LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 2 | Community Forum Area report

CFA9 | Central Chilterns

November 2013

VOL 2

ES 3.2.1.9

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Department for Transport

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

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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 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 reports and map books – 26 reports and associated map books providing a description of the 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 Introduction to HS2

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

1.1.2 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 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.

1.1.3 During Phase One beyond the dedicated high-speed track, these 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.

1.1.4 Phase Two will involve the construction of lines from Birmingham to Leeds and Manchester; with construction commencing around 2023, and planned to be operational by 2033.

1.1.5 Section 4 of Volume 1 describes the anticipated operational characteristics of HS2, including the anticipated frequency of trains. As Volume 1 shows, the frequency of trains is expected to increase over time and to increase further upon opening of Phase Two. In assessing the environmental effects of the Proposed Scheme the anticipated Phase 2 operational frequency has been used. For further detail about operation of the scheme in the Central Chilterns (CFA9) area, see Section 2.4.

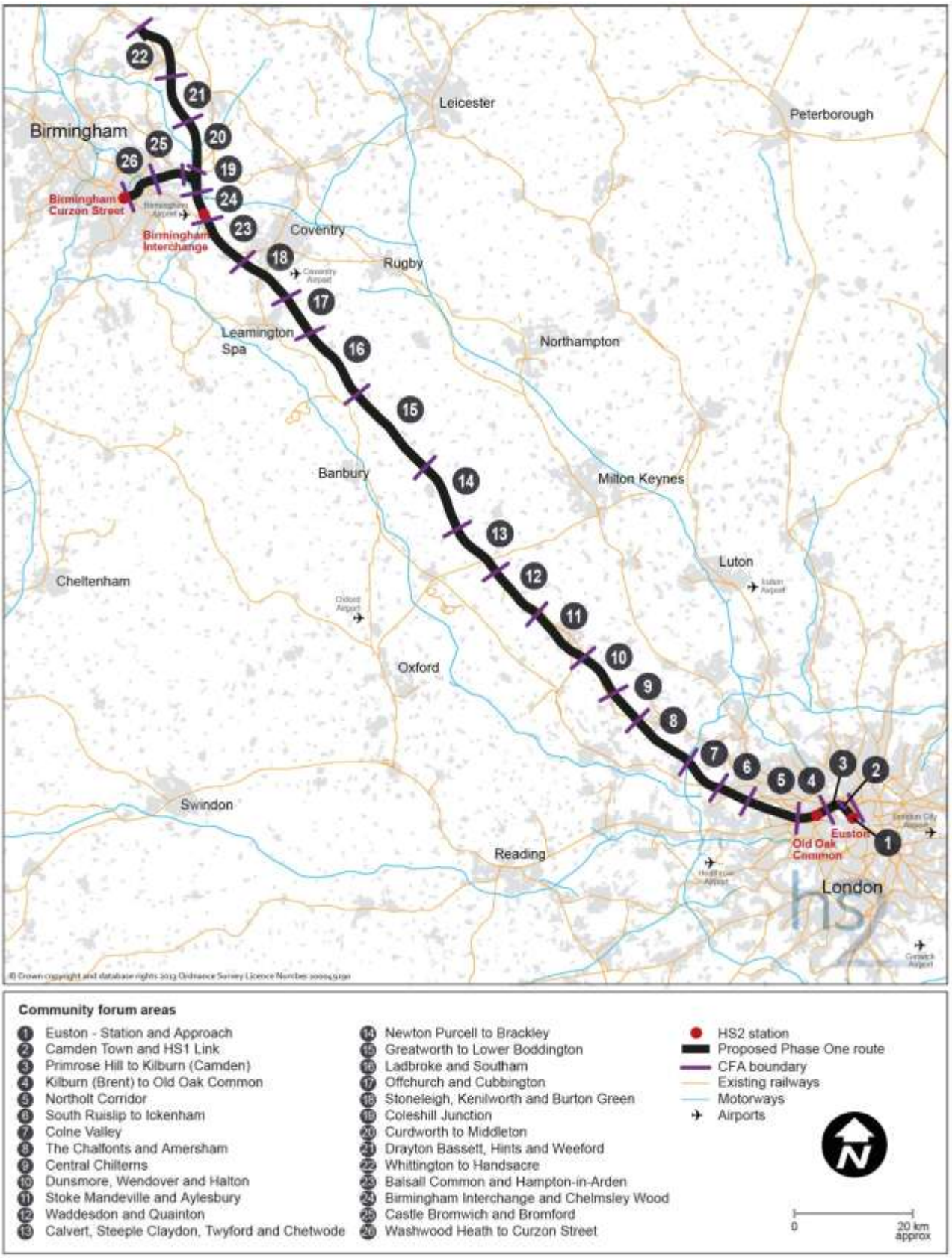
1.1.6 The Government believes that the HS2 network should link to Heathrow and its preferred option is for this to be built as part of Phase Two. However, the Government has since taken the decision to pause work on the Heathrow link until after 2015 when it expects the Airports Commission to publish its final report on recommended options for maintaining the country's status as an international aviation hub.

1.1.7 For consultation and environmental assessment purposes, the proposed Phase One route has been divided into 26 community forum areas (CFA), as shown in Figure 1. This has enabled wider public engagement on the scheme design and on the likely adverse and beneficial effects.

1.2 Purpose of this report

1.2.1 This report presents the likely significant environmental effects of the construction and operation of the Proposed Scheme on the environment within CFA9 (Central Chilterns). The report describes the mitigation measures that are proposed for the purpose of avoiding, reducing or managing the likely significant adverse effects of the Proposed Scheme on the environment within CFA9.

Figure 1: HS2 Phase One route and community forum areas



1.3 Structure of this report

1.3.1 This report is divided into the following sections:

- Section 1 – an introduction to HS2 and the purpose and structure of this report.
- Section 2 – overview of the area, description of the Proposed Scheme within the area and its construction and operation, and a description of the main local alternatives.
- Sections 3-13 – an assessment for the following environmental topics:
  - agriculture, forestry and soils (Section 3);
  - air quality (Section 4);
  - community (Section 5);
  - cultural heritage (Section 6);
  - ecology (Section 7);
  - land quality (Section 8);
  - landscape and visual assessment (Section 9);
  - socio-economics (Section 10);
  - sound, noise and vibration (Section 11);
  - traffic and transport (Section 12); and
  - water resources and flood risk (Section 13).

1.3.2 Each environmental topic section comprises: an introduction to the topic; a description of the environmental baseline within the area; the likely significant environmental effects arising during construction and operation of the Proposed Scheme; and proposed mitigation measures for any significant adverse effects.

1.3.3 Environmental effects have been assessed in accordance with the methodology set out in Volume 1, the Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2).

1.3.4 Where appropriate, potential climate change impacts and adaptation measures are discussed in the relevant environmental topic section. Volume 1 and Section 6A of the SMR Addendum also include additional information about climate change adaptation and resilience.

1.3.5 The maps relevant to the Central Chilterns are provided in a separate corresponding document entitled Volume 2: CFA9 Map Book, which should be read in conjunction with this report.

1.3.6 The Proposed Scheme described in this report is that shown on the Map Series CT-05 (construction) (Volume 2, CFA9 Map Book) and CT-06 (operation) (Volume 2, CFA9 Map Book). There is some flexibility during detailed design to alter the horizontal and

vertical alignments and other details within the limits shown on the plans and sections submitted to Parliament and as set out in the Bill and this flexibility is included within the scope of the environmental assessment. Further explanation is provided in Volume 1, Section 1.4.

1.3.7 In addition to the environmental topics covered in Sections 3-13 of this report, electromagnetic interference is addressed in Volume 1 and climate (greenhouse gas emissions and carbon), and waste and material resources are addressed in Volume 3. An assessment of potential environmental effects beyond the CFA has also been undertaken and this 'off-route' assessment is reported in Volume 4.

2 Overview of the area and description of the Proposed Scheme

2.1 Overview of the area

2.1.1 The Central Chilterns area covers a section of the Proposed Scheme approximately 6.1km in length in Chiltern District (see Figure 2) passing to the east of Little Missenden and Great Missenden. The Proposed Scheme in this area extends north-westwards from the junction of the A413 with Mop End Lane, west of Amersham, to Leather Lane, north of Great Missenden. The area includes land within the parishes of Little Missenden and Great Missenden.

2.1.2 As shown in Figure 1 the Chalfonts and Amersham area (CFA8) lies to the south and Dunsmore, Wendover and Halton (CFA10) lies to the north.

Settlement, land use and topography

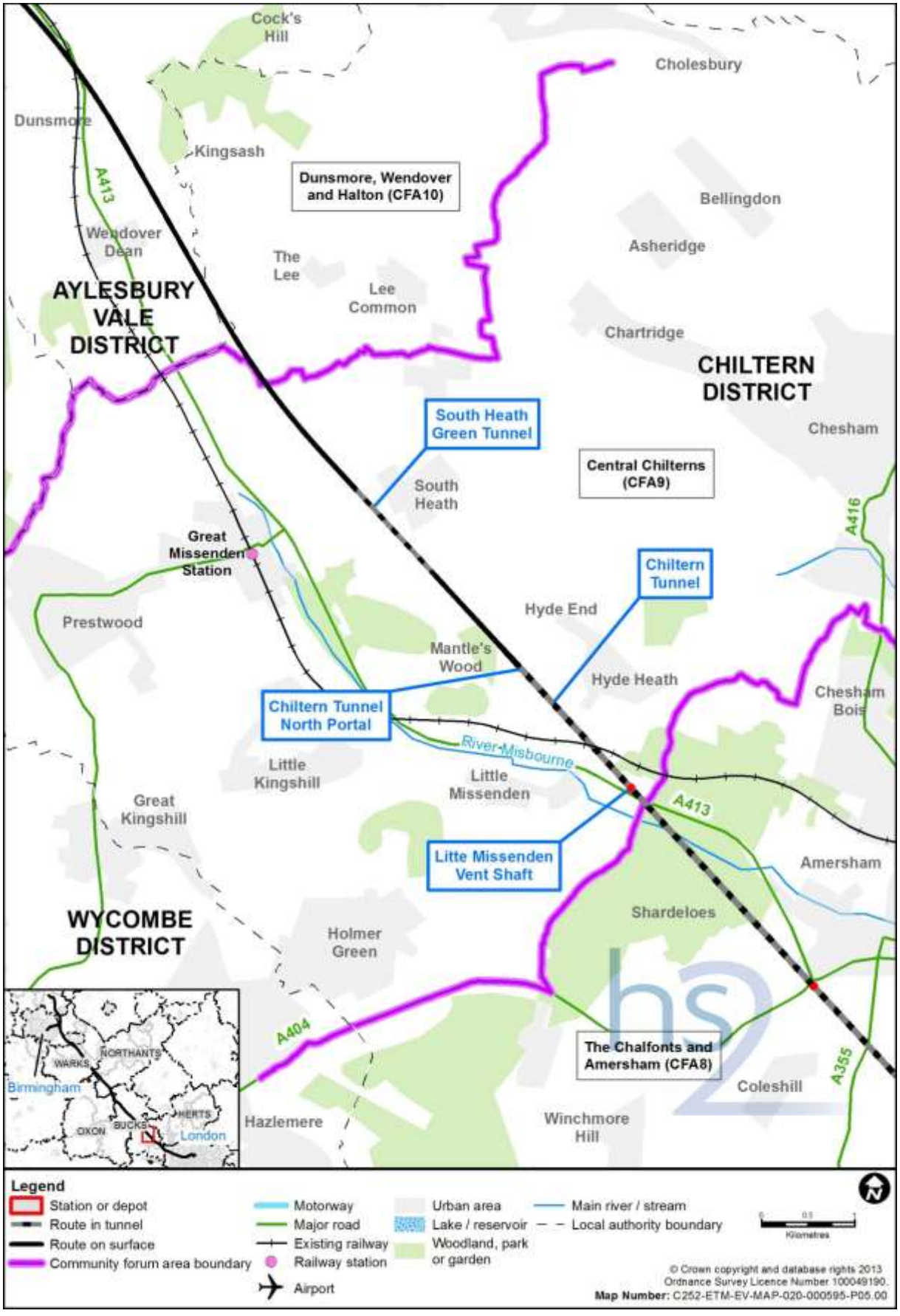
2.1.3 The area is predominantly rural in character, consisting of mixed agricultural land use interspersed with areas of woodland, scattered cottages, farmsteads and villages. The town of Chesham lies approximately 3.3km to the north-east of the Proposed Scheme and the town of High Wycombe lies 6.6km to the south-west. Villages within the area include Little Missenden, Great Missenden, Hyde Heath and South Heath.

2.1.4 The topography is generally hilly with a distinct ridgeline running south-east to north-west along the route of the Proposed Scheme. To the south-west of the ridgeline the land drops steeply to the River Misbourne in the valley below. The Proposed Scheme in this area lies entirely in the Chilterns Area of Outstanding Natural Beauty (AONB). There are a number of ancient woodlands in the area including Mantle's Wood where the north portal of the Chiltern tunnel is located, Farthings Wood and Sibley's Coppice at South Heath (see Maps CT-10-017 to CT-10-018, Volume 2, CFA9 Map Book).

Key transport infrastructure

2.1.5 The Marylebone to Aylesbury Line and the A413 run in a south-east to north-west direction, broadly following the Misbourne valley. Other key roads in the area include the B485 Chesham Road (see Map Series CT-10, Volume 2, CFA9 Map Book). The remaining road network consists of unclassified roads and tracks for private access. A key feature of the Marylebone to Aylesbury Line in this area is the station at Great Missenden, which serves as an access point to the Chilterns AONB.

Figure 2: Area context map



Socio-economic profile

2.1.6 To provide a socio-economic context for the area, data for the following demographic character areas (DCA) are used: Hyde Heath and Little Missenden; Hyde End, South Heath and Ballinger Common; and Great Missenden[1]. In total, the population of the DCA is approximately 4,900. The area's labour market performs better than the average for England as a whole; unemployment at 2.6% is significantly lower than the national level of 7.4%, while 71.4% of the population aged 16-74 is economically active compared to the national figure of 69.9%. There are approximately 2,200 people who work within the area.[2]

Notable community facilities

2.1.7 Great Missenden has a post office, public library and a number of local shops. There are two primary schools in Great Missenden, The Gateway School (for ages 2-11 years) and Great Missenden (the Church of England Combined School). There is a primary school in Little Missenden, the Little Missenden Church of England Infant School, which caters for 3-9 year olds. There is also a secondary school in Great Missenden, the Misbourne School and a further education college, Missenden Abbey Adult Education College. There are two doctors' surgeries, a chiropractor and the Chiltern Hospital (a BMI Healthcare Private Hospital) is located on London Road in Great Missenden. Further details on community facilities can be found in Section 5.

2.1.8 The villages within the area generally have a limited range of community facilities and for a greater range of shops and services residents have to travel outside of the area to the towns of Chesham, Amersham and High Wycombe.

2.1.9 The Church of St John the Baptist is located in Little Missenden and there are three other churches located in Great Missenden.

Recreation, leisure and open space

2.1.10 The area mainly consists of open agricultural land, with footpaths providing additional recreational space. There are small play areas in some of the villages and several woodlands open to the public including Mantle's Wood, Farthings Wood and Sibley's Coppice. There is a range of recreational facilities available in Great Missenden, including three recreation grounds, six allotments, the Great Missenden Memorial Centre, five playgrounds and a skate park. There is a golf course in the grounds of Chiltern Hospital and, 500m to the north-west of the hospital, there is a Lawn Tennis Club on London Road.

Policy and planning context

Planning framework

2.1.11 Given that HS2 is being developed on a national basis to meet a national need it is not included or referred to in many local plans. Nevertheless, in seeking to consider the Proposed Scheme in the local context, relevant local plan documents and policies have been considered in relation to environmental topics.

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[1] A DCA represents a community that, depending on the area, may consist of a local ward, neighbourhood or village(s). Data comes from the Office for National Statistics (ONS) (2011) Population Census. DCA unemployment rates are aggregated in this section whereas in Section 10.3 they are provided for each DCA.

[2] ONS (2012) *Business Register and Employment Survey 2011*, ONS, London

2.1.12 The following local policies have been considered and referred to where appropriate to the assessment.

- Chiltern District Council Core Strategy[3] (2011);
- Chiltern District Council Local Plan (Consolidated policies)[4] (2011);
- Buckinghamshire County Council Structure Plan[5]; and
- Buckinghamshire County Council Minerals and Waste Core Strategy (Development Management Policies[6] (MWCS) (2012).

2.1.13 There are a number of key planning designations in the area, which include public rights of way (PRoW), listed buildings, conservation areas, registered parks and gardens, ancient woodlands, Sites of Special Scientific Interest (SSSI), local wildlife sites, groundwater Source Protections Zones, minerals safeguarding area, minerals consultation area and AONB.

2.1.14 Emerging policies are not generally considered within this report. However, the Local Development Framework (DMP), which is expected to be adopted in late 2014 / early 2015, will replace many of the existing Saved Policies from the Chiltern Local Plan.

Committed Development

2.1.15 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 developments will have been completed by 2017. These are termed 'committed developments' and have been taken into account for the purpose of assessing the likely significant environmental effects of the Proposed Scheme. Where these developments have a particular relevance to an assessment topic, this is noted in the future baseline section for that topic.

2.1.16 For the Central Chilterns no committed developments have been identified which lie within the land required for the Proposed Scheme.

2.1.17 Planning applications yet to be determined and sites that are proposed allocations in development plans that have yet to be adopted, on or close to the Proposed Scheme, are termed 'proposed developments'. These are listed in Volume 5: Appendix CT-004-000. They are not included in the assessment. The progress of these proposals is being monitored by HS2 Ltd.

2.2 Description of the Proposed Scheme

2.2.1 The following section describes the main features of the Proposed Scheme in the Central Chilterns area, including the main environmental mitigation measures. Further generic information on typical permanent features is provided in Volume 1, Section 5. Similarly, a general description of the approach to mitigation is set out in Volume 1, Section 9.

[3] Chiltern District Council (2011) *Adopted Core Strategy*.
[4] Chiltern District Council (2011) *Adopted Local Plan*, Consolidated September 2007 and November 2011
[5] Buckinghamshire County Council (1991) *Buckinghamshire Structure Plan 1991-2011*: Saved Policies
[6] Buckinghamshire County Council (2012) *Minerals and Waste Core Strategy Development Plan Document*

2.2.2 The Proposed Scheme will require some land on a permanent basis, key features of which are illustrated on Map Series CT-06 (Volume 2, CFA9 Map Book). Land that will also be required, but only on a temporary basis for construction, is set out in Section 2.3.

2.2.3 In general, features are described from south to north along the route (and east to west for features that cross HS2).

2.2.4 Since the draft ES was published the following changes have been introduced to permanent features of the Proposed Scheme:

- realignment of B485 Chesham Road with a new roundabout junction with King's Lane; additional environmental mitigation areas have been incorporated into the Proposed Scheme;
- realignment of the approach to Footpath GMI/2 accommodation overbridge on the west north of its existing alignment to avoid Havenfield Wood; and
- additional environmental mitigation areas have been incorporated into the Proposed Scheme.

Overview

2.2.5 The route will enter the area in tunnel underneath the A413 junction with Mop End Lane, heading north-west. A ventilation and intervention shaft (vent shaft) and adjacent auto-transformer station will be to the north of the A413 at Little Missenden. Emerging from the tunnel north west of Hyde Heath (see Figure 2), the route will run in cutting to the west of Hyde Heath then enter a 1.2km long green tunnel past South Heath. The route will then run in cutting to Leather Lane, to the west of Ballinger Common, where the route will leave this area.

Chiltern tunnel

2.2.6 The Proposed Scheme will enter this area in a twin-bore tunnel at the junction of the A413 with Mop End Lane. The tunnel will run in a north-westerly direction and will include one vent shaft, before emerging from the Chiltern tunnel north portal. Key permanent features of this section, which will be approximately 1.9km long, will include (see Maps CT-06-030b to CT-06-031,Volume 2, CFA9 Map Book):

- circular twin-bore tunnel, each bore with an internal diameter of approximately 8.8m and an external diameter of approximately 9.6m.Depending on the surface topography in this area the tunnel depths will vary between approximately10m to 30m below ground level;
- cross passages will connect tunnel bores at approximately 380m intervals. These cross passages provide a connection between the two tunnels for rescue, maintenance and installation purposes. The cross passages will be approximately 1.5m wide and 2.3m high. Specific cross passages for the sole use by emergency services will be provided 20m either side of the vent shaft and will measure approximately 2.3m wide and 2.3m high;
- a strip of landscape earthworks along the access road to the Chiltern tunnel north portal, between Hyde Heath Road and Mantle's Farm, to provide visual screening for the residents of Hyde Heath;

- a land drainage area to the west of the landscape earthworks, just east of Mantle's Farm, with an associated access track;
- a permanent diversion of Footpath LMI/17 to the east around the tunnel portal; and
- an area of grassland habitat creation, to the south of the Chiltern tunnel north portal and east of Mantle's Farm, to mitigate the loss of great crested newt habitat.

2.2.7 Construction of this section will be managed from the Chiltern tunnel main compound in CFA7 (civil engineering) and the Chilterns main compound (rail systems) (see Section 2.3).

Little Missenden vent shaft and auto-transformer station

2.2.8 The Little Missenden vent shaft, which is required to provide pressure relief from the tunnels and a dedicated intervention point and access for emergency services, will be located south of Keeper's Lane. Key features will include (see Map CT-06-030b, Volume 2, CFA9 Map Book):

- a permanent fenced compound, which will surround the following features:
  - a shaft headhouse building, which will be approximately 41m by 27m and approximately 4m high It will provide access to the tunnels, approximately 35 m below, and will contain fans and related equipment to control smoke in the event of a fire;
  - an area of hard-standing next to the headhouse building, which will be approximately 550m^2, will allow for maintenance and emergency access and egress from the tunnel;
  - an auto-transformer station which will be approximately 45m by 25m and approximately 5m high[7];
  - below ground drainage tanks and utility connections for fire fighting and tunnel buildings drainage; and
  - land drainage areas on the eastern side of the vent shaft headhouse.
- a short access road connecting the vent shaft compound to the A413;
- landscape earthworks curving along the access road and the northern side of the vent shaft compound to integrate it into the landscape; and
- tree planting along the northern, western and southern boundary of the vent shaft compound to screen views from the residents of Little Missenden and integrate the structure into the surrounding landscape.

[7] HS2 trains will draw power from overhead line equipment, requiring feeder stations and connections to the 400kV National Grid network. In addition to feeder stations, smaller auto-transformer stations will be required at more frequent intervals. There will be no feeder stations within the local area, but two auto-transformer stations will be required.

2.2.9 Construction of this section will be managed from the Little Missenden vent shaft satellite compound (see Section 2.3).

Chiltern tunnel north portal and Chiltern tunnel north cutting

2.2.10 The Proposed Scheme will emerge from the Chiltern tunnel north portal at Mantle's Wood, north-west of Hyde Heath and will continue north-west in a cutting, up to 23m deep, for approximately 750m, then on an embankment, up to 5m high, for approximately 100m. It will then continue in a cutting, up to 13m deep, for approximately 650m up to B485 Chesham Road, south-west of South Heath. Key features of this section, which will be approximately 1.5km long, will include (see Maps CT-06-031 to CT-06-032, Volume 2, CFA9 Map Book):

- Chiltern tunnel north portal which will be located west of Hyde Heath Road including a porous portal[8] and portal building. An approximately 550m² hard-standing area will be provided next to the tunnel portal building for maintenance and emergency access and egress from the tunnel;
- an access road connecting the tunnel portal to Hyde Heath Road;
- a strip of planting along the northern edge of the tunnel portal access road which will run from Hyde Heath Road down to Mantle's Wood to link the remaining isolated section of Mantle's Wood and existing woodland to the north;
- an area of planting on the west side of the Proposed Scheme between Mantle's Wood and Farthings Wood to link the two areas of ancient woodland to mitigate for the loss of habitat;
- a drop inlet culvert with associated flow spreading pond, located approximately 190m north of the Chiltern tunnel north portal, to convey land drainage under the Proposed Scheme in the line of an existing dry valley;
- a balancing pond for rail drainage located approximately 500m west of the Proposed Scheme with an associated drainage channel running from the railway to the pond;
- strips of tree planting along the east and west side of the Proposed Scheme to screen views of the Proposed Scheme from the surrounding residents and to connect the severed areas of adjacent ancient woodland;
- a land drainage area located on the east side of the Proposed Scheme with associated access track;
- landscape earthworks with some woodland planting on the eastern side of the Proposed Scheme, between Mantle's Wood and The Hyde Cottage, to blend the cutting and embankment earthworks into the landscape and also provide visual screening for the surrounding residents;
- an area of planting approximately 500m west of the Proposed Scheme,

[8] Porous portals are perforated structures at tunnel portals (entrances), usually formed of concrete, designed to allow the passage of air from the tunnel. These are required to reduce both air pressure changes and the noise generated when a high-speed train associated with the Proposed Scheme, enters or leaves a tunnel.

adjacent to Hyde Lane and Wood End, to help compensate for the loss of ancient woodland and connect surrounding parcels of woodland;

- Footpath GMI/27 accommodation overbridge, approximately 4.4m above existing ground level, to maintain footpath connectivity and access for Hyde Farm. The overbridge will also provide access to land drainage areas from Hyde Lane over the Proposed Scheme. The approaches to the overbridge will be planted to integrate the structure into the landscape;
- noise fence barriers approximately 3m high and 350m long at the base of the cutting from Footpath GMI/27 to 100m north of Hyde Lane overbridge;
- Hyde Lane overbridge, approximately 0.5m above existing ground level, to provide an online replacement of Hyde Lane. The overbridge will incorporate a realignment of Footpath GMI/33 over the Proposed Scheme. The approaches to the bridge will be planted on the east side to integrate the structure into the landscape; landscape earthworks and planting on both sides of the Proposed Scheme, between Hyde Lane and B485 Chesham Road, to integrate the cutting into the landscape and provide visual screening for surrounding residents including those at South Heath;
- land drainage areas located on both sides of the Proposed Scheme in fields near Mantle's Wood, Hedgemoor Wood, Chapel Farm and Sheepcotts; and
- a balancing pond for highway drainage located approximately 250m east of the Proposed Scheme adjacent to B485 Chesham Road.

2.2.11 Construction of this section will be managed from the Chiltern tunnel north portal satellite compound (civil engineering) and the Chiltern tunnel north portal satellite compound (railway systems) (see Section 2.3).

South Heath green tunnel

2.2.12 The Proposed Scheme will enter South Heath green tunnel adjacent to B485 Chesham Road and will continue north-west, emerging north-west of South Heath and east of Great Missenden. Key features of this section, which will be approximately 1.2km long, will include (see Maps CT-06-032 and CT-06-033, Volume 2, CFA9 Map Book):

- South Heath green tunnel south portal which will be located south of B485 Chesham Road including a porous portal and portal building. An area of hard-standing next to the tunnel portal building, which will be approximately 550m^2 that will allow maintenance and emergency access and egress from the tunnel;
- an access road connecting the southern tunnel portal to B485 Chesham Road;
- a realignment of B485 Chesham Road over the South Heath green tunnel, with a new roundabout junction with King's Lane, approximately 100m east of the Proposed Scheme;
- a realignment of the southern end of King's Lane approximately 100m east of South Heath green tunnel to tie into the new roundabout junction with B485 Chesham Road;
- an area of planting over the length of South Heath green tunnel, up to Frith

Hill, to link severed parcels of ancient woodland and provide visual screening for the surrounding residents;

- an area of planting from the east side of King's Lane up to the boundary of Wood Lane, to link severed parcels of ancient woodland;
- re-instatement of Footpaths GMI/28, GMI/79 and GMI/80 in Sibley's Coppice over South Heath green tunnel along their existing alignments;
- re-instatement of Frith Hill over the South Heath green tunnel along its existing alignment;
- planting and landscape earthworks to integrate the South Heath green tunnel north portal into the landscape and to provide visual screening for residents of South Heath, Frith Hill and other scattered properties;
- a land drainage area located approximately 100m east of the Proposed Scheme and approximately 150m north of Frith Hill;
- a new road to provide access to either side of South Heath green tunnel for Bury Farm. This will be located approximately 140m north of Frith Hill. There will be strips of planting along the access road to provide visual screening for the surrounding residents;
- South Heath green tunnel north portal will be located approximately 250m north of Frith Hill, including a porous portal and portal building. An approximately 550m^2 hard-standing area will be provided next to the tunnel portal building for maintenance and emergency access and egress from the tunnel; and
- a short access road connecting South Heath green tunnel north portal to Frith Hill; the edges of the road will be planted and integrated into the landscape.

2.2.13 Construction of this section will be managed from the South Heath green tunnel (south) satellite compound (civil engineering), the Chilterns main compound in CFA7 (rail systems) and the South Heath green tunnel (north portal) satellite compound (see Section 2.3).

South Heath cutting

2.2.14 The Proposed Scheme will emerge from South Heath green tunnel north portal, north of Frith Hill and will continue north-west in a cutting, up to 11m deep in this area, north to Leather Lane (and which will continue through to the Dunsmore, Wendover, and Halton area). Key features of this section, which is approximately 1.5km long, will include (see Maps CT-06-033 to CT-06-034a, Volume 2, CFA9 Map Book):

- South Heath mid-point auto-transformer station and bulk supply area will be located approximately 350m north of Frith Hill on the west side of the Proposed Scheme, with an associated access track shared with South Heath green tunnel north portal access;
- noise fence barriers approximately 3m high and 700m long at the base of the cutting on the eastern side of the route, between the South Heath green tunnel north portal and 200m north of Footpath GMI/12;

- planting along both sides of the Proposed Scheme from Footpath GMI/13 to Park Farm, to screen views from the surrounding residents of South Heath;
- an area of grassland habitat creation to the east of the Proposed Scheme, west of Park Farm to mitigate the loss of terrestrial great crested newt habitat;
- an overbridge at existing ground level, providing connectivity for Footpaths GMI/12 and GMI/13 across the Proposed Scheme;
- an area of grassland habitat creation to the west of the Proposed Scheme just north of the Footpath GMI/12 overbridge;
- an area of planting to the west of the Proposed Scheme up to Footpath GMI/12 to better integrate the route into the surrounding landscape and provide visual screening for local residents;
- noise fence barriers approximately 3m high and 180m long at the base of the cutting on the eastern side of the route, either side of Footpath GMI/2 accommodation overbridge;
- a land drainage area located to the east of the Proposed Scheme with an associated access road from Potter Row;
- landscape earthworks and planting on the east side of the Proposed Scheme, from north of Mulberry Park Hill to Hammondshall Farm, to integrate the cutting into the landscape, provide visual screening to the west and noise mitigation to the east;
- an overbridge approximately 6.5m above existing ground level providing an offline replacement of Footpath GMI/2 and access for Strawberry Hill Farm[9]; the approaches to the overbridge will be planted to integrate the structure into the landscape maintain and enhance existing habitat links across the route for bats and other wildlife;
- a land drainage area to the east of the Proposed Scheme, south of Hammondshall Farm, with an associated access track from Potter Row;
- a drop inlet culvert with associated flow spreading pond, located approximately 350m south of Leather Lane, to convey land drainage under the Proposed Scheme along the line of the existing dry valley; and
- noise mitigation earthworks will be located to the east side of the Proposed Scheme from north of the Footpath GMI/2 overbridge up to Leather Lane, along Hammondshall Farm. These earthworks will be sensitively contoured in to the existing topography.

2.2.15 Construction of this section will be managed from the South Heath green tunnel (north) satellite compound (civil engineering) and South Heath green tunnel (north portal) satellite compound (rail systems) (see Section 2.3).

[9] The effect on this farm holding are reported in Section 3, Volume 2, Report 10

Leather Lane overbridge

2.2.16 The Proposed Scheme will continue north-west in the South Heath cutting past Leather Lane overbridge where it will leave this area. Key features of this section will include Leather Lane overbridge, which will be approximately 4m above existing ground level, providing an offline replacement of Leather Lane (see Map CT-06-034a, Volume 2, CFA9 Map Book). The approaches to the bridge will be planted to integrate the structure into the landscape and maintain and enhance existing habitat links across the route for bats and other wildlife.

2.3 Construction of the Proposed Scheme

2.3.1 This section sets out the strategy for the construction of the Proposed Scheme in the Central Chilterns area including:

- overview of the construction process;
- description of the advance works;
- description of the engineering works to build the railway;
- construction waste and material resources;
- commissioning the railway; and
- indicative construction programme (see Figure 5).

2.3.2 The assessment presented in this ES is based on the construction arrangements as described in this section.

2.3.3 In addition to the land that will be required permanently by the Proposed Scheme (see Section 2.2), land will be required on a temporary basis for construction. Key temporary construction features are illustrated on the construction Map Series CT-05 (Volume 2, CFA9 Map Book). Following construction works, land required temporarily will be prepared for its eventual end use, which will include being returned to its pre-construction use wherever reasonably practicable.

2.3.4 A guide to standard construction techniques is provided in Volume 1, Section 6. In instances for which more than one possible construction technique might be possible, this section specifies which technique has been assumed for the purposes of this assessment.

Overview of the construction process

2.3.5 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 and preliminary enabling works;
- civil engineering works including establishment of construction compounds, site preparation and enabling works, main earthworks and structure works, site restoration and removal of construction compounds;
- railway installation works including establishment of construction compounds,

infrastructure installation, connections to utilities, changes to the existing rail network and removal of construction compounds; and

- system testing and commissioning.

Guide to general construction control provisions

2.3.6 General provisions relating to the construction process are set out in more detail in Volume 1, Section 6 and the draft CoCP (see Volume 5: Appendix CT-003-000) including:

- the approach to environmental management during construction and the role of the Code of Construction Practice (draft CoCP, Sections 2 and 3);
- working hours (draft CoCP, Section 5);
- the management of construction traffic (draft CoCP, Section 14); and
- the handling of construction materials (draft CoCP, Section 15).

Advance works

2.3.7 General information about advance works can be found in Volume 1, Section 6.4. Advance works will be required before commencing construction works and will typically include:

- further detailed site investigations and surveys;
- further detailed environmental surveys;
- advance mitigation works including, where appropriate, contamination remediation, temporary habitat creation and translocation, and built heritage survey and investigation;
- site establishment with temporary fence construction; and
- utility diversions.

Engineering works

2.3.8 Construction of the railway will require engineering works along the entire length of the route and within land adjacent to the route. This will comprise two broad types of engineering work:

- civil engineering works such as earthworks, tunnels and erection of bridges; and
- The railway systems installation works will include track, overhead line equipment, communications equipment and traction power supply. The installation of track in open areas will comprise the laying of ballast and/or slab tracks, rail and sleepers.

2.3.9 The construction of the Proposed Scheme will be subdivided into sections, each of which will be managed from compounds. The compounds will act as the main interface between the construction work sites and the public highway, as well as performing other functions as described below. Compounds will either be main compounds or satellite compounds, which are generally smaller. Some compounds

will be used for civil engineering works and others for railway installation works, and in some cases for both.

2.3.10 In the Central Chilterns area there will be one main compound for railway installation works (which will utilise one of the civil engineering satellite compounds) and four civil engineering satellite compounds and three railway installation satellite compounds (of which one will continue to use a compound previously established for the civil engineering works).

2.3.11 Figure 3 shows the management relationship for civil engineering works compounds and Figure 4 for the railway installation works compounds. Details about individual compounds are provided in subsequent sections of this report.

General overview of construction compounds

2.3.12 Main compounds will be used for core project management staff (i.e. engineering, planning and construction delivery), and commercial and administrative staff. These management teams will directly manage some of the works and/or coordinate satellite compounds, which will manage other works. In general, main compounds will contain:

- space for the storage of bulk materials (aggregates, structural steel and steel reinforcement);
- space for the receipt, storage and loading/unloading of excavated material either onto or off the site;
- an area for the fabrication of temporary works equipment and finished goods;
- fuel storage;
- plant and equipment storage;
- necessary operational parking; and
- office space for management staff, limited car parking for staff and site operatives and welfare facilities.

2.3.13 Satellite construction compounds will be used as the base to manage specific works along a section of the route. They will usually provide office accommodation for limited numbers of staff, local storage for plant and materials, limited cark parking for staff and site operatives, and welfare facilities.

2.3.14 Some compounds will also accommodate additional functions as listed below. Where this is the case they will be included in the description of the compound:

- railheads will connect with the existing railway for the delivery of materials for the construction of the rail systems;
- roadheads will require an additional area of land adjacent to the compound for the storage and loading and unloading of bulk earthworks materials which are moved to and from the site on public highways; and
- living accommodation for the construction workforce.

2.3.15 In addition, areas adjacent to some compounds will be used for the storage of topsoil stripped as part of the works prior to it being used when the land is reinstated to its former use.

2.3.16 Further information on the function of compounds, including general provisions for their operation including security fencing, lighting, utilities supply, site drainage and codes of worker behaviour are set out in Volume 1, Section 6, and the draft CoCP, Section 5.

Construction traffic routes

2.3.17 The movement of construction vehicles carrying materials, plant, other equipment and workforce (or moving empty) will take place within the construction sites, on public roads and via the rail network. The construction compounds will provide the interface between the construction works and the public highway or rail network, and the likely road routes to access compounds are described in subsequent sections below.

2.3.18 Movements between the construction compounds and the work sites will be on designated haul roads within the site, often along the line of the railway or running parallel to it.

Figure 3: Schematic of construction compounds for civil engineering works

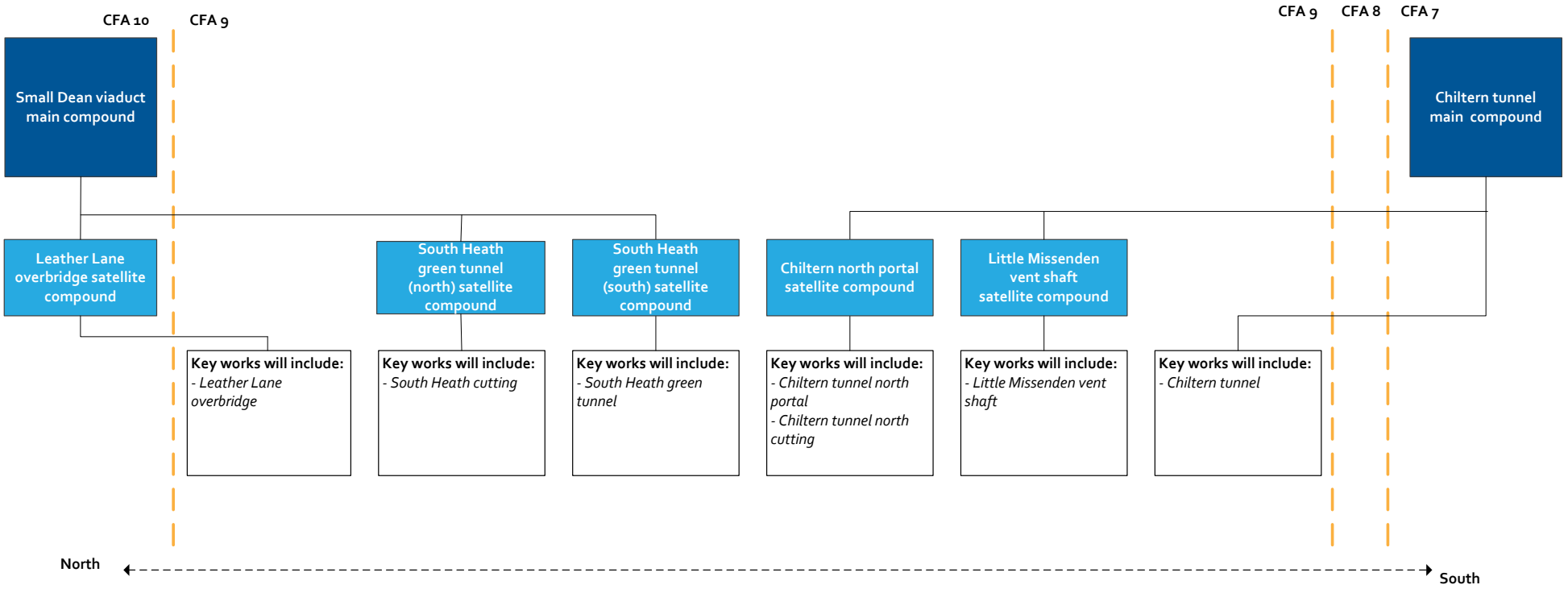
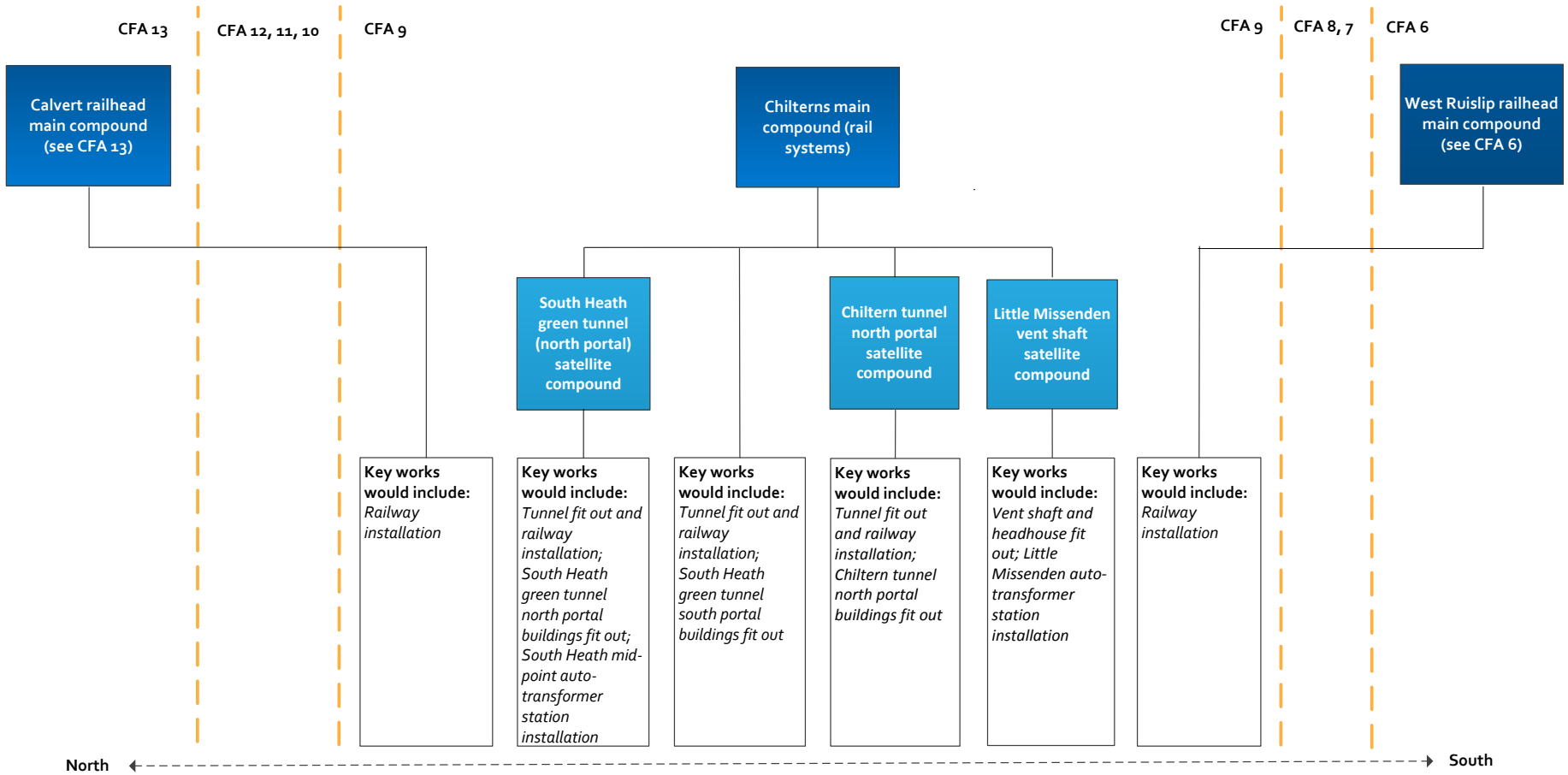


Figure 4: Schematic of construction compounds for railway installation works



West Ruislip railhead main compound

2.3.19 Whilst this compound is located within the South Ruislip to Ickenham area (CFA6), it will be used for railway installation works leading up to the Chiltern tunnel north portal, as illustrated in Figure 4. See Volume 2, CFA6 for more information about this compound.

2.3.20 The West Ruislip railhead, west of Breakspear Road south is located within the site of the Northolt tunnel and earthworks main compound (CFA6).

2.3.21 The railway systems installation works will include track, overhead line equipment, communications equipment and traction power supply. The installation of track in tunnels will be on concrete slab track. See Volume 1, Section 5.16 for descriptions of typical track layout and Section 5.17 for descriptions of typical power supply features, and Volume 1, Section 6.22 and 6.23 for their associated construction techniques respectively.

2.3.22 Works in this area will take approximately two years and three months, commencing in 2023.

2.3.23 The track will be laid in a northerly direction away from the West Ruislip railhead main compound as far as the Chiltern tunnel north portal, north of which track laying is managed from the Calvert railhead main compound (see CFA13). Before the railway systems installation can commence, adequate civil engineering work will need to be completed to allow a continuous track laying sequence.

2.3.24 The railway systems installation has its own mobile welfare facilities for the site staff.

Chiltern tunnel main compound

2.3.25 This compound is located within the Colne Valley area (CFA7) and will be used for the construction of the twin-bore tunnels between Mop End Lane and Mantle's Wood within this area and also provides support to two satellite construction compounds as illustrated in Figure 3. See CFA Report 7 for more information about this compound and the works to construct the tunnel.

2.3.26 The compound will be used to manage construction of the Chiltern tunnel, which will be approximately 13.5km[10] long of which 1.9km is within this area. The complete Chiltern tunnel will take approximately five years and nine months to construct for the civil engineering works. Volume 1, Section 5.5 describes a typical twin-bore tunnel and Section 6 describes the associated construction techniques.

Little Missenden vent shaft satellite compound

2.3.27 This compound will be used for civil engineering and railway installation works for the Little Missenden vent shaft. The construction compound will:

- be in place for six years and three months. During this period there will be civil engineering works for approximately three years and three months, starting in 2018, followed by a one year period of inactivity before the railway installation works, which will last for approximately two years, commencing in 2023;

[10] This length includes the porous portals.

- support approximately 30 workers each day throughout much of the civil engineering works period, increasing to a maximum of approximately 65 workers each day during the peak period of activity; the construction compound will also support approximately 20 workers each day throughout much of the rail systems installations works period, increasing to a maximum of approximately 45 workers during the peak period of activity;
- not provide overnight worker accommodation;
- be accessed via A413, A40 and M40;
- have an associated roadhead with access to/from the A413 for the storage and transfer of earthworks material route-wide; and
- be managed from the Chiltern tunnel main compound located in CFA7 for the civil engineering works and from the Chilterns main compound (rail systems) for the railway systems installation works.

2.3.28 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- set-up diaphragm wall plant;
- install diaphragm walls;
- excavate shaft and install propping;
- install de-watering system (if required);
- construct shaft base and walls;
- tunnel breakthrough to form connection with vent shaft;
- internal reinforced concrete fit-out;
- construction of headhouses;
- rail systems installation; and
- landscaping and planting around the vent shaft compounds.

2.3.29 The compound will be used to manage construction of the Little Missenden vent shaft, which will take approximately five years and three months to construct (with a one year gap in construction activity after approximately three years). Volume 1, Section 5.7 provides a description of a typical vent shaft, and Volume 1, Section 6.14 describes the activities associated with vent shaft construction

2.3.30 No demolitions, road, PRoW or watercourse realignments are required with works associated with this compound.

2.3.31 There are no diversions of existing utilities but the installation of new utilities will be required. The key one being a permanent 33kV supply, routed through the Chiltern tunnel from the Scottish and Southern Energy sub-station in CFA7.

2.3.32 Key railway systems installation works in this section of the Proposed Scheme will be:

- installation of vent shaft equipment and commissioning; and
- installation of the auto-transformer station.

2.3.33 See Volume 1, Section 5.17 for a generic description of power supply features including auto-transformer stations, and Volume 1, Section 6.23 for a description of associated construction activities.

Chiltern tunnel north portal satellite compound (civil engineering)

2.3.34 This compound will be used for civil engineering works only, between Mantle's Wood, north-west of Hyde Heath to Chesham Road, south-west of South Heath. The construction compound will:

- be operational for approximately four years and three months. During this period there will be civil engineering works for approximately two years and six months, starting in 2017, followed by a one year and three month period of inactivity before further civil engineering works, which will last for approximately six months, starting in 2021. This second period of works will involve the removal of the tunnel boring machines (TBM);
- support approximately 25 workers each day throughout much of the civil engineering works period, increasing to a maximum of approximately 55 workers each day during the peak period of activity;
- not provide overnight worker accommodation;
- be accessed via the upgraded access track to Mantle's Wood via Hyde Heath Road, B485 Chesham Road, Frith Hill, A413 and then A40 and M40 and/or A355, A40 and M40; and
- be managed from the Chiltern tunnel main construction compound (see Section 2.3.22 and CFA Report 7 for the civil engineering works.

2.3.35 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- demolition;
- culverts and drainage;
- construction of tunnel portal;
- TBM removal;
- cuttings, embankments, landscape earthworks and planting; and
- permanent fencing.

2.3.36 The compound will be used to manage construction of the Chiltern tunnel north portal and the Chiltern tunnel north cutting which will take approximately three years (with a one year and three month gap in construction activity after approximately two years

and six months). Volume 1, Section 5.6 provides a description of a typical tunnel portal and Section 5.2 for a cutting, and Volume 1, Sections 6.13 and 6.8 describes the activities associated with their construction respectively.

2.3.37 Demolitions will be required at five properties. These are listed in Table 1.

Table 1: Demolition works at Chiltern tunnel north portal satellite compound

Description	Location
One residential property (Rowen Farm and three associated outbuildings)	Hyde Lane
One residential property (Hedgemoor and one associated outbuilding)	Hyde Lane
Two outbuildings associated with one residential property (Sheepcotts Cottage)	Hyde Lane
Two outbuildings associated with one commercial property (Chapel Farm)	Hyde Lane
One residential property (Meadowleigh)	Chesham Road

2.3.38 One road realignment will be required at Hyde Lane. This will require a temporary closure and 6km diversion via the A413 and Chesham Road, for a period of nine to 12 months, with permanent reinstatement over Hyde Lane overbridge on its existing alignment.

2.3.39 Realignment of a number of PRoW will be required. These are as follows:

- a temporary alternative route for Footpath LMI/17, via Bullbaiters Lane and Hyde Heath Road for a period of approximately 10-12 months, adding an additional 1500m. It will then be permanently reinstated partly along its existing alignment and with a realignment to the south of the Chiltern tunnel portal;
- Footpath LMI/21 remains open during construction until it is permanently diverted 450m to the east over realigned Footpath LMI/17;
- a temporary alternative route for Footpath GMI/23/6[11], to the west for a period of approximately six to nine months, adding an additional 100m. It will then be permanently reinstated along its existing alignment;
- a temporary alternative route for Footpath GMI/23for a period of approximately three to six months adding a negligible distance until it is permanently diverted 600m to the east via the realigned Footpath LMI/17, adding an additional 700m;
- a temporary alternative route for Footpath GMI/27, via Hyde Lane for a period of approximately six to nine months, adding an additional 400m. It will then be permanently diverted via Footpath GMI/27 accommodation overbridge,

[11]The Buckinghamshire County Council subsection reference has been provided in instances where different sections of the footpath will be realigned in different ways, in order to differentiate between these sections.

adding an additional 150m;

- a temporary alternative route for Footpath GMI/33/2 via Chesham Road and Hyde Lane for a period of approximately three to six months, adding an additional 750m. It will then be permanently diverted 20m to the north over Hyde Lane, adding an additional 100m; and
- Footpath GMI/33/3 remains open during construction until it is permanently diverted 50m to the east over Hyde Lane, adding an additional 100m.

2.3.40 Diversion of utilities and the installation of new utilities will be required, the key one in this area being a permanent 33kV supply, connecting electricity to the Proposed Scheme at Chiltern tunnel north portal building.

2.3.41 Temporary diversion of the private access to Mantle's Farm will be required along Bullbaiters Lane and LMI/27 during the construction of the Chiltern tunnel north portal.

2.3.42 No watercourse diversions will be required with works associated with this compound.

Chiltern tunnel north portal satellite compound (railway systems)

2.3.43 This compound will be used for railway systems installation works only, between approximately Mantle's Wood, north-west of Hyde Heath to Chesham Road, south-west of South Heath. The compound will:

- be operational for approximately two years, starting in 2023;
- support approximately 20 workers each day throughout this period;
- not provide overnight worker accommodation;
- be accessed via the upgraded access track to Mantle's Wood via Hyde Heath Road, B485 Chesham Road, Frith Hill, A413 and then A40 and the M40 and/or A355, A40 and the M40; and
- be managed from the Chilterns main construction compound (rail systems).

2.3.44 Key railway systems installation works in this section of the Proposed Scheme will take approximately two years to complete and will include:

- fit-out of Chiltern tunnel north portal buildings; and
- fit-out of tunnel and railway systems within the Chiltern tunnel.

2.3.45 Volume 1, Section 5.6 provides a description of a typical portal and Section 6.13 describes the associated construction activities.

South Heath green tunnel (south) satellite compound and Chilterns main compound (rail systems)

2.3.46 This compound will be used for civil engineering works and railway installation works, between approximately Chesham Road, south-west of South Heath to north of Frith Hill. On completion of the civil engineering works, the compound will form the Chilterns main compound (rail systems). The compound will:

- be in place for approximately seven years and nine months. During this period there will be civil engineering works for approximately three years and six months, starting in 2017, followed by a two year period of inactivity before the railway installation works, which will last for approximately two years and three months, commence in 2023;
- support approximately 110 workers each day throughout much of the civil engineering works period, increasing to a maximum of approximately 135 workers each day during the peak period of activity; support approximately 40 workers each day throughout much of the railway installation works period;
- not provide overnight worker accommodation;
- be accessed via the B485 Chesham Road, A413, A40 and M40 from the east; and the A413,A355, A40 and/or B4009, A4010 and M40 and/or B4009, A4129, A418 and M40 from the West; and
- be managed from Small Dean viaduct main compound in the Dunsmore, Wendover and Halton area (see CFA10) for the civil engineering works.

2.3.47 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- building demolition;
- install piled wall supports;
- excavate and install propping;
- construct green tunnel;
- backfill over green tunnel;
- highway and footpath reinstatement; and
- landscaping and planting.

2.3.48 The compound will be used to manage construction of South Heath green tunnel, which will take approximately three years and six months. Volume 1, Section 5.5 provides a description of a typical green tunnel, and Volume 1, Section 6.12 describes the activities associated with its construction using the cut and cover technique.

