

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 2 | Community Forum Area report

CFA8 | The Chalfonts and Amersham

November 2013

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Department
for Transport

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Structure of the HS2 Phase One Environmental Statement

The Environmental Statement (ES) documentation comprises:

- Non-technical summary (NTS) – which provides a summary in non-technical language of the Proposed Scheme, the likely significant environmental effects of the Proposed Scheme, both beneficial and adverse, and the means to avoid or reduce the adverse effects;
- Volume 1: Introduction to the ES and the Proposed Scheme. This describes High Speed Two (HS2), and the environmental impact assessment 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

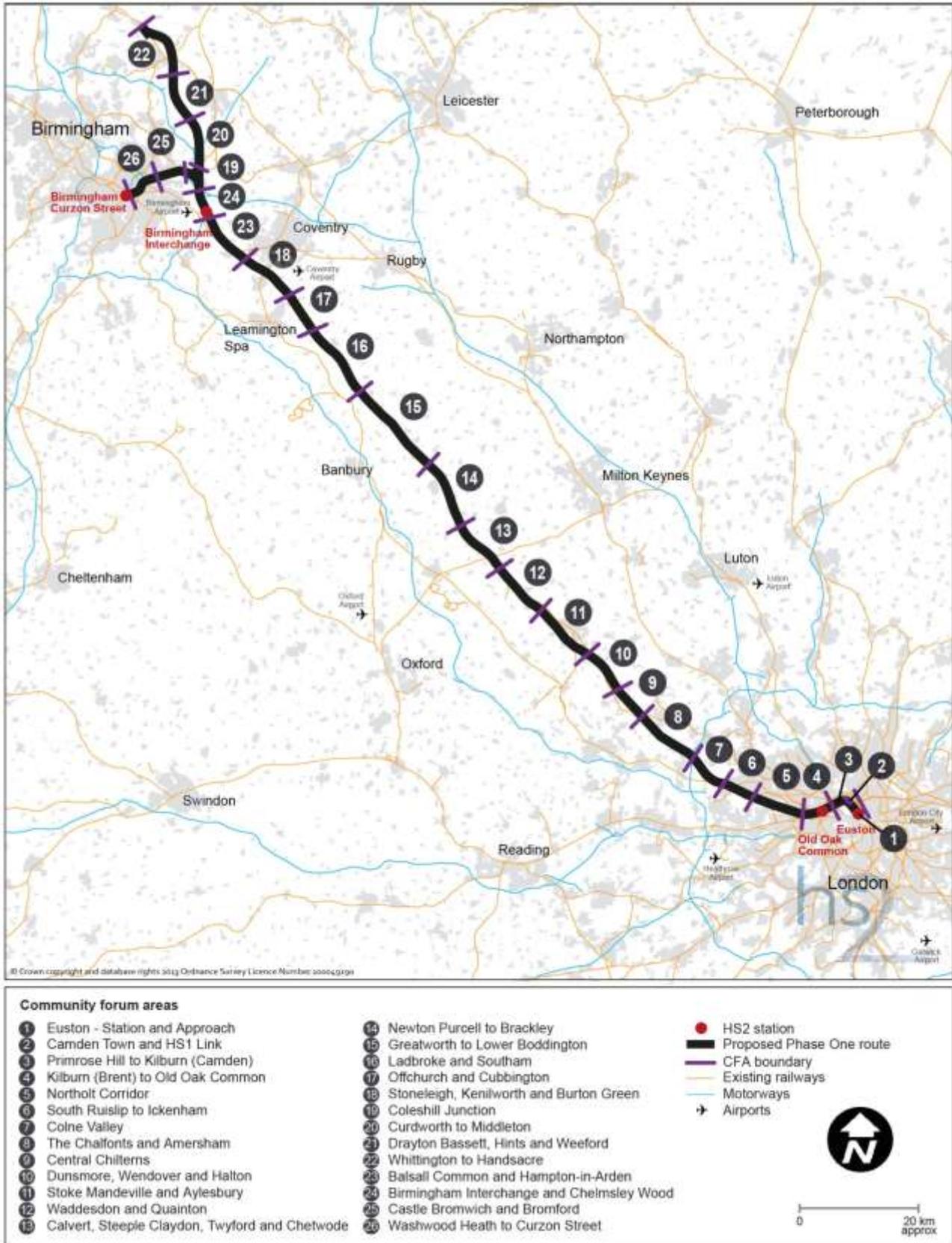
1.1 Introduction to HS2

- 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, 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 approximately 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 train services. As Volume 1 shows, the frequency of trains is expected to increase over time and to increase further upon opening of Phase Two. In assessing the environmental effects of the Proposed Scheme the anticipated Phase 2 operational frequency has been used. For further detail of the anticipated operation of the Proposed Scheme in the Chalfonts and Amersham area (CFA8), 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 Proposed Scheme design and on the likely adverse and beneficial effects.

1.2 Purpose of this report

- 1.2.1 This CFA report presents the likely significant effects of the construction and operation of the Proposed Scheme on the environment within CFA8 (Chalfonts and Amersham). 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 CFA8.

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 Chalfonts and Amersham are provided in a separate corresponding document entitled Volume 2, CFA8 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 features) (Volume 2, CFA8 Map Book) and CT-06 (permanent features) (Volume 2, CFA8 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 Chalfonts and Amersham CFA covers an approximately 11.3km section of the Proposed Scheme in the Chiltern District in the county of Buckinghamshire. The area extends from the M25, east of Chalfont St Peter, to the junction of the A413 and Mop End Lane. It includes land within the parishes of Chalfont St Peter, Chalfont St Giles, Coleshill and Amersham. The route through this area will be entirely in deep twin-bore tunnels with three associated ventilation and intervention shafts (vent shafts).

2.1.2 As shown in Figure 2, the Colne Valley (CFA7) is located to the south and the Central Chilterns (CFA9) lies to the north.

Settlement, land use and topography

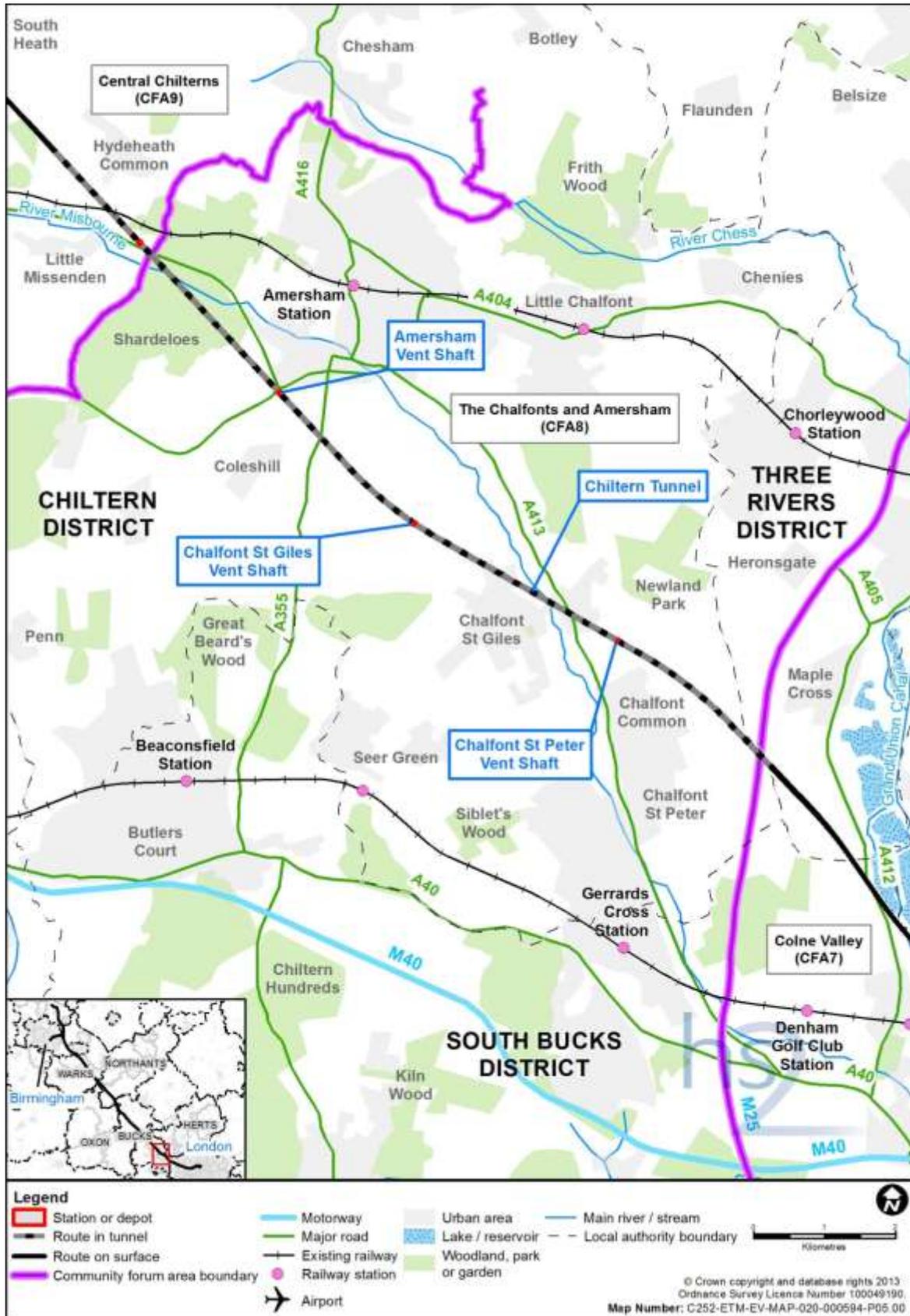
2.1.3 The area is predominantly rural in character, with agriculture being the main land use, interspersed with scattered cottages, farmsteads and villages. The topography is gently rounded as the land rises from the Colne Valley into the Chiltern Hills.

2.1.4 The route will run in twin-bore tunnels near to a number of villages and towns. The edge of the small village of Horn Hill will be approximately 50m to the north of the route and Chalfont St Peter will be approximately 180m to the south (see Map CT-10-013b, Volume 2, CFA8 Map Book). The route will pass under two sections of Chalfont St Giles located on either side of the River Misbourne (see Map CT-10-014, Volume 2, CFA8 Map Book). Coleshill village will be approximately 500m to the south of the route. Amersham Hospital, located at the southern extent of Amersham Old Town, will be approximately 100m to the north of the route (see Map CT-10-015). These villages and towns comprise rows of terraced, semi-detached and detached housing interspersed with established residential areas. The tunnels through this area will form part of the approximately 13.5km-long tunnelled section of the Proposed Scheme designed to pass beneath the Chilterns and largely avoid a surface route through the designated Chilterns AONB. The route will descend into the tunnels in the Colne Valley area, before going under the Chalfonts and Amersham and Central Chiltern areas. In total, approximately 11.3km of the tunnelled section will lie within the Chalfonts and Amersham area.

2.1.5 The River Misbourne and its tributaries flow through the Chalfonts and Amersham area and the route will pass under it at Chalfont St Giles and again at the Shardeloes Estate. The route will also pass under the northern tip of the Chalfont St Giles Conservation Area (see Map CT-10-014), wooded farmland to the southwest of Amersham and Shardeloes Grade II* registered park and garden south of the A413 (see Map CT-10-016).

CFA Report – The Chalfonts and Amersham/No 8 | Overview of the area and description of the Proposed Scheme

Figure 2: Area context map



Key transport infrastructure

- 2.1.6 The M25 forms the south-eastern boundary of this CFA and is the busiest local transport corridor. There are several cross-country highways in the area including the A413, A355 and A404. The A413 follows the Misbourne valley and passes west of Chalfont St Peter, through Chalfont St Giles and immediately to the south of Amersham. The route will pass under the A413 twice; first at Chalfont St Giles and then to the north-west of Shardeloes. The A404 Whielden Lane connects Amersham with High Wycombe. The route will pass underneath the A404 at the southern tip of Amersham Old Town. Approximately 900m further to the south-east, the route will pass under the A355 Gore Hill, which connects Amersham to Beaconsfield.
- 2.1.7 Local access roads, footpaths, cycle routes and bridleways provide important links between scattered dwellings and villages in the area. Footpaths include the promoted South Bucks Way, Chiltern Way and Old Shire Lane Circular Walk. Cycle routes include the promoted Milton Route (part of the Chiltern Heritage Trail).

Socio-economic profile

- 2.1.8 To provide a socio-economic context for the area, data for the demographic character areas (DCA) of Chalfont St Peter and Chalfont Common, Chalfont St Giles, and Amersham Old Town is used¹. In total, the population of the DCAs is approximately 13,700. The area's labour market outperforms England's as a whole; unemployment at 3.6% is significantly lower than the national level of 7.4%, while 71.7% of the working age population is economically active compared to the national figure of 69.9%². There are approximately 5,500 people who work within the area³.

Notable community facilities

- 2.1.9 The main shops and services are located in Amersham Old Town and the villages of Chalfont St Peter and Chalfont St Giles (see Maps CT-10-013b to CT-10-016). Chalfont St Giles will be closest to the Proposed Scheme, albeit above the tunnels. The Chalfont St Giles High Street, which crosses the River Misbourne, comprises shops, a library, restaurants, a post office and two public houses. The village has a Memorial Hall, two nurseries, a primary school, two dentists and a doctor's surgery. Amersham Hospital, located to the south of Amersham Old Town, is the nearest hospital serving the Chalfonts and Amersham area.
- 2.1.10 Chalfont St Peter has a smaller range of facilities, but it does have a primary school and a village hall at Horn Hill. Old Amersham High Street offers more facilities, including the Quaker Meeting House, a nursery, a dentist and a doctor's surgery.
- 2.1.11 The village of Chalfont St Giles is located to the north of Chalfont St Peter on the edge of the Chilterns. The village has a duck pond, 18th century cottages, a medieval high street

¹ A DCA represents a community that, depending on the area, may consist of a local ward, neighbourhood or village(s).

² Data comes from the 2011 Population Census.

³ Data comes from the 2011 business register and employment survey.

and provides a range of local facilities including a library, a post office and the Crown public house. In addition, St Giles’s parish church and the Merlin’s Cave public house are located on the green, which runs parallel with the High Street. The South Bucks Way (CSG/30/1 and AM/16/2) passes through Chalfont St Giles and links the Grand Union Canal at Denham to Coombe Hill near Wendover and is approximately 37km.

Recreation, leisure and open space

2.1.12 The area is predominantly open countryside and farmland, and accommodates a wide range of associated recreational facilities. A large public park is located on the Shardeloes Estate, with a lake and a field study centre (see Map CT-10-016). Shardeloes is an 18th century Grade I listed building, and is currently a set of private apartments. The route will cross under the South Buckinghamshire Way near Shardeloes Lake. The Chilterns Way runs through the area and meets with the South Buckinghamshire Way at Chalfont St Giles.

2.1.13 There are a number of museums in the area, including the Milton’s Cottage Museum in Chalfont St Giles, the Amersham Museum and the Chiltern Open Air Museum. The route will be located approximately 1km from Harewood Downs Golf Course, near Pollards Wood, and the Colne Valley Regional Park, although these facilities mainly lie within the adjoining Colne Valley area (see CFA 7 report).

Policy and planning context

Planning framework

2.1.14 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.

2.1.15 The following local policies have been considered and referred to where appropriate to the assessment:

- Buckinghamshire County Council Structure Plan⁴;
- Buckinghamshire County Council Minerals and Waste Core Strategy Development Plan Document (DPD) (MWCS) (2012)⁵;
- Chiltern District Council Core Strategy (2011)⁶;
- Chiltern District Council Local Plan (Consolidated policies) (2011)⁷;
- The Three Rivers District Council Core Strategy (2011)⁸;
- The Three Rivers District Council Development Management Policies (2013)⁹;

⁴ Buckinghamshire County Council, 1991, Buckinghamshire Structure Plan 1991-2011: Saved Policies.

⁵ Buckinghamshire County Council, 2012, Minerals and Waste Core Strategy Development Plan Document.

⁶ Chiltern District Council (2011) Local Development Framework, Core Strategy.

⁷ Chiltern District Council (2011) Adopted Local Plan, Consolidated September 2007 and November 2011.

⁸ Three Rivers District Council (2011) Core Strategy.

- Three Rivers District Council Local Plan 1996-2011 Updated Policies (2011)¹⁰;
- Hertfordshire County Council Waste Core Strategy 2011-2026 (2012)¹¹;
- Hertfordshire County Council Hertfordshire Minerals Local Plan Review 2002-2016 (2007)¹²; and
- Hertfordshire County Council Mineral Consultation Areas in Hertfordshire SPD (2008)¹³.

2.1.16 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 Zone, minerals safeguarding area, minerals consultation area and AONB.

2.1.17 Emerging policies are not considered within this report. However, the Local Development Framework Delivery DPD (Development Management Policies), 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

2.1.18 Developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme, are and 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. The proposed development that is relevant to several topics assessments in this area is Ref: Chilterns Adopted Core Strategy Policy CS7 – Land at Newland Park, Gorelands Lane, Chalfont St Giles, Buckinghamshire (see CFA8/11, Volume 5: Appendix CT-004-000). It is an opportunity to provide accommodation related to the anticipated need for elderly persons housing in the District. This development is now subject to planning application CH/2010/0976/FA.

2.1.19 The projected housing supply reveals that this land is set to be developed from 2015 to 2019 with 60 units completed each year and therefore will not be mostly completed by start of 2017 i.e. at the same time as the Proposed Scheme. It is considered to be a receptor for the operation of HS2, but also potentially to give rise to cumulative construction impacts with the Proposed Scheme on its neighbours. It is referred to in those topic sections where such a cumulative impact has been identified.

⁹ Three Rivers District Council (2013) Development Management Policies.

¹⁰ Three Rivers District Council (2011) *Local Plan 1996 – 2011 Updated Policies*.

¹¹ Hertfordshire County Council, 2012, *Waste Core Strategy*.

¹² Hertfordshire County Council, 2007, *Hertfordshire Minerals Local Plan Review 2002-2016*, Adopted March 2007.

¹³ Hertfordshire County Council, 2007, *Supplementary Planning Document, Mineral Consultation Areas in Hertfordshire*.

2.1.20 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 Chalfonts and Amersham 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.

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

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

- at the Chalfont St Peter vent shaft site, the extent of the landscape earthworks and planting has been refined and an additional area of ecological mitigation included; and
- at the Chalfont St Giles vent shaft site, new landscape earthworks have been added.

2.2.4 Construction of this section will be managed by three satellite compounds used for both civil engineering and railway installation, see Section 2.3.

Overview

2.2.5 The Chiltern tunnel will comprise a pair of bored tunnels extending approximately 13.5km in length, of which 11.3km will be under The Chalfonts and Amersham area. The Chiltern tunnel will commence south of the M25 between junctions 16 and 17 and east of Chalfont St Peter, in the Colne Valley (CFA7) area. The route will then proceed north-west passing under two sections of Chalfont St Giles located on either side of River Misbourne and then pass approximately 500m to the north of Coleshill village. It will continue to the south of Amersham Old Town through to the junction of the A413 with Mop End Lane, west of Amersham. There will be three ventilation and intervention shafts (vent shafts) in this area, near Chalfont St Peter, Chalfont St Giles and Amersham respectively (see Maps CT-06-023b to CT-06-030a, Volume 2 CFA8 Map Book).

Chiltern tunnel

2.2.6 The route will leave CFA7 in twin-bore tunnels from the Chiltern tunnel south portal and will run entirely in tunnel in the Chalfonts and Amersham area up to the junction of the A413 with Mop End Lane. Key features of the tunnel section, which is approximately

11.3km long, will include (see Maps CT-06-023b to CT-06-030a, Volume 2 CFA8 Map Book):

- circular twin-bore tunnels, each bore with an internal diameter of approximately 8.8m and an external diameter of approximately 9.6m. Depending on surface topography the tunnel depths will vary between approximately 20m and 90m below ground level and will pass beneath the River Misbourne twice along the route;
- cross passages will connect the tunnel bores approximately every 380m. 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 of the emergency services will be provided 20m either side of the vent shafts and will be approximately 2.3m wide and 2.3m high;
- a realignment of Footpath CSP/16 to maintain connection with Chalfont Lane; and
- a strip of planting along Horn Hill Road to screen views of the construction compound and permanent infrastructure (located in the Colne Valley area) from Horn Hill.

Chalfont St Peter vent shaft

2.2.7

From the M25, the route will continue north-west in tunnel to the north of Chalfont St Peter where the Chalfont St Peter vent shaft will be located approximately 50m from Chesham Lane to the south of Ashwell's Farm. The vent shaft is required to provide pressure relief from the tunnels and a dedicated intervention point and access for emergency services. Key features of this section, which will be approximately 2.6km long, will include (see Map CT-06-024, Volume 2 CFA8 Map Book):

- a permanent fenced compound, which will surround the following features:
 - a shaft headhouse building, which will be approximately 48m by 22m and approximately 4m high. It will provide access to the tunnels, approximately 63m 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 550m², will allow for maintenance and emergency access and egress from the tunnel;
 - below ground drainage tanks and utility connections will also be provided for fire fighting and tunnel buildings drainage; and
 - land drainage areas to the east and south of the vent shaft headhouse.
- a short access road connecting the vent shaft compound to Chesham Lane;
- landscape earthworks curving along the northern and western side of the vent shaft compound to integrate it into the landscape;

- areas of planting along the northern and western edges of the vent shaft compound to screen views from the surrounding residents in Chalfont St Peter and Chalfont St Giles; and
- an area of grassland habitat creation along the eastern boundary of the vent shaft compound mitigating the potential loss of great crested newt habitat.

Chalfont St Giles vent shaft

2.2.8 From the Chalfont St Peter vent shaft, the route will continue north-west within the Chiltern tunnel, past Chalfont St Giles to Bottom House Farm Lane. The Chalfont St Giles 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 in an open field approximately 300m south-west of Upper Bottom House Farm. Key features of this section, which will be approximately 3.3km long, will include (see Map CT-06-026, Volume 2 CFA8 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 35m 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 550m², will allow for maintenance and emergency access and egress from the tunnel;
 - an auto-transformer station which will be approximately 43m by 25m and approximately 5m high;
 - below ground drainage tanks and utility connections will also be provided for fire fighting and tunnel buildings drainage; and
 - land drainage areas to the north and south of the vent shaft headhouse.
- permanent widening of Bottom House Farm Lane generally along the south side, to achieve a 4m wide road, including the provision of passing bays to allow for permanent access to the vent shaft compound. Improvement works will be carried out to the junction of Bottom House Farm Lane with the A413 Amersham Road;
- strips of planting on both sides of the widened Bottom House Farm Lane to replace the existing hedgerows along the road where required;
- a short access road connecting the vent shaft compound to Bottom House Farm Lane;
- planting along the northern, western and eastern boundaries of the vent shaft compound to screen views from the surrounding residents; and
- landscape earthworks located at the north side of the vent shaft compound to integrate it into the landscape.

Amersham vent shaft

- 2.2.9 From the Chalfont St Giles vent shaft, the route will continue north-west within the Chiltern tunnel, up to the A404 Whielden Lane, south of Amersham Old Town. The Amersham 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 in the isolated parcel of land at the junction of the A404 Whielden Lane and the A413, south of Amersham Hospital. Key features of this section, which will be approximately 2.7km long, will include (see Map CT-06-028, Volume 2 CFA8 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 46m 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 550m², will allow for maintenance and emergency access and egress from the tunnel;
 - below ground drainage tanks and utility connections will also be provided for fire fighting and tunnel buildings drainage; and
 - land drainage areas to the east and south of the vent shaft headhouse.
 - realignment of an existing cycleway along A404 Whielden Lane;
 - a short access road connecting the vent shaft compound to A404 Whielden Lane;
 - planting around the outer perimeter of the vent shaft compound for visual screening; and
 - a strip of planting along the northern edge of the A404 between the Chilterns Crematorium and the A413 for visual screening.
- 2.2.10 The Proposed Scheme will require some land on a permanent basis, key features of which are illustrated in Maps CT-06-023b to CT-06-030a (Volume 2 CFA8 Map Book). Land that will also be required, but only on a temporary basis for construction, is set out in Section 2.3.

2.3 Construction of the Proposed Scheme

- 2.3.1 This section sets out the strategy for construction of the Proposed Scheme in the Chalfonts and Amersham 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.

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). 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 the 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; 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.

2.3.6 General provisions that will guide the construction process are set out in more detail in Volume 1, Section 6.4 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 6.5. Advance works will be required before commencing construction works and will typically include:

- further detailed site investigations and surveys for proposed construction compounds;

- 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 be predominantly underground within bored tunnel in the Chalfonts and Amersham area with the exception of the three vent shafts at ground level. This will comprise two broad types of engineering work:

- civil engineering works, such as bored tunnels and vent shafts; and
- railway installation works, such as laying tracks, and/or installing power supply, ventilation and smoke control equipment and communications features.

2.3.9 The construction of the 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 Chalfonts and Amersham area there are no main compounds and three satellite compounds used for both civil engineering and railway installation 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 works and/or coordinate satellite compounds, which will manage other works. Although, there are no main compounds in this area, in general the main compounds (including the Chiltern tunnel main compound in CFA7) 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; and
- necessary operational parking.

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 car 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 network to enable loading and unloading to and from trains delivering material to the HS2 site or removing excavated material;
- 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 excavated material 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, codes of worker behaviour are set out in Volume 1: Section 6.3 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 Proposed Scheme or running parallel to it.

Figure 3: Schematic of site compounds for civil engineering works

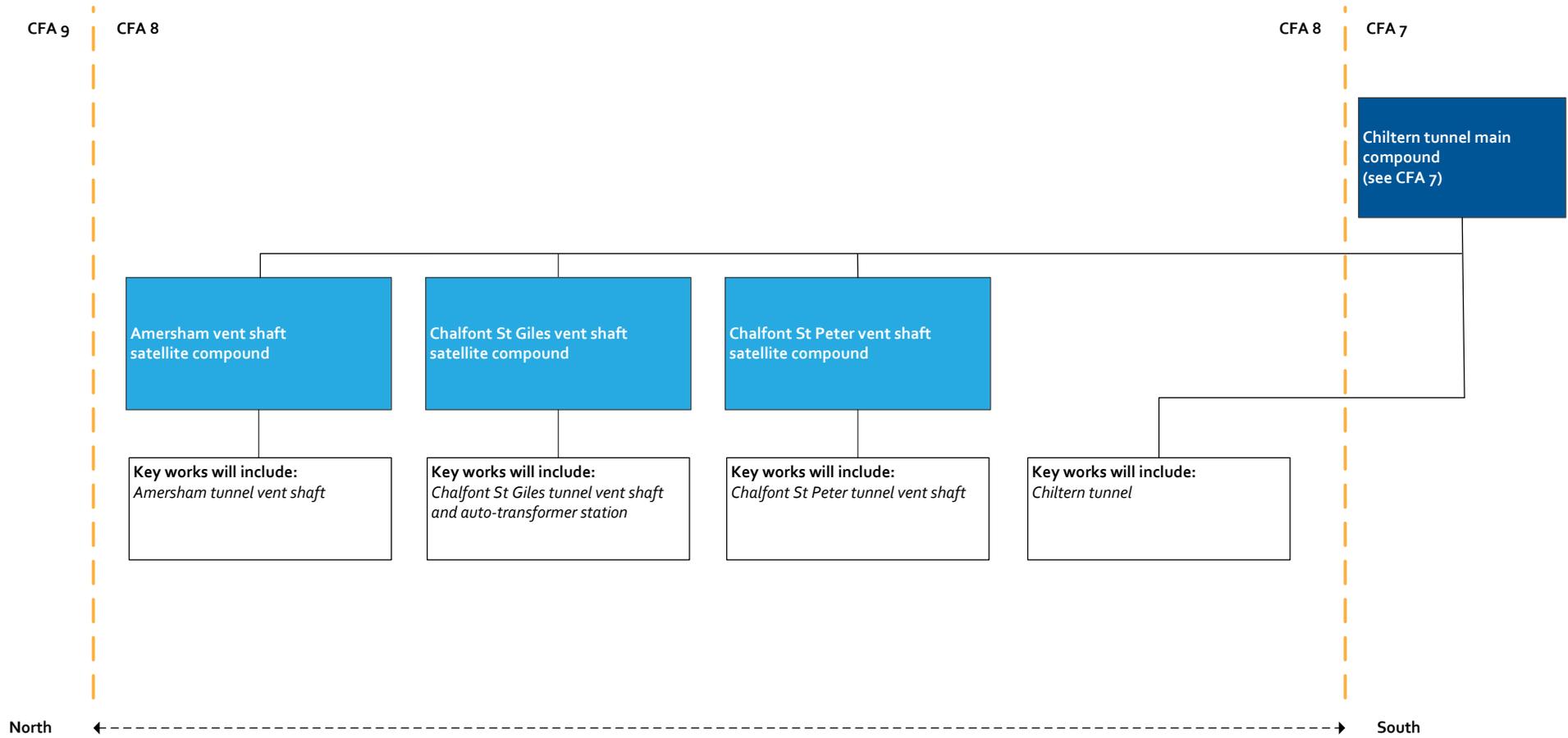
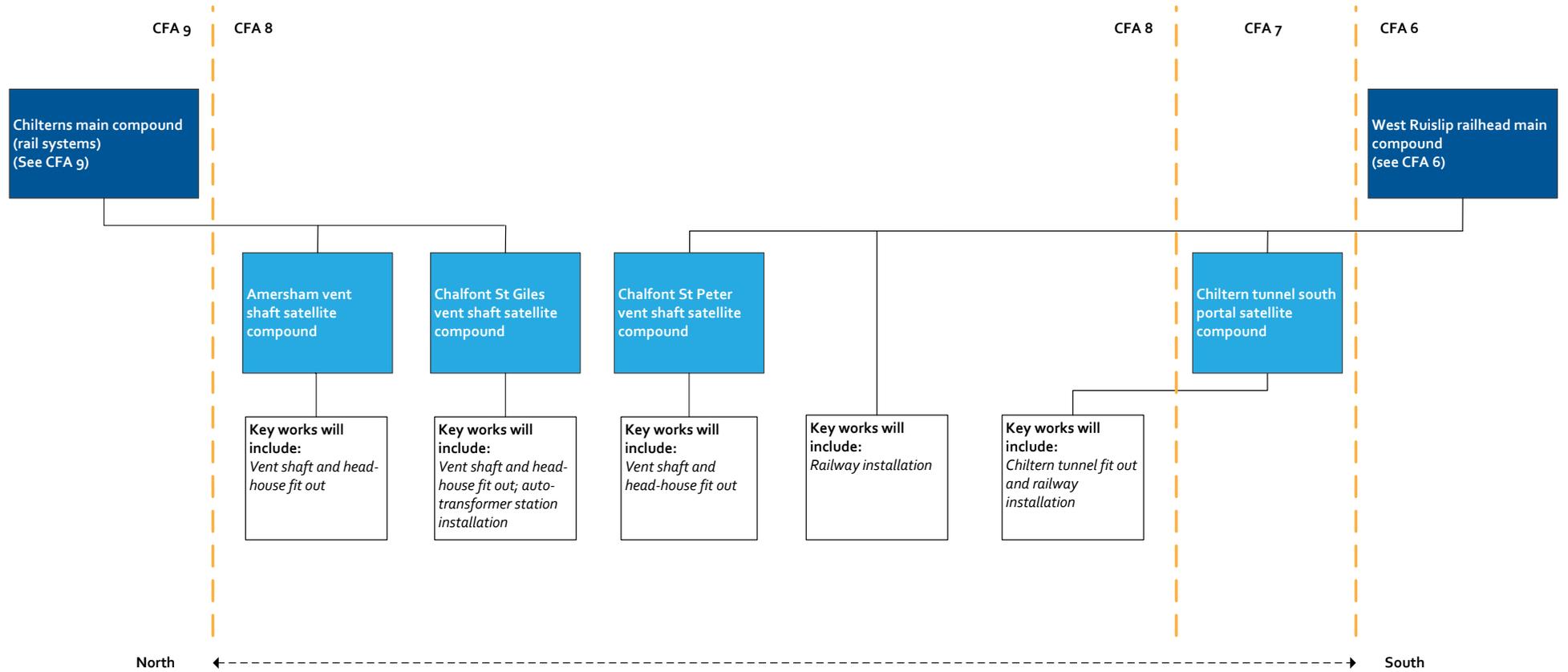


Figure 4: Schematic of site compounds for railway installation works



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 rail installation works between Chalfont St Peter and Amersham and also to provide support to two satellite compounds, as illustrated in Figure 4, which will be used to manage the construction of the Proposed Scheme within this area. See Volume 2, CFA Report 6 for more information about this compound.
- 2.3.20 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.
- 2.3.21 Railway systems installations works in this area will take approximately two years and nine months, commencing in 2022.
- 2.3.22 The track will be laid in a northerly direction away from the West Ruislip railhead main compound. Before the railway systems installation can commence, adequate civil engineering work will need to be completed to allow a continuous track laying sequence.
- 2.3.23 The railway systems installation has its own mobile welfare facilities for the site staff.

Chiltern tunnel main compound/Chiltern tunnel south portal satellite compound

- 2.3.24 Construction of the twin-bore tunnels themselves will be managed from the Chiltern tunnel main compound, located in the Colne Valley area (CFA7). This compound will subsequently reduce in size to form the Chiltern tunnel south portal satellite compound that will be used to manage the railway systems installation works through the Chiltern tunnel. See CFA Report 7 for more information about these compounds and the works to construct the tunnel.
- 2.3.25 For the duration of the construction programme, temporary slip roads onto the M25 will be provided to serve this compound. Chalfont Lane will be temporarily closed to local traffic and a temporary alternative local road will be created to the west of the M25.

Construction of vent shafts

- 2.3.26 The three satellite compounds in the Chalfont and Amersham area are required to construct vent shafts. At the compounds, which are described individually in subsequent sections, the works to construct the vent shafts 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.

2.3.27 See Volume 1, Section 5.8 for more information about vent shafts, and Volume 1, Section 6.14 for typical construction activities associated with vent shaft sites.

Chalfont St Peter vent shaft satellite compound

2.3.28 This compound will be used for civil engineering and railway installation works for the Chalfont St Peter vent shaft. The compound will:

- be in place for approximately seven years. During this period there will be civil engineering works for approximately two years, starting in 2018, followed by a three year period of inactivity before the railway installation works, which will last for approximately two years, commencing in 2023;
- support approximately 30 workers each day throughout much of the civil engineering works period; but will increase to approximately 70 workers each day during the peak period of activity and will support approximately five workers each day throughout the rail systems installations works period;
- not provide overnight worker accommodation;
- be accessed via Chesham Lane, Denham Lane, Joiners Lane, A413, A40 and M40 from the west; and
- be managed from the Chiltern tunnel main compound (see CFA Report 7) for the civil engineering works and from West Ruislip railhead main compound (see CFA Report 6) for the railway systems installation works.

2.3.29 The compound will be used to manage construction of the Chalfont St Peter vent shaft, which will take approximately four years to complete (excluding the three year period of inactivity). During the civils work the compound will also be used for maintenance of the tunnel boring machine (TBM) when it passes under this area.

2.3.30 In this area, no demolitions, no road realignments and no watercourse diversions will be required.

2.3.31 Alternative routes for the following three PRoW will be required:

- a temporary alternative route for Footpath CSP/10 will be required, to the west for approximately two years, adding an additional 100m. It will then be permanently reinstated along its existing alignment; and

- Footpath CSP/16 remains open during construction on a permanent alternative route via the realigned connection to Shire Lane, adding an additional 70m.

2.3.32 There are no diversions of existing utilities, but the installation of four new utilities will be required. A permanent 33kV supply, routed through the Chiltern tunnel from the Ickenham auto-transformer feeder station in CFA7.

2.3.33 Key railway systems installation works in this section of the Proposed Scheme will be for the installation of vent shaft equipment and commissioning.

Chalfont St Giles vent shaft satellite compound

2.3.34 This compound will be used for civil engineering and railway installation works for Chalfont St Giles vent shaft. The compound will:

- be in place for approximately six years and nine months. During this period there will be civil engineering works for approximately two years and three months, starting in 2018, followed by a two years and six month period of inactivity before the railway installation works, which will last for approximately two years, commencing in 2023;
- support approximately 30 workers each day throughout much of the civil engineering works period increasing to approximately 65 workers each day during the peak period of activity; and support approximately 20 workers each day throughout much of the rail systems installations works period increasing to approximately 45 workers each day during the peak period of activity;
- not provide overnight worker accommodation;
- be accessed via Bottom House Farm Lane, A413, A40 and M40 and/or via A413, A355, A40 and M40 from the east. To maintain access to properties on Bottom House Farm Lane during construction, a temporary construction access road will be installed adjacent to Bottom House Farm Lane to the south of The Granary. On completion of the vent shaft works this temporary access road will be removed and the agricultural land reinstated;
- have an associated roadhead with access to/from Bottom House Farm Lane for the transfer of material excavated from the vent shaft; and
- be managed from the Chiltern tunnel main compound (see CFA Report 7) for the civil engineering works and from the Chilterns main compound (rail systems) (see CFA Report 9) for the railway systems installation works.

2.3.35 The compound will be used to manage construction of the Chalfont St Giles vent shaft, which will take approximately four years and three months to construct (excluding the with a two year and six month period of inactivity). The compound will also be used for maintenance of the TBM when it passes under this area.

2.3.36 Removal of one commercial facility will be required (manage riding area only) from Chalfont Valley Equestrian at Bottom House Farm Lane.

- 2.3.37 In this area there will be no road realignments, no alternative routes for PRoW, and no watercourse diversions required.
- 2.3.38 Temporary closure of Bottom House Farm Lane will be required for through traffic, but local access will be maintained through the provision of traffic management measures and if needed a temporary construction traffic route adjacent to the existing Bottom House Farm Lane. Through traffic will be temporarily diverted via Bottrells Lane, Silver Hill, High Street, Pheasant Hill and A413 Amersham Road, for a period of approximately two years.
- 2.3.39 There are no diversions of existing utilities but the installation of four new utilities will be required. A permanent 33kV supply, routed through the Chiltern tunnel from the Ickenham auto-transformer feeder station in CFA7.
- 2.3.40 Key railway systems installation works in this section of the Proposed Scheme will be:
- installation of vent shaft equipment, and commissioning; and
 - installation and commissioning of the auto-transformer station.
- 2.3.41 See Volume 1, Section 4.4 for a generic description of power supply features including auto-transformer stations, and Volume 1, Section 4.5 for a description of associated construction activities.

Amersham vent shaft satellite compound

- 2.3.42 This compound will be used for civil engineering and railway installation works for Amersham vent shaft. The compound will:
- be in place for approximately six years and nine months. During this period there will be civil engineering works for approximately two years and nine months, starting in 2018, followed by a two year period of inactivity before the railway installation works, which will last for approximately two years, commencing in 2023;
 - support approximately 30 workers each day throughout much of the civil engineering works period; but will increase to approximately 60 workers each day during the peak period of activity and support approximately five workers each day throughout the rail systems installations works period;
 - not provide overnight worker accommodation;
 - be accessed via A404 Whielden Lane, A413, A40 and M40 and/or A413, A355, A40 and M40 from the east; and
 - have an associated roadhead with access to/from A404 Whielden Lane for the transfer of material excavated from the vent shaft; and be managed from the Chiltern tunnel main compound (see CFA Report 7) for the civil engineering works and from the Chilterns main compound (rail systems) (see CFA Report 9) for the railway systems installation works.

- 2.3.43 The compound will be used to manage construction of the Amersham vent shaft, which will take approximately four years and nine months to complete (excluding the two year period of inactivity). The compound will also be used for maintenance of the TBM when it passes under this area.
- 2.3.44 In this area no demolitions, no road realignments and no watercourse diversions will be required.
- 2.3.45 A temporary alternative route for a footpath and cycleway (between A404 Whielden Lane and A413) will be required, to the south via A404 Whielden Lane for approximately one year, adding a negligible distance. It will then be permanently reinstated along Whielden Lane.
- 2.3.46 Diversion of one utility and the installation of four new utilities will be required. A permanent 33kV supply, routed through the Chiltern tunnel from the Ickenham auto-transformer feeder station in CFA7.
- 2.3.47 Key railway systems installation works in this section of the Proposed Scheme will be for vent shaft equipment and commissioning.

Chilterns main compound (rail systems)

- 2.3.48 This compound is located within the Central Chilterns area (see CFA Report 9), but it will provide administrative support to rail installation works satellite compounds, as illustrated in Figure 4

Construction waste and material resources

- 2.3.49 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 Chalfonts and Amersham area have been prepared and are presented in Volume 5: Appendix WM-001-000.
- 2.3.50 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.
- 2.3.51 Based on the mitigation earthworks design approach adopted for the Proposed Scheme, local excess or shortfall of excavated material within the Chalfonts and Amersham area will be managed with the aim of contributing to an overall balance of excavated material on a route-wide basis. This overall balance of excavated material is presented in Volume 3, Section 14.
- 2.3.52 The quantity of surplus excavated material originating from the Chalfonts and Amersham area that will require off-site disposal to landfill as excavation waste is shown in Table 1. This is the forecast quantity of contaminated excavated material that is chemically unsuitable for reuse within the Proposed Scheme.

2.3.53 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%.

2.3.54 The quantities of demolition, construction and worker accommodation site waste that will require off-site disposal to landfill are shown in Table 1.

Table 1: Estimated quantity of waste going to off-site disposal

Waste type	Estimated material quantities that will be generated (tonnes)	Estimated quantity of waste for off-site disposal to landfill (tonnes)
Excavation ¹⁴	3,942,531	0
Demolition	335	34
Construction	173,647	17,365
Worker accommodation	0	0
Total	4,116,513	17,399

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

Commissioning of the railway

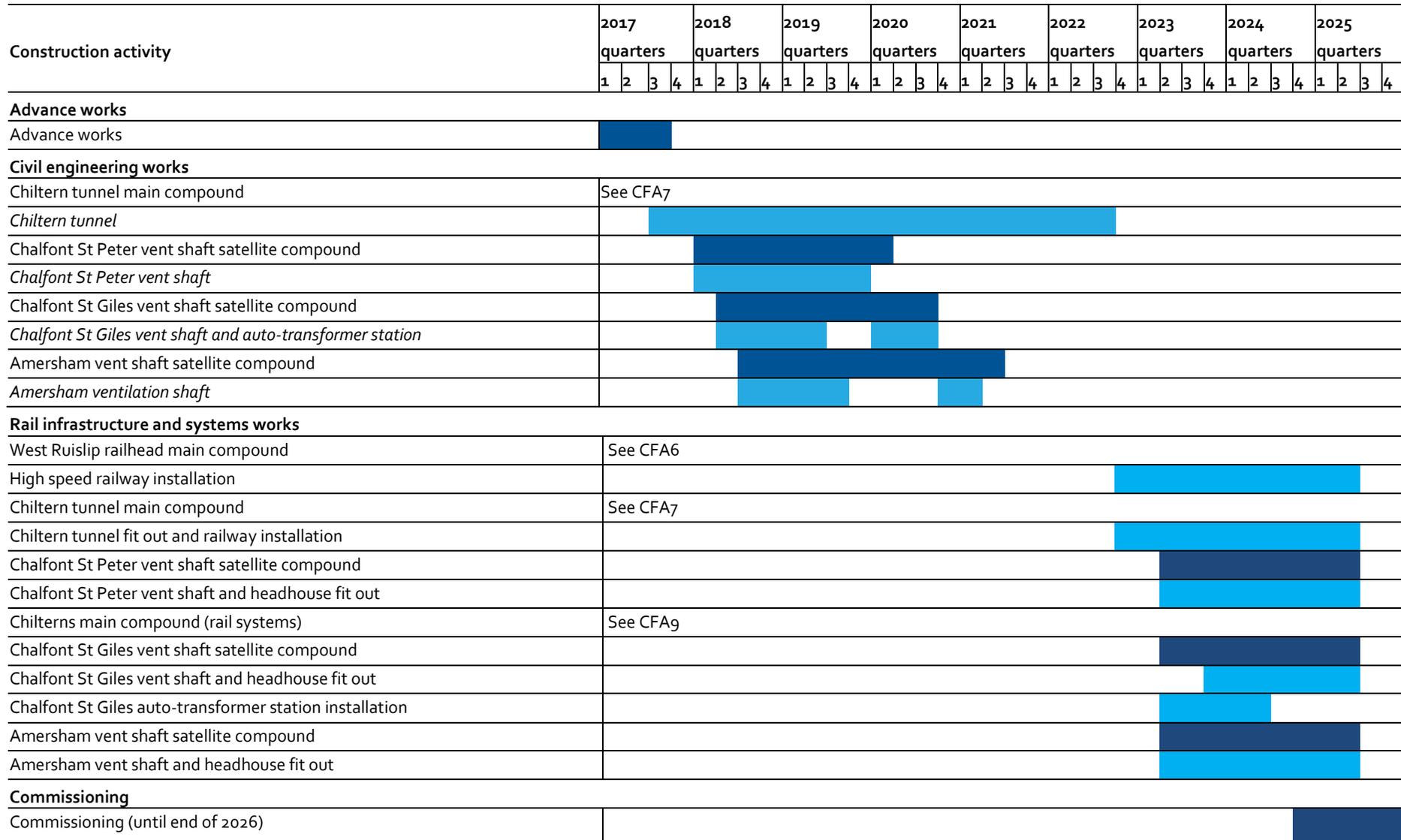
2.3.56 Commissioning is the process of testing the infrastructure to ensure that it operates as expected. This will take place in the period prior to opening. Further details are provided in Volume 1, Section 6.26.

Construction programme

2.3.57 A construction programme that illustrates indicative periods for each core construction activity in this area is provided in Figure 5.

¹⁴ Majority of this quantity of material is generated by the tunnel under this area and is removed from the southern end of the Chiltern tunnel in CFA7.

Figure 5: Indicative construction programme



Key ■ Construction works ■ Compound duration

2.4 Operation of the Proposed Scheme

Operational specification

2.4.1 Volume 1, Section 4.4 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 In this area, HS2 trains will be entirely in tunnel. It is anticipated that initially there would be 11 trains per hour each way 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 through the tunnels at speeds up to 320kph (200mph). 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 4.4 describes the maintenance regime for HS2.

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

Operational waste and material resources

2.4.8 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.

2.4.9 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.

- 2.4.10 Rolling stock maintenance waste refers to the waste that 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.
- 2.4.11 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.
- 2.4.12 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%.
- 2.4.13 On this basis, approximately 167 tonnes of operational waste will be re-used, recycled and recovered during each year of operation of the Proposed Scheme in the Chalfonts and Amersham area. Approximately 34 tonnes will require disposal to landfill (see Table 2).

Table 2: 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 trains	0	0
Rolling stock maintenance	0	0
Track maintenance	185	28
Ancillary infrastructure	16	6
TOTAL	201	34

- 2.4.14 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, local residents and action groups were undertaken. Community forum meetings were held on:

- 12 July 2012 at Chalfont St Peter Community Centre;
- 26 September 2012 at Chalfont St Peter Community Centre;
- 21 November 2012 at Chalfont St Peter Community Centre;
- 4 March 2013 at Chalfont St Peter Community Centre;
- 19 March 2013, at The Gardens Association Hall; and
- 24 September 2013, at Chalfont St Peter Community Centre.

2.5.3 In addition to 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.

2.5.4 The main themes to emerge from these meetings were:

- concerns over noise from the vent shafts and the appearance and size of these, with a preference for the design to be sensitive to the local setting;
- concerns over construction sites including the impact of the construction site in the Colne Valley, the 24 hour working schedule, noise from construction vehicles and lighting at night. Also concerns over the location, management and size of construction accommodation camps and whether these might remain for longer than is necessary, with preference for sites and camps to be sensitive to the area;
- request for the porous portal at the end of the Chiltern tunnel to be hidden;
- concerns over vibration impacts during tunnelling and when the service is operational with particular reference to Amersham Hospital, an equine centre and an epilepsy centre;
- concerns over traffic impacts from construction, given existing congestion levels and road realignments and that these could deter visitors and affect the local economy;
- concern over impacts on rights of way and a request for footpaths to be reinstated; and
- concern that the Metropolitan Line and Chiltern Railway Lines (the Marylebone to Aylesbury Line) would be affected during construction of the route, and road realignments could cut off access routes between Chesham and surrounding villages, including access to important facilities such as hospitals.

- 2.5.5 In addition to the engagement through the community forums, the draft Environmental Statement and Design Refinement consultations were launched on 16 May 2013 for a period of 8 weeks and closed on the 11 July 2013. As part of these consultations, members of local communities and other interested parties were contacted, 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 Chalfonts and Amersham area, consultations on the draft Environmental Statement were held on the 29th May 2013 at Chalfont St Giles Memorial Hall. HS2 Ltd staff were in attendance at the event including engineers and environmental specialists, for members of the public to speak to.
- 2.5.6 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 (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 this 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.
- 2.6.3 There were a number of options considered for the extension of the Chiltern tunnel, which are reported in Section 2.6 of CFAg Central Chilterns.

Tunnel depth through the Chilterns

- 2.6.4 The Proposed Scheme includes twin-bore tunnels under the Chilterns AONB in this area. The majority of this tunnelled section will fall within the Chalfonts and Amersham area; however, the tunnel options considered extended south into the Colne Valley area and north into the Central Chilterns area.
- 2.6.5 The following two options were considered to ensure that the vertical alignment of the tunnels through the Chilterns satisfied the design standard that the tunnel depth should be twice the bored diameter when passing under watercourses:
- Option A: The January 2012 announced route, with a shallower tunnel alignment; and

- Option B: The Proposed Scheme, a lowered vertical alignment.

2.6.6 Option A did not fully meet the required design standard with respect to depth below surface water features (in particular, the River Misbourne and Shardeloes Lake). Option B will provide the necessary depth below these features, and this was the main reason for its inclusion in the Proposed Scheme. In addition, the tunnel gradients of Option B will allow water to naturally drain to suitable points for it to be pumped to the surface.

2.6.7 For these reasons, Option B was adopted in the Proposed Scheme.

Vent shaft near Amersham

2.6.8 The Chalfonts and Amersham community forum were concerned that the location of the vent shaft at Amersham had been changed between the January 2012 announced route and the Proposed Scheme. The Proposed Scheme has the vent shaft located to the south of Amersham Old Town, at the junction of the A413 and A404. In the January 2012 announced route this vent shaft was further to the east, on the opposite side of Whielden Lane.

2.6.9 Two options for the vent shaft near Amersham were considered:

- Option A: The January 2012 announced route, with the vent shaft to the east of Whielden Lane; and
- Option B: The Proposed Scheme, with the vent shaft in the land formed by the junction of the A413, A404 Whielden Lane.

2.6.10 The community forum expressed concern about the impact of Option B on the road network as a result of construction traffic access to and from the proposed vent shaft location, and the operational impacts of having the vent shaft closer to the hospital.

2.6.11 Option A would involve excavating the vent shaft on a steep-sided slope, which would increase the volume of material generated and the visual impact of construction.

2.6.12 Any potential noise and vibration effect on the hospital would be dictated by the location of the tunnel rather than the location of the vent shaft, and the tunnel would be in the same proximity to the hospital for both options.

2.6.13 Option B will allow direct access to A413, A404 Whielden Lane and will be partly screened by an established existing area of scrub and trees. This vegetation will be retained where reasonably practicable and new planting added following construction, so that the vent shaft buildings and fencing will be visually screened from the view of passing motorists.

2.6.14 Option B will also take advantage of the screening provided by the existing road embankment between the vent shaft and the hospital as well as utilising a parcel of land which is bounded on all sides by existing roads.

2.6.15 For these reasons Option B was included in the Proposed Scheme.

Vent shaft near Chalfont St Giles

2.6.16 The Proposed Scheme includes a vent shaft located to the north of Chalfont St Giles along Bottom House Farm Lane. In the January 2012 announced route this vent shaft was further to the east, on the opposite side of Bottom House Farm Lane.

2.6.17 The following two options were considered to ensure the location of the vent shaft presented the least possible land required and visual impact on the surrounding properties:

- Option A: The January 2012 announced route, with the vent shaft on the southern side of Bottom House Farm Lane; and
- Option B: The Proposed Scheme, with the vent shaft 200m further west and on the northern side of Bottom House Farm Lane.

2.6.18 Option A would involve excavating the vent shaft on sloping ground, which would increase the volume of material generated and the visual impact of construction. In addition, with Option A the vent shaft would be in view of the properties at Upper Bottom House Farm and due to the vent shaft being located directly over the line of the tunnel, would increase the area of agricultural land affected.

2.6.19 Option B will be constructed on slightly flatter land, which will reduce the volume of material required to be excavated. The vent shaft will be mostly screened by a small area of woodland to the east of the site. This area of woodland will be strengthened following construction so that the vent shaft is further hidden from the sight of the properties at Upper Bottom House Farm.

2.6.20 For these reasons Option B was adopted in the Proposed Scheme.

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 and 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 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 assessment (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 the construction and operational phases. Key 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 publicly available information used in the assessment, and the results of surveys undertaken within this CFA, are contained in Volume 5: Appendix AG-001-008.

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 CFA.

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.
- 3.3.2 In this area as the only works that will be above ground are the three vent shafts and their associated infrastructure, the baseline data is directed towards those three locations.

Soils and land resources

Topography and drainage

- 3.3.3 The main topographical features within the study area are described in detail in the landscape and visual assessment (Section 9). The topography is characteristically gently rounded as the land rises from the Colne Valley into the Chiltern Hills. The predominant feature, other than the Chiltern Hills, is the Misbourne valley. The River Misbourne is a typical chalk stream with a winterbourne (a stream which only flows during wet periods) in the upper reaches. The valley and the river floodplain sit between 70 and 80m above Ordnance Datum (AOD), from which the Chilterns rise up to around 160m AOD.

Geology and soil parent materials

- 3.3.4 The main geological features are described in detail in Section 8. The predominant underlying geology mapped by the British Geological Survey is that of the White Chalk subgroup which outcrops to form a long north-east to south-west escarpment facing north-west. There is a long back slope which gradually falls to the south-east, which is covered by various plateau drift deposits. To the north-west the chalk scarp has outwash deposits at its foot which give way to the underlying clay. Small areas of

the Lambeth Group are also mapped in the south-east of this area and comprise sand, silt and clay, while further to the north-west is found an extensive clay plain formed on the Kimmeridge Clay.

- 3.3.5 At the southern end of the study area superficial deposits comprise sand and gravel or alluvium associated with the River Misbourne. Superficial deposits are generally absent from the northern half of the route section although a small area of Clay-with-Flints is evident to the west of Amersham Old Town. The route will also cross an area of Head deposits described as gravel, towards Amersham Old Town.

Description and distribution of soil types

- 3.3.6 The characteristics of the soils are described by the Soil Survey of England and Wales¹⁵ and shown on the National Soil Map¹⁶. The soils are grouped into associations of a range of soil types. They are described in more detail in Volume 5: Appendix AG-001-008 and their distribution are shown on Map AG-02-008 (Volume 5 Agriculture, Forestry and Soils Map Book).
- 3.3.7 Soils range from the versatile, well to moderately drained loamy topsoils over clay of the Marlow association to the imperfectly to poorly drained alluvial soils of the Frome association.
- 3.3.8 Frome and Coombe 1 soils are mapped in association with the River Misbourne. Both are characterised by silty and clayey loam soils overlying chalk. The Frome soils mark the immediate floodplain and are wet, often being assessed as poorly drained Wetness Class (WC) IV¹⁷. Due to the underlying chalk and their occurrence on valley sides, Coombe 1 soils are generally well drained and of WCI.
- 3.3.9 To the south-east of the area, the Marlow association soils dominates and is typically a well or moderately well-drained loamy over clay soil containing flints and assessed as WC I or II. To the west of the river and south of Amersham, the flint and chalky soils of the Batcombe, Hornbeam 2 and Sonning 2 associations are mapped. These soils typically develop in Plateau Drift or Clay-with-Flints which cap high chalky plateaux and are moderately well drained (WC II or III).
- 3.3.10 Soil of the Essendon association is mapped in the north-west of the area, developed in gravelly material and comprising flinty and loamy soils over clay. Although mapped on slopes and hilltops, Essendon soils remain imperfectly to poorly drained (WC III to IV).

Soil and land use interactions

Agricultural land quality

- 3.3.11 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

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*, National Soil Resources Institute, Cranfield University, UK.

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.

agricultural capability of land resulting from the interactions of soil, climate and the site.

- 3.3.12 The main soil properties that affect the cropping potential and management requirements of land are texture, structure, depth, stoniness and chemical fertility. The main soil characteristics in the Chalfonts and Amersham area are silty clay loam and clay loam soils overlying chalk associated with the river; flinty and chalky soils on slopes and plateaux which are moderately-to-well drained; and flinty, loam over clay textures on hill tops.
- 3.3.13 Climate in this area does not place any overarching limitation upon land quality but the interactions of climate with soil characteristics are important in determining the wetness and droughtiness limitations of the land. The local agro-climatic data have been interpolated from the Meteorological Office's standard 5km grid point data set for two points within the area and are set out in Volume 5: Appendix AG-001-008. The data show average temperatures and rainfall to be moderate. The average number of Field Capacity Days¹⁸ (FCD) is 155 days, which is slightly greater than the average for lowland England (150) and therefore considered to be slightly unfavourable for providing opportunities for land working.
- 3.3.14 Gradient and microrelief, with complex changes of slope angle or direction over short distances may be a limiting factor to the ALC grading between Chalfont St Giles and Amersham where the landscape rises up from the river valley. Land steeper than 7° cannot be better than Subgrade 3b, and land steeper than 11° cannot be better than Grade 4.
- 3.3.15 The principal limiting factors determining agricultural land quality in this area are soil wetness and droughtiness. Soils of the Frome association have silty clay loam topsoils and are most typically of WC IV due to waterlogging by high groundwater. This results in a soil workability limitation to Subgrade 3b under the climatic conditions of this section. Essendon soils may also be of WC IV which results in a similar limitation, although may be of WC III, resulting in a limitation to Subgrade 3a.
- 3.3.16 The moderately well drained medium silty clay loam soils of the Marlow association of WC II are likely to be of Grade 2, limited by soil workability. Slightly less well drained clay loam and silty clay loam Batcombe, Hornbeam 2 and Sonning 2 associations are predominantly of Subgrade 3a when assessed under a climatic regime with 155 FCD, unless the topsoils are heavy clay loam or heavy silty clay loam in which case the soils are of Subgrade 3b.
- 3.3.17 Under the climatic conditions of this area, soils that are well draining and overlying porous chalk are most likely to be BMV. Due to their free-draining characteristics and flint content Coombe and some Marlow, Batcombe, and Hornbeam 2 association soils

¹⁸ Field Capacity Day is a meteorological parameter which estimates the duration of the period when the soil moisture deficit is zero. Soils usually return to field capacity (zero deficit) 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.

in this location are also downgraded to a minor extent by droughtiness to Grade 2 or Subgrade 3a.

- 3.3.18 Defra mapping¹⁹ shows that there is generally a moderate likelihood of encountering BMV land in the locality, which makes the presence of such land a resource of medium sensitivity in this local area.

Other soil interactions

- 3.3.19 Soil fulfils a number of functions and services for society in addition to those of food and biomass production that are central to social, economic and environmental sustainability. These are outlined in sources such as the Soil Strategy for England²⁰ and The Natural Choice: securing the value of nature²¹, 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.

- 3.3.20 Forestry resources represent a potentially multifunctional source of productive timber, landscape amenity, biodiversity and carbon storage capacity. The value and sensitivity of the resources are assessed in Section 7.

- 3.3.21 The floodplain of the River Misbourne is a functional flood environment set out in Section 13 with the soils functioning as water stores for flood attenuation, as well as providing a habitat for ecology.

- 3.3.22 The presence of soil-borne cultural assets is detailed in Section 6. Concentrations of Palaeolithic and Mesolithic flint tools have been recorded within the gravel deposits in the River Misbourne valley. Little evidence for later prehistoric settlement has been recorded in the area though it would have been concentrated on the higher ground overlooking river valleys and better-drained soils.

Land use

Land use description

- 3.3.23 Aside from the settlements of Chalfont St Peter, Chalfont St Giles and Amersham, the area is predominantly rural in character, with agriculture being the main land use, interspersed with scattered cottages, farmsteads and villages. In the centre of the area, to the south of Amersham and to the east adjacent to Chalfont St Peter, there

¹⁹ Department for Environment, Food and Rural Affairs (2005), *Likelihood of Best and Most Versatile Agricultural Land*.

²⁰ Department for Environment, Food and Rural Affairs (2009), *Soil Strategy for England*.

²¹ Department for Environment, Food and Rural Affairs (2011), *The Natural Choice: securing the value of nature*.

are a number of large arable fields, with smaller grassland fields found around Chalfont St Giles and at the western end of the area.

- 3.3.24 A number of environmental designations potentially influence land use within the study area. The majority of the study 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 farm land. Holdings which have land entered into an agri-environment scheme are identified in Table 3.
- 3.3.25 Woodland is well represented as a land use, some associated with large estates in the area, and represents 21% of land cover in the area compared to the national average of 10%.

Number, type and size of holdings

- 3.3.26 There are six holdings in the vicinity of the proposed vent shafts ranging from 9 to 162 hectares (ha). It is understood that of these six, five are commercial farms operating arable and/or livestock enterprises one also with equestrian activities, and one is a smallholding where the land is let to others. The boundaries of the holdings are shown on Map Series AG-01 (Volume 5, Agriculture, