monitoring of groundwater levels will be undertaken to further inform the assessment of dewatering and additional mitigation measures identified.
- 15.5.14 For the 11 water bodies where potential risks have been identified but deterioration in status or potential is unlikely, effects arise primarily from impacts to tributaries for which there is no ecological baseline data. A precautionary approach has therefore been adopted.
- 15.5.15 WFD status and compliance will be informed by further surveys and monitoring as the fully detailed design of the Proposed Scheme develops.

Groundwater

- 15.5.16 The Proposed Scheme crosses 15 groundwater bodies. The effects of the construction and operation of the Proposed Scheme on these groundwater bodies has been assessed with respect to both chemical and quantitative status.
- 15.5.17 The majority of the Proposed Scheme is predicted to result in local or temporary effects that are considered unlikely to affect WFD status at the groundwater body scale. However, potential risks to individual WFD elements have been identified for a number of the groundwater bodies.

- 15.5.18 On the basis of the current information and assumptions, the WFD assessment concluded that no groundwater bodies will change from Good to Poor status or experience significant deterioration where already at Poor status, as a result of the Proposed Scheme.
- 15.5.19 Eight of the 15 groundwater bodies were identified as being at potential risk for quantitative elements. Three of the 15 groundwater bodies were identified as being at potential risk for chemical elements. This may be considered analogous to being at Good status with Low confidence or, in the case of groundwater WFD elements already at Poor status, it is considered to be non-significant deterioration.
- 15.5.20 For Mid-Chilterns Chalk, a significant residual risk to the drinking water protected area element has been identified owing to the proximity of the Proposed Scheme to existing public water supply abstractions. Further mitigation measures are under discussion with the Environment Agency in consultation with Affinity Water. These are set out in the Other Mitigation Measures section in the CFA reports (CFA6, 7, 8 and 9). In developing the management strategy for the public water supply abstractions, due regard will be given to Catchment Abstraction Management Strategies, the relevant RBMP and the requirements of any necessary consents or approvals. Until the mitigation has been agreed and assessed by all parties, there remains the risk of WFD deterioration with respect to the drinking water protected area WFD element for chemical status of the Mid-Chilterns Chalk groundwater body.
- 15.5.21 For the remaining groundwater bodies where risks were identified, there are uncertainties due to the limitations of the baseline dataset. A precautionary approach has therefore been adopted, but deterioration in status is considered to be unlikely.

Compliance

- 15.5.22 The WFD assessment provides an indication of the likely compliance of the Proposed Scheme at the time the assessment was prepared. It is based on the Proposed Scheme design, incorporated mitigation measures and on the current status of 60 surface water bodies and 15 groundwater bodies.
- 15.5.23 The assessment concluded that the Proposed Scheme will not prevent future attainment of Good status or potential where not already achieved.
- 15.5.24 The assessment also concluded that 45 surface water bodies and six groundwater bodies will not experience any deterioration in current status or potential.
- 15.5.25 For 15 surface water bodies and nine groundwater bodies, there is considered to be some risk of deterioration. For 11 surface water bodies and eight groundwater bodies, the risk of deterioration in status is considered to be low.
- 15.5.26 For the remaining four surface water bodies and one groundwater body, there is a higher risk of deterioration in current status or potential despite mitigation measures identified in the CFA reports. These particular water bodies are discussed previously.
- 15.5.27 Where the failure to prevent deterioration in the status of a body of surface water or groundwater is the result of new modifications to the physical characteristics of a

surface water body or alterations to the level of bodies of groundwater, there will be no breach of the WFD where:

- all practicable steps are taken to mitigate the adverse impact on the status of the body of water;
- the reasons for those modifications or alterations are specifically set out and explained in the RBMP;
- the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives set out in Article 4.1 of the WFD are outweighed by the benefits of the new modifications or alterations to (among other things) sustainable development; and
- the beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option.

15.5.28 It is concluded that:

- in light of the work carried out by HS2 Ltd in liaison with the Environment Agency, all practicable measures to mitigate adverse impacts on surface water bodies and groundwater have been identified, and those measures will continue to be reviewed;
- the RBMP process is subject to review and effects of the Proposed Scheme will be taken into account in future RBMP;
- there is an overriding public interest in the construction of the Proposed Scheme, and in any event the benefits of the Proposed Scheme as a form of sustainable development outweigh the benefits of achieving the objectives in Article 4(1) (to the limited extent that the Proposed Scheme will hinder the attainment of those objectives); and
- there are no better environmental options to the works described which are technically feasible and proportionate in cost.

15.5.29 For those reasons, even if the Proposed Scheme does result in the deterioration in status of a body of surface water or groundwater, there will be no breach of the WFD.

15.6 Flood risk

15.6.1 The design of the Proposed Scheme has followed the principles and approach to flood risk which is contained in the NPPF and its supporting technical guidance. It is this approach that forms the main reasoning for the rationale and approach to the Sequential and Exception Tests outlined in this section. Further details of this process are provided in the route-wide flood risk assessment in Volume 5: Appendix WR-001-000.

Sequential Test

- 15.6.2 The Sequential Test is described in paragraph 101 of the NPPF which states: “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. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding.”
- 15.6.3 Avoidance of areas with a high probability of flooding was a consideration in the HS2 London to the West Midlands AoS which considered several route options, and following consultation, resulted in the selection of the Proposed Scheme, announced by the Secretary of State in January 2012. It is considered therefore that the Sequential Test, as defined in the NPPF, has been applied.

Exception Test

- 15.6.4 The NPPF indicates in paragraph 102 that ‘wider sustainability objectives’ can be a reason as to why some development such as essential infrastructure, which includes the Proposed Scheme, must inevitably be located in areas at risk of flooding: “If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate.”
- 15.6.5 The approach for the Exception Test is also set out within paragraph 102 of the NPPF and supporting Technical Guidance. It states that for certain types of development, where the Sequential Test has been applied, for the Exception Test to be passed it must be demonstrated that:
- the development provides wider sustainability benefits to the community that outweigh flood risk – informed by the strategic FRA when one is available; and
 - a site specific FRA “must 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”.
- 15.6.6 It is considered that the Proposed Scheme will provide wider sustainability benefits to the community, as demonstrated in Volume 2 and this report. The FRA for each CFA demonstrates that the Proposed Scheme will be safe from flooding for its lifetime and will not increase flood risk elsewhere. This includes those locations where the route passes through areas at high risk of flooding.
- 15.6.7 It is considered therefore that the Exception Test, as defined in the NPPF, has been applied.

Flood risk mitigation

- 15.6.8 The Proposed Scheme crosses about 12km of floodplain classified by the Environment Agency as Flood Zone 3. In addition, about 2.5km is crossed when the route is in tunnel. It may be necessary for a number of construction sites to be located within areas at risk of flooding, although this will be avoided where possible in accordance

with the draft CoCP. The most vulnerable receptors in a site will, where practicable, be located in areas with the lowest probability of flooding. During the construction stage, there may be the potential for offsite flood risk to temporarily increase as a result of obstructions to flood flow routes and/or through a loss of floodplain storage. This will be managed appropriately by measures such as site specific flood risk management plans, replacement floodplain storage areas and SuDS. These are defined in the draft CoCP and reported in the FRA for each CFA (Volume 5: Appendix WR-003-001 to WR-003-026).

- 15.6.9 Replacement floodplain storage areas, required to ensure that flood risk is not increased elsewhere, will where practicable, be located adjacent to the affected floodplain. These replacement floodplain storage areas are designed to accommodate for events up to and including the 1 in 100 year (1%) annual probability river flooding event including climate change. Sustainable drainage systems will also reduce the effects on flood risk, to levels that are not likely to be significant, by controlling the rate and volume of runoff from the Proposed Scheme.
- 15.6.10 Assessments have been carried out to determine the risk of flooding from artificial bodies, such as canals and reservoirs, and from surface water, groundwater and sewers.
- 15.6.11 There are not likely to be significant regional or route-wide temporary or permanent adverse effects on flood risk as a result of the construction process or the operation and maintenance of the Proposed Scheme.

15.7 Conclusions

- 15.7.1 Apart from the likely significant temporary adverse effect reported on groundwater resources in Section 15.4, there are not likely to be any significant regional or route-wide, temporary or permanent adverse effects on water resources and flood risk as a result of the construction process or the operation and maintenance of the Proposed Scheme.

16 Phase One and Phase Two combined impacts

16.1.1 Table 42 presents a summary of the potential total impacts of both Phase One (the Proposed Scheme) and Phase Two on a range of environmental receptors. Impacts of the Proposed Scheme (Phase One) are based on design data and assessments undertaken as part of this EIA or assessments prepared in support of the January 2012 Updated AoS Report for Phase One²⁶⁵. The Phase Two data is taken from the Phase Two Sustainability Statement²⁶⁶.

Table 42: Combined impacts of Phase One (Proposed Scheme) and Phase Two

	Phase One total	Phase Two Manchester	Phase Two Leeds	Phase Two total	Overall Total
Route characteristics (km)					
Total	225.5 ²⁶⁷	150.4	184.8	335.2	560.7
At grade	0.1	16.8	7.3	24.1	24.2
Tunnel	53.4	17.6	9.7	27.3	80.7
Cutting	73.8	55.8	75.1	130.9	204.7
Viaduct	18.5	14.3	32.7	47.0	65.5
Embankment	65.2	45.9	60.0	105.9	171.1
Property and settlements					
Demolitions (residential)	339 dwellings ^{268, 269} (265 buildings)	139	139	278	617
Demolitions (community)	21 community facilities ²⁷⁰	1	3	4	25
Demolitions (commercial/retail)	404 units (312 buildings) ²⁷¹	99	128	227	631
Demolitions (manufacturing/ industrial)		2	9	11	
Total demolitions (including residential)	600 buildings ^{272, 273}	241	279	520	1,120

²⁶⁵ Booz&Co. Temple (2012), *High Speed 2 London to West Midlands Appraisal of Sustainability - Post Consultation Route Refinements*.

²⁶⁶ Temple ERM (2013), *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*.

²⁶⁷ This total includes another 14.5km attributed to retaining walls and stations.

²⁶⁸ This figure excludes student accommodation at Curzon Street on the basis that this is a commercially operated business for short term lets (and is included as two buildings under commercial/retail demolitions).

²⁶⁹ This figure excludes future baseline (i.e. committed residential development not currently completed).

²⁷⁰ This figure is provided for the number of community resources (i.e. a cluster of buildings providing a single resource is reported as a single demolition). This figure does not include the demolition of buildings which will not prevent the continued operation of a community resource (e.g. outbuildings or other ancillary structures), however these are included under total demolitions.

²⁷¹ This figure includes some properties which also provide community resources, e.g. public house, local services.

²⁷² This total includes the total number of residential, community, commercial/retail/manufacturing/industrial & miscellaneous buildings.

²⁷³ This number is different to that published in the Phase Two Sustainability Statement (which was based on data in the Draft Environmental Statement) as there have been some changes to the design and more detailed knowledge of other buildings not previously referenced (e.g. outbuildings).

	Phase One total	Phase Two Manchester	Phase Two Leeds	Phase Two total	Overall Total
Employment and housing					
Permanent jobs created	2,200 ²⁷⁴	-	-	1,400	3,100 ²⁷⁵
Construction jobs created	14,600 ²⁷⁶	-	-	10,000	24,600
Jobs supported ²⁷⁷	30,000 ²⁷⁸	30,000-43,600	18,700-26,700	48,700-70,300	78,700-100,300
Houses supported	5,620 ²⁷⁹	3,100-4,100	2,100-3,500	5,200-7,600	10,820-13,220
Jobs displaced	8,430 ²⁸⁰	1,900	2,900	4,800	13,230
Noise					
People affected by noise (WebTAG annoyance) (mitigated scheme)	~525 ²⁸¹	~250	~1,400	~1,600 ²⁸²	~2,125
People affected by noise (WebTAG annoyance) per km	~2.3	~1.7	~7.6	~4.8	~3.8
Landscape					
AONB crossed at surface (km)	8.9	0	0	0	8.9
Cultural heritage					
Scheduled Monuments directly affected	1	0	1	1	2
Registered Battlefields directly affected	1	0	0	0	1
Grade I & II* structures directly affected	1 ²⁸³	0	0	0	1
Grade II structures directly affected	18	3	5	8	26
Registered Parks and Gardens directly affected	2	0	0	0	2
Conservation Areas directly affected	2	2 ²⁸⁴	6	8	10
Biodiversity and wildlife					
Natura 2000 sites affected	0	0	0	0	0

²⁷⁴ Indicative direct operational employment figure which has been estimated to the nearest 100 jobs (see Section 11).

²⁷⁵ Figures are not additive as some jobs associated with classic compatible services for Phase One will transfer to Phase Two.

²⁷⁶ Number reported as an approximate equivalent of permanent full time construction jobs (see Section 11).

²⁷⁷ Figures account for jobs displaced.

²⁷⁸ Booz & Co. Temple (2012), *High Speed 2 London to West Midlands Appraisal of Sustainability - Post Consultation Route Refinements*.

²⁷⁹ Booz & Co. Temple (2012), *High Speed 2 London to West Midlands Appraisal of Sustainability - Post Consultation Route Refinements*.

²⁸⁰ 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).

²⁸¹ Methodology used is consistent with that used in the Phase Two Sustainability Statement, July 2013.

²⁸² Figure rounded in Phase Two Sustainability Statement, July 2013.

²⁸³ This comprises the alteration to a curtilage wall to a Grade 1 Listed building.

²⁸⁴ One area (Trent and Mersey Canal) affected at two locations.

Volume 3: Route-wide effects | Phase One and Phase Two combined impacts

	Phase One total	Phase Two Manchester	Phase Two Leeds	Phase Two total	Overall Total
SSSIs directly affected	2	0	1	1	3
Habitats of Principal Importance directly affected	41	19	43	62	103
Ancient Woodlands directly affected	19	5	9	14	33
Water resources and flood risk					
Major rivers diverted	7	0	5	5	12
Route through Flood Zone 3 (km)	12.0	5.5	23.0	28.5	40.5
Station/depot occupation of Flood Zone 3 (ha)	2.1	0.5	23.1	23.6	25.7
Cutting or tunnel through SPZ 1 or 2 (km)	8.1	1.7	0	1.7	9.8
Land use resources					
Active landfills crossed	0	2	3	5	5
Grade 1 and 2 agricultural land (km)	22.0	20.7	30.1	50.8	72.8
Waste and material resources					
Excavated material (million m ³)	62.2 ²⁸⁵	16.65	12.35	29.00	91.2
Concrete (million tonnes)	13.62	3.11	3.66	6.77	20.39
Steel (million tonnes)	1.36	0.32	0.41	0.73	2.09

²⁸⁵ 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 surplus excavated material that will be made available for use off-site or disposed of on or off-site.

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