2.3.49 Demolitions will be required at nine properties and for two structures. These are shown in Table 2.

Table 2: Demolition works at South Heath green tunnel satellite compound and Chilterns main compound

Description	Location
One property (two buildings) with commercial and residential use (former Annie Bailey's public house and restaurant)	Chesham Road
One residential property and four associated outbuildings (94 King's Lane and one outbuilding on an adjacent plot)	King's Lane

Description	Location
One residential property (Wenash, 90 Kings Lane)	King's Lane
Two outbuildings associated with one residential property (86 King's Lane – the Grade II listed 86 King's Lane is to be retained)	King's Lane
National Grid pylon	Frith Hill
One commercial property (two buildings) (Elwis Field Farm)	West of Sibley's Coppice
One commercial property (the workshop, Elwis Field Farm)	West of Sibley's Coppice
One commercial property (Weights and Measures Gym)	Frith Hill
One outbuilding associated with one residential property (Orchard Cottage)	Frith Hill
One residential property and associated outbuilding (Chiltern Cottage)	Frith Hill
National Grid pylon	West of Jenkin's Wood

2.3.50 Realignment of two roads will be required:

- permanent realignment of B485 Chesham Road, 120m to the north, across the green tunnel, including the associated realignment of King's Lane and provision of a roundabout junction with Chesham Road. Part of the existing King's Lane alignment will be stopped up. Local access to 86 King's Lane will be retained; and
- temporary closure of Frith Hill and 2.6km diversion of traffic via B485 Chesham Road and King's Lane, for a period of one year and six months to two years, with permanent reinstatement on the existing alignment.

2.3.51 The realignment of six PRoW will be required including:

- a temporary alternative route for Footpath GMI/33/4, to the south for a period of approximately six months, adding an additional 100m. It will then be permanently diverted along Hyde Lane and South Heath green tunnel south portal access track, adding an additional 400m;
- a temporary alternative route for Footpath GMI/33/5, to the south for a period of approximately one year and six months to two years, adding an additional 250m. It will then be permanently reinstated along its existing alignment;
- a temporary alternative route for Footpath GMI/28, via King's Lane and Chesham Road for a period of approximately one year and six months to two years, adding an additional 400m. It will then be permanently reinstated along its existing alignment;
- a temporary alternative route for Footpaths GMI/28, GMI/79 and GMI/80 via Chesham Road and King's Lane for a period of approximately one year and six months to two years all adding an additional 400m. They will then be permanently reinstated along their existing alignment; and

- a temporary alternative route for Frith Hill footpath, to the east for a period of approximately one year and six months to two years, adding an additional 400m. It will then be permanently reinstated along its existing alignment.

2.3.52 The diversion of a number of existing utilities and the installation of new utilities will be required, the key ones including:

- temporary diversion of 400kV National Grid overhead power lines, 40m to the east, for a period of approximately two years, with permanent reinstatement along its existing alignment; and
- a permanent 33kV underground supply, routed through the Chiltern tunnel from the Ickenham auto-transformer feeder station in CFA7.

2.3.53 No watercourse diversions will be required with works associated with these compounds.

2.3.54 Key railway systems installation works in this section of the Proposed Scheme will take approximately one year and three months to complete and will include:

- fit-out of South Heath green tunnel south portal buildings; and
- fit-out of tunnel and railway systems within South Heath green tunnel.

2.3.55 Volume 1, Section 5.6 provides a description of a typical portal and Section 6.13 describes the associated construction activities.

South Heath green tunnel (north portal) satellite compound (railway systems)

2.3.56 This compound will be used for railway systems installation works only, to the north of South Heath. The compound will:

- be operational for approximately one year and nine months, starting in 2023;
- support approximately 25 workers each day throughout much of this period, increasing to a maximum of approximately 45 workers each day during the peak period of activity;
- not provide overnight worker accommodation;
- be accessed via Frith Hill, B485 Chesham Road, A413, A40 and M40 from the east; and the A413, A355, A40 and M40 and/or A413, B4009, A4010 and M40 and/or A413, B4009, A4010, A4129, A418 and M40 from the West; and
- be managed from the Chilterns main compound (rail systems).

2.3.57 Key railway systems installation works in this section of the Proposed Scheme will take approximately one year and nine months to complete and will include:

- installation of a mid-point auto-transformer station north of South Heath green tunnel north portal;
- fit out of South Heath green tunnel north portal buildings; and
- fit out of tunnel and railway systems within South Heath green tunnel.

2.3.58 Volume 1, Section 5.6 provides a description of a typical portal and Section 6.13 describes the associated construction activities. Volume 1, Section 5.17 for a generic description of power supply features including auto-transformer stations, and Volume 1, Section 6.23 for a description of associated construction activities.

South Heath green tunnel (north) satellite compound

2.3.59 This compound will be used for civil engineering works north of Frith Hill to Leather Lane. The construction compound will:

- be operational for approximately three years and nine months, starting in 2017;
- support approximately 15 workers each day throughout much of the civil engineering works period, increasing to a maximum of approximately 40 workers each day during the peak period of activity;
- not provide overnight worker accommodation;
- be accessed via Frith Hill, B485 Chesham Road, A413, A40 and M40 from the east; and the A413, A355, A40 and M40 and/or A413, B4009, A4010 and M40 and/or A413, B4009, A4010, A4129, A418 and M40from the West; and
- be managed from Small Dean viaduct main construction compound in the Dunsmore, Wendover and Halton area (CFA10).

2.3.60 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- demolition;
- culverts and drainage;
- construction of bridges;
- cuttings, embankments;
- permanent fencing; and
- landscaping and planting.

2.3.61 The compound will be used to manage construction of the South Heath cutting, which will take approximately three years and six months. Volume 1, Section 5.3 provides a description of a typical cutting, and Volume 1, Section 6.8 describes the activities associated with its construction.

2.3.62 Demolitions will be required at one property and for one structure:

- one residential building and four associated outbuildings at one property (Mulberry Park Hill, located off Potter Row); and
- one National Grid pylon structure (ZL 434) at Frith Hill.

2.3.63 No road realignments will be required with works associated with this compound.

2.3.64 Alternative routes for three of the PRoW will be required, including:

- Footpath GMI/13 remains open during constructionuntil it is permanently diverted 400m to the west over Footpath GMI/12 overbridge adding an additional 750m;
- a temporary alternative route for Footpath GMI/12 to the south for a period of approximately six to nine months, adding an additional 100m. It will then be permanently reinstated along its existing alignment across Footpath GMI/12 overbridge; and
- Footpath GMI/2 remains open during construction. It will then be permanently diverted 200m to the west over Footpath GMI/2 accommodation overbridge, adding an additional 550m.

2.3.65 Temporary diversion of two private access will be required:

- the access to Park Farm will require a temporary diversion along diverted Footpath GMI/12 during the construction of Footpath GMI/12 during the construction of Footpath GMI/12 overbridge;
- the access towards Havenfield Wood will require a temporary diversion along diverted Footpath GMI/2 during the construction of Footpath GMI/2 accommodation overbridge.

2.3.66 There will be no key utilities diversions required.

2.3.67 No watercourse diversions will be required with works associated with this compound.

Leather Lane overbridge satellite compound

2.3.68 This compound will be located in the Dunsmore, Wendover and Halton area (CFA10) and will be managed from Small Dean viaduct main compound (also located in the Dunsmore, Wendover and Halton area). It will provide for civil engineering works at Leather Lane overbridge. See Volume2, Dunsmore, Wendover and Halton (CFA 10) for more information about this compound.

2.3.69 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- construction of overbridge;
- drainage;
- embankments;
- permanent fencing; and
- landscaping and planting.

2.3.70 The construction compound will be used to manage construction of Leather Lane overbridge, which will take approximately one year. Volume 1, Section 5.10 provides a description of a typical overbridge, and Volume 1, Section 6.17 describes the activities associated with its construction.

2.3.71 No demolitions, realignments of PRoW, utilities or watercourses will be required with works associated with this compound.

2.3.72 Leather Lane will be permanently realigned, 50m to the south of its current location, across the new Leather Lane overbridge.

Small Dean viaduct main compound

2.3.73 This compound is located within the Dunsmore, Wendover and Halton area (CFA10). It will provide support to two satellite compounds in this area and the Leather Lane overbridge satellite compound in the Dunsmore, Wendover and Halton area, which manages work in this area (see Figure 3). See CFA 10 for more information about this compound.

Calvert railhead main compound

2.3.74 This construction compound is located within the Calvert, Steeple Claydon, Twyford and Chetwode area (CFA13) but it will provide support to all railway installation works north of the Chiltern tunnel north portal as illustrated in Figure 4, which provide for the high speed railway construction from the Chiltern tunnel north portal northwards throughout this area. See CFA13 for more information about this compound.

2.3.75 The railway systems installation works will include track, overhead line equipment, communications equipment and traction power supply. The installation of track in open areas will be of standard ballast or slab track configuration. The track installation through green tunnels in this area will also comprise standard ballast or slab track construction.

2.3.76 Works in this area will take approximately one year and three months, commencing in 2024.

2.3.77 The track will be laid in a southerly direction away from the Calvert Railhead main compound as far as the Chiltern tunnel north portal, south of which track laying is managed from the West Ruislip railhead main compound (See CFA 6). Before the railway systems installation can commence, adequate civil engineering work will need to be completed to allow a continuous track laying sequence.

2.3.78 The railway systems installation has its own mobile welfare facilities for the site staff.

Construction waste and material resources

2.3.79 Forecasts of the amount of construction, demolition and excavation waste (CDEW) and worker accommodation site waste produced during the construction of the Proposed Scheme in the Central Chilterns area have been prepared and are presented in Volume 5: Appendix WM-001-000.

2.3.80 The majority of excavated material generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme, either with or without treatment.

2.3.81 Based on the mitigation earthworks design approach adopted for the Proposed Scheme, local excess or shortfall of excavated material within the Central Chilterns area will be managed with the aim of contributing to the overall balancing of

excavated material on a route-wide basis. This overall balance of excavated material is presented in Volume 3, Section 14.

2.3.82 Sustainable placement of inert surplus excavated material will be used where the material cannot be reused beneficially along or locally beyond the route and where it cannot be removed by either rail or along the construction corridor. One area of sustainable placement will be used in CFA10 to permanently dispose of surplus excavated material generated from this area, to avoid causing significant environmental effects associated with the road transport of that material. The sustainable placement area of surplus excavated material is located near Hunt's Green Farm.

2.3.83 The quantity of surplus excavated material originating from the Central Chilterns area that will require off-site disposal to landfill as excavation waste is shown in Table 3. This is the forecast quantity of contaminated excavated material that is chemically unsuitable for reuse within the Proposed Scheme.

2.3.84 The quantities of demolition, construction and worker accommodation site waste that will be re-used, recycled and recovered (i.e. diverted from landfill) have been based on the performance of similar projects as follows:

- demolition waste:90%;
- construction waste:90%; and
- worker accommodation site waste: 50%.

2.3.85 The quantities of demolition, construction and worker accommodation site waste that will require off-site disposal to landfill are shown in Table 3.

Table 3: Estimated construction, demolition and excavation waste

Waste type	Estimated material quantities that will be generated (tonnes)	Estimated quantity of waste for off-site disposal to landfill (tonnes)
Excavation	6,976,960	0
Demolition	9,246	925
Construction	38,880	3,888
Worker accommodation site	0	0
TOTAL	**7,025,086**	**4,813**

2.3.86 The assessment of the likely significant environmental effects associated with the disposal of surplus excavated material, demolition and construction waste, and worker accommodation site waste has been undertaken for the Proposed Scheme as a whole (see Volume 3, Section 14).

Commissioning of the railway

2.3.87 Commissioning is the process of testing the infrastructure to ensure that it operates as expected. This will take place in the period prior to opening. Further details are provided in Volume 1, Section 6.26.

Construction programme

2.3.88 A construction programme that illustrates indicative periods for the construction activities described above is provided in Figure 5.

Figure 5: Indicative construction programme

Construction activity	2017 quarters				2018 quarters				2019 quarters				2020 quarters				2021 quarters				2022 Quarters				2023 quarters				2024 quarters				2025 quarters			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Advance works																																				
Advance works																																				
Civil engineering works																																				
Chiltern tunnel main compound	See CFA 7																																			
Little Missenden vent shaft satellite compound																																				
Little Missenden ventilation shaft and auto-transformer station																																				
Chiltern tunnel north portal satellite compound *																																				
Chiltern tunnel north portal																																				
Chiltern tunnel north cutting																																				
Mantle's Wood drop inlet culvert																																				
Farthings Wood culvert																																				
South Heath green tunnel (south) satellite compound																																				
Footpath GMI / 27 accommodation overbridge																																				
Hyde Lane overbridge																																				
South Heath green tunnel																																				
South Heath green tunnel (north) satellite compound																																				
South Heath drop inlet culvert																																				
South Heath cutting																																				
South Heath MPATS																																				
Footpath GMI / 12 overbridge																																				
Leather Lane overbridge satellite compound	See CFA 10																																			
Footpath GMI / 2 accommodation overbridge																																				
Havenfield Wood drop inlet culvert																																				
Leather Lane overbridge																																				

Construction activity	2017 quarters				2018 quarters				2019 quarters				2020 quarters				2021 quarters				2022 Quarters				2023 quarters				2024 quarters				2025 quarters			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Leather Lane drop inlet culvert																																				
Rail infrastructure and systems works																																				
West Ruislip railhead main compound	See CFA 6																																			
High-speed railway installation																																				
Calvert railhead main compound	See CFA 13																																			
High-speed railway installation																																				
Chilterns main compound (rail systems)																																				
South Heath tunnel fit out and railway installation (south)																																				
South Heath green tunnel south portal buildings fit out																																				
Little Missenden vent shaft satellite compound																																				
Vent shaft and head house fit out																																				
Little Missenden auto-transformer station installation																																				
Chiltern tunnel north portal satellite compound																																				
Chiltern tunnel fit out and railway installation																																				
Chiltern tunnel north portal buildings fit out																																				
South Heath green tunnel north portal satellite compound																																				
South Heath tunnel fit out and railway installation (north)																																				
South Heath green tunnel north portal buildings fit out																																				
South Heath mid-point auto-transformer station installation																																				
Commissioning																																				
Commissioning (until end 2026)																																				

* The final six months of this compound duration is associated with the TBM removal.

Key

Construction works

Compound duration

2.4 Operation of the Proposed Scheme

Operational specification

2.4.1 Volume 1, Section 4.3 describes the envisaged operational characteristics of Phase One of HS2 as a whole and how they may change when Phase Two is also operational.

HS2 services

2.4.2 It is anticipated that initially there would be 11 trains per hour each way passing through the Central Chilterns area in the morning and evening peak hours, and fewer during other times. The first trains of the day would leave the terminus stations no earlier than 05:00 Monday to Saturday (and 08:00 on Sundays) and the last would arrive no later than midnight.

2.4.3 It is anticipated that with Phase One in place the frequency of services could rise to 14 trains per hour each way during peak hours, and that with Phase Two in place the frequency could rise to 18 trains per hour each way during peak hours. The assessment of sound, noise and vibration has taken into account the frequency during Phase Two.

2.4.4 In this area, trains will run at speeds up to 360kph (225mph). The trains will be either single 200m long trains or two 200m long trains coupled together, depending on demand and time of day.

2.4.5 The operation of the Proposed Scheme is described in more detail in Volume 1.

Maintenance

2.4.6 Volume 1, Section 4.3 describes the maintenance regime for HS2.

2.4.7 For bored tunnel sections, the intention is that maintenance staff will access the tunnels via the vent shafts to carry out inspections and maintenance on a regular basis. This will be at night when the railway is not operating. Generally, there will be routine preventative maintenance, including grinding and milling of the rails to keep them in good condition, and more periodic heavy maintenance as necessary.

2.4.8 Should an emergency situation arise, emergency services will use the vent shafts to access the railway below.

Operational waste and material resources

2.4.9 Forecasts of the amount of operational waste that will be produced annually during operation of the Proposed Scheme have been prepared and are presented in Volume 5: Appendix WM-001-000.

2.4.10 Railway station and train waste refers to waste that will arise at each station. It will include waste from station operations and passenger waste removed from trains at terminating stations. This has only been reported for areas along the route in which these stations will be located.

2.4.11 Rolling stock maintenance waste is that which will be generated by the relevant train operating company at rolling stock maintenance facilities. This has only been reported for the areas along the route in which these facilities will be located.

2.4.12 Track maintenance waste and ancillary infrastructure waste (for example waste from depots, signalling locations, operations and maintenance sites) has been estimated

using an average waste generation rate per kilometre length of total track. For this reason, both track maintenance waste and ancillary infrastructure waste has been reported for each area along the route.

2.4.13 The quantity of operational waste that will be re-used, recycled and recovered (i.e. diverted from landfill) has been based on landfill diversion performance information from Network Rail and other sources as follows:

- railway station and trains: 60%;
- rolling stock maintenance: 80%;
- track maintenance: 85%; and
- ancillary infrastructure: 60%.

2.4.14 On this basis, approximately 89 tonnes of operational waste will be re-used, recycled and recovered during each year of operation of the Proposed Scheme in the Central Chilterns area. Approximately 18 tonnes will require disposal to landfill (see Table 4).

Table 4: Operational waste forecast for the Proposed Scheme

Waste source	Estimated quantity of waste generated per annum (tonnes)	Estimated quantity of waste for disposal to landfill per annum (tonnes)
Railway station and train	0	0
Rolling stock maintenance	0	0
Track maintenance	99	15
Ancillary infrastructure	8	3
TOTAL	107	18

2.4.15 The assessment of the likely significant environmental effects associated with the disposal of operational waste has been undertaken for the Proposed Scheme as a whole (see Volume 3, Section 14).

2.5 Community forum engagement

2.5.1 HS2 Ltd's approach to engagement on the Proposed Scheme is set out in Volume 1.

2.5.2 A series of community forum meetings and discussions with individual landowners, organisations and action groups were undertaken. Community forum meetings were held on:

- 11 July 2012 at Great Missenden Memorial Centre;
- 25 September 2012 at Little Kingshill Village Hall;
- 27 November 2012 at Little Kingshill Village Hall;
- 26 February 2013 at Little Kingshill Village Hall; and
- 17 September 2013 at Little Kingshill Village Hall.

2.5.3 In addition, a Great Missenden, South Heath and Wendover Community Forum was held on 20 March 2012 at the Wendover Library Room. The outcome of this Community Forum meeting led to a change in boundaries and the emergence of the Central Chilterns Community Forum.

2.5.4 As well as HS2 Ltd representatives, attendees at these community forum meetings typically included local residents (and residents groups), public representatives, representatives of local authorities and parish and district councils, action groups, affected landowners and other interested stakeholders. The main themes to emerge from these meetings were:

- that the Proposed Scheme could have visual and noise impacts for those people who wish to enjoy the Chilterns AONB;
- the forum would like the landscape of the AONB to be preserved in its current form;
- potential noise impacts on areas close to the tunnel portals;
- that construction and operation of the Proposed Scheme may deter tourists from visiting the area which would have an effect on local economies;
- that construction traffic would impact upon local roads and towns;
- concern that road realignments would prevent access for delivery vehicles and cause severance of some communities, such as South Heath;
- the potential impact on Grim's Ditch;
- potential impacts of public rights of way (PRoW), bridleway and cycleway realignments upon people using these facilities;
- potential health and safety considerations arising from construction activity and realignment of roads and PRoW; and
- potential impacts on local habitats and wildlife.

2.5.5 In addition to the engagement through the community forums, the draft Environmental Statement consultations were launched on 16 May 2013 for a period of eight weeks and closed on the 11 July 2013. As part of these consultations, members of local communities and other interested parties were notified, provided with information and invited to engage on issues pertinent to the draft Environmental Statement and the development of the scheme. Details of the local consultation events were provided on HS2 Ltd website, social media, posters at local venues, national and regional advertising and to properties within 1km of the Proposed Scheme. In the Central Chilterns area (CFA9) consultations on the draft Environmental Statement was held on 30 May 2013, at Great Missenden Memorial Centre.

2.5.6 HS2 Ltd staff attended the events, including engineers and environmental specialists, for members of the public to speak to.

2.5.7 Responses from the draft Environmental Statement consultation have been analysed and an overview of those received and how the Environmental Statement has taken

account of responses is contained in the Draft Environmental Statement Consultation Summary Report (Volume 5: Appendix CT-008-000 in Volume 5).

2.6 Route section main alternatives

2.6.1 The main strategic alternatives to the Proposed Scheme are presented in Volume 1. The main local alternatives considered for the Proposed Scheme within the local area are set out within this section.

2.6.2 Since April 2012, as part of the design development process, a series of local alternatives have been reviewed within workshops attended by engineering, planning and environmental specialists. During these workshops, the likely significant environmental effects of each design option have been reviewed. The purpose of these reviews has been to ensure that the Proposed Scheme draws the right balance between engineering requirements, cost and potential environmental impacts.

Extended Chiltern tunnel to the end of the AONB

2.6.3 The Proposed Scheme travels through the Chilterns AONB from Chalfont St Giles (in CFA8) to its northern edge at Nash Lee Lane (in CFA10).

2.6.4 Following consultation in 2011, there was a review of a number of long tunnel options for the tunnel under the Chilterns. This review was documented in a report entitled 'Review of possible refinements to the proposed HS2 London to West Midlands Route' which considered extended twin-bore tunnel options[12]. As a result, additional tunnelling was incorporated into the scheme as part of the announcement made in January 2012.

2.6.5 Subsequently, the community forums within the AONB continued to request that the Chiltern tunnel should be extended to pass beneath the entire AONB. Whilst a number of longer tunnel options were considered and discounted prior to the January 2012 announcement, additional options were given further consideration at this stage with the objective of reviewing their impacts through the AONB. The scheme announced by HS2 in January 2012 was initially considered along with three further options, defined as:

- Option A: The Proposed Scheme, the January 2012 announced route (with the tunnel portal at Mantle's Wood);
- Option B: The extended twin-bore tunnel to the northern end of the green tunnel at South Heath;
- Option C: The extended twin-bore tunnel to the north-west of Wendover; and
- Option D: The extended twin-bore tunnel to the north side of Leather Lane.

2.6.6 The extended tunnels, Options B to D, all performed well on environmental grounds compared with Option A as they avoided a range of impacts upon environmental receptors. This included the reduction of landscape and visual, ecological, cultural heritage, noise, community and agricultural impacts within the AONB. Option C

[12] HS2 Ltd (2012) Review of possible refinements to the proposed HS2 London to West Midlands Route (A report to Government by HS2 Ltd); London, Department for Transport.

would have had the most potential benefits as compared with the other options as this would avoid direct impact to the majority of the AONB and local residents as well as on Grim's Ditch scheduled monument. In addition, due to the extended length of tunnel under Option C there would have been less land required for both construction and operation of the Proposed Scheme resulting in reduced severance of farmland and sites designated for ecological value. Similar benefits, but not to the same extent, would be achieved with Options B and D.

2.6.7 The Proposed Scheme, Option A will include environmental measures to mitigate the impacts associated with the open sections of the route through the AONB and providing longer tunnel lengths under Options B to D would have incurred additional cost for the project. This was consistent with the work previously undertaken in reviewing longer tunnel options prior to the announcement in January 2012 and so these Options B, C and D were not considered further.

2.6.8 Subsequently, the Chiltern Ridge Action Group (CRAG) promoted a further two extended twin-bore tunnel options for which further assessment was undertaken.

- Option A: The Proposed Scheme with the tunnel portal at Mantle's Wood;
- Option B: The CRAG T1 option with an extended bored tunnel to north-west of Wendover with a 600m long open section at Mantle's Wood and seven vent shafts along the entire length of the tunnel; and
- Option C: The CRAG T2 option with an extended bored tunnel to north-west of Wendover with a 500m long open section at Durham Farm and six vent shafts along the entire length of the tunnel.

2.6.9 The longer tunnel options would be over 20km in length and so would require additional safety considerations compared with Option A.

2.6.10 The two CRAG Options, B and C would comply with this requirement by including an intervention gap within the overall tunnel length to provide a minimum 500m open gap between tunnel portals. Both options also propose utilising tunnel boring machines (TBM) from either end of the tunnel to aid construction. Option C would also require an enlarged temporary excavation adjacent to Little Missenden vent shaft to allow for the TBM to be removed.

2.6.11 Due to the reduced surface impacts associated with Options B and C, these options are preferred from an environmental perspective in comparison with Option A. There would be reduced landscape and visual effects on the AONB as well as for severance of agricultural land, fewer properties demolished and benefits for designated ecological and archaeological features, in particular to areas of ancient woodland. This would include Sibley's Coppice under Option B and additionally Farthings Wood and Mantle's Wood for Option C.

2.6.12 Options B and C would also reduce construction as well as operational noise impacts for certain locations. However, there would be some new local impacts under both Options as they would require tunnel boring to be conducted from the northern end of the extended tunnel resulting in the need for an extensive construction site north of Wendover. This would increase traffic, noise, construction and material handling in this location. In particular, the surplus material from the tunnel would have to be

bought to the surface, treated and moved to a suitable location for reuse or disposal. Additional lorry movements on the road network within the AONB under Options B and C would therefore be required. Under Option A it is proposed that all tunnel activities and material handling for the bored tunnel is conducted at the southern portal of the tunnel in CFA7.

2.6.13 The requirement for an intervention gap could also generate adverse environmental effects within the AONB. This gap would need to be a large open or semi-retained cut to provide an open area adjacent to the rail track together with emergency evacuation routes, potentially waiting areas for evacuated passengers and all emergency requirements such as water supply and power for both tunnels. Appropriate landscaping and planting could be used to help mitigate some of the visual effects similar that identified within in the AONB for the Proposed Scheme, Option A.

2.6.14 The main difference between Options B and C in environmental terms would be the location of the open section; at Mantle's Wood under Option B and Durham Farm under Option C. Option C would be preferred environmentally as it would avoid the impact on the ancient woodland, however additional impacts would include adverse visual effects at Durham Farm and from the enlarged vent shaft adjacent to Keepers Wood. Mantle's Wood would be similarly affected by either Options A or B from either the tunnel portal or from the intervention gap. While the extended options are feasible in engineering terms and would have an environmental benefit, there would be a financial cost in extending the bored tunnel. This remains the case even when accounting for engineered structures which are no longer required. In addition, Option B and C would significantly increase the construction programme due to the longer tunnelling lengths required and the associated increased tunnel fit out times. These increases would impact on the project completion and opening dates.

2.6.15 For the Proposed Scheme, Option A includes sections of cutting and green tunnel to help mitigate the impact of the railway. In addition, areas of landscaping and planting have been proposed to further reduce the visual and noise effects of the sections of route not in bored tunnel. It is considered that these, combined with the tunnel as announced in January 2012, would provide a package of measures to mitigate the impacts of the section of the scheme through the AONB.

2.6.16 For these reasons, Option A with the north portal of the Chiltern tunnel at Mantle's Wood has been adopted as the Proposed Scheme.

2.6.17 Subsequent to the production and publication of the draft ES, liaison and correspondence has been on going with the CRAG group in relation to the potential scheme costs of Option B and C. A further review of these costs has been undertaken following a reduction in the initially assumed bore diameter in the Chiltern tunnel and other cost assumptions which would have implications for these options. However, the cost reductions were not significant enough to alter the decision reached previously and so the north portal of the Chiltern tunnel remains at Mantle's Wood for the Proposed Scheme as in the January 2012 announced route.

Extended Chiltern Tunnel to Liberty Lane (near leather Lane)

2.6.18 A further option for an extension to the Chiltern tunnel was received through the draft ES consultation responses from the Residents' Environmental Protection Association

(REPA). This proposed an extension of the Chiltern twin-bore tunnel past South Heath from Mantle's Wood to Liberty Lane, adjacent to Leather Lane, requiring an extension in twin-bore tunnel length of approximately 3.6km. Further assessment was undertaken and compared to the Proposed Scheme as follows:

- Option A: The Proposed Scheme, with the tunnel portal at Mantle's Wood; and
- Option B: The REPA proposal for an extension of the twin-bore tunnel past South Heath with an additional tunnel vent shaft included near Chesham Road. This Option assumes that all tunnel excavated material would continue to be removed at the southern portal (as per the Proposed Scheme).

2.6.19 Option B would perform better on environmental grounds compared with Option A as it would avoid a range of impacts upon environmental receptors due to reduced surface impacts, as noted for earlier extended tunnel options. There would be reduced landscape and visual effects on South Heath and the AONB and benefits for ecology. In particular, a number of areas of ancient woodland would be avoided including Mantle's Wood, Farthings Wood and Sibley's Coppice. In addition, some land severance impacts on agriculture and habitat would be reduced under Option B compared with Option A.

2.6.20 Both Option A and Option B would provide effective noise mitigation for the majority of South Heath during the operation of the railway. However, Option B would also reduce operational noise impacts either side of South Heath and for certain locations would result in reduced construction impacts as well. However, there would be some new local impacts under this Option due to the need to construct an additional vent shaft by Chesham Road and due to the increased width and cutting depth and associated land take to the north of Leather Lane arising from the lower alignment of the route as it exits from the twin-bore tunnel portal. A large amount of additional surplus tunnel excavated material would need to be handled at the tunnel southern portal in CFA7, requiring off-site removal or local sustainable placement.

2.6.21 While the extended tunnel option is feasible in engineering terms and would have environmental benefits, there would be a financial cost in extending the bored tunnel. This remains the case even when accounting for savings in engineered structures which would no longer be required. In addition, Option B would increase the construction programme due to the longer tunnelling lengths required and the associated increased tunnel fit out times. These increases would impact on the current project completion and opening dates.

2.6.22 Option A, the Proposed Scheme includes sections of cutting and green tunnel to help mitigate the impact of the railway. In addition, areas of landscaping, noise fence barriers and planting have been proposed to further reduce the visual and noise effects of the sections of route not in tunnel. It is considered that these measures, combined with the tunnel as announced in January 2012, would provide a package of measures to mitigate the impacts of this section of the Proposed Scheme past South Heath.

2.6.23 For these reasons the north portal of the Chiltern tunnel is proposed to be at Mantle's Wood at it was in the January 2012 announced route.

Raising the alignment from Mantle's Wood through the green tunnel at South Heath

2.6.24 Following consultation in 2011, a review of a number of refinement options was undertaken. This review was documented in a report entitled 'Review of possible refinements to the proposed HS2 London to West Midlands Route' which proposed a horizontal change of alignment as it passed South Heath[13].

2.6.25 The effect of moving the line was that it passed through a different section of landform, consequently the depth of the cutting was shallower than in the January 2012 announced route compared with the 2011 consultation.

2.6.26 Following the January 2012 announced scheme further design refinement work has been undertaken between Mantle's Wood and the northern end of the green tunnel at South Heath. The depth of cutting through this area has been further reduced in the Proposed Scheme to realise a number of benefits to the local area.

2.6.27 In making this decision two alternatives were considered:

- Option A: The January 2012 announced scheme; and
- Option B: The Proposed Scheme, with a raised vertical alignment between Mantle's Wood and the northern end of the South Heath green tunnel.

2.6.28 Option B will raise the alignment by up to approximately five metres. This will reduce the depth of cutting immediately north of Mantle's Wood and prior to the green tunnel at South Heath returning to the January 2012 alignment by the northern end of the green tunnel.

2.6.29 This change was proposed in order to reduce the extent of the construction footprint through this section and consequently the surplus volume of material that needs to be excavated compared with Option A. Benefits will include a shorter construction programme, reduced cost to the project and require a reduced number of lorry movements within the AONB. To further reduce lorry movements in the AONB, an area of sustainable placement has also been proposed on land to the east of the Proposed Scheme at Hunt's Green Farm in CFA10.

2.6.30 Option B will still be in cutting for most of this section of the route and this will provide visual and noise mitigation as it will still be up to approximately 20m deep. Under Option B the most notable change compared with Option A will be as the Proposed Scheme passes the dry valley at Farthings Wood. The alignment under Option B will be on embankment for a short distance as it traverses the dry valley, whereas under Option A it would be in very shallow cutting.

2.6.31 The reduced construction area resulting from raising the alignment under Option B has enabled a review of the Hyde Lane crossing. Therefore, under Option B, an online reinstatement of Hyde Lane could be achieved without requiring the demolition of the Grade II listed Sheepcotts Cottage. Although this will require a temporary diversion of traffic during construction, this was felt to be beneficial because the permanent

[13] HS2 Ltd (2012) Review of possible refinements to the proposed HS2 London to West Midlands Route (A report to Government by HS2 Ltd); London, Department for Transport.

effects will be reduced. The requirements for agricultural access during construction have been addressed through an accommodation bridge.

2.6.32 On balance it was considered that the cost savings and reduced construction works required justified the raising of the alignment under Option B. The potential impact at the dry valley at Farthings Wood will be addressed through additional mitigation. For this reason Option B has been incorporated into the Proposed Scheme.

Lower the alignment through the AONB

2.6.33 The Proposed Scheme follows the same horizontal alignment as the scheme announced in January 2012, however the vertical alignment between Mantle's Wood and the northern end of the South Heath green tunnel has been changed, as described previously. The community has raised concerns over the potential effects and has proposed a lowering of the alignment through this section.

2.6.34 This lowering of the alignment has been proposed as a way to increase the mitigation for noise and visual impacts. However, to increase the depth of the alignment over an extended distance would increase the volume of material generated and add to the cost of the Proposed Scheme. This would also increase the quantities of surplus excavated material that would need to be moved along local roads causing disruption to road users. These were all considerations in the decision to raise the alignment through this section, as explained previously. Buckinghamshire County Council, The Chilterns Conservation Board and the community forum have all suggested that retained cuttings or other construction techniques could be used to reduce the volume of material generated and still increase the depth of the railway. While it is correct that these techniques can be used and are being proposed in certain locations, such as Sibley's Coppice in order to reduce the impacts of the Proposed Scheme, they would add complexity and cost to the Proposed Scheme and extend the construction period.

2.6.35 In addition and as discussed previously, a lowering of the alignment through the AONB would increase surplus excavated material within this area with associated impacts on traffic movements on local roads. To mitigate the existing vehicle movements of the Proposed Scheme an area for sustainable disposal has been identified at Hunt's Green Farm in CFA10. If the scheme were to be lowered further this would either negate the reduction in vehicle movements achieved through this new material being moved off site or would require an additional receptor site to be identified within the AONB.

2.6.36 Mitigation measures have been incorporated into the Proposed Scheme including sections of cutting, green tunnel and areas of earthworks adjacent to the alignment for visual and noise attenuation (including noise fence barriers). For these reasons the alignment through the AONB has not been lowered in the Proposed Scheme.

Operational speeds through the AONB

2.6.37 The Proposed Scheme will be designed for a maximum speed of 400kph. In this area however it is currently anticipated that high-speed trains will operate at speeds of up to 360kph. The local community suggested that a lower speed should be applied specifically through the AONB.

2.6.38 The community consider this would reduce the noise impacts and would allow for the route to curve more through the designated area and reduce the potential environmental impacts.

2.6.39 The Government has previously considered alternative route speeds[14]. Any reduction in train speed would affect the journey time-savings resulting from high-speed rail. The length of the bored tunnel was extended in the Proposed Scheme, announced in January 2012, to reduce the impacts from the scheme and mitigation measures have been incorporated into the sections of the route not in tunnel.

2.6.40 For these reasons a lower speed through the AONB has not been adopted in the Proposed Scheme.

Leather Lane

2.6.41 The Proposed Scheme includes a new road overbridge for Leather Lane. This will be an off line realignment to the south of the current Leather Lane. This is the same as the January 2012 announced scheme. The local community have proposed an alternative to the north side of the existing road giving two options:

- Option A: The January 2012 announced scheme and the Proposed Scheme, with Leather Lane reinstated to the south of its current alignment; and
- Option B: That Leather Lane would be reinstated on an alignment to the north of its current alignment.

2.6.42 Option B was proposed to reduce the impact on a row of mature trees along the south side of the existing road, which is a sunken lane. For Option A, it is intended that as many trees are retained as reasonably practicable through careful management of construction. However, there will remain an impact on them as the realignment will have to pass through the row of trees at two points.

2.6.43 While Option B would avoid the impact on the trees to the south of the existing Leather Lane it would introduce new impacts to the north of the road. In particular, Option B would require an increased embankment height due to the difference in ground level at this point and this would increase visual impact. In addition, it would also result in the loss of a small copse of trees to the north of the current alignment of Leather Lane.

2.6.44 For these reasons it was considered that Option A provided a better overall environmental outcome and so was adopted in the Proposed Scheme.

Hyde Farm access overbridge

2.6.45 The Proposed Scheme includes a new farm access bridge which crosses the route to the north-east of Hyde Farm to maintain access to parcels of land under a single ownership on either side of the route. Owing to the raised route alignment identified previously, the initial location identified for the bridge, which made use of local contours to reduce engineering earthworks, was no longer a viable option. A series of alternative options were considered, including:

[14] HS2 Ltd (2012) Review of HS2 London to West Midlands Route Selection and Speed (A report to Government by HS2 Ltd); London, Department for Transport.

- Option A: The January 2012 announced route with an engineered bridge option across the Proposed Scheme close to the existing track alignment;
- Option B: Moving the bridge approximately 200m south of the existing alignment;
- Option C: Changing the bridge to an underpass and moving it approximately 100m south of the existing alignment to meet the required gradient for the associated PRoW realignment;
- Option D: The Proposed Scheme – moving the bridge approximately 100m north of the existing alignment;
- Option E: Removal of the access bridge and extension of the track on the eastern side of the alignment to Hyde Lane; and
- Option F: Removal of the access bridge and Hyde Lane to be used for access to Hyde Farm.

2.6.46 Due to the raising of the alignment through this section of the Proposed Scheme as described previously, Option A would now be located on a short section of embankment whereas it was previously over a section of cutting. To construct a bridge over the Proposed Scheme that ties into this new embankment would have resulted in a bridge with associated access that would have been very prominent within the AONB landscape and on views from a number of listed properties in Hyde Lane. Due to these impacts Option A was not considered further and the alternatives were considered in more detail.

2.6.47 Options B to D would impact on Hedgemoor Wood, a biodiversity action plan (BAP) habitat with Option C, with its wide engineered approaches to the underpass, having the most significant impact upon this feature. In addition the need to create a usable gradient to the access track would mean meant that land requirements for this option were considerably larger than for other alternatives. For this reason Option C was not considered further.

2.6.48 Option B was not included due to the increased landscape and biodiversity impact that constructing this option would have on the BAP habitat and the surrounding AONB landscape.

2.6.49 Options E and F considered the removal of the access track altogether given the close proximity of Hyde Lane. Both Options would incur increased journey times for users of the PRoW and Farm track resulting in diversions of approximately 600m under Option E and 1.5km under Option F.

2.6.50 For these reasons it was considered that Option D will provide a better overall environmental outcome and so was adopted in the Proposed Scheme.

Hyde Lane bridge

2.6.51 The Proposed Scheme will cross under Hyde Lane in cutting and a new online bridge is proposed to maintain this road alignment. This is the same as the January 2012 announced route. A series of alternatives were reviewed that would have maintained continuous access along Hyde Lane during the construction period including:

- Option A: The January 2012 announced route with an initial engineered bridge option with a southern offline realignment;
- Option B: An offline crossing approximately 50m south of the current alignment;
- Option C: Closing Hyde Lane and permanently diverting traffic via the access road to the portal of the South Heath green tunnel and onto Chesham Road; and
- Option D: The Proposed Scheme – constructing Hyde Lane online and diverting farm traffic via the Hyde Farm access track overbridge and traffic through local road networks (Chesham Road and the A413) during the construction period.

2.6.52 Option A would require the demolition of the Grade II listed Sheepcotts Cottage and would also significantly impact on the curtilage of Sheepcotts. For this reason this option was not considered for inclusion in the Proposed Scheme.

2.6.53 Option B was rejected as it would have impacted significantly on the curtilage of the Grade II listed Sheepcotts Cottage and would have significant visual impacts on a number of other local properties including Sheepcotts, Hyde Farm and Chapel Farm.

2.6.54 Option C would have reduced the impact on locally listed buildings compared with Options A and B. However, the closing of Hyde Lane would isolate those properties on either side of the Proposed Scheme. This would have a significant impact on the local residents in terms of community severance and landscape character. In addition the diversion route during construction was via the South Heath green tunnel portal access track. This would mean the general public having access to a construction route, which whilst manageable in safety terms was an additional construction complication that could be avoided. For these reason this option was also rejected.

2.6.55 Option D has been included in the Proposed Scheme as it avoids impacts to the listed building at Sheepcotts Cottage, associated visual impacts on other surrounding properties, some of which are also listed, maintains permanent access along Hyde Lane and does not require the integration of a diversion route with a construction route. It was recognised that the temporary diversion route via the A413 and Chesham Road during the construction period would have some local impacts in terms of journey times. However, these did not outweigh the significant landscape and cultural heritage benefits that Option D has over the alternative options.

2.6.56 For these reasons it was considered that Option D provided a better overall environmental outcome and so was adopted in the Proposed Scheme.

Mantle's Wood access track

2.6.57 The Proposed Scheme includes an upgrade to an existing farm access track that leads from Hyde Heath Road to the northern portal of the Chiltern tunnel and associated porous portal hood and buildings in Mantle's Wood. The local community proposed an alternative, to the south side of Mantle's Wood leading from the A413, giving two options (either of which would be permanent solutions, as access to the portal buildings will need to be maintained in the long term):

- Option A: The Proposed Scheme, the January 2012 announced route with an initial engineered access route from Hyde Heath Road; and
- Option B: A new access road from the A413 leading to the north portal of the Chiltern tunnel in Mantle's Wood.

2.6.58 Both options would impact on the ancient woodland of Mantle's Wood as they approach the northern portal of the Chiltern tunnel.

2.6.59 Option B would require a new permanent access bridge to be constructed over the Marylebone to Aylesbury Line. This would have a significant permanent visual impact on the Chilterns AONB and would also sever an important area of ecological mitigation located to the south of the Proposed Scheme linking two areas of ancient woodland.

2.6.60 Subsequently, representatives of residents from Hyde Heath suggested a further development of Option B. This would have included an access track from the A413, up Chalk Lane, under the Marylebone to Aylesbury Line and then along the northern side of this Line before turning northwards through Mantle's Wood to the Chiltern tunnel northern portal. The option was not considered practicable for two key reasons. Firstly, construction vehicles will not fit under the existing railway bridge on Chalk Lane without significant and costly engineering works to it. This would have associated implications for users of this Line during the upgrade works to this bridge. Secondly, the route along the northern side of the Marylebone to Aylesbury Line would need the creation of a new access track through the ancient woodland of Mantle's Wood, further impacting on this feature.

2.6.61 Option A will utilise an existing farm access track, with some localised widening, leading to the north portal of the Chiltern tunnel and only require the creation of a short extension to this track to join it with the north portal reducing the permanent impact on the Chilterns AONB.

2.6.62 In addition, the total volume of surplus excavated material to be transported along Chesham Road is limited due to the introduction of the sustainable placement area to the south-west of Hunts Green Farm as described in CFA10. Excavated material will be moved to the sustainable placement area along the route. This avoids the need for extensive movement of material off-site along the local road network.

2.6.63 For these reasons it was considered that Option A provided a better overall environmental outcome and so was adopted in the Proposed Scheme.

B485 Chesham Road and King's Lane junction

2.6.64 The Proposed Scheme includes a new roundabout junction between Chesham Road and King's Lane, both of which are permanently realigned to allow for the construction of the South Heath green tunnel. The roundabout option has come about through local concerns raised over the severance of land at Middle Grove Farm and the impacts on the farming and leisure operations of this business. This proposal replaced an earlier T-junction which broadly mirrored the existing junction configuration but located approximately 100m to the east. The options considered included:

- Option A: The January 2012 announced route with an engineered T-junction

option;

- Option B: The Proposed Scheme – with the Chesham Road realignment to accommodate a roundabout at the King's Lane Junction; and
- Option C: realignment of Chesham Road including a new priority junction.

2.6.65 Option B will reduce the severance of a field owned by Middle Grove Farm over Option A, however, there is potential for a lit roundabout junction to have a greater visual impact on the Chilterns AONB, especially at night. The latter issues will be mitigated through careful lighting, highways design and planting to provide visual screening from key viewpoints, however night time impacts on the AONB are unlikely to be mitigated by this in the short term.

2.6.66 Due to the duration and length of diversion via Chesham Road and King's Lane for Frith Hill traffic during the construction period, Option B will also allow for the increase in vehicles to safely use this junction.

2.6.67 Option C would follow much the same alignment as Option B to reduce the construction land required from Middle Grove Farm, but would incorporate a priority (or 'T' junction) with the B485. However, adopting this form of junction, would require tighter curves, introducing potential safety implications. Therefore this option was not considered further.

2.6.68 For these reasons it was considered that Option B will be included in the Proposed Scheme as this conformed to local community preferences and provides a junction that is capable of managing the increased vehicle movements that are expected.

Hunt's Green Farm sustainable placement area

2.6.69 An area of sustainable placement for disposal of surplus excavated material has been identified and is located in the fields south-west of Hunt's Green Farm in CFA10. The aim of this sustainable placement area is to reduce HGV movement on local roads within the Chilterns AONB. As this is in the adjacent area a discussion of the alternatives is reported in CFA10.

3 Agriculture, forestry and soils

3.1 Introduction

3.1.1 This section provides a description of the current baseline for agriculture, forestry and soils and an assessment of the likely impacts and significant effects as a result of the construction and operation of the Proposed Scheme. Consideration is given to the extent and quality of the soil and land resources underpinning the primary land use activities of farming, forestry and the physical and operational characteristics of enterprises engaged in these activities. Consideration is also given to diversification associated with the primary land uses, and to related land-based enterprises, notably equestrian activities.

3.1.2 The quality of agricultural land in England and Wales is assessed according to the Agricultural Land Classification (ALC) system, which classifies agricultural land into five grades from excellent quality Grade 1 land to very poor quality Grade 5 land. Grade 3 is subdivided into Subgrades 3a and 3b. The main issue in the assessment of the impacts on agricultural land is the extent to which land of best and most versatile (BMV) agricultural quality (Grades 1, 2 and 3a) is affected by the Proposed Scheme.

3.1.3 Forestry is considered as a land use feature and the impacts have been calculated quantitatively. The qualitative effects on forestry land and woodland are addressed principally in the ecology and landscape and visual assessments (see Sections 7 and 9).

3.1.4 Soil attributes other than for food and biomass production, are identified in this section but the resulting function or service provided is assessed in other sections, notably cultural heritage, ecology and landscape and visual assessments (see Sections 6, 7 and 9).

3.1.5 The main issue for farm holdings is the disruption by the Proposed Scheme of the physical structure of agricultural holdings and the operations taking place upon them, during both its construction and operational phases. Engagement has been undertaken with farmers and landowners affected by the Proposed Scheme to obtain factual information on the scale and nature of the farm and forestry operations and related farm-based uses.

3.1.6 Details of published and publically available information used in the assessment, and the results of surveys undertaken, are contained in Volume 5: Appendix AG-001-009.

3.2 Scope, assumptions and limitations

3.2.1 The assessment scope, key assumptions and limitations for the agriculture, forestry and soils assessment are set out in Volume 1, the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

3.2.2 The study area for the agriculture, forestry and soils assessment covers all of the land that will be required for the construction and operation of the Proposed Scheme. The resources and receptors that are assessed within this area are agricultural land, forestry land and soils; together with farm and rural holdings. The assessments of the impacts on agricultural land quality and forestry land are made with reference to the

prevalence of BMV land and forestry in the general locality, taken as a wider 4km corridor centred on the Proposed Scheme.

3.2.3 Common assumptions that have been applied to the Proposed Scheme, such as the restoration of agricultural land to pre-existing quality, the handing back of land used temporarily to the original landowner and the non-replacement of capital items demolished, are set out in Volume 1. There are no assumptions or limitations that are specific to the assessment in this local area.

3.3 Environmental baseline

Existing baseline

3.3.1 This section sets out the main baseline features that influence the agricultural and forestry use of land within this area. These include the underlying soil resources which are used for food and biomass production, as well as providing other services and functions for society and the associated pattern of agricultural and other rural land uses.

Soils and land resources

Topography and drainage

3.3.2 The main topographical features within the study area are described in the landscape and visual assessment (Section 9).

3.3.3 The area is characterised by a series of chalk hills dissected by the Misbourne valley. This valley lies to the west of the Proposed Scheme and connects the two villages of Great Missenden and Little Missenden. The River Misbourne lies at around 130m above Ordnance Datum (AOD) with the valley sides rising steeply up to approximately 190m AOD at the northern end of the study area.

Geology and soil parent materials

3.3.4 The main geological features are described in detail in the land quality assessment (Section 8). The principal underlying geology in this area is chalk of the White Chalk subgroup which forms a long north-east to south-west escarpment facing north-west. The chalk is overlain by the Clay-with-Flints formation to the south-east, and by outwash deposits to the north-west. Superficial alluvial deposits of clay, silt, sand and gravel mark the course of the river valley.

Description and distribution of soil types

3.3.5 The characteristics of the soils are described by the Soil Survey of England and Wales[15] and shown on the National Soil Map[16]. The soils are grouped into associations of a range of soil types and are described in more detail in Volume 5; their distribution is shown on Map AG-02-009 (Volume 5, Agriculture, Forestry and Soils Map Book).

3.3.6 The predominant soils are described as being of the moderately-to-imperfectly drained Batcombe association. Developed over the Clay-with-Flints Formation, these soils consist typically of slightly stony silt loam or silty clay loam topsoils, which overlie

[15] Soil Survey of England and Wales (1984) *Soils and Their Use in South East England*.
[16] Cranfield University (2001) *The National Soil Map of England and Wales* 1:250,000 scale.

slightly stony clay loam and clay subsoils and are susceptible to slight seasonal waterlogging; they are classified as Wetness Class[17] (WC) II or III.

3.3.7 The River Misbourne flows to the west of Proposed Scheme. Poorly draining Frome soils are present on the floodplain and typically comprise stoneless silty clay loam topsoils overlying extremely stony sandy loam lower horizons. Frome soils are most commonly assessed as WC IV.

3.3.8 Well drained (WC I) silty clay loam Coombe 1 and Charity 2 soils develop in chalky drift and occupy the sides of the Misbourne valley. Both soils have slightly or moderately stony silty clay loam topsoils. The Coombe soils are commonly shallow, with chalk and flints being encountered within as little as 20cm depth. The Charity 2 soils are typically found further north-west than the Coombe soils in the dry valley beyond the source of the river.

Soil and land use interactions

Agricultural land quality

3.3.9 The principal soil/land use interaction in the study area is the quality of the agricultural land resource. The ALC is based on the identification of physical limitations to the agricultural capability of land resulting from the interactions of soil, climate and the site.

3.3.10 The main soil properties which affect the cropping potential and management requirements of land are texture, structure, depth, stoniness and chemical fertility. There are three distinct soil types within the area:

- slightly seasonally waterlogged silty and clayey soils over the Clay-with-Flints formation;
- the poorly drained, fine textured alluvial soils associated with the River Misbourne; and
- well drained silty clay loam soils over chalk occupying valley sides.

3.3.11 Climate is a limiting factor to the grading of agricultural land in the area, being moderately cool and wet. The resulting moisture deficits are moderate. The cool and wet conditions give rise to relatively large numbers of field capacity days (FCD[18]) for the area, averaging approximately 170 days, which are considered unfavourable for providing opportunities for land works. This combination of climatic factors places a slight overarching limitation to the higher land at South Heath to no better than Grade 2.

3.3.12 Gradient and microrelief, with complex changes of slope angle or direction over short distances, are considered a limiting factor to land grading in parts of the area, particularly to the west of the route.

[17] The Wetness Class (WC) of a soil is classified according to the depth and duration of waterlogging in the soil profile and has six bands
[18] FCD is a meteorological parameter which estimates the duration of the period when soils are wet. Soils usually return to field capacity during the autumn or early winter and the field capacity period, measured in days, ends in the spring when evapotranspiration exceeds rainfall and a moisture deficit begins to accumulate and opportunities for mechanised fieldwork are then possible.

3.3.13 Flooding can be a limitation to ALC grading but as the route does not pass through the floodplain of the River Misbourne it is not a factor that needs to be considered in this area.

3.3.14 The principal limiting factor determining agricultural land quality in this area is soil workability. Overall, interactions between climate and the imperfectly drained (WC III) soils of the Batcombe association, which typically have medium silty clay loam topsoils, limit land to Subgrade 3a. The silty clay loam to silty clay topsoils of the Frome association (WC IV) result in soils being of Subgrade 3b quality also on the basis of limited workability. In addition, land is occasionally limited to Grade 4 quality due to steep gradients.

3.3.15 The fine silty, well drained Coombe and Charity soils (WCI), are limited to Subgrade 3a throughout the study area, due to a droughtiness limitation.

3.3.16 Department for Environment, Food and Rural Affairs (Defra) mapping[19] shows that there is a moderate likelihood of encountering BMV land in this locality, which makes such land a resource of moderate sensitivity in this area.

Other soil interactions

3.3.17 Soil fulfils a number of functions and services for society in addition to those of food and biomass production which are central to social, economic and environmental sustainability. These are outlined in sources such as the Soil Strategy for England[20] and The Natural Choice: securing the value of nature[21], and include:

- the storage, filtration and transformation of water, carbon and nitrogen in the biosphere;
- support of ecological habitats, biodiversity and gene pools;
- support for the landscape;
- protection of cultural heritage;
- providing raw materials; and
- providing a platform for human activities, such as construction and recreation.

3.3.18 Forestry resources represent a potentially multifunctional source of productive timber, landscape amenity, biodiversity and carbon storage capacity. Ancient woodland is located at Mantle's and Farthings Wood along with Sibley's Coppice. The value and sensitivity of the forestry resources are assessed in Section 7.

3.3.19 The wetlands and floodplains of the River Misbourne are a functional flood environment, as set out in Section 13. Flood Zone mapping available from the Environment Agency shows there to be a risk of flooding over agricultural land within the wider area.

3.3.20 The potential presence of buried cultural assets within the soils of the area is assessed in Section 6. The study area lies in the middle of the Chilterns and prehistoric cross-

[19] Defra (2005) *Likelihood of Best and Most Versatile Agricultural Land.*
[20] Defra (2009), *Soil Strategy for England.*
[21] Defra (2011), *The Natural Choice: securing the value of nature.*

ridge dykes suggest that a pattern of trackways had been established before the Roman period. By the Norman Conquest the present settlement pattern had probably been established.

Land use

Land use description

3.3.21 Agricultural land use in this area is split between arable and pasture. Smaller grassland fields are found in the valley bottom near Little Misbourne and around South Heath and are farmed with various livestock enterprises. Towards the centre of the area and to the west of Potter Row are large blocks of arable land.

3.3.22 A number of environmental designations potentially influence land use within the study area. The whole area is a nitrate vulnerable zone (NVZ), which is an area in which nitrate pollution is a potential problem. Statutory land management measures apply which seek to reduce nitrogen losses from agricultural sources to water. Some agricultural land is also subject to management prescriptions associated with the Environmental Stewardship Scheme which seeks either generally (the Entry Level Scheme – ELS) or specifically (the Higher Level Scheme – HLS) to retain and enhance the landscape and biodiversity qualities and features of farmland. Holdings which have land entered into an agri-environment scheme are identified in Table 5.

3.3.23 There are also a number of areas of woodland, with the largest being located in the southern half of the study area including Keeper's Wood, Mantle's Wood, Farthings Wood, Hedgemoor and Sibley's Coppice. In the northern half of the study area the parcels of woodland are smaller and mostly located away from the route. Generally within the area, woodland is well represented covering approximately 17% of the study area compared to the national average of 10% which makes woodland a resource of low sensitivity.

Number, type and size of farms

3.3.24 There is a mixture of owner-occupation and tenancies along the route of the Proposed Scheme. With the exception of Field Acres Farm (CFA09/4), which is situated away from the area in Chesham, the affected farms within the Central Chilterns area are of moderate size or small. The boundaries of the holdings are shown on Maps AG-01-017 to AG-01-018 (Volume 5, Agriculture, Forestry and Soils Map Book) along with the location of the main farm buildings. No field drains or irrigation have been identified in this area.

3.3.25 Table 5 sets out the sensitivity of individual holdings to change, which is determined by the extent to which they have the capacity to absorb or adapt to impacts, which in turn is determined primarily by their nature and scale. In general terms, larger holdings have a greater capacity to change enterprise mix and scale, can better absorb impacts and are less sensitive. Units that rely on the use of buildings (such as intensive livestock and dairy farms, and horticultural units) are less able to accommodate change and have a higher sensitivity. Smaller (less intensively used) units, such as pony paddocks associated with residential properties, have a low sensitivity.

3.3.26 The holding/reference name provides a unique identifier and relates to Map Series AG-01 (Volume 5, Agriculture, Forestry and Soils Map Book) and Volume 5: Appendix AG-001-009.

Table 5: Summary characteristics of holdings

Holding reference/name	Holding type	Holding size (ha)	Diversification	Agri-environment	Sensitivity to change
CFA09/1 Cokes Bottom Farm	Arable	97	None	None	Medium
CFA09/2 Mantle's Farm	Arable (let) and woodland	114	None	None	Medium
CFA09/3* Hyde Farm	Grazing (let)	32	None	None	Low
CFA09/4 Field Acres Farm	Arable	930	None	None	Medium
CFA09/5 Middle Grove Farm	Sheep, arable and equestrian	183	Equestrian and buildings let	ELS	Medium
CFA09/6* Bury Farm	Grazing (let)	35	None	None	Low
CFA09/7 Mulberry Park Hill	Grazing (let)	11	None	None	Low
CFA09/8 Springfield Farm	Grazing (let)	24	None	None	Low
CFA09/9 Hammonds Hall Farm	Grazing	4	Cottage let	None	Low
CFA09/10 Park Farm	Grazing	28	None	None	Medium
CFA09/12* Elwis Field Farm	Grazing	5	None	None	Low
CFA09/13* Unnamed paddock	Grazing	4	None	None	Low
CFA09/15* Farthings Wood	Woodland	5	None	None	Low
CFA09/16* 94 King's Lane	Residential with grazing	1	None	None	Low
CFA09/17* part of which is Sibley's Coppice	Woodland	6	None	None	Low

Holding reference/name	Holding type	Holding size (ha)	Diversification	Agri-environment	Sensitivity to change
CFA09/18* part of which is Sibley's Coppice	Woodland	2	None	None	Low
CFA09/19* Gates Farm	Grazing	5	None	None	Medium
CFA09/20* Unnamed paddock	Residential with grazing	3	None	None	Low
CFA09/21* Orchard Cottage	Residential with grazing	1	None	None	Low
CFA09/22* Frith Hill Farm	Residential with grazing	2	None	None	Low
CFA09/23* Cottage Farm	Grazing	17	None	None	Medium

* No Farm Impact Assessment interview conducted; data estimated
(CFA09/11 and CFA09/14 have been incorporated into other land holdings)

Future baseline

Construction (2017)

3.3.27 No committed developments have been identified in this area that will materially alter the baseline conditions in 2017 for agriculture, forestry and soils.

3.3.28 The future of agri-environment schemes is uncertain at present due to ongoing reform of the Common Agricultural Policy. The majority of schemes seem likely to cease over the next two to three years and replacements are uncertain. Whilst this will remove a level of support from the agricultural industry that has been used to offset some of the costs incurred in managing land in an environmentally responsible manner, it is unlikely to materially alter the way agricultural land is managed in the future. Whilst some field margins may be cropped closer to hedgerows and stocking rates may increase in some locations, the stocking and cropping baseline set out in the previous section is unlikely to change significantly.

Operation (2026)

3.3.29 No committed developments have been identified that will materially alter the baseline conditions in 2026 for agriculture, forestry and soils.

3.4 Effects arising during construction

Avoidance and mitigation measures

3.4.1 During the development of the design, measures have been incorporated to avoid or mitigate impacts on agriculture, forestry or soils during construction including

agricultural accommodation overbridges incorporated into footpath overbridges at Hyde Farm (CFA09/3) and Strawberry Hill Farm (CFA10/2).

3.4.2 In addition, there is a need to avoid or reduce environmental impacts to soils during construction. It is an essential element of the construction process that the soil resources from the areas of land required temporarily and permanently are stripped and stored so that land required for construction purposes which is currently in agricultural use can be returned to that use, where agreed, and to its pre-existing agricultural condition.

3.4.3 Subject to the adoption of good practice techniques in handling, storing and reinstating soils on land where agricultural or forestry uses are to be resumed, there will be no reduction in the long-term capability which will downgrade the quality of disturbed land. Some land with heavier textured soils will need careful management during the aftercare period to ensure this outcome.

3.4.4 Compliance with the CoCP will avoid or reduce environmental impacts during construction. Of particular relevance to agriculture, forestry and soils are the following measures (see Volume 5, Appendix CT-003-000):

- the reinstatement of agricultural land which is used temporarily during construction to agriculture, where this is the agreed end use (draft CoCP: Section 6);
- the provision of a method statement for stripping, handling, storing and replacing agricultural and woodland soils to reduce risks associated with soil degradation on areas of land to be returned to agriculture and woodland following construction, based on detailed soil survey work to be undertaken prior to construction. This will include any remediation measures necessary following the completion of works (draft CoCP: Section 6);
- a requirement for contractors to pay due consideration to the impacts of extreme weather events and related conditions which may affect agriculture, forestry and soil resources during construction (draft CoCP: Section 5);
- arrangements for the maintenance of farm and field accesses affected by construction (draft CoCP: Section 6);
- the protection and maintenance of existing land drainage and livestock water supply systems, where reasonably practicable (draft CoCP: Sections 6 and 16);
- the protection of agricultural land adjacent to the construction site, including the provision and maintenance of appropriate stock-proof fencing (draft CoCP: Sections 6 and 9);
- the adoption of measures to control the deposition of dust on adjacent agricultural crops (draft CoCP: Section 7);
- the control of invasive and non-native species; and the prevention of the spread of weeds generally from the construction site to adjacent agricultural land (draft CoCP: Section 9);
- the adoption of measures to prevent, as far as reasonably practicable, the

spread of soil-borne, crop and animal diseases from the construction area (draft CoCP: Sections 6 and 9); and

- liaison and advisory arrangements with affected landowners, occupiers and agents, as appropriate (draft CoCP: Sections 5 and 6).

Assessment of impacts and effects

3.4.5 The cessation of existing land uses will be required in the area to construct and operate the Proposed Scheme. This includes not only the land on which permanent works will be sited but also that required temporarily to facilitate the delivery of those permanent works.

3.4.6 All of the land required to implement the Proposed Scheme will, therefore, be affected during the construction phase. The land required for the construction and operation of the Proposed Scheme will, in places, sever and fragment individual fields and operational units of agricultural and forestry land. This could result in potential effects associated with the ability of affected agricultural interests to continue to access and effectively use residual parcels of land. There may also be the loss of, or disruption to, buildings and operational infrastructure such as drainage. The scheme design seeks, however, to reduce this structural disruption[22] as far as reasonably practicable, and to incorporate inaccessible severed land as part of environmental mitigation works.

3.4.7 The timing and duration of various construction elements are set out in Section 2.3. Where land is restored to agricultural use it will be subject to a further period of five years of managed aftercare to ensure stabilisation of the soil structure, where appropriate.

Temporary effects during construction

Impacts on agricultural land

3.4.8 During the construction phase, the total area of agricultural land required will be 169.9ha. Of this total, 71.9ha will be restored and available for agricultural use following construction.

Table 6: Agricultural land quality

Agricultural land quality	Area required (ha)	Percentage of agricultural land	Areas to be restored (ha)
Grade 1	0	0	0
Grade 2	0	0	0
Subgrade 3a	144.2	91	65.8
BMV subtotal	144.2	91	65.8
Subgrade 3b	24.1	9	6.1
Grade 4	1.6	0	0
Grade 5	0	0	0

[22] Structural disruption is disruption to the existing structure of farm holdings principally from severance and the loss of key farm infrastructure.

Total agricultural land	169.9		71.9

3.4.9 The temporary disturbance during construction to 144.2ha of BMV land is assessed as an impact of high magnitude, comprising more than 60% of the overall agricultural land requirement. As BMV land in this area is a receptor of medium sensitivity, the effect on BMV land is assessed as a major/moderate adverse effect of the Proposed Scheme, which is significant.

Nature of the soil to be disturbed

3.4.10 The sensitivity of the soils is greatest in relation to those which will be disturbed by construction activity and returned to an agricultural or rural land-based use upon completion of the Proposed Scheme. The quantum of each disturbed soil type is less important than the sensitivity of particular soils to the effects of handling during construction and reinstatement of land.

3.4.11 Successful soil handling is dependent upon movements being undertaken under appropriate weather and ground conditions using the appropriate equipment. The principles of soil handling are well established and set out in advisory material such as Defra's Code of Practice for the Sustainable Use of Soils[23]. These guidance materials will be followed throughout the construction period.

3.4.12 Compliance with the CoCP will ensure that the magnitude of the impact on soil is low and the significance is negligible.

Impacts on holdings

3.4.13 Land may be required from holdings both permanently and temporarily (i.e. the latter just during the construction period). In most cases, the temporary and permanent land requirement will occur simultaneously at the start of the Proposed Scheme and it is the combined effect of both that will have the most impact on the holding. In due course some agricultural land will be restored and the impact on individual holdings will reduce, but the following assessment focuses on the combined effect during the construction phase. The residual permanent effects are discussed at the end of this section.

3.4.14 The effects of the Proposed Scheme on individual agricultural and related interests is summarised in Table 7. This table shows the total area of land required on a particular holding in absolute terms and as a percentage of the total area farmed. It also shows the area of land that will be returned to the holding following the construction period. The degree of impact is based on the proportion of the holding required rather than the absolute area of land. The holding/reference name provides a unique identifier and relates to Map Series AG-01 (Volume 5, Agriculture, Forestry and Soils Map Book) and Volume 5: Appendix AG-001-009.

3.4.15 The effects of severance during construction are judged on the ease and availability of access to severed land. For the most part these will be same during and post construction but occasionally they will differ between the two phases. The disruptive

[23] Department for Environment, Food and Rural Affairs (2009), *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*

effects, principally of construction disturbance and dust, are assessed according to their effects on land uses and enterprises. Full details of the nature and significance of effects are set out in Volume 5: Appendix AG-001-009. Where the area of land summed by ALC grade differs from the area of land summed by holding, the difference is because some holdings are affected in more than one CFA area and some holdings include non-agricultural land. Where holdings are affected in more than one CFA the combined impact has been reported in the CFA report where the main holding is located.

Table 7: Summary of temporary construction effects on holdings

Holding reference/name	Total area required	Construction severance	Disruptive effects	Scale of construction effect	Area to be restored
CFA09/1 Cokes Bottom Farm	4.7ha (5%) Negligible	Negligible	Negligible	Minor adverse	1.7ha
CFA09/2 Mantle's Farm	43.6ha (38%) High	Access maintained using highway Medium	Negligible	Major/moderate adverse due to the proportion of the holding required and severance	8.9ha
CFA09/3 Hyde Farm	13.3ha (42%) High	Land inaccessible to north during construction High	Negligible	Moderate adverse due to proportion of the holding required, severance and low sensitivity of holding	5ha
CFA09/4 Field Acres Farm	10.8ha (1%) Negligible	Negligible	Negligible	Negligible	9.1ha
CFA09/5 Middle Grove Farm	42ha (22%) High	Land severed by re-aligned Chesham Road Medium	Negligible	Major/moderate adverse due to the proportion of the holding required and severance	18.4ha
CFA09/6 Bury Farm	18.5ha (53%) High	Use of highway during green tunnel construction Medium	Negligible	Moderate adverse due to the proportion of the holding required, severance and the low sensitivity of the holding	6.4ha
CFA09/7 Mulberry Park Hill	11.1ha (100%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	0.9ha
CFA09/8 Springfield Farm	5.9ha (25%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	2.3ha
CFA09/9 Hammonds Hall Farm	1.5ha (38%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	1.2ha

Holding reference/name	Total area required	Construction severance	Disruptive effects	Scale of construction effect	Area to be restored
CFA09/10 Park Farm	2.1ha (8%) Low	Negligible	Negligible	Minor adverse	0.1ha
CFA09/12 Elwis Field Farm	5.2ha (100%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	3ha
CFA09/13 Unnamed paddock	2.4ha (61%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	2.4ha
CFA09/15 Farthings Wood	0.4ha (0%) Negligible	Negligible	Negligible	Negligible	0ha
CFA09/16 94 King's Lane	1.3ha (95%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	1.0ha
CFA09/17 Part of which is Sibley's Coppice	2.6ha (41%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	2.5ha
CFA09/18 part of which is Sibley's Coppice	< 0.1ha (2%) Negligible	Negligible	Negligible	Negligible	< 0.1ha
CFA09/19 Gates Farm	1.7ha (33%) High	Negligible	Negligible	Major/moderate adverse due to the proportion of the holding required and medium sensitivity	1.7ha
CFA09/20 Unnamed paddock	2.3ha (89%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	2.3ha
CFA09/21 Orchard Cottage	0.9ha (70%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	0.9ha
CFA09/22 Frith Hill Farm	0.7ha (47%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required and low sensitivity	0.7ha
CFA09/23 Cottage Farm	< 0.1ha (< 1%) Negligible	Negligible	Negligible	Negligible	< 0.1ha

3.4.16 Overall, it is considered that 15 holdings will experience moderate or moderate/major temporary adverse effects during construction, which are significant.

3.4.17 No farm enterprises that are particularly sensitive to noise or vibration emitted during the construction phase, for example intensive poultry houses, have been identified within the area.

Cumulative effects

3.4.18 As no development has been identified in this area that will affect agricultural land there are no cumulative effects to report.

Permanent effects from construction

Impacts on agricultural and forestry land

3.4.19 Land used for the construction of the Proposed Scheme will fall into a number of categories when work is complete, as follows:

- part of the operational railway and kept under the control of the operator;
- returned to agricultural use (with restoration management);
- used for drainage or flood compensation which may also retain some agricultural use; or
- used for ecological and landscape mitigation.

3.4.20 Following construction and restoration, the area of agricultural land that will be permanently required will be 98ha, as shown in Table 8.

Table 8: Agriculture and forestry land required permanently

Agricultural land quality	Permanent works	
	Area (ha)	% agricultural land
Grade 1	0	0
Grade 2	0	0
Subgrade 3a	78.4	80
BMV subtotal	78.4	80
Subgrade 3b	18.0	18
Grade 4	1.6	2
Grade 5	0	0
Total	98.0	
Forestry land	13.8	

3.4.21 The permanent change of 78.4ha of land of BMV quality to non-agricultural use is assessed as an impact of high magnitude, comprising more than 60% of the overall agricultural land requirement. BMV land is a receptor of moderate sensitivity in this study area so that the permanent effect on BMV land is assessed as a major/moderate adverse effect of the Proposed Scheme, which is significant.

3.4.22 As described in Section 2, some areas of agricultural land that are required for the construction of the Proposed Scheme will revert to land for ecological and landscape

mitigation and will be removed from mainstream agricultural production. These areas include land adjacent to Mantle's and Farthings Woods, land adjacent to Hyde Lane and Wood End, and land south of Mulberry Park Hill (CFA09/7). This agricultural assessment assumes that none of this land will return to agriculture.

3.4.23 This assessment also assumes that all the agricultural land required for the construction of the South Heath green tunnel will be reinstated to its former use, though some is proposed for use as ecological mitigation and may not, in fact, be available for agriculture.

3.4.24 Areas of woodland that will be permanently affected include Mantle's Wood, Farthings Wood and Sibley's Coppice. Overall, the total amount of forestry land required to implement the Proposed Scheme within this area will be approximately 13.8ha, out of a total land area (including non-agricultural) of 226ha, which represents approximately 6% of the land required, and including ancient woodland. This is assessed as an impact of medium magnitude in an area where forestry resources have a low sensitivity to change. As such the significance on forestry in this area is minor and is not significant.

Impacts on holdings

3.4.25 The permanent effects of the Proposed Scheme on individual agricultural and related interests is summarised in Table 9. The land required column refers to the area of land permanently required to operate the Proposed Scheme (in absolute terms and as a percentage of the overall area farmed). The scale of effect is based on the proportion of land required. The effects of severance are judged on the ease and availability of access to severed land once construction is completed and the impact on farm infrastructure refers mainly to the loss of or damage to farm capital, such as property, buildings and structures, and the consequential effects on land uses and enterprises. Full details of the nature and scale of effects are set out in Volume 5: Appendix AG-001-009.

Table 9: Summary of permanent effects on holdings from construction

Holding reference/name	Land required	Severance	Infrastructure	Scale of effect
CFA09/1 Cokes Bottom Farm	3.0ha (3%) Negligible	Negligible	Negligible	Negligible
CFA09/2 Mantle's Farm	34.7ha (30%) High	Access over tunnel portal Negligible	Negligible	Major/moderate adverse due to the proportion of the holding required
CFA09/3 Hyde Farm	8.3ha (26%) High	Access via accommodation structure Low	Negligible impact	Moderate adverse due to the proportion of the holding required, severance but the low sensitivity of the holding
CFA09/4 Field Acres Farm	1.7ha (< 1%) Negligible	Negligible	Negligible	Negligible
CFA09/5	22.6ha (12%)	Land severed by	Residential	Major/moderate adverse

Holding reference/name	Land required	Severance	Infrastructure	Scale of effect
Middle Grove Farm	Medium	re-aligned Chesham Rd Medium	property demolition High	due to the proportion of the holding required, severance, demolition and medium sensitivity
CFA09/6 Bury Farm	12.1ha (35%) High	Access to land over South Heath green tunnel Low	Negligible	Moderate adverse due to the proportion of the holding required, severance and low sensitivity
CFA09/7 Mulberry Park Hill	10.2ha (92%) High	Severed land inaccessible High	Residential property demolition High	Moderate adverse due to the proportion of the holding required, severance, demolition and low sensitivity
CFA09/8 Springfield Farm	3.6ha (15%) Medium	Negligible	Negligible	Minor adverse due to the proportion of the holding required and low sensitivity
CFA09/9 Hammonds Hall Farm	0.3ha (8%) Low	Negligible	Negligible	Negligible
CFA09/10 Park Farm	2.1ha (7%) Low	Negligible	Negligible	Minor adverse due to the proportion of the holding required and low sensitivity
CFA09/12 Elwis Field Farm	2.2ha (42%) High	Negligible	Agricultural building demolished High	Moderate adverse due to the proportion of the holding required, demolition and low sensitivity
CFA09/13 Unnamed paddock	0ha (0%) Negligible	Negligible	Negligible	Negligible
CFA09/15 Farthings Wood	0.4ha (9%) Low	Negligible	Negligible	Negligible
CFA09/16 94 King's Lane	0.3ha (24%) High	Negligible	Residential property demolition High	Moderate adverse due to the proportion of the holding required, severance, demolition and low sensitivity
CFA09/17 part of which is Sibley's Coppice	0.1ha (1%) Negligible	Negligible	Negligible	Negligible
CFA09/18 part of which is Sibley's Coppice	< 0.1ha (< 1%) Negligible	Negligible	Negligible	Negligible

Holding reference/name	Land required	Severance	Infrastructure	Scale of effect
CFA09/19 Gates Farm	oha (0%) Negligible	Negligible	Negligible	Negligible
CFA09/20 Unnamed paddock	oha (0%) Negligible	Negligible	Negligible	Negligible
CFA09/21 Orchard Cottage	oha (0%) Negligible	Negligible	Negligible	Negligible
CFA09/22 Frith Hill Farm	oha (0%) Negligible	Negligible	Negligible	Negligible
CFA09/23 Cottage Farm	0.1ha (< 1%) Negligible	Negligible	Negligible	Negligible

3.4.26 Overall, it is likely that seven holdings will experience moderate or moderate/major permanent adverse effects from the construction of the Proposed Scheme, which is significant. Although financial compensation will be available, there can be no certainty that this will be used to reduce the above adverse effects by the purchase of replacement land or construction of replacement buildings. Therefore, the above assessment should be seen as the worst-case, which could be reduced if the owners and occupiers are able, and choose, to use compensation payments to replace assets.

3.4.27 Three holdings will cease to operate as a result of demolition and the proportion of land required for the construction of the Proposed Scheme, namely: Mulberry Park Hill (CFA09/7); Elwis Field Farm (CFA09/12) and 94 King's Lane (CFA09/16).

Cumulative effects

3.4.28 As no development has been identified in this area that will affect agricultural land there are no cumulative effects to report.

Other mitigation measures

3.4.29 Planting is proposed along this section of the Proposed Scheme including between Mantle's and Farthings Woods, next to the woodlands at Wood End. As this planting matures it will reduce the effect on forestry. Soils displaced from the ancient woodlands will be translocated. The qualitative loss of ancient woodland in ecological terms is assessed in Section 7.

Summary of likely significant residual effects

3.4.30 Once the construction is complete and land required has been restored, the residual permanent area of land which will have undergone a change of land use from agriculture will be 98.0ha, of which 78.4ha is BMV. This is assessed as a major/moderate adverse residual effect of the Proposed Scheme which is significant.

3.4.31 A total of seven holdings have been identified that will experience moderate or moderate to major permanent adverse effects that are significant. Four holdings will

be affected by demolition with three of these holdings losing residential properties. Of the seven holdings most adversely affected, four holdings are likely to remain as agricultural or rural businesses and the use of compensation payments to purchase replacement land or farm buildings could reduce the effects.

3.5 Effects arising from operation

Avoidance and mitigation measures

3.5.1 No measures are proposed to mitigate operational effects of the Proposed Scheme on agriculture, forestry and soils.

Assessment of impacts and effects

3.5.2 Potential impacts arising from the operation of the Proposed Scheme will include:

- noise emanating from moving trains and warning signals; and
- the propensity of operational land to harbour noxious weeds.

3.5.3 The potential for significant effects on sensitive livestock receptors from noise has been assessed. No likely significant effects have been identified.

3.5.4 The propensity of linear transport infrastructure to harbour and spread noxious weeds is not only a consequence of the management of the highway and railway land, but also of the readiness of weed spread onto such land from adjoining land, which could be exacerbated with the effects of climate change. The presence of noxious weeds, ragwort in particular, will be controlled through the adoption of an appropriate management regime which identifies and remedies areas of weed growth which might threaten adjoining agricultural interests.

Cumulative effects

3.5.5 As no development has been identified in this area that will affect agricultural land there are no cumulative effects to report.

Summary of likely significant residual effects

3.5.6 No significant residual effects on agriculture, forestry and soils have been identified for the operation of the Proposed Scheme.

4 Air quality

4.1 Introduction

4.1.1 This section of the report provides an assessment of the impacts and likely significant effects on air quality arising from the construction and operation of the Proposed Scheme, covering nitrogen dioxide (NO_2) , fine particulate matter (PM10, PM2.5)[24] and dust.

4.1.2 With regard to air quality, the main potential effects are anticipated to result from construction activities, traffic generated from construction activities and changes in traffic flows and new road alignments when the Proposed Scheme is operational.

4.1.3 Detailed reports on the air quality data and assessments for this area, as well as relevant maps are contained within Volume 5. These include:

- Volume 5: Appendix AQ-001-009;
- Map AQ-01-009 (Volume 5, Air Quality Map Book); and
- Maps AQ-02-009-01 and AQ-02-009-02 (Volume 5, Air Quality Map Book).

4.1.4 Maps showing the location of the key environmental features can be found in Volume 2, CFA9 Map Book.

4.2 Scope, assumptions and limitations

4.2.1 The assessment scope, key assumptions and limitations for the air quality assessment are set out in Volume 1, the SMR (Appendix CT-001-000/1) and its addendum (Appendix CT-001-000/2) and appendices presented in Volume 5: Appendix AQ-001-009. This report follows the standard assessment methodology.

4.2.2 The study area for the air quality assessment has been determined on the basis of where impacts on air quality may occur from construction activities, from changes in the nature of traffic during construction and operation or where road alignments have changed.

4.2.3 The assessment of impacts arising from construction dust emissions has been undertaken using the methodology based on that produced by the Institute of Air Quality Management (IAQM)[25]. It is important to note that this methodology provides a means of assessing the scale and significance of effects that is partly dependent on the approximate number of receptors within close proximity to the dust-generating activities. In doing so, it assigns a lower scale of effect to cases where the number of properties is small, e.g. fewer than 10 properties within 20m of dust-generating activities. Thus, a single property very close to a construction site cannot experience a 'significant effect' as defined by this methodology. The assessment presented here reaches a conclusion that incorporates this concept of significance being proportional to the number of people affected. However, in cases where less than 10 properties are

[24] PM2.5 and PM10 describe two size fractions of airborne particles that can be inhaled and therefore are of concern for human health. The designations refer to particles of size less than 2.5 and 10 microns in diameter.
[25] IAQM (2012) Guidance on the assessment of the impacts of construction on air quality and the determination of their significance.

within 20m of the construction activity, it will still be the case that mitigation in accordance with the CoCP will be applied.

4.2.4 The assessment of construction traffic impacts has used traffic data that is based on an estimate of the average daily flows in the peak month of the construction period (2017-2026). However, the assessment assumes 2017 vehicle emission rates and 2017 background pollutant concentrations. The reason for this is because both pollutant emissions from exhausts and background pollutant concentrations are expected to reduce year by year as a result of vehicle emission controls, and so the year 2017 represents the worst case for the assessment. Furthermore, it has been assumed that the changes in construction traffic would occur for the whole year. In many cases, this represents a pessimistic assumption as the duration of the proposed construction works may be much shorter.

4.3 Environmental baseline

Existing baseline

4.3.1 The environmental baseline reported in this section represents the environmental conditions identified within the study area. The air quality in this area is typical of the generally rural nature of this part of Buckinghamshire, with concentrations of airborne pollutants well within air quality standards. There are relatively few roads and these generally have low traffic flows and associated emissions.

4.3.2 Estimates of background air quality have been obtained from Department of Environment Food and Rural affairs (Defra) background maps[26] for 2012. These data are estimated for 1km grid squares for nitrogen oxides (NOx), NO2, PM10 and PM2.5. All average background pollutant concentrations are well below relevant air quality standards. Details of the background concentrations for all pollutants can be found in Volume 5: Appendix AQ-001-009.

4.3.3 Chiltern District Council conducts routine diffusion tube monitoring at several locations. However, almost all of these are at roadside locations or in towns in locations that are away from the Proposed Scheme and are not affected by traffic associated with the Proposed Scheme. On this basis, these monitoring data are not considered relevant to this assessment and are therefore not used to inform this assessment.

4.3.4 The available mapping data indicate that all parts of this area currently experience concentrations of PM10 and PM2.5 that meet air quality standards, as supported by the absence of any air quality management areas (AQMA) declared for these pollutants.

4.3.5 An AQMA has been declared by Chiltern District Council for NO2 in the town of Chesham (see Map AQ-01-009). This area is too far from the route to be affected by traffic associated with construction of the Proposed Scheme.

4.3.6 Potential receptors are primarily those residential properties close to construction activity and alongside roads where traffic flows will change as a consequence of

[26] Defra (2010); Background Pollutant Concentration Maps; http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html; Accessed: July 2013

construction activity or realignment of roads. Notable receptors in close proximity to construction activity are residential properties at Pipers Wood Cottages, Park View Cottages, Mantle's Farm, Chapel Farm, Sheepcotts Cottage, Mantle's Green Cottage, Orchard Cottage, Frith Hill Farm, Cudsdens Court and Brambles. Receptors at greatest risk of dust effects are indicated in Maps AQ-02-009-01 and AQ-02-009-02 (Volume 5, Air Quality Map Book). Notable receptors near roads where traffic flows may change during construction include King's Pond Cottage and 59 King's Lane.

Future baseline

4.3.7 Section 2.1 and Appendix CT-004-000 identify developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the future baseline for the assessment of effects from the construction and operation of the Proposed Scheme.

4.3.8 The potential cumulative impact from committed developments on air quality acting in conjunction with the effects from the construction and operation of the Proposed Scheme have been considered as part of this assessment. This has been achieved by including changes in traffic predicted as a result of the committed developments within the traffic data used for the air quality assessments for construction and operation, in which the future air quality baselines are defined as the 'without Proposed Scheme scenarios' at each stage.

4.3.9 The data used for the air quality assessment take account of predicted changes in traffic, which are derived from a combination of regional traffic growth factors and consideration of major locally consented schemes, as described in the Traffic and Transport section. In this way, the assessment accounts for cumulative effects

Construction (2017)

4.3.10 Future background pollutant concentrations have been sourced from Defra background maps[26] for 2017. Defra background maps predict NO2 and PM10 levels in 2017 to be lower than in the 2012 baseline.

Operation (2026)

4.3.11 Future background pollutant concentrations have been sourced from Defra background maps[26] for 2026. Defra background maps predict NO2 and PM10 levels in 2026 to be lower than in the 2012 baseline.

4.4 Effects arising during construction

Avoidance and mitigation measures

4.4.1 Emissions to atmosphere will be controlled and managed during construction through the route-wide implementation of the CoCP, where appropriate. The draft CoCP includes a range of mitigation measures that are accepted by the IAQM as being suitable to reduce impacts to as low a level as reasonably practicable. It also makes provision for the preparation of Local Environmental Management Plans (LEMP) which will set out how the project will adapt and deliver the required environmental and community protection measures within each area through the implementation of specific measures required to control dust and other emissions from activities in the area.

4.4.2 The assessment has assumed that the general measures detailed in Section 7 of the draft CoCP (Volume 5: Appendix CT-003-000) will be implemented. These include:

- contractors being required to control dust, air pollution , odour and exhaust emissions during construction works;
- inspection and visual monitoring after engagement with the local authority to assess the effectiveness of the measures taken to prevent dust and air pollutant emissions;
- cleaning (including watering) of haul routes and designated vehicle waiting areas to suppress dust;
- keeping material stockpiles away from, sensitive receptors where reasonably practicable and also taking into account the prevailing wind direction relative to sensitive receptors;
- using enclosures to contain dust emitted from construction activities; and
- undertaking soil spreading, seeding and planting of completed earthworks, as soon as reasonably practicable following completion of earthworks.

Assessment of impacts and effects

Temporary effects

4.4.3 Impacts from the construction of the Proposed Scheme could arise from dust-generating activities and emissions from construction traffic. As such, the assessment of construction impacts has been undertaken for human receptors sensitive to dust and exposure to NO_2 and PM10, as well as ecological receptors sensitive to dust and nitrogen deposition.

4.4.4 An assessment of construction traffic emissions has also been undertaken for two scenarios during the construction period; a without Proposed Scheme scenario and a with Proposed Scheme scenario. The traffic data include the additional traffic from future committed developments.

4.4.5 In this area, dust-generating activities will comprise the construction of the vent shaft associated with the Chiltern tunnel, cuttings and embankments, a small number of bridges and a green tunnel. Activities with the potential to generate dust at these sites include the demolition of buildings, earthworks required for the preparation of the ground, bulk excavation, processing and temporary stockpiling of materials, construction of structural embankments, landscaping, the construction and use of construction compounds, construction of permanent replacement road infrastructure and bridges, the movement of vehicles along haul routes and the movements of vehicles onto roads.

4.4.6 Given the mitigation contained within the draft CoCP, including the LEMPs for features such as haul routes, the assessment of impacts arising from dust emissions has concluded that there will not be a significant effect. The basis for this conclusion can be found in Volume 5: AQ-001-009

4.4.7 Construction activity could also affect local air quality through the additional traffic generated on local roads as a result of construction traffic routes and changes to traffic patterns arising from temporary road realignments.

4.4.8 Examination of the changes in traffic flows for 2017 along the affected roads has identified that there are two roads that meet the criteria set out in Volume 1 of the SMR (Appendix CT-001-000/1) for an assessment. This assessment, reported in Volume 5, Appendix AQ-001-009, concluded that impacts would be negligible at worst case receptors assessed for NO2, PM10 and PM2.5. The effect will not be significant.

Permanent effects

4.4.9 There are no permanent effects anticipated to arise during construction of the Proposed Scheme.

Cumulative effects

4.4.10 The construction dust assessment has considered the potential cumulative air quality effects of the Proposed Scheme and other committed developments. The traffic data used for the assessment include the traffic changes expected from the committed developments and therefore their impacts have been included within the assessment.

Other mitigation measures

4.4.11 No other mitigation measures during construction are proposed in relation to air quality in this area.

Summary of likely significant residual effects

4.4.12 The methods outlined within the draft CoCP to control and manage potential air quality effects are considered effective in this location and no significant residual effects are considered likely.

4.5 Effects arising from operation

Avoidance and mitigation measures

4.5.1 No mitigation measures are proposed during operation in relation to air quality in the Central Chilterns area.

Assessment of impacts and effects

4.5.2 Impacts from the operation of the Proposed Scheme will relate to changes in the volume, composition and distribution of road traffic. There are no direct atmospheric emissions from the operation of trains that will cause an impact on air quality and these have therefore not been assessed. In normal operations there will be no pollutant emissions from vent shafts as there are no air pollutants emitted within the tunnels and indirect emissions from sources such as rail wear and brakes have been assumed to be negligible.

4.5.3 The assessment of operational traffic emissions has been undertaken for two scenarios in the operation year 2026, without the Proposed Scheme scenario and a with the Proposed Scheme scenario. These traffic data include a contribution from future committed development where there are developments identified.

4.5.4 Traffic data in the Central Chilterns area have been screened to identify roads that required further assessment and to confirm the likely effect of the change in emissions from vehicles using those roads in 2026.

4.5.5 One road is predicted to meet the criteria set out in the SMR (Volume5, Appendix CT001-00/1) for a more detailed air quality assessment. This relates to the re-alignment of the B485 Chesham Road, east of King's Lane, which will cause a small decrease in NO2 and PM10 concentrations at the worst-case receptor, Kings Pond Cottage. This is a negligible beneficial impact and not a significant effect.

Cumulative effects

4.5.6 The traffic data used for the assessment include the traffic changes expected from the committed developments and therefore their impacts have been included within the assessment.

Other mitigation measures

4.5.7 No other mitigation measures are proposed during operation in relation to air quality in this area.

Summary of likely significant residual effects

4.5.8 No significant residual effects are anticipated for air quality in this area during operation of the Proposed Scheme.

5 Community

5.1 Introduction

5.1.1 This section reports the impacts and likely significant effects on local communities resulting from the construction and operation of the Proposed Scheme.

5.1.2 Key issues concerning the community assessment for this study area comprise:

- demolition of small clusters of residential properties in Hyde End and South Heath;
- demolition of the Weights and Measures Gym and the former Annie Bailey's public house and restaurant (which includes residential accommodation, although not presently occupied) in South Heath;
- land required for the construction of the Proposed Scheme at Sibley's Coppice in South Heath;
- permanent loss of land at Mantle's Wood west of Hyde Heath;
- the temporary closures of Frith Hill, which is the principal link between South Heath and Great Missenden;
- impacts on amenity for residential properties in South Heath during construction; and
- impacts on amenity for residential properties in Hyde End and South Heath during operation.

5.1.3 Further details of the community assessments and write-ups of open space surveys and recreational public rights of way (PRoW) surveys undertaken within the study area are contained in Volume 5: Appendix CM-001-009.

5.1.4 Significantly affected community resources are shown in Maps CM-01-029 to CM-01-030 (Volume 5, Community Map Book).

5.1.5 The current assessment draws on information gathered from regional and local sources including: Buckinghamshire County Council; Weights and Measures Gym regarding the services and facilities they provide to members; Great Missenden Parish Council and Little Missenden Parish Council.

5.2 Scope, assumptions and limitations

5.2.1 The assessment scope, key assumptions and limitations for the community assessment are set out in Volume 1, Section 8, the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

5.3 Environmental baseline

Existing baseline

5.3.1 Baseline data on community resources was collected up to 1km from the centre line of the Proposed Scheme and, additionally, up to 250m from the boundaries of land required for the construction of the Proposed Scheme.

5.3.2 The study area includes the area of land required both temporarily and permanently for the construction and operation of the Proposed Scheme, together with a wider corridor within which receptors or resources could be affected by a combination of significant residual effects, such as noise, vibration, construction dust, poor air quality and visual intrusion. In addition, the study area has regard to the proposed routeing of construction traffic and takes account of catchment areas for community facilities that could be affected where crossed by the Proposed Scheme. This area includes land at Hyde Heath and Little Missenden; Hyde End; South Heath and Ballinger Common; and Great Missenden. Overall the study area is taken as the area of land which encompasses the likely significant effects of the Proposed Scheme.

5.3.3 The area is characterised by farmland interspersed with the villages and the small town of Great Missenden. Outside the settlements the majority of the population reside in farmhouses and rural cottages.

Hyde Heath and Little Missenden

5.3.4 The majority of Hyde Heath is south of Weedon Hill road with the exception of Hyde Heath Infant School, Hyde Heath Pre-School and St Andrew's Church on The Green. Other community facilities within and surrounding Hyde Heath include The Plough public house, Hyde Heath village hall, Hyde Heath Union Chapel, Hyde Heath Common, a cricket pitch with a play area and local shops.

5.3.5 Chalk Lane and Keepers Lane provide links between Hyde Heath and Little Missenden. Little Missenden is a linear development located to the south of the A413 Aylesbury Road and the River Misbourne.

5.3.6 Mantle's Wood, west of Hyde Heath, is an area of woodland, which is privately owned but is accessible to local residents for walking by two PRoW (Footpaths LMI/17 and LMI/21).

Hyde End

5.3.7 The small village of Hyde End is located between Hyde Heath and South Heath on the Chesham Road. There are no community facilities in the village.

South Heath and Ballinger Common

5.3.8 South Heath is located to the north-west of Hyde End and north-east of Great Missenden. It is centred on Frith Hill and Ballinger Road. The former Annie Bailey's public house and restaurant is located on Chesham Road and Weights and Measures Gym is on Frith Hill. Furthermore Sibley's Coppice is a 7ha area of woodland accessible to local residents for walking activities by several PRoW.

5.3.9 Ballinger is a hamlet and common located to the north of South Heath and Great Missenden. The Ballinger War Memorial Hall can be found in the centre of the village

and serves as a village hall to surrounding villages including South Heath. The Church of St Mary's is located on Blackthorne Lane in the village.

Great Missenden

5.3.10 Great Missenden is located to the south-west of South Heath and east of the neighbouring village of Prestwood. Great Missenden is centred on the High Street contained between the existing Marylebone to Aylesbury Line and the A413. In addition there is a housing estate on Rignall Road to the north-west and another housing estate centred on Martinsend Lane which forms the link between Prestwood and Great Missenden.

5.3.11 There are three schools within Great Missenden: Great Missenden Church of England Combined School, Gateway School and Misbourne School and three churches: Great Missenden Baptist Church, St Peter and St Paul (Church of England) Church and The Immaculate Heart of Mary (Catholic) Church. Other community facilities include shops, Memorial Hall, a post office, a library, a fire station, The Roald Dahl museum, a police station and several public houses. Missenden Abbey is also located in Great Missenden, this is an adult education college and has a management and conference centre. In addition the privately owned Chiltern Hospital is located approximately 1km to the south of Great Missenden, just east of Little Kingshill.

Future baseline

Construction (2017)

5.3.12 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2017. No committed developments have been identified in this area that will materially alter the baseline conditions in 2017 for the community assessment.

Operation (2026)

5.3.13 The review of future baseline conditions has not identified any additional committed developments within the study area, which will be completed by the year of operation.

5.4 Effects arising during construction

Avoidance and mitigation measures

5.4.1 The following measures have been incorporated into the scheme design as part of the design development process to avoid or reduce the adverse environmental effects during construction:

- the open space within the land required for the construction of the Proposed Scheme at Sibley's Coppice at South Heath will be reinstated post-construction. This open space will be reinstated using the woodland seed bank found in the soils retained from the area of woodland which will be removed during construction; and
- there will be an ecological mitigation area, with public access, south of Mantle's Wood and Farthings Wood to mitigate for the loss of ancient woodland in this area. See Section 7 for further details.

5.4.2 The draft CoCP includes a range of provisions that will help mitigate community effects associated with construction within this area, including the following (see Volume 5: Appendix CT-003-000/1):

- appointment of community relations personnel (draft CoCP, Section 5);
- community helpline to handle enquires from the public (draft CoCP, Section 5);
- sensitive layout of construction sites to reduce nuisance (draft CoCP, Section 5);
- where reasonably practicable, maintenance of PRoW for pedestrians, cyclists and equestrians around the perimeter of construction sites and across entry and exit points (draft CoCP, Section 5);
- monitoring and management of flood risk and other extreme weather events which may affect community resources during construction (draft CoCP, Sections 5 and 16);
- specific measures in relation to air quality and noise will also serve to reduce impacts for the neighbouring communities including discretionary noise insulation for sensitive community resources and, in special circumstances, temporary rehousing (draft CoCP Sections 7 and 13); and
- where reasonably practicable, the avoidance of large goods vehicles operating adjacent to schools during drop off and pick up periods (draft CoCP, Section 14).

Assessment of impacts and effects

5.4.3 Details of all assessments of community resources are included in Volume 5: Appendix CM-001-009. Each assessment form presents information that explains the rationale for determining the rating for sensitivity of the affected community resource, magnitude of impact and the assessment of significance.

Hyde Heath and Little Missenden

Temporary effects

5.4.4 No significant temporary effects have been identified in the community assessment for Hyde Heath and Little Missenden.

Permanent effects

Open space and recreational PRoW

5.4.5 The Chiltern tunnel will surface with a tunnel portal in Mantle's Wood, north-west of Hyde Heath and the Proposed Scheme will then proceed in cutting. Approximately 31% of the wood (approximately 6.2ha out of 20ha) will be permanently required, severing the north and the south of the wood. The Proposed Scheme provides for 16ha of ecological mitigation planting south of Chiltern tunnel north portal.

5.4.6 Mantle's Wood is a designated Local Wildlife Site (LWS), owned by the Forestry Commission and promoted as a place to visit by the Woodland Trust[27]; at present the

[27] Woodland Trust, (2012) *http://visitwoods.org.uk/en/visit-woods/Pages/large-wood-map.aspx?wood=38910&site=Mantle's-Wood#.UIZdZsWCmrg*

site is leased to a private tenant. Presently, it is partly accessible by two PRoW, which are used by local residents for walking activities. One of these Footpaths (LMI/17) will be temporarily re-routed during construction for up to one year; the additional length of this Footpath during this period will be 450m.The other PRoW to the west (LMI/21) will be stopped up after LMI/17 is re-instated. This will reduce public access to Mantle's Wood.

5.4.7 A survey undertaken in August 2012 showed usage of the PRoW within Mantle's Wood with 31 people observed over the course of the day. Information received from Great Missenden Parish Council indicates that this is a valued community resource.

5.4.8 There is alternative open space and woodland (which is accessible by PRoW) within walking distance (1km) of Mantle's Wood including Hyde Heath Common, Bray's Wood and White's Wood. Farthings Wood and Hedgemoor are also within walking distance but these are not accessible by PRoW and are also partially in the land required for the construction of the Proposed Scheme.

5.4.9 Even though there are accessible alternatives, given that Mantle's Wood is a popular resource and it is permanently severed by construction activities with approximately 31% of it made unusable, the effect is considered to be moderate adverse and is significant.

Cumulative effects

5.4.10 No cumulative effects during construction have been identified in the community assessment for Hyde Heath and Little Missenden.

Hyde End

Temporary effects

5.4.11 No significant temporary effects have been identified in the community assessment for Hyde End.

Permanent effects

Residential properties

5.4.12 Construction of the section of cutting between Mantle's Wood and South Heath will require the demolition of two residential properties in Hyde End. These are Rowen Farm and Hedgemoor on Hyde Lane. Given that Hyde End is a small community (approximately 25 residential properties) this will have a significant effect at a community level.

Cumulative effects

5.4.13 No cumulative effects during construction have been identified in the community assessment for Hyde End.

South Heath and Ballinger Common

Temporary effects

Residential properties

5.4.14 Up to 40 residential properties in South Heath, located on Sibleys Rise and Frith Hill, are predicted to experience various in-combination effects arising from construction activities as summarised below. These in-combination effects are:

- significant visual effects due to views of works associated with the construction of the South Heath green tunnel including the demolitions on Frith Hill;
- significant noise effects associated with the South Heath green tunnel construction; and
- significant increases in HGV movements along Frith Hill as a result of construction activities co-ordinated by several compounds in and around South Heath. (The duration of operation of these compounds is set out in section 2.3 and Figure 5 and further information is also provided in section 12: Traffic and transport).

5.4.15 Residential properties will experience the in-combination effects for at least eight months. A small number of properties will experience effects for a longer period. As a result there will be a major adverse effect on residential amenity on Frith Hill and Sibleys Rise, which is significant.

5.4.16 Elsewhere in South Heath, approximately 50 residential properties on King's Lane are predicted to experience in-combination effects arising from construction activities. These in-combination effects are:

- significant noise effects due to the construction traffic using King's Lane; and
- a significant increase in HGV volumes along King's Lane due, which will use this route to access compounds in the South Heath area. The duration of operation of these compounds is set out in section 2.3 and Figure 5 and further information is also provided in section 12: Traffic and transport.

5.4.17 The combination of these effects for the properties on King's Lane will have a major adverse effect on residential amenity and this is considered significant.

5.4.18 Just north of South Heath on Potter Row it is predicted that approximately 10 residential properties will experience in-combination effects. These in-combination effects are:

- significant affects on views due to construction activity associated with the South Heath green tunnel north portal, the South Heath green tunnel (north) satellite compound, the Leather Lane satellite compound and of the Leather Lane overbridge; and
- a significant increase in HGV movements along Potter Row between Frith Hill and Leather Lane, which will use this route to access compounds in the South Heath area. The duration of operation of these compounds is set out in section 2.3 and Figure 5 and further information is also provided in section 12: Traffic

and transport.

5.4.19 The combination of these effects for the residential properties on Potter Row will have a major adverse effect on residential amenity. This is considered to be significant.

5.4.20 During construction of a section of the South Heath green tunnel it will be necessary to close Frith Hill to traffic for a period of up to two years, which has the potential to cause an isolation effect. During this time, traffic using this route will be diverted via Kings Lane and the B485 Chesham Road, with an approximate additional distance of 700m (the total length of the route is 2.6km). Frith Hill also forms part of National Cycle Route 57; cyclists using this route, therefore, will be subject to the same diversion. There will also be a need to accommodate pedestrian users of this road during the construction period. Frith Hill, which has a narrow footpath, links with a subway (underneath the A413) which surfaces in Great Missenden next to Great Missenden Church of England Combined School. During the closure of Frith Hill, there will be a temporary footpath diversion. Just west of the properties on Sibley's Rise, the footpath will be temporarily routed east of Frith Hill and around the South Heath green tunnel construction works, before re-joining Frith Hill near to Orchard Cottage and Firth Hill Farm. This will result in an additional distance for pedestrians of approximately 400m.

5.4.21 Frith Hill is the principal link connecting the villages of South Heath and Ballinger Common (both to the east of the Proposed Scheme) and the larger community of Great Missenden (to the west). South Heath and Ballinger Common have very limited community infrastructure and therefore residents need to make daily use of the community infrastructure in Great Missenden, which includes shopping, schooling, medical care, a post office, a library and other recreational and social facilities. Survey results indicate that the footpath is reasonably well used.

5.4.22 Given that the additional length of the journey for motor vehicles and bicycles (approximately 700m) and pedestrians (approximately 400m) is not extensive, this is considered to be a minor adverse isolation effect, which is not significant.

Open space and recreational PRoW

5.4.23 The construction of the South Heath green tunnel will require land on the south-western side of Sibley's Coppice to the west of South Heath. The construction of the section of South Heath green tunnel that passes by South Heath will take approximately two years to construct. During this time approximately one third of Sibley's Coppice (or an estimated 2.6ha)[28] will be unavailable for public use.

5.4.24 Sibley's Coppice, which is adjacent to the village of South Heath, is a designated LWS and is accessible by several PRoW (which link South Heath to Great Missenden). A survey undertaken in 2012 indicated that the Coppice is well-used by the local community, particularly by walkers and dog walkers[29]. There are two alternative open space sites within walking distance of South Heath: Jenkin's Wood (approximately 500m to the north off Potter Row) and Redding Wick (approximately 650m to the east off Wood Lane) both are accessible by PRoW.

[28] The full area of Sibley's Coppice is 7.5ha.
[29] A survey undertaken by Atkins (Lot 1 Consultants) on Saturday 25th August 2012 reports a total of 18 users (13 walkers and 5 dog walkers).

5.4.25 Whilst there are a couple of alternative open spaces within walking distance of the village, Sibley's Coppice is a highly valued community resource and one third of it will be inaccessible for up to two years. As such this effect will be moderate adverse for the community of South Heath and therefore is considered to be significant.

Permanent effects

Residential properties

5.4.26 Construction of the South Heath green tunnel and South Heath cutting from South Heath to Leather Lane, will require the demolition of five residential properties in the village of South Heath; one property on Chesham Road, two properties on King's Lane, one property on Frith Hill and the residential property above the former Annie Bailey's Public House on Chesham Road. The permanent loss of these properties will have a moderate adverse effect on the local community and is considered significant.

5.4.27 Construction of South Heath cutting that will run from South Heath to Leather Lane (west of Ballinger Common) will require the demolition of one residential property on Mulberry Park Hill, north-west of South Heath. The demolition of this property is not considered significant at a community level.

Community infrastructure

5.4.28 The South Heath green tunnel that starts south-west of South Heath, will require the demolition of the former Annie Bailey's public house and restaurant on Chesham Road between Hyde End and South Heath. Annie Bailey's public house opened in 2002 and ceased operations in 2013. The nearest alternative public houses for the community are in Hyde Heath approximately 2km to the south east and Great Missenden, 2km to the west.

5.4.29 The demolition of this building (which has an A4 planning designation[30]) will prevent its re-establishment in future. Annie Bailey's public house had played an important community function for residents of South Heath, Ballinger Common and Hyde End although it is currently closed. Despite the alternatives, the permanent loss of Annie Bailey's will be a moderate adverse effect and is significant.

5.4.30 Construction of the South Heath green tunnel will also require the demolition of the Weights and Measures Gym on Frith Hill in South Heath. The closest alternative gym (Sprinters Leisure Centre, Honor End Lane, Prestwood) is approximately 6km from South Heath. Given that this facility will be permanently lost and the nearest alternative facility is over 5km away, this will be a major adverse effect on the community of South Heath. Therefore, this is considered to be significant.

Cumulative effects

5.4.31 Residents of South Heath are predicted to experience a combination of residential and community infrastructure demolitions, changes to residential amenity in places throughout the village, temporary loss of land at Sibley's Coppice and the minor adverse temporary isolation effects from facilities in Great Missenden. This is considered to have a community wide effect on the community of South Heath.

[30] A4 planning designation: Drinking establishment

Great Missenden

Temporary effects

5.4.32 No significant temporary effects have been identified in the community assessment for Great Missenden.

Permanent effects

5.4.33 No significant permanent effects resulting from construction have been identified in the community assessment for Great Missenden.

Cumulative effects

5.4.34 No cumulative effects have been identified in the community assessment for Great Missenden.

Other mitigation measures

5.4.35 HS2 Ltd will seek to provide temporary access to land for ecological mitigation (see Section 7) as a potential means of offsetting the effects of the temporary use of publicly accessible land at Sibley's Coppice during construction.

Summary of likely significant residual effects

5.4.36 Likely significant residual effects include the permanent loss of land at Mantle's Wood in Hyde Heath; permanent loss of residential properties in Hyde End; permanent loss of residential properties and community infrastructure in South Heath; temporary adverse effects on residential amenity for some properties in South Heath; and the temporary loss of land at Sibley's Coppice in South Heath.

5.5 Effects arising from operation

Assessment of impacts and effects

Hyde Heath and Little Missenden

5.5.1 No significant operational effects have been identified within the community assessment for Hyde Heath or Little Missenden.

Hyde End

Residential properties

5.5.2 The residents of approximately six properties in the vicinity of Hyde Lane in Hyde End are predicted to experience in-combination effects associated with the operation of the Proposed Scheme. These in-combination effects are:

- significant visual effects due to views of the Hyde Lane overbridge; and
- significant daytime noise effects from the passing trains.

5.5.3 The combination of these effects will have a major adverse effect on residential amenity and is therefore considered to be significant.

South Heath and Ballinger Common

Residential properties

5.5.4 The residents of approximately ten properties on Potter Row in South Heath are predicted to experience in-combination effects associated with the operation of the Proposed Scheme. These in-combination effects are:

- significant visual effects due to views of the Leather Lane overbridge, the South Heath green tunnel north portal and the South Heath cutting; and
- significant daytime noise effects from the passing trains.

5.5.5 The combination of these effects will have a major adverse effect on residential amenity and is therefore considered to be significant.

Great Missenden

5.5.6 No significant operational effects have been identified within the community assessment for the community of Great Missenden.

Cumulative effects

5.5.7 No cumulative effects have been identified within the community assessment during operation.

Other mitigation measures

5.5.8 No other mitigation measures have been identified within the assessment.

Summary of likely significant residual effects

5.5.9 The assessment has concluded that there will be residual permanent adverse effects on residential amenity for some properties in Hyde End and on Potter Row in South Heath.

6 Cultural heritage

6.1 Introduction

6.1.1 This section provides a description of the current baseline for heritage assets and reports the likely impacts and significant effects resulting from the construction and operation of the Proposed Scheme. Consideration is given to the extent and heritage value (significance) of assets including archaeological and palaeoenvironmental remains; historic buildings and the built environment and historic landscapes.

6.1.2 With regard to heritage assets, the main issue is the extent to which designated and non-designated assets are affected by the Proposed Scheme. Impacts on assets as a result of the Proposed Scheme will occur largely through the physical removal and alteration of assets and changes to their setting.

6.1.3 Maps showing the location of the key environmental features can be found in Volume 2, CFA9 Map Book. Maps showing the location of all designated and non-designated heritage assets can be found in Volume 5, Cultural Heritage Map Book. Detailed reports on the cultural heritage character and surveys undertaken within the local area are contained in the Volume 5 Appendices. These include:

- Appendix CH-001-009 - Baseline Report;
- Appendix CH-002-009 - Gazetteer of Heritage Assets;
- Appendix CH-003-009 - Impact Assessment Table; and
- Appendix CH-004-009 - Survey Reports.

6.1.4 Throughout this section, assets within the study areas are identified with a unique reference code, CCXXX; further detail on these assets can be found in the gazetteer in Volume 5: Appendix CH-002-009.

6.1.5 Engagement has been undertaken with the Buckinghamshire County Council planning archaeologist and the Conservation Officers for Chiltern District Council and Aylesbury Vale District Council with regard to the nature of the cultural heritage assets within the local area.

6.2 Scope, assumptions and limitations

6.2.1 The assessment scope, key assumptions and limitations for the cultural heritage assessment are set out in Volume 1, the SMR (Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

6.2.2 The setting of all designated heritage assets within the Zone of Theoretical Visibility (ZTV) of the Proposed Scheme has been considered. The study area within which a detailed assessment of all assets, designated and non-designated, has been carried out, is defined as the land required, temporarily or permanently, to construct the

Proposed Scheme plus 500m. For the purposes of this assessment, any assets within the 10mm settlement contour[31] are included within the assessment.

6.2.3 The cultural heritage methodology includes the consideration of the intra-project effects of a number of technical topic assessments, for example, landscape and visual, ecology and water resources and flood risk. Consequently, these interactions have been included in the assessment of impacts and effects.

6.2.4 In undertaking the assessment the following limitations were identified:

- the LiDAR[32] data examined did not encompass the full extent of the study area; and
- not all areas of survey as identified in the archaeological risk model[33] were available for survey.

6.2.5 However, a non-intrusive field survey was undertaken in one area within the study area to provide data regarding the nature of sub-surface archaeological assets. Information from other sources of data, including the historic environment record (HER) and local archives was utilised to provide information relating to the potential archaeological assets that may be present.

6.3 Environmental baseline

Existing baseline

6.3.1 In compiling this assessment, documentary baseline data was collected from a variety of sources as set out in Volume 5: Appendix CH-001-009.

6.3.2 In addition to collating this baseline data, the following surveys were undertaken:

- walkover and site reconnaissance from areas of public access or in locations where access was granted. This was undertaken to understand the character and form of heritage assets and the historic landscape, to review the setting of assets and to identify previously unknown assets;
- desk-top review of remote sensing data including LiDAR, aerial photographs and hyperspectral data (see Volume 5: Appendix CH-004-009); and
- a programme of non-intrusive surveys including geophysical surveys (see Volume 5: Appendix CH-004-009).

Designated assets

6.3.3 The following designated heritage assets are located partially or wholly within the land required, temporarily or permanently, for the construction of the Proposed Scheme (see Map CH-02-014 in Volume 5, Cultural Heritage Map Book):

- ancient woodland at Mantle's Wood (CC019), Farthings Wood (CC030) and Sibley's Coppice (CC050), assets of high value, lie partially within the land

[31] The area in which ground settlement is estimated to be 10mm in depth above the bored tunnel.
[32] Light detection and ranging (LiDAR) is a high resolution remote sensing technique to capture 3D data.
[33] The archaeological risk model is an approach that enables the identification of those areas of the Proposed Scheme where archaeological assets are known or suspected and provides a mechanism for the prioritisation of the programme of survey.

required, temporarily and permanently, for the construction of the Proposed Scheme.

6.3.4 The following designated assets are located within the ZTV (see Maps CT-10-017 and CT-10-018 in Volume 2, CFA 9 Map Book and Map CH-02-014 in Volume 5, Cultural Heritage Map Book):

- Grim's Ditch scheduled monument lies partially within the ZTV, however, is more extensive both within the ZTV and within the land required, temporarily or permanently, to construct the Proposed Scheme in CFA10. The asset is assessed there as DWH008 and in Volume 5: Appendices CH-001- 003;
- five scheduled monuments of high value: Castle Tower (CC017); The Castle, Rook Wood (CC038); a Moated site in Chalkdell Wood 100m north-west of Frith Hill House (CC054); a Moated site and enclosures at Redding Wick (CC065) and a Moated Site immediately north-west of Little Pednor Farm (CC091);
- two Grade I listed buildings of high value: the Parish Church of St John the Baptist, Little Missenden (within grouping CC014) and the Church of St Peter and Paul, Great Missenden (within the Missenden Abbey asset grouping CC051);
- six Grade II* listed buildings of high value: Great Hunbridge Manor (within asset grouping CC027); the Chapel at Great Hunbridge Manor (within grouping CC027); the George Inn public house (within grouping CC053); a Barn at the rear of The George Inn public house (within grouping CC053); Elmhurst (Flats Numbers 1 – 7 consecutively (within grouping CC053) and Abbey Farmhouse (within grouping CC053);
- a total of 20 areas of ancient woodland of high value: Weedon Hill Wood/High Spring/Ostler's Wood (CC001); Bray's Wood (CC007); Todd's Wood (CC010); White's Wood (CC011); Breache's Wood (CC012); Halfacre and Coleman's Wood (CC013); Devil's Den (CC028); Willow Coppice (CC029); Rook Wood (CC039); Atkins's and Hobbshill Woods (CC058); Angling Spring Wood (CC059); Stocking's Wood (CC062); Rignall Wood (CC063); Redding Wick (CC108); Jenkin's Wood (CC073); Black Grove (CC080); Havenfield Wood (CC081); Coneybank Wood (CC086); Furze Wood (CC087) and Bellows Wood (CC093);
- the northern edge of Shardeloes, a Grade II* registered park and garden (RPG) of high value lies just inside the southern boundary of this area. It is assessed as part of CFA8;
- three conservation areas of moderate value: Little Missenden (CC014); Missenden Abbey (CC051) and Great Missenden (CC053);
- one Grade II RPG of moderate value at Missenden Abbey (CC051); and
- a total of 129 Grade II listed buildings of moderate value. Forty-three of these lie within the historic settlement at Great Missenden (CC053), with a further nine associated with Missenden Abbey and its landscape park (CC051). There

are also 32 within and on the periphery of Little Missenden (CC014), three in Hyde Heath (CC009) and one in South Heath (CC049). The remaining 41 Grade II listed buildings principally comprise houses, cottages, a public house and agricultural buildings associated with farms, farmsteads and dispersed hamlets.

Non-designated assets

6.3.5 The following non-designated assets of high value lie wholly or partially within the land required, temporarily or permanently, for the construction of the Proposed Scheme:

- earthwork remains and associated potential buried archaeological remains of possible medieval date within Mantle's Wood, associated with Mantell's Manor (CC109); and
- the western edge of Potter Row (CC077) between Frith Hill and Hammondshall Farm, in which earthwork remains of a possible motte and bailey survive in Jenkins Wood ancient woodland (CC073) and also potential earthwork and buried archaeological remains of a former moated site at Bury Farm (CC066). These are set within an extensive area of probable medieval and post-medieval pottery production and possible settlement (CC077);

6.3.6 The following non-designated assets of moderate value lie wholly or partially within the land required, temporarily or permanently, for the construction of the Proposed Scheme:

- land to the south of Hyde House and north of Mantle's Wood where prehistoric remains of all dates but particularly of Neolithic and Bronze Age date, as well as medieval remains, have been found during fieldwalking surveys (CC024);
- land between Hedgemoor and Cudsden's Farm and north of Broome Farm, east of Wendover Woods where multi-period finds of prehistoric, Roman and medieval date have been found during fieldwalking surveys. There is the potential for the existence of a medieval farmstead immediately south of Cudsden's Farm (CC035);
- land between Chesham Road and Frith Hill passing through Sibley's Coppice ancient woodland where Neolithic – Bronze Age flint tools have been found during fieldwalking surveys which could define an area of extensive utilisation of clay and flint deposits as raw material (CC064); and
- seven hedgerows and groups of hedges that qualify as historically important under the Hedgerow Regulations 1997[34] (CC020, CC021, CC067, CC068, CC069, CC071 and CC072).

6.3.7 The following identified non-designated assets of low value lie wholly or partially within the land required, temporarily or permanently, for the construction of the Proposed Scheme:

[34] The Hedgerow Regulations (1997) Statutory Instrument 1997 No. 1160.

- Great Missenden's remnant medieval agricultural hinterland (CC032). This historic landscape component has only slight historical coherence, comprising several areas where much degraded earthwork remains of ridge and furrow survive. These areas were identified during an aerial photographic and LiDAR survey (Appendix CH-004-009; assets I71, I72, I73, I74, I77 and I78). These remnant landscape elements may also be associated with contemporary medieval settlement at the moated sites in Chalkdell Woods (CC054), at Redding Wick (CC065) and at Bury Farm (CC066) and the possible former farmstead at Cudsden's Farm (CC035);
- land to the north of Rowan Farm between the junctions of Hyde Lane and Chesham Road where multi-period finds of prehistoric, Roman and medieval date have been found during fieldwalking surveys (CC034);
- Chapel Farm on Hyde Lane (CC042);
- Annie Bailey's public house and restaurant, the former Barley Mow public house on Chesham Road (CC055);
- Chiltern Cottage on Frith Hill (CC060); and
- Weights and Measures Gym on Frith Hill (CC061).

6.3.8 All non-designated heritage assets within 500m of the land required, temporarily or permanently, for the construction of the Proposed Scheme are listed in the gazetteer in Volume 5: Appendix CH-002-009 and identified on Maps CH-01-029 and CH-01-030 (Volume 5, Cultural Heritage Map Book). There are a number of built heritage assets, the settings of which have been considered, for example:

- Mantle's Farm (CC018);
- Hyde Heath (CC022);
- Sheepcotts (CC043);
- Friendly Lodge Farm, now called The Hyde (CC044);
- Wick Cottage and Littlewood Place, Little Wood Corner (CC113);
- Orchard Cottage (CC033);
- Frith Hill Farm (CC111);
- King's Pond Cottage (CC112)
- South Heath Cottage (CC114);
- Hyde End Hall (CC115);
- Hyde Heath Cottage (CC116);
- Cottages at Middle Grove Farm (CC117);
- Hillcroft (CC075);
- Park Farm (CC078);

- Springfield Farm (CC079);
- Beeway Cottage (CC102);
- The Firs (CC103);
- Hedgesparrow Cottage (CC104);
- The Lamb (CC105);
- Lamb Cottage and Sunnyside (CC106);
- Chiltern's Cottage (CC110);
- Havenfields Lodge, now called Havenfields (CC081); and
- Three Bears Cottage (CC107).

Cultural heritage overview

6.3.9 This area lies on the dipslope of the Chilterns and flanks the valley of the River Misbourne which drains eastward to the River Colne and then to the River Thames.

6.3.10 The area is generally characterised by chalk plateau land, dissected by valleys, notably the River Misbourne. The underlying geology comprises chalk overlain on the plateau to the east by superficial Clay-with-Flints with some glacial head within the valley floor. There are also some alluvial deposits and possibly colluvial deposits on the valley floor. Further details of the geology of the area are contained in land quality (Section 8).

6.3.11 The River Misbourne rises on the outskirts of Great Misbourne and flows through the Misbourne valley and Little Missenden to its confluence with the River Colne and the valley forms a natural routeway across the dipslope of the Chilterns.

6.3.12 The present settlement character is predominantly one of dispersed settlement comprising farmsteads and small hamlets with small enclosures adjacent to the principal valleys set within a rural and agricultural landscape. Some 15% of the study area comprises woodland; much of it ancient beechwood.

6.3.13 There is no potential for the discovery of significant waterlogged deposits and/or palaeo-environmental remains along the route within the study area since it does not cross any alluvial deposits associated with the Misbourne valley.

6.3.14 Within the study area only one recorded Palaeolithic axe is recorded (circa 500,000 BC-circa 10,000 BC), found during fieldwalking to the south-west of Hyde House (CC024) on the plateau adjacent to the Misbourne valley. It is possible that other stone tools or animal bones may survive in areas of head deposits.

6.3.15 Mesolithic activity (circa 10,000 BC-circa 4,000 BC) is likely to be restricted to scatters of bone, flint and other stone artefacts present within the ploughsoil and subsoil. Such remains have been recovered during widening of the A413 (CC015) and fieldwalking on land to the north of Mantle's Wood (CC024), between Rowan Farm and Hyde Lane (CC034) and between Broome Farm and Cudsden's Farm, east of Wendover Woods (CC035). These areas lie on the higher plateau land to the east of the Misbourne valley.

6.3.16 By the Neolithic and Early Bronze Age periods (circa 4,000-circa 1,500 BC) ceremonial/burial monuments, such as causewayed enclosures, henges and round barrows were characteristic and examples have been found on the higher plateau/cross ridges where they are overlain by Clay-with-Flints, although they are absent from the Chiltern dipslope and the Misbourne valley.

6.3.17 Extensive scatters of Neolithic and Early Bronze Age flint artefacts, found during fieldwalking surveys on the plateau lands suggest the area was well utilised, certainly as a source of flint and probably for other resources too. Tools, cores and flakes have been recovered to the north and south of Frith Hill and west of Sibley's Coppice, around Hyde Farm, south-west of Hyde House, north of Chapel Farm, in fields around Cudsden's Farm, at Springfield Farm in Potter Row and around Havenfields and Woodland Park at the northern end of the study area (CC024, CC034, CC035, CC064 and CC083). There is potential elsewhere on the higher valley slopes and the plateau within the study area for the survival of scatters of flint tools and flakes dating to the Neolithic and Bronze Age.

6.3.18 Settlement evidence of Neolithic and Early Bronze Age date is scarce in Buckinghamshire (typically comprising only shallow pits or scrapes) and discovery is hampered by destruction through slope erosion and burial under later colluvium.

6.3.19 Late Bronze Age to Early Iron Age pottery (circa 1,000 BC-circa 400 BC) was found at Bury Farm (CC066) but elsewhere only very occasional finds, such as during fieldwalking south-west of Hyde House, have been recorded (CC024).

6.3.20 Late Bronze Age and Iron Age hillforts and cross-ridge dykes, running perpendicular to the Chiltern scarp elsewhere in the Chilterns, have been thought to indicate either a pattern of routeways or possibly a large-scale arrangement of earthworks designed for stock management. There is little real evidence for a network of prehistoric route ways in this area, although a co-axial landscape trend evident in surviving routeways and field boundaries has been identified.

6.3.21 Evidence for land division in the Iron Age is indicated by Grim's Ditch (a section of which lies at the northern end of the study area, but more extensively in CFA10, where it is assessed. For a detailed description of this asset, separately scheduled as two monuments (DWH008 and DWH077), see Volume 5, Appendix CH-001-010 and Appendix CH-002-010). Grim's Ditch may have been a tribal boundary feature but is more likely to have been established to constrain cattle being driven within valleys linking to the Rivers Wye and Chess. During the Late Iron Age and Roman periods settlement was attracted to the valleys on the dipslope, specifically that of the Misbourne.

6.3.22 In the wider area, settlement of Roman date is usually more extensive in scale than that dating to the late prehistoric period and these sites have a far greater and more diverse range of material culture.

6.3.23 Villas appear in the Romano-British countryside from the late 1st to early 2nd century AD; typically at 2 to 3km intervals and a number are recorded in the Misbourne valley between Little Missenden and Amersham. Possible remains, unexcavated, lie just outside the study area at Little Missenden for example.

6.3.24 No excavated settlement evidence of Roman date has yet been identified within the study area, although small quantities of Roman artefacts have been recovered during fieldwalking north of Rowan Farm (CC034) and around Cudsden's Farm, east of Wendover Woods (CC035).

6.3.25 Material remains are drastically reduced during the early medieval period (AD 410 to 1066) as pottery does not survive well in plough soils, coinage is very rare and many settlements have since been built over by later ones. No archaeological sites of the period are currently known within the study area.

6.3.26 By the Norman Conquest (1066) the present settlement pattern, focused on the villages of Little Missenden (CC014) and Great Missenden (CC053) had probably been established. Mention of both in the Domesday survey (1086) suggests they had been established in the pre-Conquest period. Earthworks and probable buried remains of a number of moated sites and possible motte and bailey castles are recorded at Castle Tower (CC017), The Castle in Rook Wood (CC038), in Chalkdell Woods just north of Frith Hill (CC054), in woodland at Redding Wick (CC065) and just north-west of Little Pednor Farm (CC091). These sites are all scheduled monuments.

6.3.27 Non-designated earthwork remains survive in Bray's Wood (CC007) and within Mantle's Wood (CC109), possibly associated with Mantle's Farm (CC018). Jenkin's Wood (CC073) contains the remains of a possible motte and bailey type earthwork in a similar tradition to that at Redding Wick (CC065). Nearby at Bury Farm another moated site is recorded which post-dates medieval field boundaries and a fishpond close by but may still be of medieval origin (CC066).

6.3.28 At Bury Farm excavation has produced large quantities of misfired 11th to 14th century pottery (CC066), suggesting a kiln site nearby. This is probably associated with the development of a pottery industry at Potter Row which appears to have been active between the 13th and 15th centuries and subsequently rejuvenated in the 17th century. Pottery waste and kiln remains have been recovered from fieldwalking at Springfield Farm (CC076) and around Potter Row (CC077). Documentary evidence also indicates that the name Potter Row was in existence by 1311, as Le Pottererewe.

6.3.29 There is another possible medieval farmstead at Cudsden's Farm. Fieldwalking yielded large assemblages of 13th and 14th century pottery concentrated in fields immediately to the south of the existing post-medieval buildings (CC035).

6.3.30 One of the major landholders of the area during the medieval period was Missenden Abbey, which was founded at Great Missenden in 1133. After the dissolution of the monasteries in 1536 the abbey was converted into a private house and then in the late 18th to early 19th century a landscape park was laid out, now a Grade II registered park and garden extending to the north-east, east and south-east, also designated a conservation area. The 12th to 13th century church of St Peter and Paul lies within the landscape park in an elevated position on the eastern side of the A413 set within a partially overgrown churchyard (CC051). A hollow-way links the Grade I listed church with the moated site on Frith Hill (CC054).

6.3.31 Within Great Missenden there are several other medieval buildings, including the Grade II* Abbey Farmhouse (CC053). The historic core of the town is also designated a conservation area. Other buildings of medieval date within the study area include the

Grade I Church of St John the Baptist at Little Missenden (CC014) which lies with the Little Missenden conservation area. On the eastern periphery of Little Missenden lie Mill End Cottages, originally an early 16th century hall house (CC014). Elsewhere Hyde Farmhouse is also of 16th century origin (CC036) and part of a former 13th century private chapel has been incorporated into the late 17th century Great Hunbridge Manor (CC027). The former are both Grade II, the latter are Grade II* buildings.

6.3.32 It is likely that the pattern of scattered settlement set within a relatively wooded landscape established in the medieval period forms the basis for the pattern that continued through the post-medieval period (1539 to 1900) to the present day.

6.3.33 The historic landscape character within the study area displays a mixed character of an essentially "ancient" rural landscape of fields and woodlands which have been strongly influenced and affected by development in the 20th century.

6.3.34 The historic settlement pattern is a combination of nucleated and dispersed forms. Dispersed settlement tends to be located on higher ground, taking the form of common edge settlements, linear rows, such as Hyde Heath, South Heath and Potter Row and widely distributed farmsteads. Historic nucleated villages, represented in the study area by Little Missenden and Great Missenden, are found in the Misbourne valley.

6.3.35 The Chiltern District has an extensive area of co-axial field systems (with fields on the same orientation) which may have pre-medieval origins and are found mainly north and east of Chesham. Such remnant field systems are predominantly represented within the study area to the north of Hyde Heath and east and west of South Heath on the higher ground of the plateau. There are also co-axial fields to the south of Little Missenden. The route will pass the south-western edge of South Heath in green tunnel through elements of these early field systems.

6.3.36 Irregular fields of medieval and post-medieval date are much more extensive in the wider district. The route will also pass through these within the study area as well as elements of regular field systems associated with parliamentary enclosure and more modern enclosure.

6.3.37 Woodlands comprise a significant proportion of the historic landscape and much of this is ancient semi-natural or replanted woodland. The study area contains 24 ancient woodlands and of these the route will pass through Mantle's Wood (CC019), Farthings Wood (CC030) and Sibley's Coppice (CC050). Further details of areas of ancient woodland are contained in ecology (Section 7).

6.3.38 Within the study area there are pockets of surviving remnant medieval, perhaps pre-medieval co-axial field systems intermixed in a more widespread landscape of parliamentary and modern enclosure with a quite well-preserved mosaic of ancient semi-natural and replanted woodlands, which in those designated cases may have at least medieval origins.

6.3.39 There has been little change in the field boundaries within the study area since the 1st Edition Ordnance Survey mapping of the 1880s. Seven hedgerows that qualify as historically important under the Hedgerow Regulations 1997 lie within the land required for the construction of the Proposed Scheme (CC020, CC021, CC067, CC068, C069, CC071 and CC072).

6.3.40 The 18th and 19th centuries marked the zenith of parks and gardens in the Chilterns and the district contains some fine examples of this period. A number of large houses established by the gentry are present within the Misbourne valley and are often associated with surrounding planned estates, parks and gardens.

6.3.41 These country estates were established by the wealthiest landowners as an aesthetic expression of power and wealth. Many parks and gardens have earlier antecedents but were substantially redesigned or expanded during this period as fashion and tastes changed. Missenden Abbey, a Grade II RPG, is an example (CC051). The other example, Shardeloes, the northernmost edge of which lies within the study area, is a Grade II* Humphrey Repton designed landscape park (assessed as part of CFA08).

6.3.42 One small non-designated designed garden and parkland is associated with Hyde House (CC026). This comprises the early 18th century Hyde House itself, with 19th century additions, along with a probable 18th century granary dovecote; both Grade II listed. Another 19th century garden is associated with Missenden House in Little Missenden (CC014) and 19th century Ordnance Survey mapping depicts formal gardens at Woodlands Park, a Grade II former Italianate villa (CC097).

6.3.43 Many of the farmhouses and associated agricultural buildings in the study area were built between the 17th and 19th centuries but it is generally buildings within the settlements of Little Missenden (CC014) and Great Missenden (CC053) and to a far lesser extent Hyde Heath (CC009) and South Heath (CC049) that comprise the majority of this period's built heritage.

6.3.44 Hyde Farm is focused around a Grade II building with medieval origins (CC036), probably early 16th century and there are a number of other outlying farmsteads and houses in the study area, both set on their own or focused around Grade II listed buildings of post-medieval date. These comprise Kennel Farm (CC003), Hawthorn Farm (CC025), Sheepcotts Cottage (CC045), 86 King's Lane (CC048), South Heath Farm (CC049), Bury Farm (CC066), Rignall Farm (CC084), Road Farm (CC088), Crawley Farm (CC089), Pednor House (CC090), Great Pednor Manor (CC092), Hammondshall Farm (CC094) and Cottage Farm (CC097).

6.3.45 Nine farmsteads within the study area are depicted on the 1st Edition Ordnance Survey mapping of the 1880s. These comprise Mantle's Farm on the southern edge of Mantle's Wood (CC018), Hyde Heath Farm on the northern periphery of Hyde Heath (CC022), Chapel Farm on Hyde Lane (CC042), Friendly Lodge Farm, now called The Hyde south of Chesham Road (CC044), Frith Hill Farm on Frith Hill (CC111), Hillcroft at the southern end of Potter Row (CC075), Park Farm in Potter Row (CC078), Springfield Farm at the northern end of Potter Row (CC079) and Havenfields Lodge, now called Havenfields, north of Great Missenden (CC081).

6.3.46 Post-medieval industry is predominantly represented by brick and tile workings, chalk extraction pits and the later, post-medieval evidence of pottery kilns at Potter Row (CC077). A number of mills and watercress beds also took advantage of the River Misbourne's supply.

6.3.47 Post-medieval historic transport infrastructure in the study area is represented by the turnpike road that follows the route of the modern B413/London Road/Aylesbury Road (CC008) and the former Aylesbury to Chorleywood Railway built by Great

Central Railways in the 1880s (CC005), on the line of the current Marylebone to Aylesbury Line. Development within the modern period comprises predominantly limited expansion of residential and commercial development around Little Missenden (CC014), Great Missenden (CC053), Hyde Heath (CC009) and South Heath (CC049). There is also an early 20th century former firing range south-east of Jays Hatch near Bray's Wood (CC002). Elsewhere within the study area commercial development predominantly comprises modern structures associated with agriculture and the transport network. Modernisation of the A413 and Marylebone to Aylesbury Line the most notable of the latter.

Future baseline

Construction (2017)

6.3.48 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2017. None of the identified developments affect the assessment of the Proposed Scheme's likely construction impacts on heritage assets.

Operation (2026)

6.3.49 No committed developments have been identified in this local area that will materially alter the baseline conditions in 2026.

6.4 Effects arising during construction

Avoidance and mitigation measures

6.4.1 The draft CoCP sets out the provisions that will be adopted to control effects on cultural heritage assets. The provisions include the following (see Volume 5: Appendix CT-003-000):

- management measures that will be implemented for assets that are to be retained within the land required, temporarily or permanently, for construction of the Proposed Scheme (draft CoCP, Section 8);
- the preparation of project wide principles, standards and techniques for works affecting heritage assets (draft CoCP, Section 8);
- a programme of archaeological investigation and recording to be undertaken prior to/or during construction works affecting the assets (draft CoCP, Section 8); and
- a programme of historic building investigation and recording to be undertaken prior to modification or demolition of the assets (draft CoCP, Section 8).

6.4.2 The following measures have been incorporated into the design of the Proposed Scheme to reduce impacts on assets:

- the design of the overbridge on Hyde Lane to avoid physical impacts on the Grade II listed Sheepcotts Cottage (CC045);
- the design of landscape earthworks at Mantle's Wood (CC019) to reduce the Proposed Scheme footprint and to reduce impacts on the ancient woodland;
- the provision of a retained cut for the construction of South Heath green

tunnel avoids the demolition of 86 King's Lane (CC048), a Grade II listed building;

- the South Heath green tunnel will reduce setting impacts on Briarwood (CC046), the granary at Cudsden's Farm (CC047), 86 King's Lane (CC048) and South Heath Farm (CC049), all of which are Grade II listed buildings;
- woodland planting near South Heath will compensate for the loss of the woodland at Mantle's Wood (CC019), Farthings Wood (CC030) and Sibley's Coppice (CC050) and will result in a net increase in the extent of woodland; and
- general landscape earthworks and planting will reduce impacts on the setting of designated assets within the ZTV.

Assessment of impacts and effects

Temporary effects

6.4.3 The construction works, comprising excavations and earthworks and including temporary works such as construction compounds, storage areas, and diversion of existing roads and services, have the potential to affect heritage assets during the construction period (for details on construction periods see Section 2.3). Impacts will occur to assets both within the land required, temporarily or permanently, for construction of the Proposed Scheme and assets in the wider study area due to the visibility of plant, cranes and equipment and other construction factors.

6.4.4 Construction of the Chiltern tunnel north cutting through Hyde Lane and the South Heath green tunnel through Chesham Road and King's Lane will require the realignment of King's Lane, the realignment of Chesham Road, construction of the Hyde Lane overbridge and access to the South Heath green tunnel south portal. There will also be extensive landscaping, temporary material stockpiles, the construction of the South Heath green tunnel (south) satellite compound and closing and realignment of a Footpath GMI/27. The construction works for the Chiltern tunnel north cutting will take place over two years and six months and those for the South Heath green tunnel will take place over three years and six months. This will affect the settings of Grade II listed buildings at Hyde Farm (CC036), Sheepcotts Cottage (CC045), the granary at Cudsden's Farm (CC047) and 86 King's Lane (CC048) all of which are of moderate value. The character of their setting, comprising the area around Hyde Lane, King's Lane and the rural agricultural context in which all are set will be altered comprehensively. This will cause a high adverse impact and a major adverse effect to each of these assets.

6.4.5 There will be an adverse effect on the character and setting of Grade II listed Hammondshall Farmhouse (CC094) an asset of moderate value. The Proposed Scheme will be in the South Heath cutting as it passes Hammondshall Farmhouse, which is located just outside the construction boundary. This will require landscaping, the provision of an attenuation pond, temporary earthworks stockpiling and the installation of the Leather Lane overbridge satellite compound, located adjacent to Leather Lane, which itself will be permanently realigned over the Leather Lane overbridge. Construction of which will take approximately one year. Construction works for the South Heath cutting will be intermittent and will take place over approximately three years and three months. Hammondshall Farmhouse's setting,

defined by surrounding non-designated buildings, yards and gardens in the rolling hills on the Chiltern plateau, will be comprehensively altered. This will cause a high adverse impact and a major adverse effect.

6.4.6 There will be an adverse effect on the character and setting of Grade II listed Cottage Farm and Woodlands Park (CC097), both of moderate value. The Proposed Scheme will be in the South Heath cutting as it passes approximately 200m to the north-east. This will also require associated landscaping and temporary earthworks stockpiling. Construction works will be intermittent and will take place over approximately three years and three months. These works will affect the settings of Woodlands Park and Cottage Farm, defined by their rural agricultural surroundings and associated views including views of Grim's Ditch (DWH008) which contributes to their setting. This will have a high adverse impact and a major adverse effect.

6.4.7 There will be an adverse effect on the character and setting of scheduled monument The Castle (CC038) an asset of high value. The Proposed Scheme will be in the Chiltern tunnel north cutting as it passes 650m to the east of The Castle, a site of high value in Wendover Woods. Construction of this cutting will be intermittent, and will take approximately two years and six months. This will require extensive landscaping very close by the monument to the south. The rural character of the monument's setting, comprising the surrounding woodland of Wendover Woods and to a lesser extent agricultural fields to the east and south will be altered during the construction phase. This will cause a low adverse impact and a moderate adverse effect.

6.4.8 There will be an adverse effect on the character and setting of the Missenden Abbey asset group, collectively of high value, and defined by the boundary of the Missenden Abbey Conservation Area, which includes the Grade I listed Church of St Peter and Paul, the Grade II RPG of Missenden Abbey and nine Grade II listed buildings (CC051). At this location, the Proposed Scheme will be in the Chiltern tunnel north cutting, then the South Heath green tunnel, approximately 700m to the east of the Missenden Abbey asset group. There will be extensive temporary material stockpiles and landscaping to the east and the establishment of a haul route along Chesham Road and Frith Hill passing within 150m. The construction works for the Chiltern tunnel north cutting will be intermittent lasting approximately two years and six months and those for the South Heath green tunnel lasting approximately three years and six months. Construction noise in the landscaping area and along the haul route will slightly alter the rural agricultural and wooded landscape setting of the asset group and views across the rolling hills of the rising valley side to the east and south. This will cause a low adverse impact and a moderate adverse effect.

6.4.9 There will be an adverse effect on the character and setting of the scheduled monument moated site in Chalkdell Wood (CC054). The Proposed Scheme will be in the Chiltern tunnel north cutting, then the South Heath green tunnel, approximately 700m to the east of the scheduled monument moated site in Chalkdell Wood, Frith Hill. There will be extensive temporary material stockpiles and landscaping to the east and the establishment of a haul route along Chesham Road and Frith Hill passing within 150m. The construction works for the Chiltern tunnel north cutting will be intermittent, lasting approximately two years and six months and those for the South Heath green tunnel lasting approximately three years and six months. Construction disturbance in the landscaping area and along the haul route will slightly alter the rural

agricultural and wooded landscape setting of the asset group and views across the rolling hills of the rising valley side to the east and south. This will cause a low adverse impact and a moderate adverse effect.

6.4.10 Construction of the Proposed Scheme in the Chiltern tunnel north cutting through Hyde Lane and as the South Heath green tunnel through Chesham Road and King's Lane will require the realignment of King's Lane, the realignment of Chesham Road, the construction of the Hyde Lane overbridge and access to the South Heath green tunnel south portal. There will also be extensive landscaping, temporary material stockpiles, the installation of the South Heath green tunnel (south) satellite compound, and the realignment of Footpath GMI/27. The construction works for the Chiltern tunnel north cutting will be intermittent lasting approximately two years and six months and those for the South Heath green tunnel lasting approximately three years and six months. This will affect the settings of two Grade II listed buildings at Briarwood (CC046) and South Heath Farmhouse (CC049) both of moderate value. The character of their setting, comprising the area around Chesham Road, King's Lane and the rural, agricultural context in which they are set will be noticeably altered. This will cause a medium adverse impact and a moderate adverse effect to each of these assets.

6.4.11 There will be an adverse effect on the character and setting of Grade II listed Bury Farm (CC070). The Proposed Scheme will be in the South Heath green tunnel exiting into the South Heath cutting as it passes Bury Farm, a group of four Grade II listed farm buildings of moderate value. The construction works for the South Heath green tunnel will be intermittent lasting approximately three years and six months and those for the South Heath cutting lasting approximately three years and three months. There will also be landscaping works, the installation of an attenuation pond, temporary earthworks stockpiling and the installation of the South Heath green tunnel satellite (north) compound. There will also be construction works to realign Footpaths GMI/13, GMI/12 and GMI/2 and to reinstate Frith Hill over the South Heath green tunnel. This will result in severance of views toward and from associated farmland rising westwards. This will cause a medium adverse impact and a moderate adverse effect.

6.4.12 There will be an adverse effect on the character and setting of Chapel Farm (CC042) and Sheepcotts (CC043). The Proposed Scheme will be in the Chiltern tunnel north cutting, which passes through Hyde Lane, and the South Heath green tunnel through Chesham Road and King's Lane. This will require the realignment of King's Lane, the realignment of Chesham Road, construction of the Hyde Lane overbridge and access to the South Heath green tunnel south portal. There will also be extensive landscaping and closing and realignment of a Footpath GMI/27. The construction works for the Chiltern tunnel north cutting will be intermittent lasting approximately two years and six months and those for the South Heath green tunnel lasting approximately three years and six months. The rural and agricultural character of the setting of Chapel Farm and Sheepcotts, both non-designated buildings of low value in Hyde Lane, will be comprehensively altered by the construction of the Proposed Scheme. This will cause a high adverse impact and a moderate adverse effect.

6.4.13 There will be an adverse effect on the character and setting of Orchard Cottage (CC033). The Proposed Scheme will be in the South Heath green tunnel as it passes

Orchard Cottage on Frith Hill, a non-designated building of low value. This will require the temporary diversion of Frith Hill for the construction of the green tunnel, associated landscaping, installation of the South Heath green tunnel satellite (north) compound and temporary material stockpiles close by, to the north and south of Frith Hill. The construction works for the South Heath green tunnel will be intermittent lasting approximately three years and six months. The character of the asset's setting, comprising its rural agricultural surroundings and views south-east toward Sibley's Coppice will be comprehensively altered by the construction of the Proposed Scheme. This will cause a high adverse impact and a moderate adverse effect.

6.4.14 There will be an adverse effect on the character and setting of Three Bears Cottage (CC107). The Proposed Scheme will be in the South Heath cutting at Grim's Ditch as it passes approximately 50m to the east of Three Bears Cottage, a non-designated building of low value. The construction works for the South Heath green tunnel will be intermittent lasting approximately three years and six months. This will require extensive landscaping and temporary earthworks stockpiling which will comprehensively alter the character of the asset's rural setting. This will cause a high adverse impact and a moderate adverse effect.

Cumulative effects

6.4.15 It is not considered that there will be any cumulative effects from temporary impacts on heritage assets within the study area.

Permanent effects

6.4.16 Permanent significant effects can occur either as a result of physical impacts on heritage assets within the land required, temporarily or permanently, for construction of the Proposed Scheme or through changes to the setting of heritage assets through the presence of the Proposed Scheme.

6.4.17 Land will be required from Mantle's Wood ancient woodland (CC019), an asset of high value. Construction of the Proposed Scheme in the Chiltern tunnel, changing to the Chiltern tunnel north cutting, through the designated ancient woodland at Mantle's Wood. The construction of Chiltern tunnel north portal buildings and a porous portal hood will require the removal of approximately 6.2ha of the existing woodland. This will cause a medium adverse impact and a major adverse effect.

6.4.18 There will be disturbance of possible archaeological remains of medieval date, an asset of high value (CC109). Construction of the Proposed Scheme in the Chiltern tunnel, changing to the Chiltern tunnel north cutting, through Mantle's Wood and the construction of Chiltern tunnel north portal buildings, a porous portal hood and extensive landscaping to the north, east and west will affect part of an area of surviving earthwork remains and associated potential buried archaeological remains of possible medieval date. These could be associated in a wider context with Mantell's Manor, a possible precursor to the present day Mantle's Farm. This will cause a medium adverse impact and a major adverse effect.

6.4.19 Land will be required from Farthings Wood ancient woodland (CC030), an asset of high value. Construction of the Proposed Scheme in the Chiltern tunnel north cutting across the northern part of the designated ancient woodland at Farthings Wood and extensive landscaping to the east will require the removal of approximately 0.5ha of

the existing woodland. This will cause a medium adverse impact and a major adverse effect.

6.4.20 Land will be required from Sibley's Coppice ancient woodland (CC050), an asset of high value. Construction of the Proposed Scheme in the South Heath green tunnel through the designated ancient woodland at Sibley's Coppice and modifications to surrounding roads for use as haul roads will require the removal of approximately 2.6ha of the existing woodland. This will cause a medium adverse impact and a major adverse effect.

6.4.21 There will be disturbance of potential surface and buried remains of prehistoric date associated with flint exploitation and of moderate value, on land between Chesham Road and Frith Hill, passing through Sibley's Coppice ancient woodland (CC064). Construction of the Proposed Scheme in South Heath green tunnel, landscaping and temporary earthworks stockpiling between Chesham Road and Frith Hill will affect the majority of an area of potential surface and buried remains of prehistoric date associated with the exploitation of flint resources and land use. This will cause a medium adverse impact and a moderate adverse effect.

6.4.22 There will be disturbance of potential surface and buried remains of prehistoric, Roman and medieval date associated with flint exploitation and later settlements and of low value, on land to the north of Rowan Farm between the junctions of Hyde Lane and Chesham Road (CC034). Construction of the Proposed Scheme in the Chiltern tunnel north cutting and the South Heath green tunnel between Hyde Lane and Chesham Road and provision of the Hyde Lane overbridge, an attenuation pond and landscaping south of King's Pond Cottage will affect the majority of an area of potential surface and buried remains of prehistoric, Roman and medieval date associated with the exploitation of flint resources and with later settlement and land use. This will cause a high adverse impact and a moderate adverse effect.

6.4.23 There will be disturbance of potential surface and buried remains of prehistoric, Roman and medieval date and of moderate value, associated with a possible former farmstead, and with flint exploitation (CC035). Construction of the Proposed Scheme in the Chiltern tunnel north cutting, changing to the South Heath green tunnel, between Hedgemoor Wood and Cudsden's Farm, surface water management and landscaping west of Broome Farm will affect a small area of potential surface and buried remains of prehistoric, Roman and medieval date associated with a potential medieval farmstead at Cudsden's Farm, the prehistoric exploitation of flint resources and land use. This will cause a medium adverse impact and a moderate adverse effect.

6.4.24 There will be demolition of three 19th century non-designated buildings of low value, comprising Annie Bailey's public house (CC055), Chiltern Cottage (CC060) and the Weights and Measures Gym (CC061). Construction of the Proposed Scheme in the Chiltern tunnel north cutting at Hyde Lane, changing to the South Heath green tunnel through Chesham Road and King's Lane requires the realignment of King's Lane, the realignment of Chesham Road, construction of the Hyde Lane overbridge and access to the South Heath green tunnel south portal. There will also be extensive landscaping and closing and realignment of a PRoW. Annie Bailey's public house, Chiltern Cottage and Weights and Measures Gym on Frith Hill, three non-designated buildings of 19th

century date, will be demolished. This will cause a high adverse impact and a moderate adverse effect.

6.4.25 There will be disturbance of potential surface and buried remains of medieval and post-medieval date associated with pottery manufacture and industrial or settlement remains at Potter Row and Bury Farm, both of high value (CC077 and CC066). Construction of the Proposed Scheme in the South Heath green tunnel, changing to the South Heath cutting at the South Heath green tunnel north portal as it passes Bury Farm between Frith Hill and Leather Lane will require landscaping and an attenuation pond at Leather Lane. Public rights of way will be closed and diverted and there will be a new permanent realignment of Leather Lane over the Proposed Scheme at the Leather Lane overbridge. The Potter Row area lies on the eastern edge of the route and represents a possible extensive medieval and post-medieval focus of pottery production. These construction works will affect approximately five per cent of earthwork and buried archaeological remains of medieval and post-medieval pottery manufacture and associated industrial or settlement remains. This will cause a low adverse impact and a moderate adverse effect.

6.4.26 There will be removal of parts of seven historically important hedgerows (CC020, CC021, CC067, CC068, C069, CC071 and CC072). Construction of the Proposed Scheme will require the removal of parts of seven hedgerows identified as being historically important by the Hedgerow Regulations 1997. These are assets of moderate value. This will cause a medium adverse impact and a moderate adverse effect.

Impacts on the setting of heritage assets

6.4.27 The Proposed Scheme will be in the Chiltern tunnel north cutting through Hyde Lane, then in the South Heath green tunnel at it passes through Chesham Road and King's Lane. This will require the realignment of King's Lane, the realignment of Chesham Road, construction of the Hyde Lane overbridge, access to the South Heath green tunnel south portal and the realignment of public right of way. This will affect the settings of Grade II listed buildings at Hyde Farm (CC036) and Sheepcotts Cottage (CC045) each of moderate value. The character of their setting, comprising the tree-lined rural Hyde Lane and the rural, agricultural context in which they are set will be noticeably altered. These assets will be subject to a medium adverse impact and a moderate adverse effect.

6.4.28 There will be an adverse effect on the character and setting of Grade II listed Cottage Farm and Woodlands Park (CC097), both of moderate value, as the Proposed Scheme passes approximately 200m to the north-east in cutting. This will affect the settings of Woodlands Park and Cottage Farm, defined by their rural agricultural surroundings and associated views including views of Grim's Ditch (DWH008) which contributes to their setting. This will cause a medium adverse impact and a moderate adverse effect.

6.4.29 There will be an adverse effect on the character and setting of Grade II listed Bury Farm an asset group of moderate value (CC070). The Proposed Scheme will be in the South Heath green tunnel exiting into cutting at the South Heath green tunnel north portal as it passes Bury Farm, a group of four Grade II listed farm buildings. The assets' rural, agricultural setting, looking west toward the Misbourne valley will be severed

from the farm complex and such that it will be noticeably altered. This will cause a medium adverse impact and a moderate adverse effect.

6.4.30 There will be an adverse effect on the character and setting of Grade II listed Hammondshall Farm an asset of moderate value (CC094). The Proposed Scheme will be in the South Heath cutting as it passes 100m to the west of the asset. There will also be an attenuation pond and the installation the Leather Lane overbridge. The farm's setting is defined by surrounding non-designated buildings, yards and gardens in the rolling hills on the plateau above the Misbourne valley. Views to the west overlooking the valley will be noticeably altered due to their severance from the farm complex. This will cause a medium adverse impact and a moderate adverse effect.

Permanent cumulative effects

6.4.31 There are no permanent cumulative effects considered to be of specific relevance to the cultural heritage topic.

Other mitigation measures

6.4.32 Refinements to the mitigation measures incorporated into the design of the Proposed Scheme or included in the draft CoCP will be considered during detailed design to reduce further the significant effects described above. These refinements will include the identification of:

- suitable locations for advance planting, to reduce impacts on the setting of assets; and
- locations where the physical impact on below ground assets can be reduced through the design of earthworks.

Summary of likely residual significant effects

6.4.33 A range of archaeological assets will be permanently lost due to the construction of the Proposed Scheme; which include: archaeological remains in Mantle's Wood (CC109), archaeological remains on land to the north of Rowan Farm between the junctions of Hyde Lane and Chesham Road (CC034), archaeological remains on land between Hedgemoor Wood and Cudsden's Farm and west of Broome Farm (CC035), archaeological remains on land between Chesham Road and Frith Hill passing through Sibley's Coppice ancient woodland (CC064) and archaeological remains at the western edge of Potter Row (CC066, CC077). A programme of archaeological works will be prepared to investigate, analyse, report and archive these assets.

6.4.34 The Proposed Scheme will result in the demolition of Annie Bailey's public house on the B485 Chesham Road (CC055), Chiltern Cottage (CC060) and the Weights and Measures Gym (CC061) both on Frith Hill. A programme of built heritage works will be prepared to investigate, analyse, report and archive these assets.

6.4.35 The setting of several historic settlements and buildings will be affected by the presence of the Proposed Scheme, including landscaping, overbridges and other associated infrastructure. This presence will affect these assets through physical loss or severance of landscape elements or disruption of landscape associations that contribute to their value. These include: Mantle's Wood (CC019), Farthings Wood (CC030), Sibley's Coppice (CC050), seven historically important hedgerows within the

study area (CC020; CC021; CC067; CC068; C069; CC071; and CC072), Hyde Farm (CC036), Sheepcotts Cottage (CC045), Woodlands Park and Cottage Farm (CC097), Bury Farm (CC070) and Hammondshall Farm (CC094).

6.5 Effects arising from operation

Avoidance and mitigation measures

6.5.1 The following measures have been incorporated into the design of the Proposed Scheme to reduce the impacts and effects on assets;

- noise mitigation measures have been included within the Proposed Scheme to reduce potential impacts on identified assets; and
- landscape planting will increasingly reduce the potential impacts derived from changes to the setting of identified assets within the study area as it matures during the operational phase.

Assessment of impacts and effects

6.5.2 The assessment considers the Proposed Scheme once operational and all effects are considered to be permanent. There will be no physical impacts on buried archaeological remains or other heritage assets arising from the operation of the Proposed Scheme. Impacts on the setting of heritage assets arising from the physical presence of the Proposed Scheme are described as permanent occurring within the construction phase and are not repeated in detail here, albeit that they will endure through the operation of the Proposed Scheme. Where there is a combined effect on the setting of an asset from the presence of the Proposed Scheme and its operation, this is reported in the assessment of operation.

6.5.3 Hyde Farm comprises two Grade II listed buildings of moderate value (CC036) and Sheepcotts Cottage is a Grade II listed building of moderate value (CC045). These assets will experience a change in their setting caused by the movement of trains and the associated increase in noise. This will constitute a medium adverse impact resulting in a moderate adverse effect. In combination with the permanent construction impacts of the Proposed Scheme, this will result in a medium adverse impact resulting in a moderate adverse effect.

Cumulative effects

6.5.4 No significant cumulative effects have been identified in relation to cultural heritage.

Other mitigation measures

6.5.5 Refinements to the mitigation measures incorporated into the design of the Proposed Scheme will be considered during detailed design to further reduce the significant effects described above.

Summary of likely residual significant effects

6.5.6 The setting of several buildings will be affected visually and by noise once the Proposed Scheme becomes operational. This comprises: two buildings at Hyde Farm (CC036) and one at Sheepcotts Cottage (CC045). In due course, visual effects will reduce as planting matures and the new railway assimilates into the landscape.

Operational noise will be reduced through noise fence barriers and landscaped earthworks.

7 Ecology

7.1 Introduction

7.1.1 This section describes the ecological baseline and identifies likely impacts and significant ecological effects that will arise from the construction and operation of the Proposed Scheme. These include impacts on species, habitats and sites designated for their importance for nature conservation.

7.1.2 The principal ecological issues in this area are the loss of woodland from Mantle's Wood Local Wildlife Site (LWS), Hedgemoor and Farthing Wood LWS and Sibley's Coppice LWS (parts of all three LWS are ancient woodland) and the loss of a common pipistrelle maternity roost.

7.1.3 Volume 5 of the ES contains supporting information to the ecological assessment reported in this section, including:

- ecological baseline data (Appendices EC-001-002, EC-002-002, EC-003-002 and to EC-004-002);
- a register of local/parish effects, which are not reported individually in Volume 2 (Appendix EC-005-002); and
- data obtained from bat trapping/radio tagging study (Appendix EC-008-002).

7.1.4 As well as survey data, the assessment draws on existing information gathered from national organisations and from regional and local sources including: Buckinghamshire and Milton Keynes Environmental Records Centre; Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust; Chilterns Conservation Board; North Bucks Bat Group; Berkshire and South Buckinghamshire Bat Group; Buckinghamshire Bird Club and Buckinghamshire Amphibian and Reptile Group.

7.2 Scope, assumptions and limitations

7.2.1 The scope and methodology of the ecological assessment are introduced in the SMR (Volume 5: Appendix CT-001-000/1) and SMR Addendum (Volume 5: Appendix CT-001-000/2). Further detail, including the study area for individual surveys, is provided within the SMR Addendum (Volume 5: Appendix CT-001-000/2). The assessment methodology is summarised in Section 8 of Volume 1, along with route-wide assumptions and limitations. Limitations associated with particular surveys are described within the relevant baseline survey reports in Volume 5: Appendices EC-001-002, EC-002-002, EC-003-00 and EC-004-002.

7.2.2 A Water Framework Directive assessment has been undertaken in conjunction with the environmental assessment. Details of this assessment are presented in Volume 5: Appendix WR-001-000.

7.2.3 As well as the standard range of surveys described in the SMR, capture and radio-tracking surveys of bats were undertaken along woodland edge habitat at Mantle's Wood, Farthings and Hedgemoor Wood to establish the species assemblage. The surveys were designed in particular to confirm the presence or likely absence of the

rare[35] barbastelle and Bechstein's bats. Further details are provided in Volume 5: Appendix EC-008-002.

7.2.4 Access was not obtained to all of the land area where general habitat survey (Phase 1 habitat survey) was proposed. Locations with the potential to support key ecological receptors where access could not be gained for survey include the interiors of Mantle's Wood, Hedgemoor and Farthings Wood and Jenkin's Wood and the land surrounding Jenkin's Wood. In addition, access was not secured for land north of Great Missenden, scattered woodland between South Heath and Little Missenden and Rook Wood until June 2013, thus limiting survey work in this area. Further details are provided in Volume 5: Appendices EC-001-002, EC-002-002, EC-003-002 and EC-004-002.

7.2.5 There are no watercourses relevant to the ecological assessment within this area and so otter, water vole and white-clawed crayfish have been scoped out of this assessment. The River Misbourne, which flows across the southern corner of the area, is considered in the CFA8 report.

7.2.6 Where data are limited, a precautionary baseline has been built up according to the guidance provided in in Volume 5: Appendix CT-001-000/2. This constitutes a 'reasonable worst-case' basis for the subsequent assessment.

7.2.7 The precautionary approach to the assessment has been adopted to identify the likely significant ecological effects of the Proposed Scheme.

7.3 Environmental baseline

Existing baseline

7.3.1 This section describes the ecological baseline relevant to the assessment: the designated sites, habitats and species recorded in this area. Further details are provided in the reports and maps presented in Volume 5 (Appendices EC-001-002, EC-002-002, EC-003-002 and EC-004-002 and Map Series EC-01 to EC-12, Volume 5, Ecology Map Book). Statutory and non-statutory designated sites are shown on Map Series EC-01 (Volume 5, Ecology Map Book).

7.3.2 Land required for the construction of the Proposed Scheme and that adjacent to it consists of arable and pasture fields with isolated woods, some of which are wholly or partly ancient woodland, a characteristic habitat in this part of the Chilterns. The largest woodlands are Rook Wood, Mantle's Wood, Hedgemoor and Farthings Wood, which are located at or adjacent to the Chiltern tunnel north portal and Sibley's Coppice, which is located immediately south of South Heath. The southernmost 1.9km of the route will form part of the Chiltern tunnel, in which the only development will be the Little Missenden vent shaft at the southern extent of the area.

Designated sites

7.3.3 There are no statutory sites designated for nature conservation located within 500m of the land required for the construction of the Proposed Scheme. There are six LWS and three Biological Notification Sites (BNS) relevant to the assessment in this area. Each is considered to be of county/metropolitan value. The sites are:

[35] Bat Conservation Trust (2012) *The state of the UK's bats: National bat monitoring programme populations trends 2012*. BCT. London.

- Weedon Hill Wood/High Springs/Ostler's Woods LWS (49.9ha) – is designated for lowland mixed deciduous woodland parts of which qualify as a habitat of principal importance as identified in Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)[36] and local Biodiversity Action Plan (BAP) habitat. It comprises ancient woodland; 3.8ha (8%) being broad-leaved ancient semi-natural woodland and 46.1ha (92%) being ancient replanted woodland[37] dominated by conifers. Acidic and calcareous woodlands are present, with a corresponding variety of plant communities. Of particular nature conservation interest are areas of mature pedunculate oak and beech woodland, areas with a diverse ancient woodland ground flora, old boundary trees, and calcareous grassland along woodland rides. The site is located immediately adjacent to land required for the construction of the Little Missenden vent shaft and parts are above the alignment of the Chiltern tunnel;

- Mop End Lane LWS (2.5ha) – is designated for species-rich hedgerows. It is adjacent to land required for the construction of the Proposed Scheme west of Shardeloes Lake. Mop End Lane LWS is partly within this area and partly within the adjoining CFA8;

- Mantle's Wood LWS (20.5ha) – is designated for deciduous woodland, parts of which qualify as a habitat of principal importance and a local BAP habitat. It has been managed for forestry and is predominantly conifer plantation that qualifies as ancient replanted woodland (17.1ha, 85%). In the north-western part of the wood there remains broad-leaved ancient semi-natural woodland with as many as 30 ancient woodland indicator species; this is distributed across three areas totalling 3.2ha (15%). Part of the site is within the land required for the construction of the Proposed Scheme;

- Hedgemoor and Farthings Wood LWS (12.9ha) – is designated for deciduous woodland, parts of which qualify as habitats of principal importance and local BAP habitat. Hedgemoor to the west is the larger block (8.1ha) comprising broad-leaved trees. It is not ancient woodland, although it contains old trees and woodbanks that are of ecological interest. Farthings Wood (4.8ha), which borders Hedgemoor to the east is a mixture of coniferous and broad-leaved woodland of which the north-eastern 2.6ha (20% of the LWS) is ancient replanted woodland. The LWS includes woodland on clay and chalk with corresponding variety in species diversity, including many ancient woodland indicator species. The site is partly within the land required for the construction of the Proposed Scheme immediately north of the Chiltern tunnel north portal where the route is in cutting;

- Sibley's Coppice LWS (7.5ha) – is designated for deciduous woodland, which qualifies as a habitat of principal importance and local BAP habitat. It is also ancient woodland. The site comprises mature beech and oak on an acid substrate and several plants that are uncommon in the county have been

[36] *Natural Environment and Rural Communities Act 2006* (Chapter 16).London. Her Majesty's Stationery Office.
[37] Ancient replanted woodland can retain a high biodiversity value because ancient woodland species often survive in reduced quantity, even under conifers, so that there is potential for restoration of the previous high species diversity.

recorded. The southern part of the woodland is in the land required for the construction of the Proposed Scheme, immediately south of South Heath;

- Rook Wood LWS (30.9ha) – is designated for deciduous woodland, of which 11.7ha (38%) is ancient replanted woodland. The remaining woodland is semi-natural broad-leaved and qualifies as a habitat of principal importance and a local BAP habitat. The woodland is mostly dominated by beech, with box locally frequent in the shrub layer and a range of ancient woodland indicator species in the ground flora. It is south-east of Great Missenden and its south-eastern boundary is adjacent to an area of land required for ecological compensation;
- Hyde Heath Common BNS (5.2ha) – is designated for deciduous woodland and open grassland. The woodland qualifies as a habitat of principal importance and as a local BAP habitat. It is north-west of Hyde Heath and adjacent to an area of land required for ecological compensation;
- Hyde House Wood BNS (18.9ha) – is designated for deciduous woodland with a diverse shrub and ground flora. The woodland qualifies as a habitat of principal importance and a local BAP habitat. It adjoins the northern boundary of Hyde Heath Common BNS and extends north to Chesham Road. It is adjacent to land required for ecological compensation; and
- Hyde Lane Verge BNS (0.4ha) – is a narrow lane bounded by tall holly hedgerows with the occasional hazel. It is located near Broome Farm north of No Man's Wood and adjacent to land required for ecological compensation.

7.3.4 In addition to ancient woodland in the designated sites, there are two ancient woodlands adjacent to the land required for the construction of the Proposed Scheme in the northern part of the area. These are Jenkin's Wood (3.1ha) and Havenfield Wood (2.9ha); both also qualify as lowland mixed deciduous woodland, a habitat of principal importance and as local BAP habitat. These ancient woodlands represent an irreplaceable resource.

Habitats

7.3.5 The following habitat types which occur in this area are relevant to the assessment.

Woodland

7.3.6 There are six woods, five of which are either fully or partly ancient woodland. They all qualify as a habitat of principal importance (either lowland mixed deciduous woodland or lowland beech and yew woodland) and are a local BAP habitat. They are all large and diverse in plant species. Each wood is a site of the same name designated for its woodland and so each woodland is of county/metropolitan value. The woodlands are briefly described below; further details of these woodlands are provided in Appendix EC-001-002 of Volume 5:

- Weedonhill Wood/High Springs/Ostler's Woods were not surveyed due to a lack of owner permission but desk study results confirm the presence of goldilocks buttercup, wood millet, yellow archangel and coralroot among its

ancient woodland flora; coralroot is nationally scarce[38] and largely confined to the Chilterns;

- Mantle's Wood is predominantly coniferous plantation but the north-western and south-eastern blocks have beech with frequent wild cherry in the canopy and ancient woodland indicator species including bluebell and wood melick among the ground flora. Some of the northern parts have been planted with Scots Pine. National Vegetation Classification (NVC)[39] surveys indicated that parts of these woods could be classified as the beech/bramble woodland, W14 *Fagus sylvatica-Rubus fruticosus* woodland community;
- Hedgemoor and Farthings Wood comprise beech woodland. Hedgemoor has a small area that has been replanted with Corsican pine but the rest has a good diversity of woodland ground flora species, such as yellow archangel, wood millet and sweet woodruff. NVC surveys indicated that parts of these woods could be classified as the beech/bramble woodland, W14 *Fagus sylvatica-Rubus fruticosus* woodland community;
- Sibley's Coppice is a beech woodland with frequent pedunculate oak, ash and rowan, a habitat type, which is typical of the Chilterns area. Dense holly with occasional hazel and yew is present along the southern and western boundaries but infrequent throughout the rest of the wood. Southern woodrush, heath woodrush and pill sedge are present within the mainly sparse understorey. NVC surveys indicated that parts of this wood is classified as the beech/bramble woodland, W14 *Fagus sylvatica–Rubus fruticosus* woodland community;
- Rook Wood is a large beech woodland. It supports a good plant diversity including 15 ancient woodland indicator species. Within Rook Wood, there are also areas of mixed woodland and of yew woodland; and
- Hyde House Wood and Hyde Heath Common Wood form a large, connected block of broad-leaved woodland.

7.3.7 Jenkin's Wood and Havenfield Wood are both ancient woodland but smaller in extent and more isolated than the woodland described above. They are of district/borough value.

Hedgerows

7.3.8 The hedgerows either side of Hyde Lane Verge BNS are particularly species-rich with 11 woody species including hornbeam, hazel, field maple, spindle, blackthorn and several ancient woodland indicator species among the ground flora. These two hedgerows are of county/metropolitan value.

7.3.9 There are approximately 16km of hedgerows in the land required for the construction of the Proposed Scheme. Of the 5.3km of hedgerows that were accessible for survey, all qualified as habitats of principal importance and 2.7km (qualify as important

[38] Taxa which are recorded in 16-100 hectads (10km squares) but not necessarily included in one of the Red List Categories.
[39] NVC is a detailed survey and classification system that is used to compare plant communities with a range of defined community types.

hedgerows (under the Hedgerows Regulations 1997[40]). In total up to 2.1km of the important hedgerows are within the land required for the construction of the Proposed Scheme. The dominant species of the important hedgerows are hawthorn, holly and blackthorn, while ash and hazel are also present. The important hedgerows are distributed throughout the area. As part of the precautionary approach, it is also assumed that further important and species-rich hedgerows will occur within land that was not surveyed. Due to the number of established hedgerows and the connectivity they provide between the ancient woodlands, the hedgerow network is of district/borough value.

Orchards

7.3.10 There are four small traditional orchards present in the area. One (0.26ha) at Mantle's Farm adjacent to the land required for the construction of the Proposed Scheme, near the Chiltern tunnel north portal. There are two traditional orchards near Park Farm; one (0.21ha) within the land required for the construction of the Proposed Scheme and the other (0.12ha) adjacent to it. All three orchards qualify as a habitat of principal importance and as a local BAP habitat. The fourth orchard (0.46ha), which is north-east of Hyde Farm is 10m outside the land required for the construction of the Proposed Scheme and qualifies as a local BAP habitat but not as a habitat of principal importance. These orchards are small and either comprise a few trees surrounded by managed grassland or appear to be unmanaged. They are each of local/parish value.

Grassland

7.3.11 Surveys at Mulberry Park Hill recorded semi-improved neutral grassland, about 5ha of which lies within the land required for the construction of the Proposed Scheme. The grass sward is dominated by sweet vernal grass, Yorkshire fog, meadow foxtail and common bent and the herbaceous species included black knapweed, oxeye daisy, bird's-foot trefoil and meadow buttercup. Most of this grassland qualifies as the neutral grassland type MG5 Cynosurus cristatus-Centaurea nigra with a small area referable to sub-community MG5a, the meadow vetchling sub-community. Although several unimproved neutral grassland indicator species were present, they were uncommon in the sward and it was not of sufficient quality to qualify as a habitat of principal importance. This grassland is of local/parish value.

7.3.12 Other areas of semi-improved grassland were recorded near Mantle's Farm (10.4ha and 2.0ha) and Woodland's Park (north of Great Missenden (1.9ha). Semi-improved grassland is present infrequently in the area but none of the examples were of sufficient quality to qualify as a habitat of principal importance and as such are each of local/parish value.

Ponds

7.3.13 There are five ponds within the land required for the construction of the Proposed Scheme. One was accessible and was found to support great crested newts and

[40] The Hedgerows Regulations (1997) Statutory Instruments 1997 No. 1160. The Hedgerows Regulations 1997 comprise two criteria for determining whether a hedgerow is important or unimportant: Wildlife and Landscape, and Archaeology and History. The Ecology Chapter and the Technical Appendix for hedgerows (Volume 5: Appendix EC-001-002) refer to the Wildlife and Landscape criteria. Therefore it is likely that there will be differences between the total number of important hedgerows in the Section 7, ecology and Section 6 cultural heritage sections of this report.

therefore qualifies as a habitat of principal importance. The pond was not subject to detailed plant or invertebrate surveys as it was eutrophic. It is of local/parish value.

7.3.14 As part of the precautionary assessment, the four ponds within the land required for the construction of the Proposed Scheme, which were not accessible are considered to be of up to local/parish value.

Other habitats

7.3.15 Other habitats recorded include extensive arable and cultivated land throughout the area and small areas of parkland with scattered trees near Jenkin's Wood and Havenfield Wood. None of these habitats are of more than local/parish value.

Protected and/or notable species

7.3.16 A summary of the species relevant to the assessment is provided in Table 10.

Table 10: Protected and/or notable species

Species/ species group	Value	Receptors	Baseline and rationale for valuation
Bats	County/metropolitan	Common pipistrelle population near Park Farm	A maternity roost with at least 50 individuals was recorded during field surveys in an old residential building that is within land required for the construction of the Proposed Scheme. Maternity roosts are uncommon and necessary to maintain populations over wide areas. These records meet the threshold for county importance[41]. There were also two summer/transient common pipistrelle roosts in the same building complex, each with low numbers of bats. The bats were recorded foraging at nearby mature trees and along hedgerows, which they are likely to use as commuting routes.
	District/borough	Bat assemblage associated with habitat near Park Farm	Low numbers of soprano pipistrelle bat and the less common serotine and noctule bat were also recorded foraging around mature trees and along hedgerows, which are likely to be used as commuting routes to access roosts and other foraging sites. Soprano pipistrelle is a species of principal importance.
	District/borough	Bat assemblage using the network of woodland, hedgerows and tree-lined roads around South Heath.	Based on the results of driven activity transects around South Heath, the bat assemblage around South Heath consists of at least four species: common pipistrelle (in low numbers) and individuals of soprano pipistrelle, *Myotis* species and noctule. The assemblage of species and low numbers of bats in the assemblage is representative of similar habitat that is abundant in this part of Buckinghamshire. As part of the precautionary assessment, it has been assumed that higher numbers of bats may be present in this area at different times of the year. The desk study indicates that Daubenton's bats are also present close by. It also shows that low numbers of Natterer's bat, brown long-eared bat and serotine have been recorded over 500m from the land required for the construction of the Proposed Scheme. Natterer's bat, noctule and brown long-eared bat are species of principal importance.
	District/borough	Bat assemblage using the woodland and	Static monitoring and activity surveys recorded foraging and commuting activity of at least six species of bat; common pipistrelle (moderate numbers) and individual records for

[41] Wray, S., Wells, D., Long, E. and Mitchell-Jones, T. (2010), *Valuing bats in ecological impact assessment*. In Practice: December issue. CIEEM.

Species/ species group	Value	Receptors	Baseline and rationale for valuation
		hedgerows around Mantle's Wood	soprano pipistrelle, Daubenton's bat, noctule, a *Myotis* species and either noctule, Leisler's bat or serotine[42]. Activity from static detector surveys was only recorded in July for all species indicating the habitat is of lower importance in the early part on the bats active season. The presence of uncommon species, albeit in low numbers (Leisler's bat and serotine) indicate that the habitat is important for foraging and commuting. As part of the precaution approach it is assumed that bat tree roosts for common species are also present in the wood.
Birds	County/metropolitan	Barn owl population	Breeding barn owl territories were recorded around the Missendens; one east of Little Missenden, one east of Great Missenden and one north-east of Great Missenden. Barn owl has a restricted distribution and is a scarce breeding species in Buckinghamshire This population meets the threshold for county/importance (more than 1% of the county population).[43]
	District/borough	Breeding birds north-east of Great Missenden	Field surveys recorded a single pair of red kite, one breeding pair of spotted flycatcher and two probable marsh tit breeding territories, (the last two are species of principal importance). Desk study records indicate the presence of little ringed plover. While not of county importance the numbers of breeding marsh tit and two other notable species exceeds local importance.
	District/borough	Breeding birds around Little Missenden	Field surveys recorded approximately 30 bird species. Two red kite nests were recorded east of Little Missenden and one red kite nest was recorded west of Little Missenden. A single breeding pair of marsh tit was also present east of Little Missenden. Desk study records include lesser spotted woodpecker, cuckoo (both species of principal importance), hobby and little ringed plover. The species diversity was not high given the quality of habitat surveyed and no notable species were recorded in high numbers. Most records were of common and widespread breeding bird species typical of open countryside and woodland.
	Local/parish	Wintering bird assemblage associated with habitats throughout the area	Field surveys recorded 28 species. Notable species recorded included raven. Desk study records indicate that the bird population largely comprises common and widespread species typical of arable and pasture habitat. No large or significant populations of rare birds were recorded.
Hazel dormouse	Up to county/ metropolitan	Potential presence in Hedgemoor and Farthings Wood	Field surveys close to Mantle's Wood and at Sibley's Coppice recorded no evidence of this species. Desk study data confirmed the presence of hazel dormouse in woodland approximately 3.5km either side of the route. There are many large woodlands and an intact hedgerow network near these woods. As part of the precautionary approach it is therefore assumed that small populations could be present in the two large woodlands that were not surveyed; Hedgemoor and

[42] Automated bat recordings were inconclusive for identification to species level.
[43] Lewington, I. et al (2008) *The Birds of Buckinghamshire*. Buckinghamshire Bird Club; *Birds of Oxfordshire*. Oxford Ornithological Society.

Species/ species group	Value	Receptors	Baseline and rationale for valuation
			Farthings Wood. If such a population exists it may meet the threshold for county importance[44]. Hazel dormouse is a species of principal importance.
Amphibians	Up to county/ metropolitan	Potential great crested newt population near Chesham Road	One pond, which could not be surveyed due to access restrictions is surrounded by land required for the construction of the Proposed Scheme. As part of the precautionary assessment, it is assumed that it could support a medium population of breeding great crested newt and thus it could be of county importance. Great crested newt is a species of principal importance.
	Up to county/ metropolitan	Potential great crested newt population near Jenkin's Wood	Five ponds are present in close proximity to each other and were not surveyed due to access restrictions. Three are within land required for the construction of the Proposed Scheme and two are within 250m of it. A breeding population may be present in any of these ponds and the five ponds together may support a metapopulation.[45] As part of the precautionary assessment, it is assumed that the ponds could support a medium population of breeding great crested newt and thus could be of county importance.
	Up to county/ metropolitan	Potential great crested newt population near Potter Row, Springfield Farm	Two ponds are present in close proximity to each other and neither was surveyed due to access restrictions. One is surrounded by, and one is within 50m of land required for the construction of the Proposed Scheme. A breeding population may be present in either of these ponds and the two ponds together may support a metapopulation. As part of the precautionary assessment, it is assumed that it could support a medium population of breeding great crested newt and thus it could be of county importance.
	Up to county/ metropolitan	Potential great crested newt population near Browns Road	Two ponds are within 200m of the eastern edge of the Proposed Scheme and neither was surveyed due to access restrictions. A breeding population may be present in either of these ponds and the two ponds together may support a metapopulation. As part of the precautionary assessment, it is assumed that it could support a medium population of breeding great crested newt and thus could be of county importance.
	Up to county/ metropolitan	Potential great crested newt population near Kennel Farm, Little Missenden	One pond is present within 200m of the western edge of the land required for the construction of the Proposed Scheme and was not surveyed due to access restrictions. As part of the precautionary assessment, it is assumed that it could support a medium population of breeding great crested newt and thus could be of county importance. Given its distance from other ponds it is unlikely to support a metapopulation.
	District/borough	A small breeding population of great crested newts north of Mantle's Wood	Three adult great crested newts and two larval great crested newts were recorded in a pond north of Mantle's Wood. This qualifies as a small population and so the pond is of less than county importance.

[44] Buckinghamshire and Milton Keynes Environmental Records Centre (2009) *Criteria for the Selection of Local Wildlife Site in Berkshire, Buckinghamshire and Oxfordshire*.
[45] A set of local populations within some larger area, where typically migration from one local population to at least some other patches is possible.

Species/ species group	Value	Receptors	Baseline and rationale for valuation
Terrestrial invertebrates	District/borough	Invertebrate assemblage associated with woodland edge at Mantle's Wood	Field surveys recorded three nationally scarce species of beetle and a nationally scarce species of fly along the woodland edge. Two of the beetles are associated with decaying wood. These numbers exceed the threshold for local importance but do not meet the threshold for county importance.[46]
	District/borough	Invertebrate assemblage associated with woodland edge at Sibley's Coppice	Field surveys recorded two nationally scarce species of fly in the woodland. These numbers exceed the threshold for local importance but do not meet the threshold for county importance.
Reptiles	Up to district/borough	Potential population of reptiles throughout the area	Field surveys did not record any reptiles and historic records show grass snake were only present greater than 1km from the land required for the construction of the Proposed Scheme. However, as habitat suitable to support reptiles is locally abundant, it is assumed that common species of reptile (grass snake, adder, slow-worm and common lizard) occur in low numbers but their distribution and abundance in the area is restricted. All reptile species are species of principal importance. Given the absence of data from surveys, it is likely that any populations would be small and are unlikely to be of county importance[47].
Plants	District/borough	Population of wood barley near South Heath	Desk study records indicated the presence of this nationally scarce species. Access was not available to confirm if it is still present.
	District/borough	Population of box in Hedgemoor and Farthings Wood	Desk study records indicated the presence of this rare species[48]. It is likely that it is present within ancient woodland throughout the Chilterns. Access was not available to confirm if it is still present.
	Up to district/borough	Rare and notable plants throughout the area	Field surveys did not record any nationally or locally notable plant species within the land required for the construction of the Proposed Scheme. Notable species are however, known to be present within the ancient woodland, as described previously within the sections on ancient woodland. In addition wild pansy species (*Viola tricolor*) a county rarity[49] was recorded close to but outside of the land required for the construction of the Proposed Scheme.
Badger	Local/parish	Badgers throughout the area	Field surveys recorded one main sett and a single outlying sett near woodland. Desk study records indicate badgers are present throughout the area. Badgers are common and widespread in lowland habitats in the UK and populations are not threatened or thought to be vulnerable at present.
Aquatic invertebrates	Up to local/parish	In ponds throughout the area	Suitable habitat is limited to a few ponds. Field surveys and desk study records indicate no notable species close to the land required. There are no watercourses relevant to the

[46] Colin Plant Associates (2006) *Invertebrates and Ecological Assessment*. Unpublished Report to the Institute of Ecology and Environmental Management.
[47] Buckinghamshire and Milton Keynes Environmental Records Centre (2009) Criteria for the Selection of Local Wildlife Site in Berkshire, Buckinghamshire and Oxfordshire.
[48] Joint Nature Conservation Committee (JNCC) (undated). Conservation Designations for UK Taxa. Available on-line: http://jncc.defra.gov.uk/default.aspx?page=3408 (accessed September, 2013).
[49] Maycock, R and Woods, A. (2005). A checklist of the plants of Buckinghamshire. Milton Keynes Natural History Society. City Print

Species/ species group	Value	Receptors	Baseline and rationale for valuation
			assessment in this area.
Fish	Negligible	In ponds throughout the area	Habitat suitable for fish is limited to a few ponds (there are no watercourses relevant to the assessment in this area). There are no desk study records. Based on pond habitat surveys, notable fish species are unlikely to be present.

Future baseline

Construction (2017)

7.3.17 A summary of the known developments which are assumed to be mostly built and occupied prior to construction of the Proposed Scheme is provided in Section 2.1 of this report, with further details provided in Volume5: Appendix CT-004-000.

7.3.18 There are no known proposed developments, which will be under construction or operational, that are likely to alter the current baseline.

Operation (2026)

7.3.19 There are no known committed developments or changes to management in this area that will affect the operational baseline.

7.4 Effects arising during construction

Avoidance and mitigation measures

7.4.1 The following measures have been included as part of the design of the Proposed Scheme and avoid or reduce impacts to features of ecological value:

- the Proposed Scheme will be in a twin-bore tunnel for 1.9km of this area, with no surface structures except for the Little Missenden vent shaft, therefore avoiding direct impacts on the Weedonhill Wood/High Springs/Ostler's Woods LWS and species that use this woodland and the surrounding area;
- the land required for the construction of the Little Missenden vent shaft will avoid any direct impacts on the Weedonhill Wood/High Springs/Ostler's Woods LWS and its ancient woodland;
- the alignment of the Leather Lane overbridge will avoid the loss of mature trees and an established farmland pond; and
- the alignment of the Havenfield Field Wood overbridge will avoid the loss of ancient woodland.

7.4.2 The assessment also assumes implementation of the measures set out within the draft CoCP (CT-003-000), which includes translocation of protected species where appropriate.

Assessment of impacts and effects

Designated sites

7.4.3 Construction of the Chiltern tunnel north portal (including the satellite compound and Chiltern tunnel north cutting) will affect Mantle's Wood LWS. As a rare and irreplaceable resource the extent of ancient woodland is important to the integrity of the site, as is maintaining it as a single intact wood. Construction will remove 6.2ha (31%) of woodland, of which 4.2ha is ancient replanted woodland and 2.0ha is ancient semi-natural woodland. The construction of the Chiltern tunnel north portal will also sever Mantle's Wood LWS (by 180m at its narrowest point), creating two smaller woodlands (7.8ha and 6.3ha north and south of the route of the Proposed Scheme respectively). The Chiltern tunnel north cutting and the Chiltern tunnel north portal satellite compound (and associated activities) will also increase the distance between Mantle's Wood and the adjacent Hedgemoor and Farthings Wood LWS and Hyde Heath Common BNS. This fragmentation and isolation will restrict the movement of plants and animals between the remaining woods, which over time could alter the composition of the woodland species assemblage. Loss and fragmentation will result in a permanent adverse effect on the integrity of Mantle's Wood LWS that will be significant at the county/metropolitan level.

7.4.4 The construction of the Chiltern tunnel north cutting and the Farthings Wood culvert (dry valley) will affect Hedgemoor and Farthings Wood LWS. As a rare and irreplaceable resource the extent of ancient woodland is important to the integrity of the site, as is its proximity to and connectivity with other woodland. At Farthings Wood construction will remove approximately 3.5ha (27%) of woodland, 0.5ha of which is ancient replanted woodland and the remainder is lowland mixed deciduous woodland, a habitat of principal importance. In addition to this loss, the construction of the Chiltern tunnel north portal will increase the distance between Hedgemoor and Farthings Wood LWS and Mantle's Wood from 70m to over 200m at the nearest point. A loss of this extent and the increased isolation will result in a permanent adverse effect on the integrity of the LWS that will be significant at the county/metropolitan level.

7.4.5 Construction will affect the southern part of Sibley's Coppice LWS. As the entirety of the LWS is ancient woodland, its extent is important to its integrity, as is maintaining a minimum viable area[50]. Construction of the South Heath green tunnel will remove 2.5ha (31%), which is all ancient woodland. In addition, construction of the South Heath green tunnel will sever Sibley's Wood LWS (100m at its narrowest point), creating two woodlands; the largest (5ha) to the north and the smallest (0.2ha) to the south. Due to its small size and isolation, the nature conservation value of the smallest remnant is likely to decline. Habitat loss and fragmentation of this extent will result in a permanent adverse effect on the integrity of the LWS that will be significant at the county/metropolitan level.

7.4.6 No impacts are expected on the following designated sites, which form part of the baseline: Weedonhill Wood/High Springs/Ostler's Woods LWS, Mop End Lane LWS, Rook Wood LWS, Hyde Heath Common BNS, Hyde House Wood BNS and Hyde Lane

[50] Minimum viable area is the smallest possible size (extent) at which the woodland can maintain its biological and ecological functions (e.g. being species-rich) and exist without being damaged due to increased vulnerability by external environmental factors.

Verge BNS. As less than 1% of the Weedonhill Wood/High Springs/Ostler's Woods LWS and Mop End Lane LWS will be adjacent to any construction works, any change in noise or air pollution will be highly localised and temporary. The later four sites will be adjacent to ecological compensation areas and not any engineering works.

Habitats

7.4.7 Approximately 12ha of woodland will be lost at various locations during construction. As an important and large component of the habitats in this area the extent of woodland (and particularly ancient woodland) is important to its conservation status. A total of 9ha of ancient woodland will be removed from Mantle's Wood (6.2ha), Sibley's Coppice (2.5ha) and Farthings Wood (0.5ha). An additional 3ha of woodland that qualifies as a habitat of principal importance (but that is not ancient woodland) will be removed from Farthings Wood. The impact of habitat loss will be exacerbated by fragmentation in areas where the route of the Proposed Scheme passes through woodland blocks. Ancient woodland cannot be replaced and loss and fragmentation of this extent from each of these woods will result in a permanent adverse effect on the conservation status of each of these woods that will be significant at county/metropolitan level.

7.4.8 Of the 19 important hedgerows in this area, 14 will be affected. The proportion and extent of important hedgerows are integral to the conservation status of this habitat, and so is the continuity of the network as a system of wildlife corridors. During construction approximately 16km of hedgerows will be removed. Nine (1.2km) of the important hedgerows will be removed and five of the important hedgerows will be partially removed (approximately 950m). As part of the precautionary assessment, it is assumed that further important and species-rich hedgerows will be lost from land that was not surveyed. The loss of hedgerows between Mantle's Wood and Sibley's Coppice and between Jenkin's Wood and Leather Lane will fragment the network in an area where it provides the only connectivity across the arable landscape. The loss of hedgerows between Mantle's Wood and Sibley's Coppice and between Jenkin's Wood and Leather Lane will fragment the network in an area where it provides the only connectivity across the arable landscape. Habitat loss of this extent will result in a permanent adverse effect on the conservation status of the habitat that will be significant at the district/borough level.

7.4.9 It is considered unlikely that any other effects on habitat receptors at more than the local/parish level will occur. Effects at the local/parish level are listed in Volume 5: Appendix EC-005-002.

Species

7.4.10 The removal or disturbance of habitat features that are utilised by bats during breeding and hibernation or migrating between roosts are considered to have the potential to result in adverse effects on the bat populations and species assemblages during construction. However, the point at which such impacts are considered likely to result in a significant adverse effect on conservation status will differ according to the species concerned.

7.4.11 Construction will affect a common pipistrelle maternity roost near Park Farm. Bats depend on maternity roosts to rear young and for shelter and protection and on the extent and continuity of linear vegetation for commuting and foraging. This roost will

be removed during the demolition of four buildings at Park Farm during the construction of the northern edge of the South Heath cutting. In addition, the habitat used by this breeding population for moving through the landscape and for foraging will be affected, particularly the network of established hedgerows to the south-west of the maternity roost. The South Heath cutting will remove approximately 4km of mature connected hedgerows from within 500m of the roost. This will sever the hedgerow network, leaving gaps of up to 500m. The loss of the maternity roost and extent of habitat loss and fragmentation will result in a permanent adverse effect on the conservation status of this common pipistrelle population that will be significant at the county/metropolitan level.

7.4.12 As part of the precautionary approach, it is assumed that additional bat tree roosts will be removed during vegetation clearance. This is particularly likely at Mantle's Wood and Farthing's Wood where restricted access prevented detailed surveys. Elsewhere, fragmentation of other habitat within the land required for the construction of the Proposed Scheme may require some bats to travel further and expend more energy during day to day foraging and movement throughout their home range. Most notably this will occur in the south of the area due to the fragmentation of Mantle's Wood. Further north, the South Heath cutting will fragment linear vegetation that provides flight lines for bats, including that along Leather Lane and close to Havenfield Wood. The extent of fragmentation in these areas could reduce the frequency with which bats cross the Proposed Scheme and therefore sever roosts from other roosts or important foraging habitat. The loss of bat tree roosts and fragmentation of habitat could result in a significant adverse effect on the bat assemblages present in this area, each of which could be significant at up to the district/borough level.

7.4.13 If present in the area, hazel dormice would be affected at Hedgemoor and Farthings Wood. The availability of large species-rich woods that are connected to similar woodlands by intact hedgerows is important to the conservation status of this species. Construction of the South Heath green tunnel will remove 3.5ha (27%) of woodland reducing the size of the available habitat to 9.4ha and increasing the distance from Mantle's Wood to 250m (at the closest point). Woodland below 10ha and separated from similar suitable habitat is unlikely to maintain a viable breeding population[51]. As part of the precautionary approach, habitat loss and fragmentation could therefore result in a permanent adverse effect on the conservation status of this species that would be significant up to county/metropolitan level.

7.4.14 If present in the area, great crested newt could be affected during vegetation clearance. Maintaining the number of breeding ponds within a network of habitat suitable for foraging and hibernating (e.g. grassland, scrub, hedgerows and woodland edge habitat) is important to the conservation status of this species. If present, construction could significantly affect three great crested newt populations:

- a pond adjacent to Chesham Road will be retained but surrounded by land required for the construction of the Proposed Scheme. The terrestrial habitat near the pond that is suitable for this species will therefore be removed;

[51] English Nature (2006) *The dormouse conservation handbook*, Second Edition.

- five ponds are present in close proximity to Jenkin's Wood, of which three lie within the land required for the construction of the Proposed Scheme and two are within 250m of the land required. Much of the surrounding terrestrial habitat will also be removed; and
- two ponds occur close to Potter Row near Springfield Farm; one will be retained but surrounded by land required for the construction of the Proposed Scheme, the second pond will be 50m north of the construction Loss of habitat in the area will remove suitable foraging and hibernating features and fragment the two ponds from one another.

7.4.15 The loss and/or fragmentation of possible breeding ponds and extensive surrounding terrestrial habitat could reduce the viability of a breeding population. As part of the precautionary approach, habitat loss and fragmentation could result in a permanent adverse effect on the conservation status of each population that would be significant at up to the county/metropolitan level.

7.4.16 A small great crested newt population near Mantle's Wood, which is restricted to a single isolated breeding pond will be removed during the construction of the Chilterns tunnel north portal. The surrounding terrestrial habitat will also be removed. The loss of the breeding pond will affect the viability of this breeding population and result in a permanent adverse effect on its conservation status that is significant at the district/borough level.

7.4.17 Notable terrestrial invertebrate species will be affected at Mantle's Wood LWS and Sibley's Coppice LWS. The continuous provision of uncommon habitat features such as dead wood is an important aspect of the conservation status of woodland invertebrates. The construction of the Chiltern tunnel north portal and the South Heath green tunnel will reduce the extent of woodland at both locations. This will reduce the quantity of available deadwood and other habitat features, which is likely to result in a permanent adverse effect on the conservation status of terrestrial invertebrates at both sites that is significant at the district/borough level.

7.4.18 If present in the area, notable plant species could be affected during vegetation clearance, particularly within the ancient woodland of Mantle's Wood, Hedgemoor and Farthings Wood and Sibley's Coppice. The removal of small numbers of box or coralroot could affect the viability of the population and would result in a permanent adverse effect on the conservation status of populations of notable plants that would be significant at up to the district/borough level.

7.4.19 If present in the area, common reptile species could be affected. The extensive loss of grassland, field margins and hedgerows throughout the area could reduce the extent of habitat available for foraging and sheltering below that which is required to maintain a viable population. These impacts could therefore result in a permanent adverse effect on the conservation status of reptiles that would be significant at up to the district/borough level.

7.4.20 It is considered unlikely that any other effects on species receptors at more than the local/parish level will occur. Effects at the local/parish level are listed in Volume 5: Appendix EC-005-002.

Other mitigation measures

7.4.21 This section describes additional measures designed to reduce or compensate for significant ecological effects. These include habitat creation, linking existing habitats and maintaining habitat continuity, which will allow wildlife to cross the route.

7.4.22 Ancient woodland is irreplaceable. The loss of 9.2ha ancient woodland within this area will result in a permanent adverse effect that is significant at a county/metropolitan level. However, this loss of woodland will be compensated through a range of measures. Ancient woodland soil with its associated seed bank (and any notable species such as box and coralroot) will be collected and translocated to several large receptor sites. This will 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 may also be appropriate.

7.4.23 Five areas of lowland mixed deciduous woodland will be created near South Heath and will compensate for habitat loss at Mantle's Wood LWS, Hedgemoor and Farthings Wood LWS and Sibley's Coppice LWS. They are approximately:

- 16ha immediately south of the Chiltern tunnel north portal to link the fragmented southern and western parts of Mantle's Wood LWS with the remaining parts of Hedgemoor and Farthings Wood LWS. The new planting will also connect to existing woodland to the south;
- 8ha about 400m to the west of the Hedgemoor and Farthings Wood LWS to connect the new woodland described above with Wendover Woods to the west and to the Hyde Lane Verge BNS;
- 3ha to connect the new woodland described above to the Hyde House Wood BNS and Hyde Heath Common BNS (and the northern fragment of the Mantle's Wood LWS);
- 3ha to extend the remaining 5ha of the Sibley's Coppice LWS and connect it to woodland at Little Wood Corner east of South Heath. This will be achieved by woodland planting on top of the South Heath green tunnel; and
- 10ha after construction on South Heath green tunnel to connect Sibley's Coppice to Wendover Woods (to the south) and also to the new woodland described above.

7.4.24 The new planting described above will provide an overall increase in secondary woodland cover of approximately 40ha of lowland mixed deciduous woodland (a habitat of principal importance). Lowland meadow (also a habitat of principal importance) will be planted within rides and glades in the woodland to increase habitat diversity. There are also extensive areas of landscape mitigation planting around the Chesham Road realignment and either side of the South Heath cutting that will provide additional that will provide additional ecological value. Therefore, in total approximately 50ha of woodland will be planted between Mantle's Wood and Leather Lane. The new planting will improve habitat connectivity, particularly between the remaining areas of ancient woodland and will include rides and glades to help maintain the identity of the adjacent retained woodland. All planting will be

undertaken in accordance with the ecological principles of mitigation identified within the Volume 5: Appendix CT-001-000/2. Following the maturation of the new woodland any adverse impacts on Mantle's Wood LWS, Hedgemoor and Farthings Wood LWS and Sibleys's Coppice LWS will be reduced to a level that will not result in a significant adverse effect on the integrity of the sites.

7.4.25 While not fully replicating the woodland that will be lost (particularly the ancient woodland), the large increase in woodland extent will maintain the conservation status of the woodland in the area, and when mature (a minimum of 50 years) will result in a separate beneficial effect that is significant at the district/borough level.

7.4.26 Hedgerow planting will be undertaken throughout the area to compensate for the loss and fragmentation during construction, with hedgerows that reflect the species composition present in the wider landscape. The alignment of the new hedgerows will connect with the existing network to maintain connectivity either side and across the route. All planting will be undertaken in accordance with the ecological principles of mitigation identified within the Volume 5: Appendix CT-001-000/2. Following establishment, there will be no permanent adverse effects on the conservation status of hedgerows in this area.

7.4.27 Compensatory roost(s) for the loss of a common pipistrelle maternity roost near Park Farm will be provided in accordance with the ecological principles of mitigation identified within the Volume 5: Appendix CT-001-000/2. The roosts will be situated at the edge of the remaining part of Sibley's Coppice and where planting over the South Heath green tunnel will provide habitat connectivity over the Proposed Scheme. The location is also close to the large areas of woodland created to the south, which will provide optimal foraging habitat. Following the implementation of the measures proposed it is likely that any adverse impacts on the pipistrelle population near Park Farm and other bat species seen in the area during the construction of the Proposed Scheme will be reduced to a level at which there will not be any significant effect on the conservation status of the species.

7.4.28 To offset the possible loss of bat tree roosts from un-surveyed land (particularly Mantle's Wood, Hedgemoor and Farthings Wood and Sibley's Coppice) replacement roosting habitat will be provided as necessary in line with the ecological principles of mitigation identified within the Volume 5: Appendix CT-001-000/2. Such provision will allow common bat species to roost in close proximity to existing foraging habitat and will maintain the favourable conservation status of bat populations in this area.

7.4.29 The likely fragmentation of habitat used by bats will be addressed by restoring and creating links between woodlands. Landscape planting and habitat creation close to the Chiltern tunnel north portal will provide a habitat corridor enabling bats to reach the two parts of Mantle's Wood. Linkages across the route of the Proposed Scheme will be provided by woodland planting over the South Heath green tunnel. Elsewhere in this area, planting on the embankments of overbridges for the footpath south of Hyde Lane, for Leather Lane and for the farm access near Havenfield Wood, will allow bats to cross the route of the Proposed Scheme. All measures will be implemented in accordance with the ecological principles of mitigation as set out in Volume 5: Appendix CT-001-000/2. Following the implementation of the measures proposed, it is expected that any adverse impacts will be reduced to a level at which they will not

result in any significant effect on the conservation status of the bat populations concerned.

7.4.30 Should hazel dormouse be present in the land required for the construction of the Proposed Scheme, woodland habitat creation will provide sufficient compensatory habitat. It includes areas that will be planted early and that will therefore provide suitable receptor sites if animals are found. Other appropriate measures will be taken to hasten the development of suitable habitat, as described in the ecological principles of mitigation identified within Volume 5: Appendix CT-001-000/2. This habitat will also link woodlands and so allow dormice to move across the landscape so as to maintain viable populations. Following the implementation of the measures proposed it is expected that any adverse impacts will be reduced to a level that they will not result in significant effect on the conservation status of hazel dormouse.

7.4.31 Habitat for great crested newt will be provided in accordance with the ecological principles of mitigation identified within Volume 5: Appendix CT-001-000/2. The small population of great crested newt that will be lost from a single pond to the north of Mantle's Wood will be moved to one of the new woodland compensation areas. Parts of the compensation areas will be planted with lowland meadow and ponds will be created. If great crested newts are recorded in any ponds that were not surveyed due to access restrictions, they will be moved to one of two additional ecological compensation areas near Jenkin's Wood (2.1ha and 1.2ha), which, if required will comprise of lowland meadow and scrub with ponds. Habitat creation of this extent in close proximity to known and potential populations of great crested newt will ensure that there will not be any significant effects on their conservation status.

7.4.32 Creation of woodland habitat will replace that lost for notable terrestrial invertebrates. Features that support these species, including dead wood, coppice stools, log piles and other materials, will be translocated from those areas of Mantle's Wood and Sibley's Coppice affected by the Proposed Scheme to retained or newly created woodlands in accordance with the ecological principles of mitigation as set out in Volume 5: Appendix CT-001-000/2. Such features will also result in the larvae of invertebrates being translocated thus facilitating colonisation of new habitat. These measures will mitigate for effects on the conservation status of terrestrial invertebrates. Creation of new woodlands will also create new linkages between woodlands to compensate for fragmentation, by facilitating the movements of terrestrial invertebrates between woodlands. Following the implementation of the measures proposed, it is expected that there will no significant adverse effect on the conservation status of the terrestrial invertebrate populations.

7.4.33 If reptiles are found, they will be translocated to one of the ecological compensation areas before the start of construction. The creation and management of new habitat suitable for reptiles within these areas and within areas of landscape planting will be carried out in accordance with ecological principles of mitigation as set out in Volume 5: Appendix CT-001-000/2. The location and extent of new habitat will allow the current distribution of reptiles to be retained. This will ensure that there are no significant adverse effects on the conservation status of reptiles.

7.4.34 Mitigation measures to address the potential killing, injury and disturbance of badgers will be provided in accordance with the ecological principles of mitigation identified

within the Volume 5: Appendix CT-001-000/2. This will include the provision of badger proof fencing and replacement setts where necessary.

Summary of likely residual significant effects

7.4.35 Taking into account mitigation, compensation and enhancement proposed, anticipated significant residual ecological effects during construction are:

- the permanent loss of approximately 6ha of ancient woodland from Mantle's Wood, which is irreplaceable;
- the permanent loss of approximately 0.5ha of ancient woodland from Farthings Wood, which is irreplaceable;
- the permanent loss of approximately 2.3ha of ancient woodland from Sibley's Coppice, which is irreplaceable; and
- when mature, there will be a separate beneficial increase in the extent of semi-natural broad-leaved woodland, associated with the planting of over 40ha of new woodland.

7.5 Effects arising from operation

Avoidance and mitigation measures

7.5.1 The following measures have been included as part of the design of the Proposed Scheme and avoid or reduce impacts on features of ecological value:

- the southern 1.9km of the route is in twin-bore tunnel and will provide habitat continuity and reduce risk of animal mortality due to train strike;
- the South Heath green tunnel (1.2km) will provide habitat continuity and reduce risk of animal mortality due to train strike; and
- the creation of planted embankments either side of road, footpath and access crossing points will encourage bats to fly at a safe height over the Proposed Scheme (particularly at Hyde Lane, Leather Lane and the farm access near Havenfield Wood).

Assessment of impacts and effects

7.5.2 The operation of the Proposed Scheme has the potential to result in a variety of impacts on bat populations including those as a result of collision with passing trains, turbulence and noise. The point at which such impacts are considered to result in a significant adverse effect on the conservation status of the population concerned will differ between species. As a consequence the following assessment of operational impacts takes into account the differing character and nature of the bat populations and/or assemblages concerned in determining the likely effects of the Proposed Scheme on each of these receptors.

7.5.3 Due to the large areas over which bats forage it is likely that any loss of or displacement from, suitable foraging habitat in the vicinity of the Proposed Scheme would in itself amount to only a small proportion of the wider available resource. However, the impact of any such disturbance or displacement could be greatly

increased if bats are hampered in moving between breeding sites, hibernation sites and other roosts which they commonly utilise.

7.5.4 Where the route of the Proposed Scheme bisects or is located in close proximity to existing features known to be utilised regularly by foraging or commuting bats, there is an increased risk that bats could be killed or injured as a result of collisions with passing trains or associated turbulence. The significance of any such effect will be dependent on both the flight habitat of the species or species concerned and the vertical alignment of the Proposed Scheme (i.e. if the railway in cutting, on embankment, on a viaduct, or at grade) at the point the impact occurs.

7.5.5 The levels of bat activity along hedgerows and woodland edges at Mantle's Wood demonstrated that bats are likely to cross the route of the Proposed Scheme and could be at risk of being killed or injured at this location. There were low levels of activity for rarer bats (Leisler's bat and/or serotine) and the conservation status of these species could be affected, particularly if roosts are present close to the Proposed Scheme. However, any adverse effects will be reduced to a level that is not significant due to the planting over the South Heath green tunnel, and by the habitat connections along and over the Proposed Scheme.

7.5.6 Noise, vibration and lighting from passing trains have the potential to disturb bat species foraging and commuting within habitats close to the Proposed Scheme. Knowledge of the impact of noise on bats caused by passing trains is limited. There is some evidence to suggest that gleaning bats, such as brown long-eared, will have reduced foraging success within areas where there is persistent noise from busy roads. However, noise generated from passing trains will be regular but temporary and as such will differ from that resulting from a busy road. Any such, disturbances are therefore not likely to result in any significant adverse effects on the bat populations or assemblages present in this area.

7.5.7 The noise made by passing trains has the potential to disturb birds within habitats close to the Proposed Scheme. Birds habituate to loud noises that they hear 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 with the Proposed Scheme as trains will pass quickly. The effect of train noise on breeding birds is therefore not considered to be significant.

7.5.8 The majority of bird species that are known to be present in the area are not considered to be particularly vulnerable to collision with trains. However, barn owls are often killed by cars and trains. This is because they hunt low over the rough grassland habitats that are associated with road verges and railway embankments and are slow moving. Evidence suggests that such mortality is likely to result in the loss of all breeding populations of barn owls within 1.5km of the Proposed Scheme.

7.5.9 The land required for the operation of the Proposed Scheme in this area includes wide cuttings that will be colonised by vegetation that may be suitable for foraging barn owl, and may therefore increase their risk of mortality from contact with trains. This is particularly relevant south of South Heath where barn owls nest within 1.5km of the route and on both sides. One nest will be close to the Chiltern tunnel north cutting.

This population is likely to forage along the woodland edge that connects to the cutting and could cross the Proposed Scheme to forage, thus increasing the risk of train strike. The mortality of barn owl would result in a permanent adverse effect on the conservation status of this species that would be significant at up to the county/metropolitan level.

7.5.10 It is considered unlikely that any other effects on species receptors at more than the local/parish level will occur. Effects at the local/parish level are listed in Volume 5: Appendix EC-005-002.

Other mitigation measures

7.5.11 This section describes and assesses additional elements designed to reduce or compensate for significant ecological effects.

7.5.12 Train strike is likely to result in the loss of barn owls which nest close to the route. As part of the precautionary assessment it is assumed all territories within close proximity to the route could be lost and therefore adverse effects are likely to remain significant at up to the county/metropolitan level. To offset these losses 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 owls within the wider landscape and thus offset the adverse effect.

Summary of likely residual significant effects

7.5.13 The mitigation, compensation and enhancement measures described above reduce the residual ecological effects during operation to a level that is not significant, except for barn owl. Train strike is likely to result in the loss of barn owls that nest close to the route resulting in a residual significant effect. However, 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 Land quality

8.1 Introduction

8.1.1 This section presents the baseline conditions that exist along the Proposed Scheme in relation to land quality and reports the likely impacts and any significant effects resulting from the construction and operation of the Proposed Scheme. Consideration is given to land that potentially contains contamination and land that has special geological significance, either from a scientific, mining or mineral resources point of view, including geological sites of special scientific interest (SSSI), local geological sites (LGS), areas of current underground or opencast mining and areas of designated mineral resources. Mitigation measures are presented and any residual effects are summarised.

8.1.2 Potentially contaminated areas of land have been identified that could affect or be affected by, the construction of the Proposed Scheme (for example, contaminated soils may need to be removed or the construction may alter existing contamination pathways). Each of these areas has been studied to evaluate the scale of potential impacts caused by existing contamination (if present) and what needs to be done to avoid significant consequences to people and the wider environment. In addition, a review has been undertaken to establish whether the operation of the Proposed Scheme will lead to contamination of its surrounding environment and what needs to be done to prevent such contamination.

8.1.3 The main environmental features of this area include the River Misbourne; the underlying Chalk Principal aquifer; the Chilterns AONB; Mantle's Wood, Hedgemoor, Farthings Woods and Sibley's Coppice LWS and the Marylebone to Aylesbury Line at the southern end of the route section.

8.1.4 The main land quality issues in this area include potentially infilled historical gravel and chalk workings along the route at Mantle's Farm, Hyde Farm, Cudsdens Court, Chalkdell Wood, Bury Farm, Havenfields and Leather Lane and a garage/workshop with historical storage tanks on Hyde Heath Road, Hyde Heath. Details of baseline information and the land quality assessment methodology are outlined in the following appendices (presented in Volume 5):

- Appendix CT-001-000/1: the SMR and Appendix CT-001-000/2 the SMR Addendum; and
- Appendix LQ-001-009: Land quality appendix.

8.1.5 Land contamination issues are closely linked with those involving water resources and waste. Issues regarding groundwater resources are addressed in Section 13, Water resources and flood risk assessment. Issues regarding the disposal of waste materials, including contaminated soils, are addressed in Volume 3: Section 16.

8.1.6 Engagement has been undertaken with Chiltern District Council, the Environment Agency and the Petroleum Officer regarding contaminated land and Buckinghamshire County Council with regards to mineral policy and data. Information has been received on potential land contamination and mineral extraction and Mineral Safeguarding Areas (MSA) in June 2013.

8.2 Scope, assumptions and limitations

8.2.1 The assessment scope, key assumptions and limitations for the land quality assessment are set out in Volume 1, Section 8 and in the SMR and its addendum presented in Volume 5 (Appendices CT-001-000/1 and 2). This section follows the standard assessment methodology.

8.2.2 Baseline data were reviewed for the area of land required to construct the Proposed Scheme, together with a buffer extending out for a minimum of 250m, but in the case of groundwater data up to 1km. This is defined as the study area with respect to land quality issues, utility works within the highway are a low-risk construction activity, as most of the excavation works will be within the highway construction layers and re-instatement will be made with highway construction materials.

8.2.3 Site visits to the study area were made in July 2012 where the location of the Proposed Scheme was viewed from points of public access only. Due to access constraints not all sites considered to have the greatest potential for contamination were visited. However, the purpose of site visits is to verify desktop information and the lack of complete site walkovers is considered unlikely to have substantially affected the land quality assessment. Site visit notes are presented in Volume 5: Appendix LQ-001-009.

8.3 Environmental baseline

Existing baseline

8.3.1 Unless otherwise stated, all features described in this section are presented in Maps LQ-01-017 and LQ-01-018 (Volume 5, Land Quality Map Book).

Geology

8.3.2 This section describes the underlying ground conditions within the study area. It first describes any made ground present, followed by near surface superficial deposits and lastly describes the deeper bedrock geology. The geological mapping is illustrated on Map WR-02-009 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

8.3.3 The Proposed Scheme in this study area mostly crosses agricultural land; however, a cover of made ground may be present in built up areas as a result of previous cycles of development.

8.3.4 Superficial deposits, comprising Clay-with-Flints, are present over the majority of the route section from Chalk Lane to the north of the study area but absent from the area around Mantle's Wood and Hyde Farm. River alluvium associated with the River Misbourne is present approximately 120m south-west of the route of the Proposed Scheme at the southern end of this section. Head deposits comprising clay and silt lie near to the Chiltern tunnel north portal satellite compound site near Farthings Wood.

8.3.5 The bedrock in this study area comprises Cretaceous White Chalk (a soft limestone) of substantial thickness (greater than 100m).

Groundwater

8.3.6 The White Chalk has been designated by the Environment Agency as a Principal aquifer. The river alluvium has been designated a Secondary A aquifer and the Clay-with-Flints and head deposits designated unproductive.

8.3.7 The entire route will be located within a source protection zone (SPZ) alternating between SPZ2 (outer zone) and SPZ3 (total catchment) as shown on Map WR-02-009 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

8.3.8 A search for groundwater abstractions confirmed that there is one private licensed groundwater abstraction, one Public Water Supply (PWS) abstraction and one unlicensed groundwater abstraction in the area within one kilometre of the Proposed Scheme.

8.3.9 Further detail on the groundwater beneath the Proposed Scheme can be found in Section 13, Water resources and flood risk assessment.

Surface waters

8.3.10 The River Misbourne flows approximately 200m south-west of the route near the southern end of this area and there are a number of unnamed ponds along the route.

8.3.11 There are no licensed surface water abstractions within 1km of the route.

8.3.12 Further information on surface waters is provided in Section 13, water resources and flood risk assessment.

Current and historical land use

8.3.13 Current potentially contaminative land uses comprise the Marylebone to Aylesbury Line at the southern end of the route section. Historical potentially contaminative land uses comprise possibly infilled historical gravel and chalk workings along the route at Mantle's Farm, Hyde Farm, Cudsdens Court, Chalkdell Wood, Bury Farm, Havenfield Wood and Leather Lane.

8.3.14 Contaminants commonly associated with these uses could include metals, semi-metals, asbestos, organic and inorganic compounds. Infilled pits could also give rise to landfill gases such as methane, carbon dioxide or volatile organic compounds (VOC).

Other regulatory data

8.3.15 Regulatory data reviewed include pollution incidents, radioactive and hazardous substances consents and environmental permits (previously landfill, Integrated Pollution Control (IPC) and Integrated Pollution Prevention and Control (IPPC) licences). No significant data was noted.

Mining/mineral resources

8.3.16 The Buckinghamshire Minerals and Waste Core Strategy DPD[52], Policy CS1 states that development proposals in this area, other than those involving minerals extraction, will need to demonstrate that they will not sterilise any mineral resources or that consideration has been given to prior extraction of the protected mineral or that the

[52] Buckinghamshire County Council (2012) *Buckinghamshire Minerals and Waste Core Strategy, Development Plan Document*.

need for the proposed development outweighs the economic value of the mineral resource.

8.3.17 Hyde Farm Gravel Pit, 130m north-east of the route (see Map LQ-01-017, Volume 5, Land Quality Map Book), Hyde Farm Chalk Pit, 30m south-west of the route in the central area of the route section and Leather Lane chalk pit, immediately west of the route at the northern end have all been identified as areas of historical extraction of minerals.

8.3.18 The alluvium, where present, has been identified as a potential sand and gravel mineral resource and the chalk has been identified as a potential chalk mineral resource by the British Geological Survey.

8.3.19 No Mineral Consultation/Safeguarding Areas, Preferred Mineral Sites or current extractions have been identified within the study area.

Geo-conservation resources

8.3.20 There are no geological conservation resources identified within the study area.

Receptors

8.3.21 The sensitive receptors that have been identified within this study area are summarised in Table 11.

Table 11: Summary of sensitive receptors

Issue	Receptor type	Receptor description	Receptor sensitivity
Land contamination	People	Residents	High
		Workers	Moderate
	Controlled waters	Principal aquifers	High
		Secondary A aquifers	Moderate
		River Misbourne	High
		Rivers	High
	Built environment	Buildings and property	Low to high
		Underground structures and services	Low
	Mineral resources	Mineral resources of the sand and gravel and chalk	Low
Impacts on mining/mineral sites (severance and sterilisation of mineral sites)	Mineral resources	Mineral resources of sand and gravel	Low
		Mineral resources of chalk	Low

Future baseline

8.3.22 There are currently no identified committed developments within the study area which are likely to change the land quality baseline during either construction or operation of the Proposed Scheme.

8.4 Effects arising during construction

Avoidance and mitigation measures

8.4.1 The construction assessment takes into account the mitigation measures contained within the draft CoCP (see Volume 5: Appendix CT-003-000). The draft CoCP sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme. Its requirements in relation to work in contaminated areas will ensure the effective management and control of the work. Such requirements include:

- methods to control noise, waste, dust, odour, gasses and vapours (draft CoCP Sections 5, 7, 13 and 15);
- methods to control spillage and prevent contamination of adjacent areas (draft CoCP Section 5);
- the management of human exposure for both construction workers and people living and working nearby (draft CoCP Section 11);
- methods for the storage and handling of excavated materials (both contaminated and uncontaminated) (draft CoCP Sections 7 and 15);
- management of any unexpected contamination found during construction (draft CoCP Section 11);
- a post remediation permit to work system (draft CoCP Section 11);
- storage requirements for hazardous substances such as oil (draft CoCP Section 16);
- traffic management to ensure that there is a network of designated haul roads to reduce compaction/degradation of soils (draft CoCP Section 7); and
- methods to monitor and manage flood risk and other extreme weather events which may affect land quality during construction (draft CoCP Section 16).

8.4.2 The draft CoCP requires that prior to and during construction a programme of further investigations, which may include both desk based and site based work, will take place in order to confirm the full extent of areas of contamination and a risk assessment undertaken to determine what, if any, site specific remediation measures will be required to allow the Proposed Scheme to be constructed safely and to prevent harmful future migration of contaminants (draft CoCP section 11). The investigation and detailed assessment of potentially contaminated sites will be undertaken in accordance with:

- Environment Agency CLR11 Model Procedures for the Management of Land Contamination (2004) [53]; and
- British Standard BS10175 Investigation of Potentially Contaminated Sites (2011)[54].

[53] Environment Agency (2004) *CLR11 Model Procedures for the Management of Land Contamination.*
[54] British Standard Institute (2011) *British Standard BS10175 Investigation of Potentially Contaminated Sites*.

8.4.3 Where significant contamination is encountered, a remedial options appraisal will be undertaken to define the most appropriate remediation techniques. This appraisal will be undertaken based on multi-criteria attribute analysis that considers environmental, resource, social and economic factors in line with Sustainable Remediation Forum UK's publication A Framework for Assessing the Sustainability of Soil and Groundwater Remediation (2010)[55]. The preferred option will then be developed into a remediation strategy, in consultation with regulatory authorities prior to implementation.

8.4.4 Contaminated soils excavated from the site, wherever reasonably practicable, will be treated as necessary to remove or render any contamination inactive and reused within the Proposed Scheme where needed and suitable for use. Techniques are likely to include stabilisation methods, soil washing and bio-remediation to remove oil contaminants. Contaminated soil disposed of off-site will be taken to a soil treatment facility, another construction site (for treatment, as necessary, and re-use) or to an appropriately permitted landfill.

Assessment of impacts and effects

8.4.5 As the Proposed Scheme enters this area, it will run in a 1.9km section of the twin-bore Chiltern tunnel until Mantle's Wood where the north portal of the tunnel will be located. The remainder of the route in this area will be in cutting, and embankment with the exception of a 1.2km green tunnel between South Heath and Frith Hill.

8.4.6 One vent shaft for the twin-bore tunnel and an associated auto-transformer station will be in this area, at Little Missenden. South Heath mid-point auto-transformer station will be located to the north-west of Frith Hill, west of South Heath.

8.4.7 In this area there will be one main compound for railway installation works (which will utilise one of the civil engineering satellite compounds), four civil engineering satellite compounds and three railway installation satellite compounds (all of which will continue to use a compound previously established for the civil engineering works).

Land contamination

8.4.8 In line with the assessment methodology, as set out in the SMR, SMR addendum and its appendices, an initial screening process was undertaken (identified in the methodology as Stages A and B) to identify areas of current or historical contaminative use within the study area and to consider which of these areas might pose contaminative risks for the Proposed Scheme. In total, 20 areas were considered during this screening process; seven of these areas were taken forward to more detailed risk assessments (Stages C and D), in which the potential risks were assessed more fully. The majority of the sites undergoing the more detailed risk assessments were historical potentially infilled gravel or chalk pits. All areas assessed are shown on Maps LQ-01-017 to LQ-01-018 (Volume 5, Land Quality Map Book) and those considered as potentially posing a risk to the Proposed Scheme are labelled with a reference number.

8.4.9 Conceptual site models (CSM) have been produced for the six areas taken to Stage C and D assessments. The detailed CSM are provided in Volume 5 (Appendix LQ-001-

[55] Sustainable Remediation Forum UK (2010) *A Framework for Assessing the Sustainability of Soil and Groundwater Remediation*.

017, Section 3) and the results of the baseline risk assessments are summarised in this section. Potentially contaminated areas have been grouped and considered together, where appropriate. The following factors have determined the need for Stage C and D assessments:

- whether the area is on or off the Proposed Scheme or associated offline works; e.g. roads;
- the vertical alignment, i.e. whether the Proposed Scheme is in cut or on embankment;
- the presence of underlying Principal or Secondary A aquifers or nearby watercourses; and
- the presence of adjacent residential properties or sensitive ecological receptors.

8.4.10 A summary of the baseline CSM is provided in Table 12. The impacts and baseline risks quoted are before any mitigation is applied. The assessed baseline risk is based on the information provided at the time of the assessment. Where limited information is available, it is based on precautionary, worst case assumptions and may therefore report a higher risk than that which actually exists.

Table 12: Summary of baseline CSM for sites which may pose a contaminative risk for the Proposed Scheme

Area ref [1]	Area name	Main potential impacts	Main baseline risk [2], [3]
9-3	Former sand and gravel quarry (Map LQ-01-017, grid reference C6)	Exposure of Principal Chalk aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low
		Exposure of off-site ecological receptors (Mantle's Wood, Hedgemoor, Farthings Woods and Sibley's Coppice) to lateral migration of contaminants in groundwater.	Low
		Exposure of off-site ecological receptors (Mantle's Wood, Hedgemoor, Farthings Woods and Sibley's Coppice) to contact with contaminants in windblown dusts.	Moderate/low
9-4	Former sand and gravel quarry (Map LQ-01-017, grid reference D6)	Exposure of Principal Chalk aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low
		Exposure of off-site ecological receptors (Mantle's Wood, Hedgemoor, Farthings Woods and Sibley's Coppice) to lateral migration of contaminants in groundwater.	Very low
		Exposure of off-site ecological receptors (Mantle's Wood, Hedgemoor, Farthings Woods and Sibley's Coppice) to contact with contaminants in windblown dusts.	Very low
9-5	Infilled water feature (Map LQ-01-017, grid reference C6)	Exposure of off-site human receptors (residents and commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low

Area ref [1]	Area name	Main potential impacts	Main baseline risk [2], [3]
		Exposure of off-site human receptors (residents and commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Low
		Exposure of off-site human receptors (residents and commercial) to asphyxiative or explosive gases.	Moderate/low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate/low
		Exposure of off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
9-6 and 9-7	Infilled water feature (Map LQ-01-017, grid reference A6)	Exposure of off-site human receptors (residents and commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low
		Exposure of off-site human receptors (residents and commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Low
		Exposure of off-site human receptors (residents and commercial) to asphyxiative or explosive gases.	Moderate
		Exposure of properties to build up of asphyxiative or explosive gases.	Moderate
		Exposure of properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
9-8	Vehicle repair garage including historical tanks (Map LQ-01-017, grid reference F3)	Exposure of on-site human receptors (commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low
		Exposure of on-site human receptors (commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate
		Exposure of on-site human receptors (commercial) to asphyxiative or explosive gases	Moderate
		Exposure of on-site properties or migration to buildings off-site to a build-up of asphyxiative or explosive gases.	Moderate
		Exposure of on-site properties to direct contact of property on-site with contaminants in soil and groundwater.	Moderate/low
		Exposure of on-site properties to direct contact of-site properties with migrating contaminants in soil and groundwater.	Low

Area ref [1]	Area name	Main potential impacts	Main baseline risk [2], [3]
9-17	Former chalk pit (Map LQ-01-018, grid reference B6)	Exposure of the Principal Chalk aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low

(1) Each area is assigned a unique identification number (See Volume 5, Appendix LQ-001-009).
(2) CSMs have been prepared as part of the detailed land contamination methodology (refer to Volume 5) for baseline, construction and post-construction
(3) The moderate or high risks identified reflect the uncertainty in existing baseline information. Whilst there are unlikely to be properties or receptors that experience the reported high or moderate existing baseline risk in the absence of site investigation a precautionary, worst case risk is reported in the table.

Temporary effects

8.4.11 Table 13 presents the summary of the construction effects obtained from a comparison of the baseline and construction impacts. The construction risk assessment takes into account the implementation of the mitigation measures set out within the draft CoCP. The details of these comparisons are presented in Volume 5 (Appendix LQ-001-009).

8.4.12 The baseline and construction CSM have been compared to determine the change in level of risk to receptors during the construction stage, and thus to define the level of effect at the construction stage. Where there is no change between the main baseline risk and the main construction risk, the temporary effect significance is deemed to be negligible even if the risk is assessed to remain as high. This will be the case where the construction of the Proposed Scheme does not alter the risks from an existing potentially contaminated site that is outside the construction boundary.

Table 13: Summary of temporary (construction) effects

Area ref	Area name	Main baseline risk	Main construction risk [1]	Temporary effect and significance)
9-3	Former sand and gravel quarry (Map LQ-01-017, grid reference C6)	Very low to moderate/low	Low to moderate/low	Minor adverse effect (not significant)
9-4	Former sand and gravel quarry (Map LQ-01-017, grid reference D6)	Very low to moderate/low	Very low to moderate	Minor adverse effect (not significant)
9-5	Infilled water feature (Map LQ-01-017, grid reference C6)	Very low to moderate/low	None to moderate	Minor adverse effect (not significant)
9-6 and 9-7	Infilled water feature (Map LQ-01-017, grid reference A6)	Very low to moderate	None	Minor beneficial effect (not significant)
9-8	Vehicle repair garage including historical tanks (Map LQ-01-017, grid reference F3)	Low to moderate	Low to moderate	Negligible (not significant)
9-17	Former chalk pit (Map LQ-01-018, grid reference B6)	Moderate/low	Moderate	Minor adverse effect (not significant)

(1) The low/moderate main construction risk identified in the above table does not necessarily imply an unacceptable risk. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.

8.4.13 Table 13 indicates that based upon the assessment, the construction phase is expected to have a minor beneficial to minor adverse effect on the receptors overall. This effect is not considered to be significant in relation to potential land contamination.

8.4.14 The infilled water feature (ref CFA9-5) is shown on Map LQ-001-017 (Volume 5, Land Quality Map Book) will be located in the Proposed Scheme within a cutting and therefore it is expected that any contaminants here will be removed during construction in accordance with the draft CoCP.

8.4.15 Currently the main risk at the infilled water features 9-6 and 9-7, would be to the unoccupied former Annie Bailey's public house. The public house is scheduled for demolition during the construction phase and therefore the potential receptor will be removed and the main construction risk removed.

8.4.16 Construction compounds located in this area will include the storage of potentially hazardous substances, such as fuels and lubricating oils and may also be used for temporary storage of potentially contaminated soils. The measures outlined in the draft CoCP will manage risks from the storage of such materials.

8.4.17 There are anticipated to be no significant cumulative temporary effects from construction.

Permanent effects

8.4.18 Baseline and post-construction CSM have been compared to assess the permanent (post-construction) effects. The post-construction CSM assumes that all the required remediation has been carried out and validated.

8.4.19 Table 14 includes the summary of the permanent (post-construction) effects obtained from a comparison of the baseline and post-construction impacts and whether these are significant. The details of these comparisons are presented in Volume 5 (Appendix LQ-001-009).

Table 14: Summary of permanent (post-construction) effects

Area ref	Area name	Main baseline risk	Main post-construction risk (1)	Post -construction effect and significance
9-3	Former sand and gravel quarry	Very low to moderate/low	None to very low	Minor beneficial effect (not significant)
9-4	Former sand and gravel quarry	Very low to moderate/low	Very low to moderate/low	Negligible (not significant)
9-5	Infilled water feature	Very low to moderate/low	None to very low	Minor beneficial effect (not significant)
9-6 and CFA9-7	Infilled water feature	Very low to moderate	None	Minor beneficial effect (not significant)
9-8	Vehicle repair garage including historical tanks	Low to moderate	Low to moderate	Negligible (not significant)

Area ref	Area name	Main baseline risk	Main post-construction risk (1)	Post -construction effect and significance
9-17	Former chalk pit	Moderate/low	Moderate/low	Negligible (not significant)

(1) The low/moderate main construction risk identified in the above table does not necessarily imply an unacceptable risk. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.

8.4.20 The magnitude of the permanent effects and their significance have been determined by calculating the change in risk between the main baseline risk and the main post-construction risk. Therefore, where there is no change between the main baseline risk and the main post-construction risk, the permanent effect significance is deemed to be negligible even if the risk is assessed to remain as high. This will be the case where the construction of the Proposed Scheme does not alter the risks from an existing potentially contaminated site that is outside the construction boundary.

8.4.21 Table 14 shows that the Proposed Scheme results in either a reduction or no change in the level of risk already existing at each site for both on site and off site receptors. None of the post-construction effects of land contamination impacts predicted are significant. Minor beneficial effects will occur from the potential remediation of contaminated soils in the areas within cuttings. The reduction in risk and net beneficial effect on water quality in the Chalk Principal aquifer is derived from the improvements achieved by the construction activities and remediation (former sand and gravel quarry 9-3 and infilled water feature 9-5) or where the buildings have been demolished during the construction of the Proposed Scheme (infilled water features 9-5, 9-6, and 9-7).

8.4.22 There are anticipated to be no significant cumulative permanent effects.

Mining/mineral resources

8.4.23 There are no areas in this part of the route that are currently being worked or that have planning permission for mineral extraction. In addition this area will not cross a Preferred Mineral Site, a Mineral Safeguarding Area or a Mineral Consultation Area. Geo-conservation sites

8.4.24 No geo-conservation areas such as SSSI or LGS are present in the study area.

Other mitigation measures

8.4.25 No additional mitigation measures are considered necessary to mitigate risks from land contamination at construction phase beyond those set out in the draft CoCP and instigated as part of required remediation strategies. In addition to the excavation and treatment of contaminated soils, it may also be necessary to install ground (landfill) gas and leachate control systems within affected old backfilled sites, on a temporary or permanent basis, in order to ensure that gas and leachate migration pathways are controlled and do not adversely affect the Proposed Scheme or the wider environment.

Summary of likely significant residual effects

8.4.26 No likely significant adverse effects are anticipated with the application of the mitigation measures detailed above.

8.5 Effects arising from operation

8.5.1 Users of the Proposed Scheme (i.e. rail passengers), whilst within trains, will at all routine times be within a controlled environment, and have therefore been scoped out of the assessment.

Avoidance and mitigation measures

8.5.2 Maintenance and operation of the Proposed Scheme will be in accordance with environmental legislation and good practice whereby appropriate spillage and pollution response procedures will be established.

Assessment of impacts and effects

8.5.3 One vent shaft for the tunnel is planned in this area at Little Missenden and its associated auto-transformer station. South Heath mid-point auto-transformer station will be located to the north-west of Frith Hill, west of South Heath. An auto-transformer station can, in principle, be a source of contamination through accidental discharge or leaks of coolant. However, the proposed auto-transformer station, in common with other modern substations, will use secondary containment appropriate to the level of risk.

8.5.4 The operation of the trains may give rise to minor contamination through leakage of hydraulic or lubricating oils. However, such leakage or spillage is expected to be very small and unlikely to result in significant contamination.

8.5.5 It is unlikely that there will be any cumulative effects on land quality receptors due to the environmental controls that will be placed on operational procedures.

Other mitigation measures

8.5.6 No other mitigation measures will be required beyond what has already been outlined relating to land quality in the study area.

8.5.7 There may be ongoing monitoring requirements following remediation works carried out during construction. Such monitoring, including monitoring of groundwater quality or ground gas, could extend into the operational phase of the Proposed Scheme.

Summary of likely significant residual effects

8.5.8 No significant residual effects are anticipated associated with the operation of the Proposed Scheme.

9 Landscape and visual assessment

9.1 Introduction

9.1.1 This section reports the assessment of the likely significant landscape and visual effects. It starts by summarising the baseline conditions found within and around the route of the Proposed Scheme and goes on to describe the significant effects that will arise during construction and operation on landscape character areas (LCAs) and visual receptors.

9.1.2 In this section, the operational assessment section refers not just to the running of the trains but also the presence of the new permanent infrastructure associated with the Proposed Scheme.

9.1.3 Principal landscape and visual issues in the area include:

- temporary effects to LCA and visual receptors during construction arising from the presence of construction plant, compounds, demolition, removal of existing vegetation, temporary access routes, earthworks and stockpiles and severance of agricultural land; and
- permanent landscape and visual effects during operation arising from the presence of new engineered landforms cutting across the existing landscape, vent shaft head houses, auto-transformer station, highway infrastructure, overhead line equipment and regular passing of high-speed trains. Permanent effects, in some instances, will reduce over time as planting established for mitigation as part of the Proposed Scheme matures.

9.1.4 An assessment of effects on the special landscape qualities of the Chilterns AONB is presented in Volume 3, Section 2.A separate but related assessment of effects on the setting of heritage assets is included in Section 6 – Cultural Heritage. Further details on the landscape and visual assessment, including engagement, baseline information and assessment findings, are presented in Volume 5: Appendix LV-001-009, which comprises the following parts:

- Part 1 Engagement with technical stakeholders;
- Part 2 Environmental baseline report;
- Part 3 Assessment matrices; and
- Part 4 Schedule of non-significant effects.

9.1.5 The extent of the landscape and visual study area, the distribution of visual receptor viewpoints and the location of verifiable photomontages has been discussed with Chiltern District Council, Hertfordshire County Council, Buckinghamshire County Council and Chilterns Conservation Board. Summer field surveys, including photographic studies of LCA and visual assessment of viewpoints, were undertaken from June to August 2012 and from May to June 2013. Winter surveys were undertaken from December 2012 to February 2013.

9.2 Scope, assumptions and limitations

9.2.1 The assessment scope, key assumptions and limitations for the cultural heritage assessment are set out in Volume 1, Section 8, the SMR (Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

9.2.2 The study area has been informed by the construction and operational phase zones of theoretical visibility (ZTV), which are shown in Maps LV-07-032b to LV-07-035a and LV-08-032b to LV-08-035a (Volume 5, Landscape and Visual Assessment Map Book). The ZTV has been produced in line with the methodology described in the SMR Addendum (Volume 5: Appendix CT-001-000/2), and is an indication of the theoretical visibility of the Proposed Scheme. In some locations, extensive vegetation cover will mean the actual visibility is substantially less than that shown in the ZTV. 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 the assessment of effects on landscape character areas and visual receptors.

9.2.3 LCA and visual receptors within approximately 500m of the Proposed Scheme have been assessed. Long distance views of up to 1km have been considered at locations such as Hyde Heath Road, South Heath. The study area extends beyond land required for the Proposed Scheme.

Limitations

9.2.4 During the baseline survey there were some areas which were inaccessible (such as private land, commercial premises and residential buildings). In several areas PROW were also inaccessible. In these instances, professional judgement has been used to approximate the likely views from these locations.

9.3 Environmental baseline

Existing baseline

Landscape baseline

9.3.1 This section of the Proposed Scheme falls within the Chilterns Area of Outstanding Natural Beauty (AONB) which was designated in 1965 for the natural beauty of its landscape, its nature and cultural heritage. The underlying chalk geology has resulted in the characteristic rolling hills, plateaus, dry valleys and prominent escarpment. Key settlements include Great Missenden, Hyde Heath, South Heath and Little Kingshill with other small settlements and isolated farmsteads across the area. Land use is predominantly agricultural comprising a mosaic of irregular arable and pasture fields often bordered by unmanaged hedgerows. Steeper sloping ground set rolling chalk downland has become invaded by scrub, whilst other areas afford good tree cover, including well established ancient woodlands. Other land use includes leisure facilities such as golf courses and historic parks and gardens. A network of lanes, minor roads and PRoW cross the area connecting settlements. The Marylebone to Aylesbury Line and the A413 run south-east to north-west through the Misbourne valley, creating a strong linear feature within the landscape.

9.3.2 The LCA have been determined with reference to the Buckinghamshire Landscape Character Assessment[56] and Chiltern District Landscape Character Assessment[57].

9.3.3 Descriptions of all LCA are provided in Volume 5: Appendix LV-001-009 Part 2. For the purposes of this assessment the study area has been sub-divided into six discrete LCA, three of which are most likely to be affected. A summary of these three LCA is provided below. The LCA are shown in Maps LV-02-032b to LV-02-035a (Volume 5, Landscape and Visual Assessment Map Book).

Misbourne Upper North LCA

9.3.4 The narrow and gently flowing River Misbourne follows a shallow, gently sloping chalk valley, with rolling valley sides and a relatively flat bottomed floodplain. The rural valley includes the key settlements of Little Missenden and Great Missenden. There are numerous woodland blocks including ancient and semi-natural woodland scattered across the upper slopes. Un-wooded valley sides are largely in agricultural use. Fields are typically medium to large, regular in shape and bounded by strong relatively well maintained hedgerows highlighting the folds in the landform and creating a cohesive pattern. The relatively well maintained landscape is in fair condition within this LCA. The A413 and the Marylebone to Aylesbury Line run along the valley bottom, whilst narrow winding roads with strong hedgerows run up the valley sides. Despite the presence of busy transport routes, a notable sense of seclusion remains resulting in a medium level of tranquillity. Several interconnecting PRoW pass through the landscape including the South Bucks Way. The LCA is within the Chilterns AONB and contains frequent grand country properties. With registered parks and gardens as well as green belt, the landscape is considered to be valued at a national level. The landscape is of fair condition, medium tranquillity and of national value. Therefore, this area has a high sensitivity to change.

Hyde Heath North LCA

9.3.5 This LCA lies on a plateau adjacent to the Misbourne valley. The field pattern comprises a mix of larger arable fields and smaller pastoral fields bound by dense hedgerows with intermittent trees which are relatively well maintained. The main settlements of South Heath and Hyde Heath are set amongst farmland and woodland. Several other small settlements and farmsteads are located across the area. A network of quiet, narrow winding country roads and tracks connect the smaller settlements and individual farms. Relatively light levels of traffic can be found on the small local roads. Tranquillity is therefore considered to be medium. The LCA is within green belt and the Chilterns AONB and is therefore valued at a national level. The landscape is assessed as being of fair condition. Therefore, this area has a high sensitivity to change.

Lee and Buckland Common Farmland LCA

9.3.6 A complex network of numerous narrow winding roads, tracks and PRoW traverse this elevated and undulating plateau between farmstead and hamlets. The landscape pattern is a mix of larger arable fields and smaller pastoral fields bounded by dense

[56] Buckinghamshire County Council (2001) 'Landscape Plan for Buckinghamshire Part 1' Landscape Character Assessment.
[57] Land Use Consultants (2011) 'Chiltern District Landscape Character Assessment' Prepared for Buckinghamshire County Council and Chiltern District Council.

hedgerows with intermittent trees. Landscape features appear well maintained. To the north-west, larger blocks of woodland cover steeper hillsides. Hedge banks and tall hedgerows enclose rural roads. The sense of seclusion and level of isolation within this mainly rural landscape results in a medium level of tranquillity. The well maintained and managed nature of the landscape ensures that this LCA is considered to be of good landscape condition, within green belt and the Chilterns AONB and therefore is valued at national level, resulting in a high sensitivity to change.

Visual baseline

9.3.7 Descriptions of the identified representative viewpoints are provided in Volume 5: Appendix LV-001-009 Part 2. A summary description of the distribution and types of receptors most likely to be affected is provided below. The viewpoints are shown in Maps LV-07-032b to LV-07-035a and LV-08-032b to LV-08-035a (Volume 5, Landscape and Visual Assessment Map Book). The viewpoints are numbered to identify their locations. In each case, the middle number (xxx.x.xxx) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport.

9.3.8 No protected views have been identified within the study area.

9.3.9 Residential receptors have a high sensitivity to change. Within this area they include properties at the perimeter of Hyde Heath and South Heath, those along Potter Row and isolated receptors in-between.

9.3.10 Recreational receptors also have a high sensitivity to change and are concentrated along PRoW which traverses the area. Numerous PRoW cross the study area, including the Chiltern Link long distance PRoW.

9.3.11 Potential transport receptors (i.e. users of private or public transport) along scenic routes have a medium sensitivity to change and include those on Chesham Lane, Hyde Heath Road and Keepers Lane where rural views are afforded. Views from transport receptors using main roads such as the A413 include lowland pasture, arable farmland and wooded valley sides are considered to have a low sensitivity to change.

Future baseline

9.3.12 There are no known developments which are expected to be built and occupied prior to either the construction or operation of the Proposed Scheme. There are also no known developments which will introduce new visual receptors which may be significantly affected by the Proposed Scheme.

9.4 Temporary effects arising during construction

9.4.1 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 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 main civil engineering works will take place, including establishment of compounds, main earthworks and structure works. The effects associated with the peak construction phase in this CFA will generally be considered to be long term given the construction programme (see Section 2.3). Overall, civil

engineering works in this CFA will be undertaken between the third quarter of 2017 and the end of the first quarter of 2022.

9.4.2 The Chilterns main compound (rail systems) will required for civil engineering and rail installation works, and will be in place for just under eight years. Satellite compounds will be in place for between approximately two years and seven and a half years. The civil engineering works at most individual sites along the route in this CFA would occur for a period of between approximately two to three years. Effects during other phases of works are likely to be lesser due to less construction equipment being required at the time and a reduced intensity of construction activity.

9.4.3 The construction works that have been taken into account in determining the effects on landscape and visual receptors includes:

- construction of the Little Missenden vent shaft, headhouse and auto-transformer station and associated hardstanding;
- construction of the Chiltern tunnel north portal and associated buildings;
- construction of South Heath green tunnel and realignment of Chesham Road and associated roundabout junction with the realigned King's Lane;
- construction of deep cuttings for the intervening sections of route and associated mitigation earthworks as far as Leather Lane;
- construction of overbridges associated with the deep cuttings at Footpath GMI/27, Hyde Lane, Footpath GMI/12, Footpath GMI/2 accommodation overbridge and Leather Lane;
- construction compounds with concentration of buildings, vehicles and materials at Chiltern tunnel north portal satellite compound, South Heath green tunnel (south) satellite compound, South Heath green tunnel (north) satellite compound and the Chiltern tunnel main compound for rail systems installation;
- construction traffic along the Proposed Scheme and along public roads connecting the route and the A413, including Hyde Heath Road, Chesham Road, Frith Hill, Potter Row and Leather Lane; and
- general earthworks along the Proposed Scheme requiring vegetation removal, disruption to agricultural land and the presence of construction plant.

9.4.4 In addition to the construction impacts listed above there are a range of temporary and permanent PRoW diversions required as part of the Proposed Scheme. Details of these diversions can be found in Section 2 of this report.

9.4.5 Demolitions will arise as a result of the construction of the Proposed Scheme. A list of demolitions for each construction compound in this area can be found in Section 2 of this report.

Avoidance and mitigation measures

9.4.6 Measures that have been incorporated into the draft CoCP to avoid or reduce landscape and visual effects during construction include the following (see Volume 5: Appendix CT-003-000):

- maximising the retention and protection of existing trees and vegetation where possible (draft CoCP, Section 12);
- use of well-maintained hoardings and fencing (draft CoCP, Section 5);
- designing lighting to avoid unnecessary intrusion onto adjacent buildings and other land uses (draft CoCP, Section 5);
- replacement of any trees intended to be retained which may be accidentally felled or die as a consequence of construction works (draft CoCP, Section 12);
- contractors will be required to manage flood risk and other extreme weather events which may affect landscape resources during construction; and
- appropriate maintenance of planting and seeding works and implementation of management measures, to continue through the construction period as landscape works are completed (draft CoCP, Section 12).

9.4.7 These measures have been taken account of in the assessment of the construction effects below.

Assessment of temporary impacts and effects

9.4.8 Construction in this area will chiefly comprise the Little Missenden vent shaft and auto-transformer station, the Chiltern tunnel and its north portal within Mantle's Wood together with the excavation of two long cuttings, a green tunnel and associated bridges across the route. The most apparent changes to landscape character and viewpoints during construction will relate to the temporary presence of construction plant, the removal of existing landscape features, such as trees, hedges and agricultural land, the construction of mitigation earthworks and the introduction of temporary material stockpiles. The height of the construction plant and close proximity of construction activities to viewpoints, coupled with the absence of intervening screening (apart from the site hoardings) will result in significant visual effects during construction. Existing topography and the retention of intervening hedgerows and trees will partially screen low-level construction activity in certain locations.

Landscape assessment

9.4.9 The following section describes the likely significant effects on LCAs during construction. All LCAs within the study area considered to experience a non-significant effect (minor adverse or negligible) are described in Volume 5: Appendix LV-001-009 Part 4.

Misbourne Upper North LCA

9.4.10 The majority of the route will run through the character area within bored tunnel. The construction of the Little Missenden vent shaft and auto-transformer station, close to the A413, will require the use of large plant including a crane. It will include the

construction of a headhouse integrated within earthworks and an associated area of hardstanding to accommodate maintenance and emergency vehicles. In addition, adjacent to the headhouse, an area will be assigned for the provision of an auto-transformer station. Impacts will arise from the removal of roadside vegetation, the loss of agricultural land and the introduction of new features within the rural setting.

9.4.11 The construction of the Chiltern tunnel north portal and cutting will require the removal of approximately 6.2ha (31%) of woodland within Mantle's Wood; an area of intact and replanted ancient woodland. Approximately 3.5ha (27%) of Farthings and Hedgemoor woodland of which 0.5ha is ancient replanted woodland will be removed during construction. This will involve a major alteration to the woodland which forms a key feature of the character area.

9.4.12 Tranquillity will be reduced locally by activities including the construction of the vent shaft headhouse, tunnel portal and the route in cutting. Tranquillity will also be affected by an increase in construction traffic on the A413, Chesham Road and Frith Hill. A sense of seclusion will be lost locally where large areas of woodland are removed, opening views across the Misbourne valley.

9.4.13 The removal of woodland and field hedgerows will result in the disruption of field patterns altering key characteristics of the landscape setting. Activity associated with the construction of mitigation earthworks on arable fields adjacent to the Proposed Scheme will be an incongruous element within the landscape. Therefore, the magnitude of change is considered to be high.

9.4.14 The high magnitude of change, assessed alongside the high sensitivity of the character area, will result in a major adverse effect.

Hyde Heath North LCA

9.4.15 There will be extensive construction activity across this LCA. The Proposed Scheme will be in a cutting approximately 23m deep. The cutting and associated construction activity will result in the loss and severance of woodland, including approximately 2.3ha (31%) of Sibley's Coppice, agricultural fields and properties along Hyde Lane. It will involve the removal of hedgerows where they intersect the Proposed Scheme and will interrupt the continuity of existing field patterns. The Hyde Lane overbridge will be constructed using cranes and other machinery, temporarily introducing new features into the landscape during the construction phase. To the south of South Heath a section of green tunnel will be constructed requiring existing vegetation, including an area of Sibley's Coppice, to be removed and a number of properties on Chesham Road, King's Lane and Frith Hill to be demolished. The South Heath green tunnel (south) satellite compound will be located to the south of Chesham Road realignment. The construction activity associated with the permanent realignment of B485 Chesham Road across the green tunnel, the associated realignment of King's Lane, and provision of a roundabout junction with Chesham Road will result in the severance of agricultural fields and the loss of field boundary hedgerows.

9.4.16 The loss of woodland and field boundaries and removal of vegetation will substantially alter the character and setting of Hyde Heath North LCA. Large-scale construction activity including the formation of mitigation earthworks on fields adjacent to the Proposed Scheme will be an incongruous element within the landscape. There will

also be an increase in the movement of construction traffic along the A413, Chesham Road and Hyde Heath Road (accessing the portal). These combined activities will noticeably reduce tranquillity. Therefore the magnitude of change is considered to be high.

9.4.17 The high magnitude of change, assessed alongside the high sensitivity of the character area, will result in a major adverse effect.

Lee and Buckland Common Farmland LCA

9.4.18 Construction will include a short section of the South Heath green tunnel, a section of cutting, the north portal and associated buildings. This will require areas of agricultural fields to be taken out of cultivation, disrupting the existing continuity of field patterns. Several bridges will also be constructed introducing prominent elements within the character area. Cranes will be used to construct the overbridges, temporarily introducing new features within the landscape.

9.4.19 The loss of field boundaries and removal of vegetation will substantially alter the character and setting of Lee and Buckland Common Farmland LCA. Large-scale construction activity including the formation of mitigation earthworks on fields adjacent to the Proposed Scheme will be an incongruous element within the landscape. The introduction of construction compounds and associated plant located in the vicinity of South Heath green tunnel and Leather Lane overbridge, will introduce new features that will form prominent elements uncharacteristic of the rural setting. These combined activities will noticeably reduce tranquillity. Taking the above into account, the magnitude of change is considered to be high.

9.4.20 The high magnitude of change, assessed alongside the high sensitivity of the character area, will result in a major adverse effect.

Visual assessment

9.4.21 The following section describes the likely significant effects on visual receptors during construction. The construction assessment has been undertaken during winter, in line with best practice guidance, to ensure a robust assessment. However, in some cases, visibility of construction activities may be reduced during summer when vegetation, if present in a view, will be in leaf. Where residential receptors experience significant effects at night time arising from additional lighting, these are also presented in this section. Representative viewpoints within the study area considered to experience a non-significant effect (minor adverse or negligible) are described in Volume 5: Appendix LV-001-007 Part 4.

9.4.22 The number identifies the viewpoint locations which are shown in Maps LV-07-032b to LV-07-035a (Volume 5, Landscape and Visual Assessment Map Book). In each case, the middle number (xxx.**x**.xxx) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport, 6: Employment and 7: Active Sports.

9.4.23 Where a viewpoint may represent multiple types of receptor, the assessment is based on the most sensitive receptors. Effects on other receptor types with a lower sensitivity may be lower than those reported.

Viewpoint 083.4.001: View north-west from Mop End Lane across the A413 Amersham Road

9.4.24 There will be filtered views through roadside vegetation across the A413 Amersham Road to the Little Missenden vent shaft satellite compound (approximately 250m distance away) in the middle ground. There will be views of a roadhead, earthworks and associated stockpiles, as well as construction machinery. The construction of a temporary access and construction compound will also form part of the works and an increase in construction traffic will be evident in the centre of the view. As a result, the magnitude of change is considered to be medium.

9.4.25 The medium magnitude of change assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 083.2.002: View east from Parkview Cottages along the A413 Amersham Road

9.4.26 There will be filtered views through garden vegetation of the Little Missenden vent shaft satellite compound in the middle ground (approximately 200m). Existing views will be opened up as vegetation is removed to accommodate site access. The taller plant required to construct the vent shaft and accompanying headhouse will be visible in the east. An increase in construction traffic using the A413 Amersham Road during the works will also be apparent. Given the scale of the construction within the view, the magnitude of change is considered to be medium.

9.4.27 The view from this location during construction is illustrated in the photomontage shown in Figure LV-01-188 (Volume 2, CFA9 Map Book).

9.4.28 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 083.3.003: View north-east from PRoW (Footpath LMI/22/1), South Bucks Way east of Little Missenden

9.4.29 There will be filtered views through field hedgerows and roadside vegetation towards the Little Missenden vent shaft satellite compound with material stockpiles and plant associated with the roadhead in the background (approximately 550m away). The tall cranes will be visible above roadside trees bordering the A413 Amersham Road. The removal of roadside vegetation will be a noticeable element in the view. An increase in construction traffic will be apparent along the A413 Amersham Road. Overall, the magnitude of change is considered to be medium.

9.4.30 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 084.3.001: View south from PRoW (Footpath LMI/40/2) towards the A413 Amersham Road

9.4.31 There will be open views (approximately 150m) to the south-east of Keeper's Wood towards the Little Missenden vent shaft satellite compound, earthworks and associated plant in the foreground. Excavated material will be stored in temporary material stockpiles introducing a new feature within the view. Beyond the vent shaft headhouse, an increase in construction vehicles will be evident on the A413

Amersham Road. Due to the open views of construction activities in close proximity to the receptor, the magnitude of change is considered to be high.

9.4.32 The high magnitude of change assessed alongside the medium sensitivity of the receptor will result in a major adverse effect.

Viewpoint 086.2.001: View south from Bullbaiters Lane and PRoW (Bridleway LM/27/1) towards Mantles Wood

9.4.33 There will be filtered views (approximately 400m) through garden and field boundary vegetation of the Chiltern tunnel main compound. The removal of an adjacent field boundary on the east side of Mantle's Wood together with the partial loss of woodland will open up views of the access road leading down to the Chiltern tunnel north portal and there is the potential for elevated views of the of the construction works associated with the tunnel portal from Footpath LM/27/1. Due to the open views of construction activities in close proximity, the magnitude of change is considered to be high.

9.4.34 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 087.2.001: View north-east from Hyde Lane and adjacent residential properties

9.4.35 Views from this location (approximately 450m) will be filtered through intervening vegetation towards the construction of an approximately 75m wide and 20m deep cutting. There will also be filtered views of the demolition of properties and outbuildings, along with views of the removal of field boundary vegetation and earthworks excavation in the background. Footpath GMI/27 accommodation overbridge will be visible from this location. A crane will also be clearly visible. The extensive construction activities will be prominent within the view and will result in a medium magnitude of change.

9.4.36 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 087.2.002: View north from Hyde Lane and adjacent residential properties

9.4.37 There will be filtered views (approximately 100m) of the works associated with the construction of the cutting in the foreground and oblique views of the demolition of properties on Hyde Lane. The removal of field boundary vegetation and the excavation of material will also open up views. Excavated material will be stored in stockpiles up to 3m high, forming landscape screening bunds, screening views of construction activity associated with the cutting and sections of the Footpath GMI/27 accommodation overbridge. The cutting will directly affect Chapel Farm and Sheepcotts Cottage curtilage. Hyde Lane will be severed by the cutting opening up views across the cutting. A crane will also be a prominent element within the view clearly visible from this receptor. Overall, the magnitude of change is considered to be medium.

9.4.38 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 087.3.003: View north from PRoW (Footpath LMI/21)

9.4.39 From this location there will be views (approximately 50m) of works in the foreground associated with the construction of the Chiltern tunnel north portal and a section of the route in cutting. The removal of a substantial portion of Mantle's Wood will open up views to the east across agricultural fields. The Chiltern tunnel north portal compound will also be visible within the middle ground. Construction activities will be highly visible and incongruous within the existing view and the magnitude of change is therefore considered to be high.

9.4.40 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 088.2.001: View south from Hyde Heath Road and residential properties on Chesham Road

9.4.41 There will be filtered views through the back gardens from properties along Hyde Heath Road of mitigation earthworks in the middle ground and the construction of the South Heath cutting in the background (approximately 700m). There will be filtered views towards the construction of the Hyde Lane overbridge and particularly of the crane required for its construction. Overall, the magnitude of change is considered to be medium.

9.4.42 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 088.4.002: View south-west from Hyde Heath Road

9.4.43 There will be filtered views through roadside vegetation to construction activity associated with the construction of the embankment and Footpath GMI/27 accommodation overbridge and associated mitigation earthworks in the middle ground. There will also be filtered views through roadside vegetation of the Chiltern tunnel north cutting in the background (approximately 900m). There will be distant background views of construction activity associated with Hyde Lane overbridge. Construction activities will be incongruous within the existing view and the magnitude of change is therefore considered to be high.

9.4.44 The high magnitude of change assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 088.2.004: View south-east from PRoW (Footpath GMI/23/6) and residential property The Hyde

9.4.45 Views of the construction activities in the middle ground of the view (approximately 500m) will be filtered by existing intervening vegetation. The removal of areas of existing woodland will be most visible. There will also be views of the South Heath green tunnel (south) satellite compound at Chesham Road and associated plant including the crane required for the construction of the Hyde Lane overbridge. Temporary material stockpiles will be visible, as will the construction of a balancing pond. Due to, the partially screened views of construction activities, the magnitude of change is considered to be medium.

9.4.46 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 088.4.003: View south-west from Hyde Heath Road

9.4.47 The construction of the approximate 75m wide cutting will be visible (approximately 600m), along with removal of field boundaries and woodland plots. Open views of the middle ground will be dominated by temporary material stockpiles of construction materials and mitigation earthworks. The tops of cranes will also be visible in the background above Mantle's Wood, related to the construction of the Chiltern tunnel north portal worksite. Due to the open visibility of construction activities, the magnitude of change is considered to be high.

9.4.48 The high magnitude of change assessed alongside the low sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 089.3.003: View north from PRoW (Footpath GMI/33/5)

9.4.49 Temporary material stockpile areas and landscape mitigation earthworks will be highly visible in the immediate foreground; earthworks will also be visible on the other side of the Proposed Scheme further east. There will be filtered views of the cutting excavation works (approximately 200m) between the intervening stockpiles, as well as works associated with South Heath green tunnel. Due to the visibility of construction activities, the magnitude of change is considered to be high.

9.4.50 The high magnitude of change assessed alongside the medium sensitivity of the receptor will result in a major adverse effect.

Viewpoint 089.2.004: View north-east from Cudsdens Court residential properties

9.4.51 Temporary material stockpiles up to 5m high will be visible in the foreground. The construction access road and construction compound will also be visible in the middle ground. There will be filtered views (approximately 200m) through hedgerow vegetation and intervening earthworks of construction of the South Heath green tunnel in the middle ground. The demolition of properties on the alignment of the route will also be visible, including the former Annie Bailey's public house and restaurant on Chesham Road.

9.4.52 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 090.2.001: View south-west the from B485 Chesham Road and associated residential properties

9.4.53 There will be filtered views of landscape mitigation earthworks distributed across re-profiled agricultural fields in the foreground. There will be partially filtered views (approximately 250m) through garden vegetation and across agricultural fields towards the construction of the Hyde Lane overbridge and cutting, including the demolition of several properties and outbuildings. There will be filtered views through the gaps in vegetation of South Heath green tunnel (south) satellite compound and associated plant movements. Due to the addition of these highly visible construction activities, the magnitude of change is considered to be high.

9.4.54 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 090.3.002: View south-west from PRoW (Footpath GMI/23/5)

9.4.55 Construction works associated with the creation of landscape mitigation earthworks will be highly visible the foreground. The excavation and construction of a section of the South Heath green tunnel and the route in cutting will be visible in the background (approximately 500m). Vegetation removal required to enable construction, will open up views across King's Lane and Chesham Road. The demolition of properties on the route and the removal and replacement of sections of the existing road network will be visible. Associated plant movement including a number of cranes will be visible above existing vegetation. Due to the presence of construction activities which will be highly visible, the magnitude of change is considered to be high.

9.4.56 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 091.3.001: View north-east from PRoW (Footpath GMI/13/3)

9.4.57 There will be open views of the construction of the cutting, access road to the tunnel portal from Frith Hill, South Heath green tunnel and associated portal structures in the middle ground (approximately 200m). The introduction of large temporary material stockpiles of excavated material west of the Proposed Scheme combined with open and extensive views of construction activities and plant will result in a high magnitude of change.

9.4.58 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 091.3.002: View north-east from PRoW (Footpath GMI/12/1)

9.4.59 There will be open views of the construction of the cutting and Footpath GMI/2 accommodation overbridge providing access to a land parcel associated with Strawberry Hill Farm[58] in the middle ground (approximately 200m). Views of temporary material stockpiles stored in bunds up to 5m high and construction traffic will also be visible from this location. In addition to other construction plant, tall cranes will also be visible on the skyline. Construction activities and plant will be highly visible within the view resulting in a high magnitude of change.

9.4.60 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 092.2.001: View south-west from Frith Hill including associated residential properties

9.4.61 Properties on the outer edge of Frith Hill will experience filtered views of works associated with the construction of the South Heath green tunnel in the foreground (approximately 200m). The removal of field boundary vegetation will open up views to a degree. Construction plant, including a tall crane, will be visible above the existing vegetation. There will also be an increase in construction traffic on Frith Hill. Furthermore, the demolition of middle ground properties including Weights and Measures Gym and Chilterns Cottage on Frith Hill will also be visible from this

[58] Located in the Wendover, Dunsmore and Halton (CFA10) area. More information can be found in Volume 2, Report 10.

location. As a result of partially filtered views of incongruous construction activities in close proximity to the viewpoint, the magnitude of change is considered to be high.

9.4.62 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 092.3.003: View south-west from PRoW (Footpath GMI/13/3)

9.4.63 There will be open views of construction activity associated with the mitigation earthworks over South Heath green tunnel north portal and a large balancing pond in the immediate foreground. There are also views of construction activity at South Heath green tunnel (north) satellite compound in the middle ground (approximately 100m), including cranes. Temporary material stockpiles of excavated material will be visible from this location in the background of the view. Due to the presence of construction activities in close proximity to the viewpoint which will be highly visible, the magnitude of change is considered to be high.

9.4.64 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 093.3.001: View north-east from PRoW (Footpath GMI/12/1)

9.4.65 Views of works in the middle ground (approximately 450m) will be filtered by intervening field boundary hedgerows and trees to the Proposed Scheme in cutting. Gaps in the dense vegetated field boundaries removed to accommodate the construction of the route will also be visible allowing views east to west along the Proposed Scheme. There will be filtered views of the cranes required for the construction of the Leather Lane realignment. Temporary material stockpiles of excavated material will be visible approximately 400m away on the far side of the cutting. The construction of a new access track will also be seen. The introduction of incongruous construction activities including vegetation removal will be notable from this viewpoint. Therefore the magnitude of change is considered to be high.

9.4.66 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 094.2.001: View south-west from PRoW (Footpath GMI/2/10 and residential properties on Potter Row

9.4.67 There will be filtered views through garden vegetation of properties on Potter Row, towards construction of the cutting and associated plant machinery in the middle ground of the view (approximately 50m). Temporary material stockpiles of topsoil will be evident within the immediate foreground of the view. There will be oblique views of cranes constructing road and pedestrian bridges in the middle ground and on the local skyline. The excavation of a balancing pond will be visible to the left of the view. Due to the range of construction operations within the view, the magnitude of change is considered to be high.

9.4.68 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 094.2.002: View south-west from residential properties on Potter Row

9.4.69 This viewpoint is indicative of views south from residential properties along Potter Row. There will be filtered views through garden vegetation towards the excavation of the cutting and associated plant in the background (approximately 300m). Distant views of the Leather Lane satellite compound and machinery in the northern extent of the view will be heavily filtered by roadside vegetation. Within the middle ground there will be views of temporary material stockpiles on the adjacent agricultural fields. There will be views of the tops of cranes required for construction of bridges for road and pedestrian access, and in particular views of the Leather Lane overbridge. The construction of a balancing pond will also be visible in the middle ground. Due to the presence of highly visible incongruous construction activities, the magnitude of change is considered to be high.

9.4.70 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Cumulative effects

9.4.71 Appendix CT-004-000 identifies developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the baseline for the construction of the Proposed Scheme.

9.4.72 There are no known developments which are assumed to be under construction at the same time as the Proposed Scheme which will result in a consequential cumulative effect on LCAs or viewpoints. Cumulative developments which have been considered in the assessment are shown on Maps CT-13-01-017 to CT-13-01-018 (Volume 2, CFA9 Map Book).

Other mitigation measures

9.4.73 To further reduce the significant effects described above, consideration of where planting can be established early in the construction programme will be given during the detail design stage. This may include consideration of early planting in ecological mitigation sites which would have the additional benefit of providing some visual screening. However, not all landscape and visual effects can be practicably mitigated due to the visibility of construction activity and the sensitivity of surrounding receptors.

Summary of likely residual significant effects

9.4.74 The effects described above will be temporary and reversible in nature lasting only for the duration of the construction works. Any residual effects will generally arise from the widespread presence of construction activity and construction plant within the landscape and viewed from surrounding residential receptors, and users of PRoW and main roads within the study area.

9.5 Permanent effects arising during operation

9.5.1 The specific elements of the Proposed Scheme that have been taken into account in determining the effects on landscape and visual receptors includes:

- Little Missenden vent shaft, including a headhouse, hardstanding area, auto-transformer station and a short access road from the A413;
- Chiltern tunnel north portal, head wall and porous portal hood structure and associated access road;
- portal buildings and access roads at either end of South Heath green tunnel and a mid-point auto-transformer station at track level at the north portal;
- Chesham Road and King's Lane realignment and new roundabout junction between the two;
- deep cuttings for the intervening sections of route as far as Leather Lane and associated overbridges at Footpath GMI/27, Hyde Lane, Footpath GMI/12, Footpath GMI/2 accommodation overbridge and Leather Lane;
- permanent noise fence barriers located at the base of cuttings;
- relocation of overhead power lines and pylons;
- the permanent removal of ancient woodland within Mantle's Wood, Farthings Woods and Sibley's Coppice; and
- the presence of landscape earthworks designed to integrate the Proposed Scheme into the landscape and associated balancing ponds.

Avoidance and mitigation measures

9.5.2 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 operation of the Proposed Scheme. Measures that have been incorporated into the design of the Proposed Scheme include:

- embankments and cuttings, both for the route of the Proposed Scheme and highway realignments, have been shaped so as to integrate the Proposed Scheme into the character of the surrounding landscape. Planting will reflect tree and shrub species native to the landscape;
- where it is considered that a noise fence barrier will create a visual impact on neighbouring residential properties a landscape bund will be provided where reasonably practicable;
- balancing ponds will be integrated into the landscape to alleviate flooding and also provide opportunities for biodiversity; and
- landscape earthworks and planting, including native broad-leaved woodland, shrub and hedgerows, will be implemented along various sections of the Proposed Scheme to screen the Proposed Scheme from neighbouring residential properties and users of adjacent PRoW and to aid integration of the Proposed Scheme into the landscape. Selection of species will take into account possible climate change impacts associated with the quality and availability of water and the potential increase in pests and diseases.

9.5.3 These measures have been taken account of in the assessment of the operational effects below.

Assessment of impacts and effects

9.5.4 The likely significant effects on landscape character and viewpoints during operation will result from the introduction of the Proposed Scheme in cutting, the introduction of green tunnel and associated portals, new pedestrian and vehicular bridges, new vent shaft headhouse and the introduction of highway infrastructure into the rural environment. New areas of mitigation planting will also have an effect upon future local landscape character and views from identified receptors. In the most part, landscape and visual impacts associated with the scheme will reduce over time as any proposed mitigation planting establishes and aids screening of the Proposed Scheme thereby reducing the significance of effects.

Landscape assessment

9.5.5 This section describes the significant effects on LCAs during year 1, year 15 and year 60 of operation. Non-significant effects on LCAs are presented in Volume 5: Appendix LV-001-009 Part 4.

9.5.6 The assessment of effects in year 15 assume proposed planting has grown by approximately 450mm a year (i.e. trees would be 7-7.5m high). The assessment of effects in year 60 assumes all planting has reached its fully mature height.

Misbourne Upper North LCA

9.5.7 The Proposed Scheme will pass through this LCA in tunnel and deep cutting. Effects on landscape character in year 1 of operation will include:

- presence of vent shaft headhouse, auto-transformer station and associated earthworks; and
- presence of Chiltern tunnel north portal and associated buildings within deep cutting.

9.5.8 Tranquility will be reduced locally by the perception of trains entering and exiting the tunnel portal. The associated engineered structures at the vent shaft and tunnel portal will be largely inconspicuous elements within the existing setting. Although new planting will have yet to establish, existing vegetation will partially enclose the Proposed Scheme. However, there will be a perceptible loss of large areas of woodland and the area around the cutting will be more open. As a result, the magnitude of change is considered to be low.

9.5.9 The low magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect in year 1 of operation.

9.5.10 By year 15 and beyond to year 60 of operation, the establishment of proposed mitigation planting will result in greater landscape integration and screening of the Little Missenden vent shaft headhouse, auto-transformer station and Chiltern tunnel north portal, thereby reducing predicted effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Hyde Heath North LCA

9.5.11 The Proposed Scheme will be within a tunnel before exiting via the portal concealed within existing woodland, and will then pass within an approximately 23m deep cutting. The route will only form a new feature within the landscape at a local level and will not be perceived throughout the majority of the wider character area. Effects in year 1 of operation within this LCA will include:

- the presence of an approximately23m deep cutting;
- the presence of Hyde Lane overbridge and Footpath GMI/27 accommodation overbridge;
- the presence of South Heath green tunnel; and
- the noticeable absence of large areas of removed woodland.

9.5.12 The Proposed Scheme will sever Hyde Lane, fragmenting the linear settlement through the introduction of a large-scale cutting which will present a notable void within the landscape. Furthermore, the presence of trains entering and exiting the green tunnel and moving through the cutting will reduce tranquility within the locally isolated and peaceful setting. These features will be evident within a localised area of the LCA. Therefore, the magnitude of change is considered to be medium in year 1 of operation.

9.5.13 The medium magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect in year 1 of operation.

9.5.14 By year 15 and beyond into year 60, proposed mitigation will have become well established, integrating the Proposed Scheme into the landscape. The magnitude of change is considered to be low, leading to a predicted non-significant effect in year 15 and 60. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Lee and Buckland Common Farmland LCA

9.5.15 The route will run through the character area in a small section of green tunnel approximately 250m in length, followed by a 1.5km long cutting. Effects on landscape character in 2026 within this LCA will include:

- the presence of Footpath GMI/12 overbridge, Footpath GM/2 accommodation overbridge and Leather Lane overbridge; and
- the presence of the South Heath green tunnel and associated portal, including portal buildings.

9.5.16 The most evident change to landscape character will result from the loss of existing landscape features such as a woodland block and agricultural fields. New features within the landscape will include the route in cutting and new bridges. Tranquility will be reduced through the introduction of passing trains. As such, the magnitude of change is considered to be medium in 2026.

9.5.17 The medium magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect in year 1 of operation.

9.5.18 By year 15 and beyond into year 60 planting proposed as part of the Proposed Scheme will have matured, concealing the green tunnel and associated portal structure and buildings. Areas of planting adjacent to the route will have established to conceal the route in cutting thereby reducing predicted effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Visual assessment

9.5.19 This section describes the significant effects on visual receptors during year 1, year 15 and year 60 of operation. Non-significant effects on visual receptors are presented in Volume 5: Appendix LV-001-009 Part 4.

9.5.20 The view of the Proposed Scheme from viewpoint 083-2-002 (illustrated in the photomontage shown in Figure LV-01-037 (winter view, year 1 of operation) and LV-01-230 (summer view, year 15 of operation) (Volume 2, CFA9 Map Book) would not be significantly affected.

9.5.21 For each viewpoint the following assessments have been undertaken:

- effects during winter of year 1 of operation;
- effects during summer of year 1 of operation;
- effects during summer of year 15 of operation; and
- effects during summer of year 60 of operation.

9.5.22 No significant effects at night- time arising from additional lighting have been identified.

9.5.23 The number identifies the viewpoint locations which are shown in Maps LV-08-032b to LV-08-035a (Volume 5, Landscape and Visual Assessment Map Book). In each case, the middle number (xxx.x.xxx) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport.

9.5.24 Where a viewpoint may represent multiple types of receptor, the assessment is based on the most sensitive receptors. Effects on other receptor types with a lower sensitivity may be lower than those reported.

Viewpoint 084.3.001: View south from PRoW (Footpath LMI/40/2) towards the A413 Amersham Road

9.5.25 There will be open views across the adjacent agricultural field in the foreground (approximately 150m) where the vent shaft associated with the Proposed Scheme will be sited adjacent to Keeper's Wood. There will be elevated views of the vent shaft headhouse, auto-transformer station, hard standing and associated planting and earthworks. Mitigation planting will not provide screening at this early stage. As views will be partially filtered by intervening vegetation within Keeper's Wood, the magnitude of change is considered to be medium.

9.5.26 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.27 There will be no change in the summer assessment due to the close proximity of the route, open aspect of the view and lack of intervening vegetation. However, where

the PRoW passes through Keeper's Wood, existing trees in leaf will filter views to a varying degree during year 1 of operation.

9.5.28 By year 15 and beyond to year 60 of operation, intervening planting established around the vent shaft headhouse and auto-transformer station will have matured, providing improved landscape integration and screening. This will reduce predicted effects to being non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 086.2.001: View south from Bullbaiters Lane and PRoW (Bridleway LM/27/1) towards Mantle's Wood

9.5.29 There will be filtered, oblique views (approximately 500m) across adjacent agricultural land to the Chiltern tunnel north portal and associated access road in cutting in the background. The adjacent agricultural field, which will have a 3m landscape bund, will screen the lower features of the Proposed Scheme. The mitigation woodland planting will be immature but visible in the middle ground of the view. Passing trains and the overhead line equipment will not be visible as they will be in deep cutting. These changes will be partially screened by the intervening vegetation of Mantle's Wood and landform, resulting in a medium magnitude of change.

9.5.30 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.31 In year 1 of operation, although newly planted vegetation will not provide an effective screen, existing intervening vegetation within the residential gardens and along Bullbaiters Lane will filter views. This will reduce the effect to non-significant in 2026. These are reported in Part 4 of Appendix LV-001-009 (Volume 5).

9.5.32 By year 15 and beyond to year 60 of operation, the linear belt of vegetation planted parallel to Bullbaiters Lane, adjacent to the farm track to the north, will have matured, providing additional screening. This will reduce predicted effects to being non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 087.2.001: View north-east from Hyde Lane and adjacent residential properties

9.5.33 There will be filtered views (approximately 375m) through existing field boundary hedgerows to the route in cutting in the background. Consequently, passing trains and the overhead line equipment will not be visible from this location. Areas of vegetation cleared during construction will remain apparent in year 1 of operation. The adjacent mitigation planting will not be sufficiently mature to form an effective screen of the route in cutting. Views of the Footpath GMI/27 accommodation overbridge in the background will be filtered by field hedgerows. Therefore the magnitude of change is considered to be medium.

9.5.34 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.35 In year 1 of operation, while intervening field boundary and woodland vegetation will partially screen views of the route, the magnitude of change is considered to remain medium meaning the overall effect will be unchanged.

9.5.36 By year 15 and beyond to year 60, mitigation planting will have matured, further screening views of the Proposed Scheme, thereby reducing effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 087.2.002: View north from Hyde Lane and adjacent residential properties

9.5.37 There will be filtered views of the route in cutting and the associated Hyde Lane overbridge in the foreground (approximately 30m). From this location passing trains and associated overhead line equipment will not be visible. A section of the garden of Chapel Farm will have been removed, opening up views across the cutting to the properties and fields beyond. The mitigation planting will not have established and therefore the magnitude of change is considered to be high.

9.5.38 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect in the winter of year 1 of operation.

9.5.39 There will be no change in visual impact during the summer of year 1 of operation due the immaturity of proposed mitigation planting.

9.5.40 By year 15 and beyond to year 60 both existing garden and mitigation planting will predominantly screen views of the cutting and Hyde Lane overbridge. This will reduce effects to being non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 087.3.003: View north from PRoW (Footpath LMI/21)

9.5.41 There will be views of an extensive area of proposed woodland planting adjoining Mantle's Wood in the foreground. These views (approximately 50m) will extend across agricultural fields in the middle ground towards the Chiltern tunnel north portal, associated retaining structures, portal buildings and area of hard standing to accommodate emergency and maintenance vehicles. Due to the addition of these features which will be highly visible and incongruous with the existing view, the magnitude of change is considered to be high.

9.5.42 The view of the Proposed Scheme in the summer of year 1 of operation is illustrated on the photomontage shown in Figure LV-01-038 (Volume 2, CFA9 Map Book).

9.5.43 The high magnitude of change assessed alongside the medium sensitivity of the receptor will result in a major adverse effect in the winter of year 1 of operation.

9.5.44 Given the open aspect of the view, the close proximity of the route and immature mitigation planting, there will be no change to the assessment during the summer of year 1 of operation.

9.5.45 By year 15 and beyond to year 60 of operation, the extensive new woodland plot to the south of the portal will have established to form an effective screen, both enclosing and concealing the Proposed Scheme from this location. This will reduce effects to being non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 088.2.001: View south from Hyde Heath Road and residential properties on Chesham Road

9.5.46 There will be partially filtered views through garden and field boundary vegetation towards the Proposed Scheme in the background of the view (approximately 550m). Passing trains and associated overhead line equipment will be concealed within an approximately 25m deep cutting. The existing woodland belt in the west of the view will partially screen views of Hyde Lane overbridge and a long section of the route in cutting. The realignment of Chesham Road and associated vegetation removal will be visible. Due to the Proposed Scheme being partially filtered by existing vegetation and screened by the intervening landform, the magnitude of change is considered to be medium.

9.5.47 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.48 In year 1 of operation of operation, although mitigation planting will have yet to establish, intervening woodland and field boundary vegetation will filter views of the Proposed Scheme. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

9.5.49 By year 15 and beyond to year 60 of operation, large plots of woodland planting will have established between the receptor and Proposed Scheme, screening views of the route in cutting. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.Viewpoint 089.3.003: View north from PRoW (Footpath GMI/33/5).

9.5.50 There will be open views across agricultural fields in the foreground towards the Proposed Scheme in cutting and the South Heath green tunnel permanent access route (approximately 150m). These views will be partially screened by earthworks. Passing trains and overhead line equipment will not be visible as they will be within the 20m deep cutting. The mitigation planting will not have yet established. Therefore the magnitude of change is considered to be medium.

9.5.51 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.52 Due to the close proximity of the route and the open aspect of the view there will be no change to the assessment during the summer months of year 1 of operation.

9.5.53 By year 15 and beyond to year 60 of operation, a large area of proposed woodland planting will have established to form an effective screen. Consequently, the effects on this receptor will no longer be significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 089.2.004: View north-east from Cudsdens Court residential properties

9.5.54 There will be open views (approximately 50m) towards the Proposed Scheme in green tunnel, cutting and associated balancing pond in the middle ground. The mitigation planting will not have become established enough to screen views in year 1 of operation. Passing trains and associated overhead line equipment will not be visible

due to the cutting and re-profiled fields in the middle ground. The magnitude of change is considered to be medium.

9.5.55 The view of the Proposed Scheme in the winter of year 1 of operation is illustrated on the photomontage shown in Figure LV-01-040 (Volume 2 CFA9 Map Book).

9.5.56 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.57 Due to the close proximity of the Proposed Scheme, the open aspect of the view and the immature proposed planting there will be no change to the assessment during summer of year 1 of operation.

9.5.58 By year 15 and beyond to year 60 of operation, planting associated with the green tunnel and portal will have established to integrate the structure with the surrounding landscape. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

9.5.59 The view of the Proposed Scheme in the summer of year 15 of operation is illustrated on the photomontage shown in Figure LV-01-231 (Volume 2 CFA9 Map Book).

Viewpoint 090.2.001: View south from B485 Chesham Road and associated residential properties

9.5.60 There will be filtered views through roadside vegetation to the cutting and Hyde Lane overbridge in the foreground (approximately 300m). The vegetation removed and properties demolished during construction will result in open views of the route. Mitigation planting will not be effective in screening views across the cutting, but the depth of the cutting passing trains will screen views of passing trains and the overhead line equipment. Therefore, due to changes being screened by existing intervening vegetation and the landform, the magnitude of change is considered to be medium.

9.5.61 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.62 There will be no change to the assessment during the summer due to the close proximity of the route and the lack of intervening vegetation.

9.5.63 By year 15 and beyond to year 60 of operation, mitigation planting will have matured to provide screening in the immediate foreground. Planting will also conceal the green tunnel and associated portal from this location. This will reduce predicted effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 091.3.001: View north-east from PRoW (Footpath GMI/13/3)

9.5.64 There will be open views (approximately 150m) towards the Proposed Scheme in cutting, the green tunnel and associated north portal access track in the middle ground. The mitigation planting will not have become established enough to screen views in year 1 of operation. Passing trains and the associated overhead line equipment will not be visible, although the Proposed Scheme will be a noticeable feature within the view as upper slopes of the embankment will be visible. The magnitude of change is considered to be medium.

9.5.65 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.66 Due to the close proximity of the Proposed Scheme, the open aspect of the view and the immature proposed planting there will be no change to the assessment during summer of year 1 of operation.

9.5.67 By year 15 and beyond to year 60 of operation, planting associated with the green tunnel and portal will have established to integrate the structure with the surrounding landscape. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 091.3.002: View north-east from PRoW (Footpath GMI/12/1)

9.5.68 There will be open views towards the Proposed Scheme in cutting and the Footpath GMI/2 accommodation overbridge in the middle ground (approximately 100m). The mitigation planting will not have established sufficiently to screen views towards the cutting in year 1 of operation. Passing trains and associated overhead line equipment will not be visible from this location as they pass in cutting, although the railway will still be a noticeable feature within the view. The magnitude of change is considered to be medium.

9.5.69 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.70 There will be no change to the assessment during summer of year 1 of operation due to the close proximity of the route, the open aspect of the view and immature mitigation planting.

9.5.71 By year 15 and beyond to year 60 of operation, mitigation planting will have matured, screening the Proposed Scheme in cutting and partially screening the accommodation overbridge. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 092.2.001: View south-west from Frith Hill including associated residential properties

9.5.72 There will be filtered views towards a section of the green tunnel, associated portal and extensive earthworks re-profiling in the foreground (approximately 50m). The planting on the route of the green tunnel will not yet have established by year 1 of operation. Therefore, the magnitude of change is considered to be medium.

9.5.73 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.74 Due to the close proximity of the Proposed Scheme and the lack of intervening vegetation there will be no change to the assessment during the summer months of year 1 of operation.

9.5.75 By year 15 and beyond into year 60 hedgerow and woodland reinstatement planting will have established, screening views to the green tunnel in the south-west and portal to the north-west. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 092.3.003: View south-west from PRoW (Footpath GMI/13/3)

9.5.76 There will be open views towards the South Heath green tunnel north portal, South Heath cutting and a large balancing pond in the foreground of the view (approximately 30m). Mitigation planting will not have established enough to screen views of the Proposed Scheme in year 1 of operation. Passing trains and associated overhead line equipment will be located in cutting and as such will not be visible from this location. The magnitude of change is considered to be medium.

9.5.77 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.78 There will be no change to the assessment during summer of year 1 of operation due to the close proximity of the Proposed Scheme, the open aspect of the view and immature mitigation planting. However, vegetation within and surrounding the balancing pond will have begun to mature, aiding integration within the landscape.

9.5.79 By year 15 and beyond to year 60 of operation, planting established on and around the green tunnel and portal will have matured, concealing this element of the Proposed Scheme. The balancing pond will have become well established to become further integrated with the surrounding landscape. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 093.3.001: View north from PRoW (Footpath GMI/12/1)

9.5.80 There will be filtered views of the pedestrian and road bridges in the middle ground (approximately 300m). Passing trains and associated overhead line equipment will not be visible due to the 8m deep cutting. Areas of vegetation removed during construction and subsequent reinstatement planting will be some of the most noticeable changes within the view. The mitigation planting will not have fully established by year 1 of operation. Due to Proposed Scheme being partially filtered by intervening vegetation and landform, the magnitude of change is considered to be medium.

9.5.81 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.82 In the summer of year 1 of operation, although mitigation planting will not offer an effective visual screen, existing intervening field boundary hedgerows will further filter views to the Proposed Scheme in cutting. However, the magnitude of change will remain unaltered.

9.5.83 By year 15 and beyond to year 60 of operation, a band of mitigation planting will have established to form an effective screen, concealing the Proposed Scheme in cutting. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 094.2.001: View south-west from PRoW (Footpath GMI/2/1) and residential properties on Potter Row

9.5.84 There will be filtered views through garden and field boundary vegetation in the foreground to the Proposed Scheme in cutting (approximately 100m). The area of cleared vegetation will be visible from this location, resulting in a more open view. At

this stage the reinstatement and mitigation planting will not have established to screen the view of the cutting. Passing trains and associated overhead line equipment will not be visible; however Footpath GMI/2 accommodation overbridge will be visible to the north. Due to views of the Proposed Scheme being partially filtered by intervening vegetation and screened by intervening landform, the magnitude of change is considered to be medium.

9.5.85 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.86 In the summer of year 1 operation, although proposed mitigation planting will not yet offer an effective screen, existing intervening vegetation within residential gardens and along Potter Row will further screen the Proposed Scheme. This will reduce the effect to non-significant in the summer of year 1 of operation 2026. These are reported in Part 4 of Appendix LV-001-009 (Volume 5).

9.5.87 By year 15 and beyond to year 60 of operation, a large plot of woodland planting will have established adjacent to the receptor. This will reduce effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 094.2.002: View south-west from residential properties on Potter Row

9.5.88 There will be filtered views through garden and field boundary vegetation in the foreground to the Proposed Scheme in an 8m deep cutting (approximately 300m). However, passing trains and associated overhead line equipment will not be visible within the cutting. At this stage reinstatement and screening planting will not have established to mitigate the adverse effects allowing views across the cutting to the agricultural fields beyond. Pedestrian and road bridges crossing the route will be visible, particularly the Leather Lane overbridge. Due to changes in the view being partially filtered by existing vegetation and intervening landform, the magnitude of change is considered to be medium.

9.5.89 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.90 In the summer of year 1 of operation, mitigation planting will not have established, although intervening vegetation within residential gardens and hedgerow field boundaries along Potter Row will offer a degree of screening. Despite existing vegetation, the level of assessment remains unchanged. This will reduce the effect to non-significant in year 1 of operation. These are reported in part 4 of Appendix LV-001-009 (Volume 5).

9.5.91 The summer view of the Proposed Scheme from this location during year 1 of operation is illustrated in the photomontage in LV-01-041 (Volume 2, CFA9 Map Book).

9.5.92 By year 15 and beyond to year 60 of operation, a linear belt of planting running parallel with the Proposed Scheme will have established to form an effective screen, thereby reducing effects to non-significant. These are reported in Part 4 of Volume 5: Appendix LV-001-009.

Viewpoint 094.4.003: View west along Leather Lane

9.5.93 There will be open views to the west of the Proposed Scheme contained within an 8m deep cutting and the nearby elevated Leather Lane bridge (approximately 50m). A balancing pond in the immediate foreground will also be visible. The loss of mature trees along the southern edge of Leather Lane will be noticeable, opening up views to the landscape beyond. This will be particularly evident as reinstated field boundary and woodland planting will not have established in year 1 of operation. The new land profile of the sustainable placement area in CFA10 will be more prominent in year 1 as mitigation planting will not yet soften and integrate the re-profiled topography with its surroundings. Therefore, the magnitude of change is considered to be high.

9.5.94 The high magnitude of change assessed alongside the low sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.95 In the summer of year 1 of operation, although mitigation planting will not yet offer an effective screen, existing vegetation along Leather Lane will provide some limited screening of the Proposed Scheme and Leather Lane bridge. However, despite this additional screening, the magnitude of change will not alter during summer months.

9.5.96 By year 15 and beyond to year 60 of operation, a linear swathe of planting will have established to form an effective screen of the Proposed Scheme in cutting. Embankments associated with Leather Lane bridge will be further screened as mitigation planting matures, softening and integrating the Proposed Scheme with the surrounding landform thereby reducing effects to being non-significant. These are reported in Part 4 of Appendix LV-001-010 (Volume 5).

Cumulative effects

9.5.97 There are no known cumulative developments which are assumed to be completed by year 1 of operation of the Proposed Scheme which will result in consequential cumulative effect on LCAs or viewpoints. Cumulative developments which have been considered in the assessment are shown on Maps CT-13-01-017 to CT-13-01-018 (Volume 5, Cross Topic Appendix 1 Map Book).

Other mitigation measures

9.5.98 The permanent effects of the Proposed Scheme on landscape and visual receptors have been substantially reduced through incorporation of the measures described previously. Effects in year 1 of operation may be further reduced by establishing planting early in the construction programme, which will be considered during the detail design stage. This would provide additional screening and greater integration of the Proposed Scheme into the landscape. However, no other mitigation measures are considered practicable due to the high visibility of elements of the Proposed Scheme and the sensitivity of the surrounding receptors.

Summary of likely residual significant effects

9.5.99 As no other mitigation measures are considered practicable, the permanent residual significant effects during operation remain as described above. In most cases, significant effects will reduce over time as the proposed mitigation planting matures and reaches its designed intention. There will be no significant effects beyond year 15 within this area.

10 Socio-economics

10.1 Introduction

10.1.1 This section reports the likely significant economic and employment effects during the construction and operation of the Proposed Scheme.

10.1.2 The need for a socio-economic assessment results from the potential for the Proposed Scheme to affect:

- existing businesses and community organisations and thus the amount of local employment;
- local economies, including employment; and
- planned growth and development.

10.1.3 The beneficial and adverse socio-economic effects of the Proposed Scheme are reported at two different levels: route-wide; and CFA. Effects on levels of employment are reported at a route-wide level in Volume 3. Localised effects on businesses and observations on potential local economic effects are reported within each CFA report.

Construction

10.1.4 The proposed construction works will have the following relevance in terms of socio-economics in relation to:

- premises demolished, with their occupants and employees needing to relocate to allow for construction of the Proposed Scheme; and
- potential employment opportunities arising from construction in the local area (including in adjacent CFA).

Operation

10.1.5 The operation of the Proposed Scheme will have relevance in terms of socio-economics, in relation to the potential employment opportunities created by new business opportunities.

10.2 Scope, assumptions and limitations

10.2.1 The assessment scope, key assumptions and limitations for the socio-economics assessment are set out in Volume 1, the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

10.2.2 There have been no variations to the socio-economic assessment methodology arising from engagement with stakeholders and community organisations.

10.3 Environmental baseline

Existing baseline

Study area description

10.3.1 Section 2 of this report provides a general overview of the Central Chilterns area which includes data of specific relevance to socio-economics notably demographic and employment data. The following provides a brief overview of the area in terms of employment, economic structure and labour market[59].

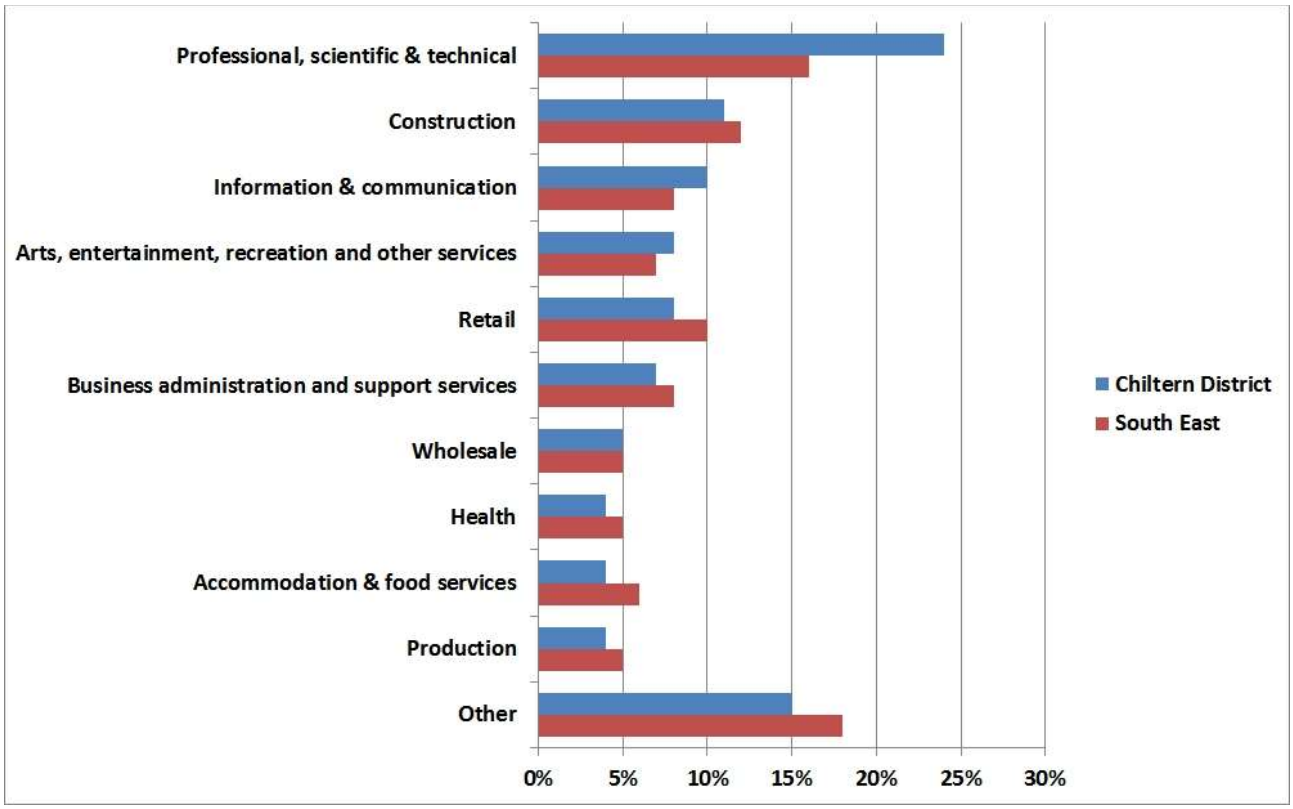
10.3.2 The Central Chilterns area largely comprises rural, semi-rural and small town or village areas, located entirely within the Chiltern District of Buckinghamshire. Where possible, baseline data has been gathered on demographic character areas (DCA)[60] to provide a profile of local communities. Map SE-02-010 (Volume 5, Socio-Economics Map Book) shows the location of the DCA. The area contains Hyde Heath and Little Missenden DCA, Great Missenden DCA and Hyde End, South Heath and Ballinger Common DCA.

Business and labour market

10.3.3 Within Chiltern District there is a wide spread of business types reflecting a diverse range of commercial services. The professional, scientific and technical services sector accounts for the largest proportion of businesses (24%), with the construction (11%), information and communication (10%), and arts, entertainment, recreation and other services (8%) sectors also accounting for relatively large numbers of businesses. This is shown in Figure 6[61]. For comparison within the South East, the professional, scientific and technical services sector also accounts for the largest number of businesses (16%), with construction (12%), retail (10%) and information and communication (8%) sectors also accounting for relatively large numbers of businesses within the region[62].

[59] Further information on the socio-economics baseline, with regard to business and labour market profile, within the area are contained in the Volume 5 Appendix SE-001-009.
[60] DCAs have been determined through an understanding of local context and aim to be aligned as closely as possible to groups of lower super output areas (LSOA).
[61] The Figure presents the proportion of businesses within each business sector but not the proportion of employment by sector.
[62] Office of National Statistics (ONS) (2012) *UK Business: Activity, Size and Location 2011*, ONS, London. Please note 2011 data has been presented to provide an appropriate comparison with 2011 Census data.

Figure 6: Business sector composition in Chiltern District and the South East[63] [64]



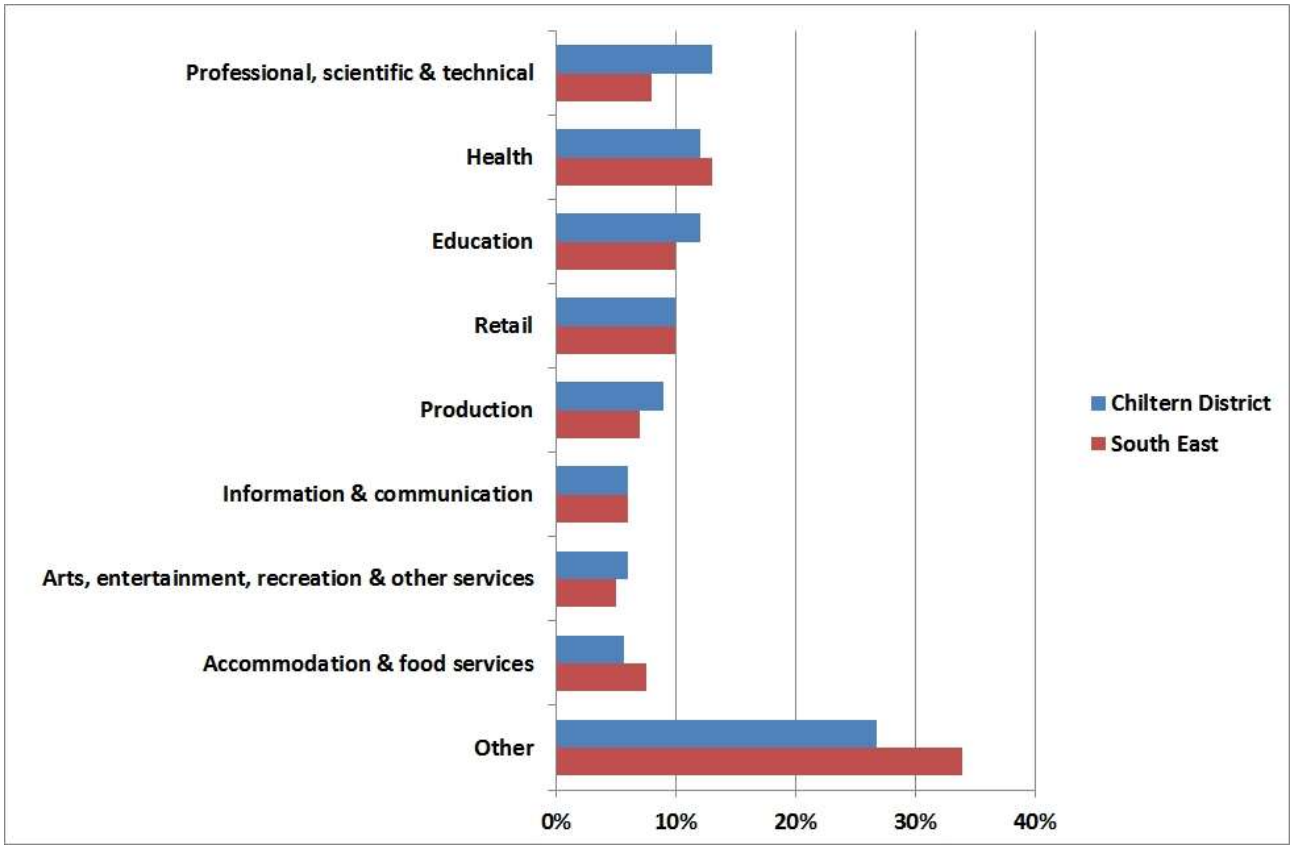
10.3.4 Approximately 31,000 people worked in Chiltern District while 300 people worked within Hyde Heath and Little Missenden DCA, 1,600 within Great Missenden DCA and 300 within Hyde End, South Heath and Ballinger Common DCA[65].

10.3.5 The sector with the highest proportion of employment in the district is professional, scientific and technical (14%). These levels are higher compared to levels across the South East and England (both 8%). There is a high proportion of employment in health in the district (12%), which is in line with regional and national levels (both 12%). There is also a high level of employment in the education sector in the district (11%) compared to that recorded in the South East (10%) and across England (9%). This is shown in Figure 7.

10.3.6 Key sectors, in terms of employment, for Hyde Heath and Little Missenden DCA are health (33%), construction (18%) and retail (13%). In Great Missenden DCA, these are health (33%) education (20%) and professional, scientific and technical (10%). Key sectors in Hyde End, South Heath and Ballinger Common DCA are professional, scientific and technical (17%), property (16%) and information and communication (10%).

[63] 'Other' includes agriculture, forestry and fishing, motor trades, transport and storage, finance and insurance, property, public administration and defence and education sectors.
[64] Office of National Statistics (ONS) (2012), *UK Business: Activity, Size and Location* 2011 ONS, London.
[65] ONS (2012), *Business Register and Employment Survey 2011*, ONS, London

Figure 7: Proportion of employment by industrial sector in Chiltern District and the South East[66] [67]



10.3.7 According to the 2011 Census[68], the employment rate[69] within the Chiltern District in 2011 was 69% (which represents 45,000 people), marginally higher than 68% recorded for the South East and 65% for England as a whole. The difference between those in employment and the number of jobs in the district indicates a high level of commuting out of the area. The employment rate in the Hyde Heath and Little Missenden DCA was 67%, 70% in Great Missenden DCA, and 72% in Hyde End, South Heath and Ballinger Common DCA.

10.3.8 The unemployment rate for the Chiltern District in 2011 stood at 4% which was lower than the England average of 7%. An unemployment rate of 1% was recorded in the Hyde Heath and Little Missenden DCA, and 3% in both Great Missenden DCA and Hyde End, South Heath and Ballinger Common DCA.[70]

10.3.9 According to the 2011 Census, 41% of Chiltern District residents aged 16 and over were qualified to National Vocational Qualification Level 4 (NVQ4), compared to 30% in the South East and 27% in England, while 15% of Chiltern District residents had no qualifications, which was lower than that recorded both for the South East (19%) and England (23%). In 2011, 45% of Hyde Heath and Little Missenden DCA residents aged 16 and over were qualified to NVQ4 level, compared to 46% in both Great Missenden,

[66] Other' includes agriculture, forestry and fishing, production, construction, motor trades, wholesale, transport and storage (including postal), finance and insurance, property, business administration and support services, and public administration and defence.
[67] ONS (2012), *Business Register and Employment Survey 2011*, ONS, London
[68] ONS (2012), *Census 2011*, ONS, London
[69] The proportion of working age (16-74 years) residents in employment. Employment comprises the proportion of the total resident population who are 'in employment' and includes full-time students who are employed.
[70] Unemployment figures have been rounded to the nearest whole number. DCA unemployment rates are presented for each DCA in this chapter while in Section 2 they are shown in aggregate.

and Hyde End, South Heath and Ballinger Common DCAs. The proportion of residents with no qualifications was 15% in both Hyde Heath and Little Missenden and Great Missenden DCA, and 10% in Hyde End, South Heath and Ballinger Common DCA.

10.3.10 The three DCA are low-density residential areas, set within a predominantly rural and agricultural area, recording high rates of employment, low unemployment and high qualifications attainment.

Future baseline

Construction (2017)

10.3.11 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2017. There are no consents or allocations in this area which are expected to result in additional material employment by 2017.

Operation (2026)

10.3.12 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2026. There are no consents or allocations in this area which are expected to result in additional material employment between 2017-2026.

10.4 Effects arising during construction

Avoidance and mitigation measures

10.4.1 In order to avoid or reduce the environmental impacts during construction, the Proposed Scheme design includes provisions to maintain access to businesses during the construction phase.

10.4.2 The draft CoCP includes a range of provisions that will help mitigate the socio-economic effects associated with construction within this local area including:

- consulting businesses located close to hoardings on the design, materials used and construction of the hoarding, to reduce impacts on access to and visibility of their premises (draft CoCP Section 5);
- reducing nuisance through sensitive layout of construction sites (draft CoCP Section 5);
- applying best practicable means (BPM) during construction works to reduce noise (including vibration) at sensitive receptors (including local businesses) (draft CoCP Section 13);
- requiring contractors to monitor and manage flood risk and other extreme weather events which may affect socio-economic resources during construction (draft CoCP Sections 5 and 16); and
- site-specific traffic management measures including requirements relating to the movement of traffic from business and commercial operators of road vehicles, including goods vehicles (draft CoCP Section 14).

Assessment of impacts and effects

Temporary effects

Change in business amenity value

10.4.3 No non-agricultural businesses[71] have been identified within the area, which are expected to experience significant amenity effects as a result of the Proposed Scheme.

Isolation

10.4.4 No non-agricultural businesses have been identified within the area, which are expected to experience significant isolation effects as a result of the Proposed Scheme.

Construction employment

10.4.5 There are plans to locate construction compounds for the Proposed Scheme within the Central Chilterns area, including four satellite compounds (civil engineering), three satellite compounds (rail systems) and the Chilterns main compound (rail systems). These are set out in Section 2.3.

10.4.6 These sites could result in the creation of up to 900 person years of construction employment[72] opportunities, equivalent to 90 full-time equivalent permanent jobs[73], which, depending on skill levels required and the skills of local people, are potentially accessible to residents in the locality and to others living further afield. The impact of the direct construction employment creation has been assessed as part of the route wide assessment (Volume 3).

10.4.7 Direct construction employment created by the Proposed Scheme could also lead to opportunities for local businesses to supply the project or to benefit from expenditure of construction workers. The impact of the indirect construction employment creation has been assessed as part of the route wide assessment (Volume 3).

Cumulative effects

10.4.8 No committed (inter-project) developments have been identified that are considered to interact with the Proposed Scheme.

10.4.9 Cumulative effects arise in relation to the accumulation of individual resource based job displacement/losses on a local labour market. These effects are assessed as part of the route-wide assessment (Volume 3).

Permanent effects

Businesses

10.4.10 Businesses directly affected, i.e. those that lie within the land which will be acquired for the construction of the Proposed Scheme, are reported in groups where possible to form defined resources, based on their location and operational characteristics. A group could contain either one or a number of businesses reflecting the fact that a

[71] Possible employment loss in agricultural businesses as a result of the Proposed Scheme is being estimated at the route-wide level.
[72] 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.
[73] Based on the convention that 10 employment years is equivalent to one full time equivalent job.

building may have more than one occupier or that similar businesses/resources are clustered together.

10.4.11 Two business accommodation units within the Central Chilterns area will be directly impacted upon by the Proposed Scheme; the Weights and Measures gym and a workshop at Elwis farm. However, from an employment perspective, no significant direct effects on employment have been identified within the Central Chilterns area.

10.4.12 It is estimated that land required for the construction of the Proposed Scheme will result in the displacement or possible loss of less than five jobs[74] in the Central Chilterns. Taking into account the availability of alternative premises and the total employed within the district, the displacement or possible loss of jobs is considered to be modest compared to the scale of economic activity and opportunity in the area.

10.4.13 From an employment perspective, no significant direct effects on non-agricultural employment[75] have been identified.

Cumulative effects

10.4.14 No committed (inter-project) developments have been identified that are considered to interact with the Proposed Scheme.

10.4.15 Cumulative effects arise in relation to the accumulation of individual resource based job displacement/losses on a local labour market. These effects are dealt with as part of the route-wide assessment (Volume 3).

Other mitigation measures

10.4.16 The assessment has concluded that there are no significant adverse effects arising during construction in relation to businesses directly affected by the Proposed Scheme.

10.4.17 Businesses displaced by the Proposed Scheme will be fully compensated within the provisions of the National 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 process.

10.4.18 The construction of the Proposed Scheme offers considerable opportunities to businesses and residents along the line of route in terms of supplying goods and services and obtaining employment. HS2 Ltd is committed to working with its suppliers to build a skilled workforce that fuels further economic growth across the UK.

Summary of likely significant residual effects

10.4.19 No residual significant socio-economic effects are likely to arise during construction of the Proposed Scheme.

[74] Employment within businesses has been estimated through a combination of sources, for example, surveys of businesses, the Experian employment dataset, employment floor space and the Homes and Communities Agency (HCA) *Employment Densities Guide 2nd Edition* (2010). The estimate is calculated using standard employment density ratios and estimates of floor areas and may vary from actual employment at the sites.

[75] Possible employment loss in agricultural businesses as a result of the Proposed Scheme is being estimated at the route-wide level.

10.5 Effects arising during operation

Avoidance and mitigation measures

10.5.1 No mitigation measures are required during operation within this area.

Assessment of impacts and effects

Resources with direct effects

10.5.2 There are no resources considered likely to experience significant direct effects during the operational phase of the project within this area.

Change in business amenity

10.5.3 No businesses have been identified within the area which, are expected to experience significant amenity effects as a result of the Proposed Scheme.

Operational employment

10.5.4 Operational employment will be created at locations along the route including stations, train crew facilities and infrastructure maintenance depots. These are considered unlikely to be accessed by residents of the area.

10.5.5 Direct operational employment created by the Proposed Scheme could also lead to indirect employment opportunities for local businesses in terms of supplying the project or benefiting from expenditure of directly employed workers on goods and services.

10.5.6 The impact of operational employment creation has been assessed as part of the route-wide assessment (see Volume 3).

Cumulative effects

10.5.7 No committed developments have been identified that are considered to interact with the Proposed Scheme.

Other mitigation measures

10.5.8 The assessment has concluded that operational effects within this section of the route will be either negligible or beneficial and therefore mitigation is not needed.

Summary of likely residual significant effects

10.5.9 No residual significant socio-economic effects are likely to arise during operation of the Proposed Scheme.

11 Sound, noise and vibration

11.1 Introduction

11.1.1 This section reports the assessment of the likely noise and vibration significant effects arising from the construction and operation of the Proposed Scheme for this area on:

- people, primarily where they live ('residential receptors') in terms of individual dwellings and on a wider community basis, including any shared community open areas[76]; and
- community facilities such as schools, hospitals, places of worship and also commercial properties such as offices and hotels, collectively described as 'non-residential receptors' and 'quiet areas'[77].

11.1.2 The assessment of likely significant effects from noise and vibration on agricultural, community, cultural heritage or ecological receptors and the assessment of tranquillity are presented in Sections 3, 5, 6, 7 and 9 of this report respectively.

11.1.3 In this assessment 'sound' is used to describe the acoustic conditions which people experience as a part of their everyday lives. The assessment considers how those conditions may change through time and how sound levels and the acoustic character of community areas is likely to be modified through the introduction of the Proposed Scheme. Noise is taken as unwanted sound and hence adverse effects are noise effects and mitigation is, for example, by noise barriers.

11.1.4 Effects can either be temporary from construction or permanent from the operation of the Proposed Scheme. These effects may be direct, resulting from the construction or operation of the Proposed Scheme and/or indirect e.g. resulting from changes in traffic patterns on existing roads or railways that result from the construction or operation of the Proposed Scheme.

11.1.5 This section sets out the means to avoid or reduce the adverse effects that may occur.

11.1.6 The approaches to assessing sound, noise and vibration and appropriate mitigation are outlined in Volume 1 and scope and methodology are defined in the following documents:

- Scope and Methodology Report (SMR) (Appendix CT-001-000/1); and
- SMR addendum (Appendix CT-001-000/2).

11.1.7 More detailed information and mapping regarding the sound, noise and vibration assessment for this area is available in the relevant appendices in Volume 5:

- sound, noise and vibration, route-wide assumptions and methodology (Appendix SV-001-000);

[76] 'shared community open areas' are those that the emerging National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park to local green space) that is nearby.

[77] Quiet areas are defined in the Scope and Methodology Report as either Quiet Areas as identified under the Environmental Noise Regulations or are resources which are prized for providing tranquillity (further information is provided in Volume 5: Appendix SV-001-000).

- sound, noise and vibration baseline (Appendix SV-002-009);
- sound, noise and vibration construction assessment (Appendix SV-003-009);
- sound, noise and vibration operation assessment (Appendix SV-004-009); and
- Map Series SV-01, SV-02, SV-03 and SV-04 (Volume 5, Sound, Noise and Vibration Map Book).

11.2 Environmental baseline

Existing baseline

11.2.1 The existing baseline sound environment for this area is varied. Generally higher sound levels prevail in and around the larger settlements and near the main transportation infrastructure. Sound levels are typically lower in the smaller villages and at isolated properties.

11.2.2 In the north of the area there are a number of individual residential dwellings situated on Potter Row. In these locations daytime sound levels are typically around 45 to 50dB[78]. Between here and South Heath, natural sounds and distant road traffic are the main contributors to the sound environment. Aircraft over-flights are also occasionally audible. At the northern end of South Heath, where Frith Hill/Ballinger Road cuts through the village, the sound of road traffic is prominent and daytime sound levels are typically around 50dB[79].

11.2.3 Situated at the southern end of South Heath is the ancient woodland known as Sibley's Coppice. Here, the sound environment is dominated by distant road traffic mixed with natural sounds. Daytime sound levels in this area are typically 45 to 50dB.

11.2.4 In Hyde End, the dominant sound source is traffic on the B485 Chesham Road. Residential properties situated directly along the B485 Chesham Road are exposed to higher sound levels than those situated further from the road. Typical daytime sound levels at locations close to the B485 Chesham Road are around 65dB. In locations further from the road daytime sound levels are typically 45 to 50dB.

11.2.5 Mantle's Farm is situated on the south-east side of the ancient woodland Mantle's Wood. The soundscape in this area is subjectively quiet; with occasional sounds from local traffic on the track serving the farm. Daytime sound levels are in this location are typically around 50dB.

11.2.6 Around the proposed vent shaft south of Keepers Wood and north of Kennel Farm, the sound environment is characterised by road traffic on the nearby busy A413 dual carriageway. Additionally, trains on the nearby Marylebone to Aylesbury Line can be heard. During lulls in the flow of road traffic on the A413, natural sounds and occasional aircraft can also be heard. In this location typical daytime sound levels are 50 to 55dB.

[78] Quoted dB values at residential areas refer to the free-field 16 hour daytime (07:00 to 23:00) equivalent continuous sound pressure level, $L_{pAeq,16hr.}$
[79] Night-time sound levels refer to the free-field 8 hour night-time (23:00 to 07:00) equivalent continuous sound pressure level, $L_{pAeq,8hr.}$

11.2.7 Throughout this area, night-time sound levels[80] reduce as a result of lower road traffic flows on main and local roads. During this period sound levels are up to 10dB lower than daytime levels.

11.2.8 Further information on the existing baseline, including baseline sound levels and baseline monitoring results, is provided for this area in Volume 5: Appendix SV-002-009.

11.2.9 It is likely that the majority of receptors adjacent to the line of route are not currently subject to appreciable vibration[81]. Vibration at all receptors from the Proposed Scheme has therefore been assessed using specific thresholds, below which receptors will not be affected by vibration. Further information is provided in Volume 1, Section 8.

Future baseline

11.2.10 Without the Proposed Scheme, existing sound levels in this area are likely to increase slowly over time. This is primarily due to road traffic growth. Changes in car technology may offset some of the expected sound level increases due to traffic growth on low speed roads. On higher speed roads[82], tyre sound dominates and hence the expected growth in traffic is likely to continue to increase ambient sound levels.

Construction (2017)

11.2.11 The assessment of noise from construction activities assumes a baseline year of 2017 which represents the period immediately prior to the start of the construction period. As a reasonable worst case, it has been assumed that no change in baseline sound levels will occur between the existing baseline (2012/13) and the future baseline year of 2017. The assessment of noise from construction traffic assumes a baseline year of 2021, representative of the middle of the construction period when the construction traffic flows are expected to be at their peak. Further information can be found in the Traffic and transport assessment in Section 12.

Operation (2026)

11.2.12 The assessment is based upon the predicted change in sound levels that result from the Proposed Scheme. The assessment initially considered a worst case (that would overestimate the change in levels) by assuming that sound levels would not change from the existing baseline year of 2012/2013. Where significant effects were identified on this basis, the effects have been assessed using a baseline year of 2026 to coincide with the proposed start of passenger services. The future baseline is for the sound environment that would exist in 2026 without the Proposed Scheme.

[80] Night-time sound levels refer to the 8 hour night-time (23:00 to 07:00) equivalent continuous sound pressure level, $L_{pAeq,8hr.}$
[81] Further information is available in the Volume 5: Appendix SV-001-000, the SMR and its Addendum.
[82] Tyre noise typically becomes the dominant sound source for steady road traffic at speeds above approximately 30mph

11.3 Effects arising during construction

Local assumptions and limitations

Local assumptions

11.3.1 The construction arrangements that form the basis of the assessment are presented in Section 2.3 of this report.

11.3.2 TBM will be used to excavate the tunnels. It is likely that materials (including tunnel lining segments), people and equipment will be transported from the surface to the TBM using small construction trains, which will travel at relatively low speeds along a temporary construction railway laid behind each TBM as it drives forward. Excavated material from each TBM will be transported to the surface by conveyor. Significant noise and vibration effects arising from use of the temporary construction railway will be avoided through appropriate design and the maintenance specification.

11.3.3 Some tunnelling support activities at Chilterns tunnel north portal will need to be undertaken during the evening and night-time for reasons of engineering practicability.

11.3.4 The assessment takes account of people's perception of noise throughout the day. More stringent criteria are applied during evening and night-time periods, when people are more sensitive to noise, compared to the busier and more active daytime period.

Local limitations

11.3.5 In this area, there are a number of locations where the land or property owners did not permit baseline sound level monitoring to be undertaken at their premises. However, sufficient information has been obtained to undertake the assessment. Further information is provided in Volume 5: Appendix SV-002-009.

Avoidance and mitigation measures

11.3.6 The assessment assumes the implementation of the principles and management processes set out in the draft CoCP which are:

- Best Practicable Means (BPM) as defined by the Control of Pollution Act 1974 (CoPA) and Environmental Protection Act 1990 (EPA) will be applied during construction activities to minimise noise (including vibration) at neighbouring residential properties;
- as part of BPM, mitigation measures are applied in the following order:
  - noise and vibration control at source: for example the selection of quiet and low vibration equipment, review of construction methodology to consider quieter methods, location of equipment on site, control of working hours, the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings[83];and then

[83] Warning signals that consist of bursts of noise

- screening: for example local screening of equipment or perimeter hoarding;

- where, despite the implementation of BPM, the noise exposure exceeds the criteria defined in the draft CoCP, noise insulation or ultimately temporary re-housing will be offered in accordance with the draft CoCP noise insulation and temporary re-housing policy;

- lead contractors will seek to obtain prior consent from the relevant local authority under Section 61 of CoPA for the proposed construction works. The consent application will set out BPM measures to minimise Construction disturbance, including control of working hours and provide a further assessment of construction noise and vibration including confirmation of noise insulation/temporary re-housing provision;

- contractors will undertake and report such monitoring as is necessary to assure and demonstrate compliance with all noise and vibration commitments. Monitoring data will be provided regularly to and be reviewed by the Nominated Undertaker and will be made available to the local authorities; and

- contractors will be required to comply with the terms of the draft CoCP and appropriate action will be taken by the Nominated Undertaker as required to ensure compliance.

11.3.7 In addition to this mitigation, taller screening as described in the draft CoCP[84] has been assumed along the south-western edge of the construction site boundary adjacent to the residential communities on Hyde Lane, Chesham Road, Frith Hill and along the north-eastern edge of the construction site boundary adjacent to the residential communities at South Heath. In addition, taller screening has been assumed around the Little Missenden vent shaft site.

11.3.8 Noise insulation will be offered for qualifying buildings as defined in the draft CoCP Noise insulation and temporary re-housing policy. Noise insulation or ultimately temporary re-housing will avoid residents being significantly affected[85] by levels of construction noise inside their dwellings. The assessment reported in this section provides an estimate of the buildings that are likely to qualify for such measures.

11.3.9 Qualification for noise insulation and temporary re-housing will be identified as part of seeking prior consent from the local authorities under Section 61 of the CoPA. Qualifying buildings will be identified early enough so that noise insulation can be installed, or temporary re-housing provided, before the start of the works predicted to exceed noise insulation or temporary re-housing criteria. Noise insulation, where required, will be installed as early as possible to reduce internal sound levels from construction activities and also when the Proposed Scheme comes into operation.

[84] As described in the draft CoCP, provided as necessary by solid temporary hoarding, temporary earth stockpiles, screening close to the activities or other means to provide equivalent noise reduction.
[85] Information is provided in the emerging National Planning Practice Guidance – Noise http://planningguidance.planningportal.gov.uk. e.g. the table summarising the noise exposure hierarchy

Assessment of impacts and effects

Residential receptors: direct effects – individual dwellings

11.3.10 Taking account of the avoidance and mitigation measures set out in the previous paragraphs, two residential buildings (a dwelling on King's Lane and a dwelling on the B485 Chesham Road) are forecast to experience noise levels higher than the noise insulation trigger levels as defined in the draft CoCP. For daytime construction the trigger level is 75dB[86] measured outdoors.

11.3.11 The mitigation measures, including noise insulation, will reduce noise inside all dwellings, including the aforementioned dwellings such that it does not reach a level where it would significantly affect[85] residents.

Residential receptors: direct effects – communities

Airborne noise

11.3.12 The avoidance and mitigation measures in this area will avoid airborne construction noise adverse effects[85] on the majority of receptors and communities. Residual temporary noise or vibration effects are identified in the rest of this section.

11.3.13 With regard to noise outside dwellings, the assessment of temporary effects takes account of construction noise relative to existing sound levels.

11.3.14 In locations with lower existing sound levels[87], construction noise effects[85] are likely to be caused by changes to noise levels outside dwellings. These may be considered by the local community as an effect on the acoustic character of the area and hence be perceived as a change in the quality of life. These effects are considered to be significant when assessed on a community basis taking account of the local context.[88]

Table 15: Direct adverse effects on residential communities and shared open areas that are considered to be significant on a community basis

Significant effect number (see Volume 5 Appendix SV-003-009)	Type of significant effect	Time of day	Location	Cause (construction activities)	Assumed approximate duration of impact
CSV09-C01	Construction noise	Daytime	South Heath: approximately 50 dwellings on Sibleys Rise, Bayleys Hatch and Frith Hill.	South Heath green tunnel construction with typical and highest monthly noise levels of around 60dB and 65-70dB.	8 months

Ground-borne noise and vibration

11.3.15 TBM will be used to excavate the tunnels. Each TBM is likely to generate ground-borne noise and vibration impacts but only at receptors within a close distance of the centre line of the tunnels and only for short periods of time (a few days). Overall, the

[86] $L_{pAeq,0800-1800}$ measured at the facade or the existing ambient if this is already above this level.
[87] Further information is provided in Volume 5: Appendix SV-001-000.
[88] Further information is provided in SV-001-000 and SV-003-009.

deeper the tunnel is, the lower the impact. The perceptible noise and vibration will increase as each TBM approaches and diminish as it moves away from the receptor. Vibration from TBMs will present no risk of any building damage.

11.3.16 The effects of vibration from TBM on building occupants will be short term (a matter of days) and hence they are not considered to be significant. Proactive and advanced community relations in advance of each TBM passing under properties will help manage expectations and allay possible concerns over the short-term presence of vibration.

Residential receptors: indirect effects

11.3.17 Construction traffic is likely to cause adverse noise effects on residential receptors located immediately adjacent to the road along King's Lane where it passes through South Heath (CSV09-C02). The receptors are forecast to experience an increase in outdoor noise levels of around 6dB during the peak months (further information on traffic flows is provided in Section 12: Traffic and transport).

11.3.18 These adverse effects[85] would be a change in the acoustic character of the area such that there is a perceived change in the quality of life and are considered significant when assessed on a community basis taking account of the local context[88].

Non-residential receptors: direct effects

11.3.19 Significant construction noise or vibration effects on non-residential receptors are unlikely to occur in this area.

Non-residential receptors: indirect effects

11.3.20 Significant noise effects on non-residential receptors arising from construction traffic are unlikely to occur in this area.

Cumulative effects from the Proposed Scheme and other committed development

11.3.21 This assessment has considered the potential cumulative construction noise effects of the Proposed Scheme and other committed developments[89]. In this area, there is no development that would be likely to result in any significant cumulative construction noise and vibration effects.

Summary of likely residual significant effects

11.3.22 The avoidance and mitigation measures reduce noise inside all dwellings from the construction activities such that it is does not reach a level where it would significantly affect[85] residents.

11.3.23 The measures reduce any adverse effects from construction noise outdoors on the majority of residential communities such that they are not considered significant except at the residential communities in South Heath along Sibleys Rise, Bayleys Hatch and Frith Hill that are closest to the works.

[89] Refer to Volume 5: Appendix CT-004-000.

11.3.24 Construction traffic on King's Lane is likely to cause significant noise effects on adjacent residential receptors where it passes through South Heath.

11.3.25 HS2 Ltd will continue to seek reasonably practicable measures to further reduce or avoid these significant effects. In doing so HS2 Ltd will continue to engage with stakeholders to fully understand the receptor, its use and the benefit of the measures. The outcome of these activities will be reflected in the Environmental Minimum Requirements.

11.4 Effects arising during operation

Local assumptions and limitations

Local assumptions – service pattern

11.4.1 The effects of noise and vibration from the operation of the Proposed Scheme have been assessed based on the highest likely train flows, including the Phase Two services. Trains are expected to be 400m long during peak hours and a mix of 200m and 400m long trains at other times.

11.4.2 The expected passenger service frequency for both Phase One, and Phase One with Phase Two services, are described in Volume 1[90]. As a reasonable worst case, this assessment is based upon the service pattern for Monday to Saturday including Phase Two services. Passenger services will start at or after 05:00 from the terminal stations and in this area will progressively increase to the number of trains per hour in each direction on the main lines set out in Table 16. This number of services is assumed to operate every hour from 07:00 to 21:00. The number of services will progressively decrease after 21:00 and the last service will arrive at terminal stations by 24:00. Train speeds are shown in Table 16.

Table 16: Train flows and speeds

Description of line	Time period for peak daytime flows	Number of trains per hour in each direction with Phase Two services (Phase One only trains per hour in each direction is set out in brackets)	Speed
Main line between London and the north	0700-2100 hours	18 (14)	330kph for timetabled trains (assumed 90% of services) and 360kph for 10% of services with speeds reducing towards the Chiltern tunnel

Local assumptions – tunnelled sections

11.4.3 Tunnel portals and the ventilation shaft are likely to include mechanical ventilation equipment. It is likely that this equipment will only operate for limited testing periods during the daytime[91] or in the event of an emergency.

[90] The change in noise and vibration effects between the different passenger services is assessed in Volume 1
[91] For example, HS1 vent shaft fans are tested monthly.

Avoidance and mitigation measures

11.4.4 The development of the Proposed Scheme has, as far as reasonably practicable, kept the alignment away from main communities and low in the ground. These avoidance measures have protected many communities from likely significant noise or vibration effects.

Airborne noise

11.4.5 HS2 trains will be quieter than the relevant current European Union specifications. This will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 300kph (186mph) with current pantograph designs, drawing on proven technology in use in East Asia. The track will be specified to reduce noise, as will the maintenance regime. Overall, these measures would reduce noise emissions by approximately 3dB at 360kph compared to a current European high-speed train operating on the new track. Further information is provided in Volume 5: Appendix SV-001-000.

11.4.6 To avoid or reduce significant airborne noise effects, the Proposed Scheme incorporates noise barriers in the form of landscape earthworks and noise fence barriers. Noise barrier locations are shown on Map Series SV-05 (Volume 2, CFA9 Map Book).

11.4.7 Generally, the assessment has been based on noise barriers having a noise reduction performance equivalent to a noise fence barrier with a top level 3m above the top of the rail, which is acoustically absorbent on the railway side and which is located 5m to the side of the outer rail. In practice, barriers may differ from this description but will provide the same acoustic performance. For example, where noise barriers are in the form of landscape earthworks they will need to be higher above rail level to achieve similar noise attenuation to a 3m barrier because the crest of the earthwork will be further than 5m from the outer rail.

11.4.8 Noise effects are reduced in other locations along the line by landscape earthworks provided to avoid or reduce significant visual effects and engineering structures such as cuttings and safety fences on viaducts (where noise barriers are not required). The location of these barriers is shown on Map Series SV-05 (Volume 2, CFA9 Map Book).

11.4.9 Tunnel portals will be designed to avoid any significant airborne noise effects caused by the trains entering the tunnel.

11.4.10 Significant noise effects from the operational static sources such as mechanical ventilation at tunnel portals and line-side equipment will be avoided through their design and the specification of noise emission requirements (for further information please see Volume 5: Appendix SV-001-000).

11.4.11 Noise insulation measures will be offered for qualifying buildings as defined in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996[92] (the Regulations). The assessment reported in this section provides an estimate of the buildings that are likely to qualify under the Regulations. Qualification for noise

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

insulation under the Regulations will be identified and noise insulation offered at the time that the Proposed Scheme becomes operational.

11.4.12 Where required, as well as improvements to noise insulation of windows facing the railway, ventilation will be provided so that windows can be kept closed to protect internal sound levels.

11.4.13 Following Government's emerging National Planning Practice Guidance[93], where the noise from the use of the Proposed Scheme measured outside a dwelling exceeds the Interim Target defined by the WHO Night Noise Guidelines for Europe[94], residents are considered to be significantly affected by the resulting noise inside their dwelling. The effect on people at night due to the maximum sound level as each train passes has also been assessed[95]. The Interim Target is a lower level of noise exposure than the Regulations trigger threshold for night noise. In these particular circumstances, where night-time noise levels for the use of new or additional railways authorised by the Bill are predicted following the methodology set out in the Regulations to exceed 55dB[96] or the maximum noise level (dependent on the number of train passes) as a train passes exceeds the criterion[95], noise insulation will be offered for these additional buildings.

Ground-borne noise and vibration

11.4.14 Significant ground-borne noise or vibration effects will be avoided or reduced through the design of the track and track-bed.

Assessment of impacts and effects

Residential receptors: direct effects – individual dwellings

Surface sections of route; airborne noise and ground-borne vibration

11.4.15 Taking account of the avoidance and mitigation measures incorporated into the Proposed Scheme, the assessment has identified one residential dwelling, Sheepcotts Cottage on Hyde Lane, Hyde Heath located close to the Proposed Scheme, where noise would exceed the daytime trigger threshold set in the Regulations. It is therefore estimated that this building is likely to qualify for noise insulation under the Regulations. This dwelling is indicated on Map Series SV-05 (Volume 2, CFA9 Map Book).

11.4.16 The mitigation measures including noise insulation will reduce noise inside all dwellings, including Sheepcotts Cottage, such that it will not reach a level where it would significantly affect residents.

Residential receptors: direct effects – communities

11.4.17 The mitigation measures in this area will avoid airborne noise adverse effects on the majority of receptors, and at the following residential communities:

[93] National Planning Practice Guidance – Noise http://planningguidance.planningportal.gov.uk
[94] World Health Organization (2010) *Night-time Noise Guidelines for Europe*
[95] During the night (2300-0700) a significant effect is also identified where the Proposed Scheme results in a maximum sound level at the façade of a building at or above: 85 dB LpAFmax (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB LpAFmax (where the number of train pass-bys exceeding this value is greater than 20).
[96] Equivalent continuous level, $L_{pAeq,23:00-07:00}$ measured without reflection from the front of buildings

- South Heath (except as identified in Table 17);
- Hyde End (except as identified in Table 17);
- Little Missenden; and
- Great Missenden.

11.4.18 Taking account of the envisaged mitigation, Map Series SV-05 (Volume 2, CFA9 Map Book) shows the long term 40dB[97] night-time sound level contour from the operation of trains on the Proposed Scheme. The extent of the 40dB night-time sound level contour is equivalent to, or slightly larger than, the 50dB daytime contour[98]. In general, below these levels adverse effects are not expected.

11.4.19 Above 40dB during the night and 50dB during the day the effect of noise is dependent on the baseline sound levels in that area and the change in sound level (magnitude of effect) brought about by the Proposed Scheme. The airborne noise impacts and effects forecast for the operation of the scheme are presented on Map Series SV-05 (Volume 2, CFA9 Map Book).

11.4.20 The changes in noise levels are likely to affect the acoustic character of the area such that there is a perceived change in the quality of life and are considered to be significant when assessed on a community basis[99] taking account of the local context[100] as identified in Table 17.

Table 17: Direct adverse effects on residential communities and shared open areas that are considered significant on a community basis

Significant effect number (see Map Series SV-05)	Source of significant effect	Time of day	Location and details
OSV09-C01	Airborne noise increase from new train services	Daytime and night-time	Hyde End: approximately five dwellings in the vicinity of Hyde Lane. Forecast increases in sound from the railway are likely to cause a major adverse effect on the acoustic character of the area around the closest two properties. The effect on the acoustic character around the other three that are located further from the railway would be moderate. There are no shared open spaces identified as being affected in this community area.
OSV09-C02	Airborne noise increase from new train services	Daytime and night-time	South Heath: approximately 10 dwellings in the vicinity of Potter Row. Forecast increases in sound from the railway are likely to cause a moderate adverse effect on the acoustic character of the area. There are no shared open spaces identified as being affected in this community area.

Residential receptors: indirect effects

11.4.21 The assessment of operational noise and vibration indicates that significant indirect effects on residential receptors are unlikely to occur in this area.

[97] Defined as the equivalent continuous sound level from 23:00 to 07:00 or $L_{pAeq,night}$)
[98] With the train flows described in the assumptions section of this CFA Report, the daytime sound level (defined as the equivalent continuous sound level from 07:00 to 23:00 or $L_{pAeq,day}$) from the Proposed Scheme would be approximately 10dB higher than the night-time sound level. The 40dB contour therefore indicates the distance from the Proposed Scheme at which the daytime sound level would be 50dB.
[99] Further information is contained in Volume 1.
[100] Further information is provided in SV-001-000 and SV-004-009.

Non-residential receptors: direct effects

11.4.22 The assessment of operational noise and vibration indicates that significant direct effects on non-residential receptors are unlikely to occur in this area.

Non-residential receptors: indirect effects

11.4.23 The assessment of operational noise and vibration indicates that significant indirect effects are unlikely to occur on non-residential receptors in this area.

Summary of likely significant residual effects

11.4.24 The mitigation measures reduce noise inside all dwellings such that it does not reach a level where it would significantly affect[85] residents.

11.4.25 The mitigation measures in this area will avoid noise and vibration adverse effects[85] on the majority of receptors and communities including shared open areas.

11.4.26 Taking account of the avoidance and mitigation measures and the local context, the residual permanent noise effects[85] on the acoustic character of the communities closest to the route in South Heath on Hyde Lane and in Hyde End on Potter Row, are considered significant.

11.4.27 HS2 Ltd will continue to seek reasonably practicable measures to further reduce or avoid these significant effects. In doing so HS2 Ltd will continue to engage with stakeholders to fully understand the receptor, its use and the benefit of the measures. The outcome of these activities will be reflected in the Environmental Minimum Requirements.

12 Traffic and transport

12.1 Introduction

12.1.1 This traffic and transport section describes the likely significant impacts on all forms of transport and the consequential effects on transport users arising from the construction and operation of the Proposed Scheme through this area.

12.1.2 With regards to traffic and transport, the main issues as a result of implementation of the Proposed Scheme are traffic generated during construction and the closures of both roads and public rights of way (PRoW), either temporarily or permanently.

12.1.3 The effects on traffic and transport have been assessed quantitatively, based on baseline traffic conditions and future projection scenarios.

12.1.4 A detailed report on traffic and transport and surveys undertaken within the area is contained in Volume 5: Appendix TR-001-000, Transport Assessment.

12.1.5 Figure 2 shows the location of the key transport infrastructure in this area.

12.1.6 Engagement has been undertaken with the key transport authority, Buckinghamshire County Council (BCC).

12.2 Scope, assumptions and limitations

12.2.1 The assessment scope, key assumptions and limitations for the traffic and transport assessment are set out in Volume 1, Section 8, the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (See Volume 5: Appendix CT-001-000/2). This report follows the standard methodology.

12.2.2 The study area includes the A413, B485 Chesham Road and local roads that are either crossed by the Proposed Scheme or are in close proximity to it.

12.2.3 A number of transport modelling tools have been used to inform the assessment including the Department for Transport's traffic forecasting tool, Trip End Model Presentation Program (TEMPRO), for future forecast road traffic growth in the area. The assessment covers morning (08:00-09:00) and evening (17:00-18:00) peak periods for an average weekday.

12.2.4 It has been assumed that bus services for the future years of assessment will be the same as those currently operating, since it is not possible to forecast how services may change in the future.

12.2.5 Forecast future year traffic flows with and without the Proposed Scheme are based on an approach that does not take account of wider effects, such as redistribution and reassignment of traffic, modal shift and peak spreading. As a consequence, adverse transport effects may be overstated.

12.3 Environmental baseline

Existing baseline

12.3.1 Existing conditions in the area have been determined through site visits, specially commissioned transport surveys and liaison with relevant transport authorities and

stakeholders to source traffic data, information on public transport, PRoW and accident data.

12.3.2 Traffic surveys were undertaken to establish current traffic flows on the road network subject to assessment during September 2012 and February 2013. The surveys comprised automatic traffic counts, junction turning counts and queue surveys. This was supplemented by traffic and transport data obtained from other sources, including BCC.

12.3.3 PRoW surveys were undertaken in August and September 2012 to establish the nature of the PRoW and their usage by pedestrians, cyclists and equestrians (non-motorised users). The surveys included all PRoW and roads that will cross the Proposed Scheme, and any additional PRoW that will be affected by the Proposed Scheme. The surveys indicated that the majority of PRoW crossing the route were observed to be used by under 40 people per day, apart from Footpaths GMI/12/1 and GMI/13/3 which were each observed to be used by under 70 people per day. The Proposed Scheme, some of which is within tunnel in this area, affects 14 PRoW and crosses or goes under 13 of these. In addition to the 13 PRoW the Proposed Scheme crosses or goes under, seven roads with potential for use by non-motorised users are affected.

12.3.4 The main strategic roads and local roads affected by the Proposed Scheme are A413, B485 Chesham Road, King's Lane, Frith Hill, Hyde Heath Road, Hyde Lane, Potter Row and Leather Lane.

12.3.5 Safety and accident data for the road network subject to assessment has been obtained from BCC for the three year period of 2009 to 2011. This has been assessed and no significant accident clusters have been identified in this area.

12.3.6 The following three bus services operate along roads that were subject to traffic and transport assessment:

- Route 55 – connecting Aylesbury to Amersham and serving Stoke Mandeville, Wendover, Great Missenden, Chesham and Chesham Bois;
- Route 190 – connecting Chesham to Amersham and serving Chesham Bois and Hyde Heath; and
- Route 177 – connecting Chesham to Great Missenden and serving Chartridge, Ballinger Common and South Heath.

12.3.7 Route 55 operates along the A413 through Great Missenden, Route 190 operates along the B485 at a peak frequency of up to one bus an hour and Route 177 operates along Frith Hill, all at a peak frequency of up to one bus an hour.

12.3.8 Frequent passenger railway services operate along the Marylebone to Aylesbury Line serving Great Missenden station within this area.

12.3.9 The Proposed Scheme does not affect any waterways in this area that are frequently used by waterborne craft and consequently these have not been considered further in this assessment.

Future baseline

12.3.10 The future baseline traffic volumes have been calculated by applying growth factors derived from TEMPRO for the future years of 2021, 2026 and extrapolation to 2041 with consideration of local major consented schemes. The factors have been derived for the individual road types and relevant wards. No other changes to the traffic and transport baseline are anticipated in this area.

Construction

12.3.11 Construction activities have been assessed against 2021 baseline traffic flows, irrespective of when they occur during the construction period. Future baseline traffic volumes in the peak hours in this area are forecast to grow by between approximately 8% and 9% by 2021 compared to 2012, depending on road type.

Operation (2026)

12.3.12 Future baseline traffic volumes in the peak hours in this area are forecast to grow by between approximately 15% and 17% by 2026 compared to 2012 depending on road type.

Operation (2041)

12.3.13 Future baseline traffic volumes in the peak hours in this area are forecast to grow by between approximately 30% and 34% by 2041 compared to 2012 depending on road type.

12.4 Effects arising during construction

Avoidance and mitigation measures

12.4.1 The following measures (as described in Section 2.3) have been included as part of the engineering design of the Proposed Scheme and will avoid or reduce effects on transport users:

- transporting construction materials and equipment along haul roads within and adjacent to the route of Proposed Scheme alignment, where reasonably practicable, to reduce lorry movements on the public highway;
- the majority of roads crossing the Proposed Scheme will be kept open during construction reducing diversions of traffic onto alternative routes;
- provision of temporary alternative routes and crossing structures early to maintain connectivity for PRoW closed during construction to reduce loss of amenity;
- HGV routeing as far as reasonably practicable along the strategic road network and using designated access roads, as shown in Map TR-03-053 (Volume 5, Traffic and Transport Map Book);
- excavated material will be reused where practicable along the alignment of the Proposed Scheme which will reduce the effects of construction vehicles movements on the public highway; and
- reducing daily travel of site workers by providing welfare facilities.

12.4.2 The draft CoCP (see Volume 5: Appendix CT-003-000) includes measures which seek to reduce the impacts and effects of deliveries of construction materials and equipment, including construction lorry trips during peak background traffic periods. The draft CoCP includes HGV management and control measures.

12.4.3 Where reasonably practicable, the number of private car trips to and from the site (both workforce and visitors) will be reduced by encouraging alternative modes of transport or vehicle sharing. This will be supported through an overarching framework travel plan[101] that will require travel plans to be used along with a range of potential measures to mitigate the impacts of traffic and transport movements associated with construction of the Proposed Scheme. As part of this, a construction workforce travel plan will be put into operation with the aim of reducing workforce commuting by private car, especially sole occupancy car travel. Where reasonably practicable within a rural context, this will encourage the use of sustainable modes of transport or vehicle sharing.

12.4.4 The measures in the draft CoCP include clear controls on vehicle types, hours of site operation and routes for heavy goods vehicles, to reduce the impact of road based construction traffic. In order to achieve this, generic and site specific management measures will be implemented during the construction of the project on or adjacent to public roads, footpaths and other PRoW affected by the Proposed Scheme as necessary.

12.4.5 Specific measures include core site operating hours that will be 08:00 to 18:00 on weekdays and 08:00 to 13:00 on Saturdays. Tunnel boring in the Chiltern tunnel will be a 24-hour a day operation and will be managed from CFA7. Site staff and workers will therefore generally arrive before the morning peak hour and depart after the evening peak hour, although assessment has assumed that some of work journeys to the construction sites take place within the morning and evening peak hours, which is a reasonable worst case scenario (draft CoCP, Section 5).

Assessment of impacts and effects

Temporary effects

12.4.6 The following section considers the impacts on traffic and transport and the consequential effects resulting from construction of the Proposed Scheme.

12.4.7 The temporary traffic and transport impacts within this area will be:

- construction vehicle movements to and from the construction compounds;
- road closures and associated diversions; and
- PRoW closures and associated diversions.

[101] Construction and operational travel plans will promote the use of sustainable transport modes as appropriate to the location and types of trip. They will include measures such as: provision of information on and promotion of public transport services; provision of good cycle and pedestrian facilities; liaison with public transport operators; promotion of car sharing; and the appointment of a travel plan coordinator to ensure suitable measures are in place and are effective

12.4.8 Construction vehicle movements required to construct the Proposed Scheme will include delivery of plant and materials, movement of excavated materials and site worker trips.

12.4.9 Details of construction compounds are provided in Section 2. The duration of when there will be busy transport activity at each site is shown in Table 18. This represents the period when the construction traffic flows are expected to be greater than 50% of the peak construction flows. Also shown is the estimated number of daily vehicle trips during the peak month of activity. The lower end of the range shows the average number of trips in the busy period and the upper end shows the average during the peak month.

Table 18: Typical vehicle trip generation for construction compounds in this area

Compound Type	Location	Access to/from compound	Indicative start/set up date	Estimated duration of use (years)	Estimated duration with busy vehicle movements (months)	Average daily combined two-way vehicle trips during busy period and within peak month of activity	
						Cars/ LGV	HGV
Satellite	Little Missenden vent shaft	A413	2018	Six years and three months	Ten months	80-90	50-60
Satellite	Chiltern tunnel north portal (civil engineering)	Upgraded access track to Mantle's Wood via Hyde Heath Road, B485 Chesham Road, Frith Hill and A413	2017	Four years and three months	Nine months	90-110	30-40
Satellite	Chiltern tunnel north portal (railway systems)		2023	Two years			
Satellite	South Heath green tunnel (south)	Chesham Road via A413	2017	Seven years and nine months	Three years and five months	150-190	50-60
Main	Chilterns (rail systems)						
Satellite	South Heath green tunnel (north)	Frith Hill, B485 Chesham Road and A413	2017	Three years and nine months	One year and one month	70-100	20-50
Satellite	South Heath tunnel north portal (rail systems)		2023	One year and three months			

12.4.10 Information on the indicative construction programme and methodology is provided in Section 2 which illustrates how the phasing of activities at different compounds will generally be staggered and that construction activities at individual compounds may not occur over the whole duration presented in Table 18. Consequently the peak traffic movements will not generally occur at the same time, although in some instances there may be some overlap.

12.4.11 Where construction routes serve more than one construction compound, the combined vehicle movements have been assessed.

12.4.12 Construction of the Proposed Scheme will result in increased traffic flows from workers and construction vehicles accessing compounds and also temporary road closures and diversions.

12.4.13 Changes in traffic flows are expected to lead to significant changes in delay and congestion[102] to vehicle occupants at the following junctions:

- A413 London Road with A4128 Link Road (moderate adverse effect);
- A413 London Road with B485 Frith Hill (major adverse effect);
- B485 Frith Hill/Chesham Road with Frith Hill (major adverse effect);
- King's Lane with Frith Hill/Ballinger Road and Potter Row (minor adverse effect);
- B485 Chesham Road with King's Lane (major adverse effect); and
- B485 Chesham Road with Hyde Heath Road (moderate adverse effect).

12.4.14 Road closures and associated diversions are expected to result in the following effects for traffic due to increased travel distance and time:

- closure of Frith Hill requiring a traffic diversion of approximately 2.6km via King's Lane and Chesham Road for a period up to two years resulting in a major adverse effect; and
- closure of Hyde Lane requiring a traffic diversion of approximately 6km via A413 and B485 Chesham Road for a period of up to one year resulting in a moderate adverse effect.

12.4.15 Construction of the Proposed Scheme is forecast to result in substantial increases in daily traffic flows (i.e. more than 30% for HGV or all vehicles) causing a significant

[102] In assessing significant effects of traffic changes on congestion and delays, a major adverse effect occurs where traffic flows at a junction will be beyond or very close to capacity with the Proposed Scheme and the increases in traffic due to the Proposed Scheme will be such as to substantially increase queues and delays on a routine basis at peak times. A moderate adverse effect will occur when traffic flows at a junction will be approaching or at capacity with the Proposed Scheme and modest increases in traffic will increase the frequency of queues and more substantial delays. A minor adverse effect occurs when traffic flows at a junction are not generally exceeding capacity with the Proposed Scheme but the increase in flows will result in occasional queues and delays or small increases in existing delays.

increase in traffic-related severance[103] for non-motorised users at the following locations :

- A413 London Road/Nash Lee Road, between B485 Frith Hill and B4009 Nash Lee Road (major adverse effect) due to an increase in HGV flow;
- A413, between B485 Frith Hill and A404 Whielden Lane (moderate adverse effect) due to an increase in HGV flow;
- Potter Row, between Leather Lane and Frith Hill (moderate adverse effect) due to an increase in HGV flow;
- Frith Hill, between Potter Row/King's Lane and B485 Frith Hill/Chesham Road (major adverse effect) due to an increase in HGV flow;
- King's Lane, between Frith Hill and B485 Chesham Road (major adverse effect) due to an increase in HGV flow as well as all traffic flow;
- B485 Frith Hill/Chesham Road, between A413 and Hyde Heath Road (minor adverse effect) due to an increase in HGV flow; and
- Hyde Heath Road between B485 Frith Hill and access road to Chiltern tunnel north portal satellite compound (major adverse effect) due to an increase in HGV flow.

12.4.16 These traffic flow increases will not result in increases in congestion and significant delays except for those locations identified above.

12.4.17 Utilities works, including diversions, have been assessed where they are major works and where the traffic and transport impacts from the works separately, or in combination with other works, is greater than other construction activities arising within this area. More minor utilities works and associated traffic management measures are expected to result in only localised traffic and pedestrian impacts and be of short duration. Utilities works are not expected to result in significant additional adverse effects.

12.4.18 No significant effects on parking or loading have been identified during construction in this area.

12.4.19 The effect on accident and safety risk is not significant as there are no locations where there are existing clusters of accidents and where there are substantial increases in traffic during construction.

12.4.20 No significant impact on bus services during the construction of the Proposed Scheme has been identified in this area.

12.4.21 There will be no effects on access to stations or public transport interchanges resulting from the construction of the Proposed Scheme in this area.

[103] In the context of this Traffic and transport section, severance is used to relate to a change in ease of access for non-motorised users due to, for example, an change in travel distance or travel time or a change in traffic levels on a route that makes it harder for non-motorised users to cross. A reference to severance does not imply a route is closed to access.

12.4.22 There will be minor adverse effects on non-motorised users due to increased travel distance from eight PRoW and two road diversions for a period of up to two years at GMI/79/1 & 2, GMI/12/1 (footpath), Frith Hill, GMI/80/1 (footpath), GMI/23/6, GMI/28/1 & 2 (footpath), GMI/33/3 (footpath) and Hyde Lane. The majority of the diversions are between 100 and 400m in length, apart from the diversions at GMI/33/3 (footpath) of 750m and Hyde Lane of 900m. There will be a moderate adverse effects due to the diversion of LMI/17/2 (footpath) by approximately 1.5km for a period of up to a year.

Cumulative effects

12.4.23 The assessment includes cumulative effects of planned development during construction by taking this into account within the background traffic growth.

12.4.24 The assessment also takes into account construction traffic and transport impacts of works undertaken in neighbouring study areas. From the areas to the north including CFA10 and to a lesser extent CFA11, the cumulative average construction traffic flows of approximately 310 cars/LGV per day (two-way) and 60 HGV per day (two-way) have been included in the assessment for this area.

12.4.25 From areas to the south, including CFA8, the cumulative average construction traffic flows of approximately 20 cars/LGV per day (two-way) have been included in the assessment for this area. Any HGV traffic generated to the south will not directly access roads assessed within this area.

Permanent effects

12.4.26 Any permanent effects of construction have been considered in assessments for operation in Section 12.5. This is because the impacts and effects of the forecast increases in travel demand and the wider impacts and effects of operation need to be considered together.

Other mitigation measures

12.4.27 The implementation of the draft CoCP (See Volume 5: Appendix CT-003-000) in combination with the framework travel plan and the construction workforce travel plan will, to some degree, mitigate the transport related effects during construction of the Proposed Scheme. The reductions in effects arising from the travel plan measures have not been included in the assessment, which will mean that the adverse effects may be over-stated.

12.4.28 No further traffic and transport mitigation measures during construction of the Proposed Scheme are considered necessary, based on the outcome of this assessment.

Summary of likely significant residual effects

12.4.29 Increased traffic during the most intensive periods of construction will cause additional traffic congestion and delay at a number of junctions in the area including at the A413 London Road with A4128 Link Road; A413 London Road with B485 Frith Hill; B485 Frith Hill/Chesham Road with Frith Hill; King's Lane with Frith Hill/Ballinger Road and Potter Row; B485 Chesham Road with King's Lane and B485 Chesham Road with Hyde Heath Road.

12.4.30 Temporary closure of Frith Hill and Hyde Lane during construction will cause some additional delay for users of these roads due to the additional travel distance required by the associated diversions whilst in operation.

12.4.31 Increased traffic during the most intensive periods of construction, particularly HGV traffic, will affect non-motorised users crossing and using the A413 London Road/Nash Lee Road, between B485 Frith Hill and B4009 Nash Lee Road; A413, between B485 Frith Hill and A404 Whielden Lane; Potter Row, between Leather Lane and Frith Hill; Frith Hill, between Potter Row/King's Lane and B485 Frith Hill/Chesham Road; King's Lane, between Frith Hill and B485 Chesham Road; B485 Frith Hill/Chesham Road, between A413 and Hyde Heath Road and Hyde Heath Road between B485 Frith Hill and access road to Chiltern tunnel north portal satellite compound.

12.4.32 Temporary closure and associated diversion of nine PRoW and two roads (GMI/79/1 & 2, GMI/12/1, Frith Hill, GMI/80/1, GMI/23/6, GMI/28/1 & 2, GMI/33/3, Hyde Lane and LMI/17/2), during construction will affect non-motorised users due to the increased travel distances required by associated diversions.

12.4.33 The significant effects that result from construction of the Proposed Scheme are shown on Map TR-03-053 (Volume 5, Traffic and Transport Map Book).

12.5 Effects arising from operation

Avoidance and mitigation measures

12.5.1 The following measures have been included as part of the design of the Proposed Scheme and will avoid or reduce impacts on transport users:

- retaining the majority of roads crossing the Proposed Scheme in, or very close to their current location resulting in no significant diversions of traffic onto alternative routes; and
- retaining PRoW crossing the Proposed Scheme, with localised realignments kept to a minimum where reasonably practicable.

Assessment of impacts and effects

12.5.2 The following section considers the impacts on traffic and transport and the consequential effects resulting from the operational phase of the Proposed Scheme (as described in Section 2.4 of this report).

12.5.3 The operational traffic and transport impacts within this area arise from the realignment of PRoW.

12.5.4 Occasional traffic may access areas of the Proposed Scheme for maintenance purposes. However, these infrequent vehicle movements will be very low. No other changes in traffic are expected and traffic flows in 2026 and 2041 will be the same with or without the Proposed Scheme. Changes in traffic flow will not, therefore, have a significant impact.

12.5.5 The effect on accident and safety risk will not be significant as there are no substantial increases in traffic during operation.

12.5.6 No significant effects on parking or loading are expected as a result of operation of the Proposed Scheme.

12.5.7 It is not expected that the operation of the Proposed Scheme will require any bus route diversions and there will be no impacts on rail services in the area. Consequently, there will be no effects on public transport users during operation of the Proposed Scheme.

12.5.8 There will be minor adverse effects on non-motorised users due to increased travel distance resulting from the permanent realignment of eight PRoW and two roads at GMI/2/1 (footpath), GMI/13/3 (footpath), King's Lane, GMI/33/4 (footpath), GMI/33/2, GMI/33/3 (footpath), B485 Chesham Road, GMI/27/1 (footpath), GMI/23/7 (footpath), LMI/21/1 (footpath). The majority of realignments are less than 400m in length, apart from GMI/2/1 (footpath) at 550m, LMI/21/1 (footpath) and GMI/23/7 (footpath) at 700m and GMI/13/3 (footpath) at 750m.

12.5.9 The impacts and consequential effects of the operation of the Proposed Scheme in 2041 will be the same as described in 2026, having taken account of increased background traffic growth.

Cumulative effects

12.5.10 The assessment includes the cumulative effects of planned development during operation by taking into account background traffic growth.

12.5.11 There will be no additional traffic in this area resulting from the operation of the Proposed Scheme in neighbouring areas.

Other mitigation measures

12.5.12 No other mitigation measures during operation of the Proposed Scheme are considered necessary based on the outcome of this assessment.

Summary of likely significant residual effects

12.5.13 The permanent realignment of eight PRoW and two roads (GMI/2/1, GMI/13/3, King's Lane, GMI/33/4, GMI/33/2, GMI/33/3, B485 Chesham Road, GMI/27/1, GMI/23/7 and LMI/21), to accommodate the Proposed Scheme, will have significant effects on non-motorised users due to the increased travel distances required by use of diverted or alternative routes.

12.5.14 The significant effects that result from the Proposed Scheme in 2026 and 2041 are shown on Map TR-04-064 (Volume 5, Traffic and Transport Map Book).

13 Water resources and flood risk assessment

13.1 Introduction

13.1.1 This section provides a description of the current baseline for water resources including surface water, groundwater and the baseline conditions for flood risk. It then reports on the likely impacts and significant effects on these aspects as a result of the construction and operation of the Proposed Scheme.

13.1.2 The main environmental features of relevance to water resources and flood risk include:

- the River Misbourne, a main river downstream of Great Missenden, a typical chalk stream with winterbourne features, i.e. some sections in the upper reaches only flow periodically. The river also has a history of low flows;
- the Cretaceous Chalk, a Principal aquifer (see Map WR-02-009 (Volume 5, Water Resources and Flood Risk Assessment Map Book);
- public water supply groundwater abstractions and associated source protection zones (SPZ) located between Little Missenden and Great Missenden in this study area and another in CFA8;
- one private licensed abstraction with an associated protection zone and one unlicensed groundwater abstraction, both near Little Missenden;
- numerous identifiable ponds and drains located outside the route but within 1km of the centre line of the Proposed Scheme; and
- dry valleys associated with tributary catchments of the River Misbourne.

13.1.3 Key environmental issues relating to water resources and flood risk include:

- potential impacts on groundwater flow towards public water supplies (PWS) from tunnelling activities;
- potential impact on the risk of surface water flooding at the Little Missenden vent shaft and in the dry valley crossings at Mantle's Wood and Farthings Wood.

13.1.4 Volume 5: Appendix WR-001-000 contains a report on the route-wide effects including:

- generic assessments on a route-wide basis;
- stakeholder engagement;
- in-combination effects;
- a draft operation and maintenance plan for water resources and flood risk;

- a Water Framework Directive[104] (WFD) compliance assessment; and
- a route-wide Flood Risk Assessment (FRA).

13.1.5 Detailed reports on water resources and flood risk within this study area are also contained in the Volume 5 appendices. These include:

- Appendix WR-002-009: Water Resources Assessment report; and
- Appendix WR-003-009: Flood Risk Assessment.

13.1.6 Map Series WR-01 to WR-03 showing some of the details, environmental baseline and design features referred to in this report and are all contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

13.1.7 Where there is a residual impact to water resources and following mitigation there is a consequent effect on ecology, this is discussed further in Section 7.

13.1.8 Discussions have been held with the Environment Agency, the Chilterns Society, the Misbourne River Action Group, Buckinghamshire County Council (as Lead Local Flood Authority), Chiltern District Council and private borehole owners.

13.1.9 Discussions have been undertaken and will continue, with the Environment Agency and Affinity Water[105], with regard to the PWS abstractions and the water resources management plan within this and the adjacent area (CFA8).

13.2 Scope, assumptions and limitations

13.2.1 The assessment scope, key assumptions and limitations for the water resources and flood risk assessment are set out in Volume 1, and in the SMR and its addendum presented in Volume 5 (Appendix CT-001-000/1 and CT-001-000/2). This report follows the standard assessment methodology.

13.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this spatial scope is defined as the study area.

13.2.3 Site visits were undertaken in the vicinity of the River Misbourne:

- September 2012; as part of an overview of the whole scheme from the Colne Valley to Greatworth to Lower Boddington; and
- June 2013; to assess the general water level and flows with regard to seasonal

[104] Water Framework Directive - 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, Strasbourg, European Parliament and European Council
[105] Affinity Water Limited

recharge and the connectivity with groundwater in the Chalk aquifer.

13.2.4 WFD classification data has been made available by the Environment Agency. For water bodies that do not have a WFD status class shown in the relevant River Basin Management Plan (RBMP), the status class for those watercourses has been taken as the status class for the first downstream water body for which a status class is reported.

13.2.5 The assessment uses existing data with regard to groundwater levels. No monitoring of groundwater levels has been undertaken as part of this assessment. Groundwater level data includes information received from the Environment Agency and Affinity Water. Maximum groundwater levels have been used to provide an indication of the potential impact from the Proposed Scheme. In general, maximum groundwater levels were observed in early 2001, as stated in the baseline discussion.

13.2.6 The exact tunnelling method has not been selected, however, it is assumed for the purpose of assessment that the TBM will be operated in a closed face mode when tunnelling within water bearing strata and the tunnel lining will be designed to reduce leakage rates to a minimum, thereby minimising the requirements for dewatering and drainage.

13.2.7 Existing flood risk mapping made available from the Environment Agency or others has been used for the assessment of flood risk. The limitations associated with flood risk within this study area are described in detail in the flood risk assessment in Volume 5: Appendix WR-003-009.

13.3 Environmental baseline

Existing baseline – surface water resources

Surface water features

13.3.1 All water bodies within this study area are located in the Colne sub-catchment that includes the River Misbourne and its tributaries. The Colne sub-catchment is located in the Thames river basin district (RBD) and is covered by the associated RBMP[106].

13.3.2 The current surface water baseline is shown on Map WR-01-011 (Volume 5, Water Resources and Flood Risk Assessment Map Book) and all surface water features within the study area are assessed within Volume 5: Appendix WR-002-009. Table 19 includes features potentially affected by the Proposed Scheme.

[106] Environment Agency (2009) *River Basin Management Plan, Thames River Basin District*.

Table 19: Surface water features potentially affected by the Proposed Scheme

Water feature	Location description (and map reference)	Watercourse classification[107]	WFD water body and current overall status	WFD status objective (by 2027* as in RBMP)	Receptor value[108]
River Misbourne	Parallel to route, at closest point 150m from route in tunnel. Watercourse approximately 1km from open sections of route (from Mantle's Wood north). (Map WR-01-11; A7 to I6)	Main river	Misbourne GB106039029830 Poor	Good Potential	High

*year may vary in different RBMPs

13.3.3 In addition to the features listed in Table 19 there are also a large number of ponds and drains within the study area. These are low value features and are not assessed by the Environment Agency for WFD status. The details are given in Volume 5: Appendix WR-002-009.

Water Framework Directive status

13.3.4 The Environment Agency states the current overall status, under the WFD, of the River Misbourne as 'Poor' Status. The Environment Agency predicts that by 2027 the River Misbourne will be at Good Potential.

Abstractions and permitted discharges

13.3.5 There are no licensed surface water abstractions in the study area[109]. There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m³ per day

13.3.6 The Environment Agency reports that there are no current consented surface water discharges in the study area.

Existing baseline – groundwater resources

Geology and hydrogeology

13.3.7 The geological formations and hydrogeology of the study area are described in this section, with additional details and a schematic geological cross-section included in

[107] Water-feature classifications: Section 113 of the Water Resources Act 1991 defines a main river as a watercourse that is shown as such on a main river map. Section 72 of the Land Drainage Act 1991 defines an ordinary watercourse as 'a watercourse that is not part of a main river'. Section 221 of the Water Resources Act 1991 defines a watercourse as including ' all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages through which water flows'. Main rivers are larger rivers and streams designated by Defra on the main river map and are regulated by the Environment Agency.
[108] For examples of receptor value see Table 43 in the SMR addendum (Volume 5, Appendix CT-001-000/2).
[109] Surface water abstractions for public supply are not included.

Volume 5: Appendix WR-002-009. Descriptions of the geological formations are also provided in Section 8.

13.3.8 The location of abstractions, geological formations and indicative groundwater levels are shown in Map WR-02-009 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

13.3.9 A summary of the superficial and bedrock geology and hydrogeology is presented in Table 20. Unless otherwise stated, the geological groups listed are all crossed by the route.

Table 20: Summary of geology and hydrogeology in CFA9

Geology	Distribution	Formation description	Aquifer classification	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value
Superficial deposits						
Alluvium	Limited to the immediate vicinity of the River Misbourne. Not crossed by the route in this area.	Clay, Silt, Sand and Gravels	Secondary type A superficial aquifer	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
Head	Limited to the dry valley south west of Mantles Wood. Not crossed by the route in this area.	Clay and silt	Unproductive	Not assessed by Environment Agency	Not assessed by Environment Agency	Low
Head, 1*	Limited to the dry valley north of the source of the River Misbourne near Great Missenden. Not crossed by the route in this area.	Clay, silt, sand and gravel	Secondary (undifferentiated) superficial aquifer	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
Diamicton	Widespread on higher ground north of the Misbourne throughout this area.	Clay-with-flints	Unproductive	Not assessed by Environment Agency	Not assessed by Environment Agency	Low
Bedrock						
Cretaceous White	Restricted to the south	Firm white chalk with	Principal	Mid Chilterns Chalk	Good	High

Geology	Distribution	Formation description	Aquifer classification	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value
Chalk (Seaford Chalk Formation)	western part of this CFA. Not crossed by the route in this area.	conspicuous semi-continuous nodular and tabular flint seams. Previously part of the Upper Chalk.		GB40601G601200 Poor		
Cretaceous White Chalk (Lewes Nodular Chalk Formation)	Outcrops throughout this CFA outside of the valley of the River Misbourne.	Composed of hard to very hard nodular chalks and hard grounds. Previously part of the Upper Chalk.	Principal	Mid Chilterns Chalk GB40601G601200 Poor	Good	High
Cretaceous White Chalk (New Pit Chalk Formation)	Outcrops within the valley of the River Misbourne.	Principally blocky, white, firm to moderately hard chalk with numerous marls or marl seams. Previously part of the Middle Chalk.	Principal	Mid Chilterns Chalk GB40601G601200 Poor	Good	High
Cretaceous White Chalk (Holywell Nodular Chalk Formation)	Outcrops within the valley of the River Misbourne in the north western parts of this CFA.	Generally hard nodular chalks with thin flaser marls and significant proportions of shell debris in part. Previously part of the Middle Chalk.	Principal	Mid Chilterns Chalk GB40601G601200 Poor	Good	High

*British Geological Survey (BGS) nomenclature, separate to Head without suffix

Superficial deposits

13.3.10 The Diamicton (Clay-with-Flints) and the smaller outcrop of head deposits are considered unproductive strata with negligible quantities of groundwater. The alluvium and the larger outcrop of head deposits are designated as Secondary aquifer, although the area of Secondary aquifer is limited to the course of the River Misbourne and is not crossed by the route in this study area.

Bedrock aquifers

13.3.11 The regional hydrogeological map shows Chalk groundwater levels in autumn 1976, (see Volume 5: WR-002-009 for further details). The map indicates that the direction of groundwater flow within the vicinity of the route is towards the south-east. The SPZ in this section of the Proposed Scheme are also aligned in this direction.

13.3.12 The Environment Agency borehole monitoring data indicates that maximum recorded groundwater levels were around 100m AOD at the boundary with CFA8 (minimum levels were approximately 96m AOD in 1997), rising to 141m AOD at the boundary with CFA10 (minimum levels approximately 117m AOD in 1997). This suggests that peak groundwater levels are above the route elevation in the tunnelled section from approximately the boundary with CFA8 to Little Missenden, although lower than route elevation in the remainder of the tunnelled section, the portal and the rest of the Proposed Scheme between Little Missenden and the boundary with CFA10.

Water Framework Directive status

13.3.13 No WFD classification has been given by the Environment Agency to the superficial deposits.

13.3.14 The Environment Agency has classified the overall WFD status of the Mid Chilterns Chalk groundwater body as Poor Status with an objective to achieve Good Status by 2027.

Abstractions and permitted discharges

13.3.15 The route passes through the Chalk, a Principal aquifer with one private licensed groundwater abstraction, one PWS abstraction and one unlicensed groundwater abstraction in the study area. There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m3 per day.

13.3.16 There are two SPZ protecting PWS (TH011 and TH316) within the study area. One of the PWS is located within the study area (TH316), the other is located in CFA8. Further details of the SPZ protecting these PWS are provided in Volume 5: Appendix WR-002-009 and shown on Map WR-02-009 (Volume 5, Water Resources and Flood Risk Assessment Map Book). Works within this CFA overlay the SPZ2 for the PWS in CFA8 and the SPZ3 for the PWS in this study area. The works include construction of the route, drainage and landscaping (see Map WR-02-009, Volume 5, Water Resources and Flood Risk Assessment Map Book).

13.3.17 The Environment Agency reports that there are ten current consented discharges to ground/groundwater in the study area. Further details are provided in Volume 5: Appendix WR-002-009 and Map WR-02-009 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

Surface water/groundwater interaction

13.3.18 There are no springs, issues or seepages shown on Ordnance Survey maps within the study area. There are a number of areas of Clay-with-Flints with small surface water features as a result of poor infiltration to the deep water table in the underlying Chalk.

13.3.19 The River Misbourne is a chalk fed stream which is in hydraulic connectivity with groundwater in the Chalk aquifer. The river is not crossed by the Proposed Scheme in this study area.

13.3.20 Groundwater flow is generally to the south-east with a local pattern of flows towards and into the River Misbourne when groundwater levels are high, and the reverse during periods where groundwater levels are low. Groundwater flow within the Chalk is predominantly through fractures and can be rapid making the Chalk vulnerable to contamination particularly where there are PWS or private abstractions for potable use.

13.3.21 Further discussion on the River Misbourne and surface water/groundwater interactions can be found in Volume 5: Appendix WR-002-009.

Water dependent habitats

13.3.22 The route will not cross any areas with statutory ecological designations in relation to surface water or groundwater in the study area.

13.3.23 The River Misbourne is a local BAP habitat (refer to Section 7 for further information on the ecological features related to the BAP) fed by groundwater from the Chalk aquifer. Further discussion on the hydrology of the River Misbourne can be found in Volume 5: Appendix WR-002-009.

Existing baseline – flood risk

River flooding

13.3.24 The agreed data set for river flooding is the Environment Agency Flood Zone Mapping.

13.3.25 There is an area of Flood Zone 3 from the River Misbourne within the study area. However, this area will not be crossed and the route will be in tunnel where the river is closest to the route. River flooding is therefore not considered any further in the study area.

Surface water flooding

13.3.26 The agreed dataset for surface water flooding is the Environment Agency Flood Map for Surface Water (FMfSW).

13.3.27 The Proposed Scheme will cross a number of dry valleys within the study area which are shown on the FMfSW to be at risk of surface water flooding. The risk results from the potential for blocking of overland flows by existing railway and highway embankments that run perpendicular to the flowpaths within the dry valleys.

13.3.28 The dry valleys of greatest significance in relation to the Proposed Scheme are located as follows:

- close to the Little Missenden vent shaft – the area is shown to be at risk of potentially 'deep' (>0.3m) surface water flooding for the 1 in 200 year annual probability (0.5%) rainfall event (Map WR-01-011,H6);
- at Mantle's Wood (Map WR-01-011, F6), immediately to the north of the

Chiltern tunnel north portal, which is also at risk of 'deep' (>0.3m) surface water flooding for the 1 in 200 year annual probability (0.5%) rainfall event; and

- Farthings Wood dry valley (Map WR-01-011, F6), where three tributary valleys converge and are at risk of potentially 'deep' surface water flooding (>0.3m) during the 1 in 200-year rainfall event. Overland flow from this dry valley combines further down-gradient with the flow from the Mantle's Wood dry valley.

13.3.29 The Buckinghamshire County Council Preliminary Flood Risk Assessment (PFRA)[110] identifies three historical surface water flooding incidents within the study area close to the village of South Heath that occurred during 2006 and 2007, including on Frith Hill which the route will cross in a green tunnel.

Sewer flooding

13.3.30 The agreed datasets for sewer flooding are the Buckinghamshire PFRA and Chiltern District Strategic Flood Risk Assessment[111] (SFRA).

13.3.31 The Buckinghamshire PFRA states that properties and infrastructure within the Chiltern District area are at risk of flooding due to the surcharging of the underground sewer system which results in overland flow.

13.3.32 Thames Water Utilities Limited historic sewer flooding records show that there have been a very small number of sewer flooding incidents within this study area. Precise locations are not recorded within either the Chiltern District SFRA or the Buckinghamshire PFRA. However, the Chiltern District SFRA data indicates that only a few houses were flooded in each location. The Chiltern District SFRA therefore concludes that sewer flooding in the region appears to be sporadic and rare.

Artificial water bodies

13.3.33 The agreed dataset for flooding from artificial water bodies is the Environment Agency Reservoir Inundation Map[112].

13.3.34 No artificial water bodies were identified in close proximity to the Proposed Scheme within the study area.

Groundwater flooding

13.3.35 Agreed datasets for groundwater flooding include the Buckinghamshire PFRA and Chiltern District SFRA. Where these datasets do not include sufficient information on the risk of flooding from groundwater, the BGS maps showing the susceptibility to groundwater flooding have been reviewed.

13.3.36 Although not explicitly a problem within the study area, the Chiltern District SFRA notes that rising groundwater levels in the Great Missenden area have exacerbated the impact of other sources of localised flooding. The Environment Agency report on

[110] Buckinghamshire County Council (2011) *Preliminary Flood Risk Assessment Report*
[111] Chiltern District Council, (2008), *Strategic Flood Risk Assessment*
[112] Environment Agency (2012) *Reservoir Inundation Map:* http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=reservoir#x=485528&y=240060&lg=1,&scale=10. Accessed: 1 February 2013.

groundwater flooding in 2000/2001[113] does not show any affected areas in this study area.

Future baseline

13.3.37 Appendix CT-004-000 identifies developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the baseline for the operation of the Proposed Scheme. The potential cumulative effects arising from committed developments in relation to water resources and flood risk have been considered as part of this assessment of the construction and operation of the Proposed Scheme.

13.3.38 Developments are required to comply with the National Planning Policy Framework[114] (NPPF), development plans and other legislation and guidance. As such committed developments should have a neutral effect on the water resources and flood risk baseline.

13.3.39 WFD future status objectives are set out in Table 19 and Table 20. This potential change in baseline is not considered to result in the effects from the Proposed Scheme changing in significance.

13.3.40 The River Misbourne catchment is considered by the Environment Agency to be over-abstracted. In relation to WFD targets, the Environment Agency is seeking to improve the water body status by reducing PWS abstractions. This process is ongoing and is likely to result in changes to the hydrological regime of the River Misbourne and the aquifer respectively.

Climate change

13.3.41 Current projections to the 2080's indicate that climate change may affect the future baseline against which the impacts of the Proposed Scheme on surface water and groundwater resources have been assessed. There may be changes in the flow and water quality characteristics of surface water and groundwater bodies as a result of changes in climate. However, except for flood flows described below, these changes are not considered to result in the reported effects from the Proposed Scheme changes in significance.

13.3.42 Current projections indicate that there will be more frequent, higher intensity rainfall events in the future. The probability and severity of surface water flooding could therefore increase as surface water drainage systems fail to cope with more frequent, higher intensity storms. Peak river flows flood events are expected to increase, potentially causing greater depths and extents of flooding.

13.3.43 When considering the influence that climate change may have on the future baseline, against which the impacts from the Proposed Scheme on flood risk have been evaluated, the assessment has used the recommended precautionary sensitivity ranges of key parameters, as given in Table 5 in the Technical Guidance to the

[113] Environment Agency (2001), *Groundwater Flooding in the Thames Region Winter 2000/2001.*
[114] Department for Communities and Local Government (2012), *National Planning Policy Framework.*

NPPF[115]. The sensitivity testing undertaken allows for variations in climate change factors included in other national guidance.

13.3.44 Further information on the potential additional impacts of climate change for water resources and flood risk is provided in Sections 7 and 8 of Volume 1 and Volume 5: Appendix CT-009-000.

13.4 Effects arising during construction

Avoidance and mitigation measures

13.4.1 The general approach to mitigation is set out in Volume 1.

13.4.2 The following are examples of avoidance and mitigation measures that will reduce potentially adverse effects on water resources and flood risk. Further details are given in Volume 5: Appendix WR-002-009 and WR-003-009.

13.4.3 The following measures will reduce potential impacts to surface water features that could arise from construction.

13.4.4 The Proposed Scheme in this study area will be partly underground in twin-bored tunnel minimising the impacts to surface water receptors and flood risk in the tunnel section.

13.4.5 Drainage, including that from associated access roads and hard standings (such as at the Little Missenden vent shaft and auto-transformer station), has been designed to reduce the rate and volume of run-off in order to avoid an increase in flood risk. Drainage will discharge to sustainable drainage systems (SuDS) such as balancing ponds, prior to subsequent discharge to surface watercourses, ground or if necessary in sewer. The balancing ponds will provide mitigation to ensure that rainfall run-off from the route will be released in a controlled manner to the receiving watercourses reducing the potential for adverse impact on the water quality and flow of the receiving watercourse. The balancing ponds, shown on Maps CT-06-024 to CT-06-030 (Volume 2, CFA9 Map Book), will be designed where practicable to discharge at existing run-off rates and will accommodate for events up and including the 1 in 100 annual probability (1%) including an allowance for climate change.

13.4.6 The following measures will reduce potential impacts to groundwater that could arise from construction.

13.4.7 Realignments of four minor roads (Hyde Lane, King's Lane, Frith Hill and Leather Lane) and one larger road (B485 Chesham Road) are required as part of the scheme in the area. The road drainage is assumed currently to infiltrate into the ground through infiltration ponds/basins or as off-the-pavement runoff and thus eventually will reach the water table in the White Chalk aquifer. Appropriate mitigation will be provided to address the risks to the receiving water bodies for both flow and water quality during the detailed design of the Proposed Scheme using the Design Manual for Roads and Bridges[116] and CIRIA guidance[117]. Runoff rates and water quality will be controlled in

[115] Department for Communities and Local Government, (2012), National Planning Policy Framework Technical Guidance
[116] Department for Transport (2013) *Design Manual for Roads and Bridges*: http://www.dft.gov.uk/ha/standards/dmrb/vol11/section3/hd4509.pdf
[117] Murname, E., Heap, A. and Swain, A., 2006, C648 Control of Water Pollution from Linear Construction Sites, CIRIA, London, UK.

accordance with the necessary approvals. In addition, detailed design of infiltration basin will follow the Groundwater Protection, Policy and Practice (GP3) documentation[118].

13.4.8 The tunnel length and vertical alignment are such that the portal and open cut sections are above the water table and this reduces potential impacts on groundwater.

13.4.9 The TBM will be operated in a closed face mode when tunnelling within water bearing strata and the tunnel lining will be designed to reduce leakage rates to a minimum, thereby reducing the requirements for dewatering and drainage.

13.4.10 Any dewatering effluents (groundwater) at cross passages will be pumped for short periods and discharged to ground (e.g. through soakage areas) where possible. Ground improvement and groundwater control at some cross passages will be undertaken below ground.

13.4.11 The method of piling will be selected to avoid creating hydraulic pathways, such as cracks and cavities between the construction and the natural rock that might establish pathways between the aquifer and shallower surface water and groundwater. This is particularly important for deep piles penetrating the Chalk and areas where contamination may exist, see Section 8, Land quality.

13.4.12 During construction, groundwater from dewatering at the Little Missenden vent shaft will be discharged back into the groundwater via recharge wells in the vicinity of the vent shaft. As a precaution in the event that a technical constraint is identified in detailed design, provision has been made to transfer some discharge from dewatering by pipeline into the River Misbourne near the shaft.

13.4.13 The route will not pass within the inner or outer protection zones[119] of the private licensed groundwater abstraction identified in the study area.

13.4.14 The draft CoCP (Volume 5, Appendix CT-003-000) sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme (see Volume 5: Appendix CT-003-000). These will provide effective management and control of the impacts during the construction period to reduce impacts.

13.4.15 The following examples illustrate how measures in the draft CoCP will reduce potentially adverse effects arising during construction on water resources and flood risk.

13.4.16 With regard to surface water, Section 16 of the draft CoCP, includes detailed method statements, will minimise effects on surface water quality or flows associated with construction; this will include any release to surface waters from the vent shaft and

[118] Environment Agency (2013) Groundwater protection: Principals and practice (GP3). August 2013, Version 1.1

[119] For private licensed or unlicensed groundwater abstractions the time of travel zones indicate the extent of a 50day travel time (inner zone) and a 400day travel time (outer zone). The zones are defined as circles centred on the abstraction with the extent of the zone determined using the methodology applied to define PWS SPZ; Environment Agency(2013). Groundwater protection: Principles and practice (GP3). August 2013, version 1.1. For unlicensed abstractions, where the rate of abstraction will not exceed 20m3/d, the zones have been defined as a circle with radius 50m and 250m, for the inner and outer travel time zones, respectively.

associated construction compound at Little Missenden and the Chiltern tunnel north portal at Mantle's Wood.

13.4.17 With regard to groundwater, Section 16 of the draft CoCP requires monitoring to be undertaken, as required, pre-construction to establish baseline water quality conditions and to confirm the effectiveness of agreed temporary and permanent mitigation measures.

13.4.18 Specific monitoring to determine the potential impact to PWS (Affinity Water) and private abstractions will be undertaken. The monitoring schedule (to be agreed with the Environment Agency and in consultation with Affinity Water) will include monitoring before, during and after construction until the groundwater quality has stabilised within acceptable limits. The monitoring data will be assessed and used to define appropriate mitigation, should it be required.

13.4.19 Any dewatering requirements, such as during construction of the Little Missenden vent shaft, would be in compliance with the draft CoCP, Section 16. This requires contractors to obtain the necessary consents from statutory authorities to enable discharge of dewatering and surface water run-off to the public sewer network or watercourses. This will be done for the construction compounds at the Little Missenden vent shaft and Chiltern tunnel north portal, preventing an increase in the risk of surface water or sewer flooding.

13.4.20 Contamination from surface infiltration at all vent shaft construction sites will be prevented through the requirements of the draft CoCP, Section 16. Tunnelling and shaft construction will have the potential to impact on groundwater quality due to the introduction of bentonite and additives in circulating fluids for TBMs, piling and diaphragm walls, prior to completion with in situ concrete and cement grouts and their associated additives. With implementation of measures required by Section 16 of the draft CoCP, any potential contaminants will be controlled at source to ensure that the impact to the high value groundwater in the Chalk aquifer and, subsequently, any groundwater fed surface water bodies, will be minimised.

13.4.21 The area identified for sustainable placement in CFA10 and the temporary material stockpiles in this area are underlain by SPZ2 with potential for infiltration into the Chalk aquifer. Suitable quality criteria will be defined prior to material being placed to ensure that the existing groundwater quality is not adversely affected by the quality of the placement material. The draft CoCP (Sections 11, 15 and 16) defines appropriate measures that will be followed to ensure impacts to groundwater and surface water quality are minimised.

13.4.22 With regard to flood risk, the Chiltern tunnel north portal satellite compound, along with the construction of the Proposed Scheme in cutting through Mantle's Wood and Farthings Wood dry valleys, will be located within surface water flood risk areas. These will have site specific flood risk management plans prepared prior to construction, as stated in Section 16 of the draft CoCP.

13.4.23 Surface water flow in the dry valleys at Mantle's Wood and Farthings Wood will be conveyed beneath the Proposed Scheme in drop-inlet culverts, which will be designed for the 1 in 100 annual probability (1%) rainfall events including an allowance for climate change.

13.4.24 In accordance with Section 16 of the draft CoCP, temporary material stockpiles, construction compounds and site offices will be located outside of areas at risk of flooding where reasonably practicable. Where this is not possible these sites will be profiled to ensure they do not block overland flow paths. Temporary material stockpiles will potentially be located within the area at risk of surface water flooding at the Little Missenden vent shaft and adjacent to the Proposed Scheme near to Hyde Farm (for Hyde Farm access track) as shown on Maps CT-05-030 and CT-05-032 (Volume 2, CFA9 Map Book).

Assessment of impacts and effects

13.4.25 This section describes the significant effects following the implementation of avoidance and mitigation measures.

13.4.26 Details of the potential impacts that have significant effects are provided in the Water Resources Assessment report in Volume 5: Appendix WR-002-009 and Flood Risk Assessment in Volume 5: Appendix WR-003-009.

13.4.27 An assessment of the impact on the WFD status of the water bodies is detailed within the WFD Compliance Assessment, contained within the route-wide water resources appendix (Volume 5: Appendix WR-001-000).

13.4.28 It is not considered that projected climate change effects, combined with the effects from the construction of the Proposed Scheme, will alter the significance of any of the reported effects on surface water and groundwater resources (see Volume 3: Route-wide Effects Assessment for further information).

Temporary effects

Surface water

13.4.29 The assessment shows that there will be no significant temporary adverse effects on surface water resources during the construction period.

Groundwater

13.4.30 Tunnelling and piling/diaphragm wall construction has the potential to impact on groundwater quality due to the migration of fluids or suspended bedrock particles giving rise to raised turbidity. At the scale of the classified Mid-Chilterns Chalk groundwater body any turbid groundwater will be attenuated within the Chalk and diluted in regional flow and the overall impact on the groundwater body as a whole is deemed to be minor, which for this high-value receptor would be a slight effect, and therefore not significant.

13.4.31 Any migration of turbid groundwater to surface water is likely to be a slow process allowing natural attenuation within the chalk and dilution, to reduce turbidity to levels that are unlikely to significantly affect surface water quality. Therefore, the impact of any change in groundwater quality in the wider groundwater body on surface water and water dependent habitats will be negligible. Surface water features and associated water dependent habitats in the area are of high value leading to a neutral effect.

13.4.32 Although effects on wider water body receptors are considered to be neutral, if fissures connect the working area of the Proposed Scheme directly to high-value receptors such as PWS or private boreholes, the impact of even low levels of turbidity could cause the closure of a source due to the high quality required to be met for potable use. The sources protected by SPZ TH011 (see CFA8 report) and TH316 (in this CFA area) are close to the route. As a result of this proximity, the risk of turbid water entering these abstraction points is greater. If a PWS was forced to shut down this would be a major impact and will therefore result in a significant adverse effect.

13.4.33 There will be no other significant temporary adverse effects on other groundwater resources or water dependent habitats during the construction period.

Flood risk

13.4.34 The assessment has identified no significant temporary effects on the risk of flooding during the construction period.

Cumulative effects

13.4.35 There are no committed developments that have been identified which will result in significant cumulative temporary adverse effects.

Permanent effects

Surface water

13.4.36 The assessment did not identify any significant permanent adverse effects on surface water resources.

Groundwater

13.4.37 The assessment has identified no significant permanent effects on groundwater resources.

Flood risk

13.4.38 The assessment has identified no significant permanent effects on the risk of flooding.

Cumulative effects

13.4.39 The assessment has identified no significant cumulative permanent effects from committed developments in this area.

Other mitigation measures

13.4.40 No further mitigation measures are envisaged for surface water resources or flooding.

13.4.41 The Proposed Scheme could give rise to a significant adverse effect on water supplies that depend on the groundwater. As a result, the programme of monitoring to be undertaken in the study area, prior to, during and following completion of the construction works, 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 developed in consultation with the Environment Agency and Affinity Water.

13.4.42 In respect of PWS, HS2 Ltd will agree a management strategy with the Environment Agency in consultation with Affinity Water 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 ground water 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 PWS 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 activities of HS2 Ltd these initiatives could provide Affinity Water with enhanced flexibility of operations across its sources and additional supplies (in the event of an extreme drought or outage[120]) to manage the impacts from the Proposed Scheme.

Summary of likely significant residual effects

13.4.43 No significant residual effects on surface water, the Mid-Chilterns Chalk groundwater body and flood risk have been identified within the assessment.

13.4.44 Tunnelling and piling/diaphragm wall construction has the potential to have a temporary impact on groundwater quality. If fissures connect the working area of the Proposed Scheme directly to the Affinity Water groundwater abstractions protected by source protections zones referenced as TH011, and TH316, the impact of low levels

[120] Outage refers to periods where there is an unavailability or decrease in the level of service or abstraction.

of turbidity will be major due to the high quality required to be met for potable use, resulting in a large and significant effect.

13.4.45 Until a management strategy is agreed with the Environment Agency in consultation with Affinity Water, a potentially significant temporary residual effect on the Affinity Water groundwater abstractions remains.

13.5 Effects arising from operation

Avoidance and mitigation measures

13.5.1 Site-specific examples of design measures that will mitigate impact include the drainage arrangements for the Proposed Scheme in the study area. This comprises a number of balancing ponds for either railway or highway drainage and land drainage areas. These ponds and their associated access tracks are shown in Maps CT-06-030 to CT-06-034 (Volume 2, CFA9 Map Book).

13.5.2 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.

13.5.3 For protection of sensitive areas such as the SPZ associated with PWS measures will be developed to reduce impacts from track runoff draining directly to the surface water receptors. These will include measures such as controls on painting, track maintenance and the application of de-icing fluids and track grease.

13.5.4 Operation and management of the Proposed Scheme is not likely to have a significant adverse effect on flood risk anywhere in the catchments through which it passes. Generic examples of management measures that may mitigate flood risk are described in Volume 1.

Assessment of impacts and effects

13.5.5 There are considered to be no significant adverse effects to surface water, groundwater or flooding arising from operation of the Proposed Scheme.

Other mitigation measures

13.5.6 There are considered to be no further measures required to mitigate adverse effects on surface water resources or groundwater resources or flood risk.

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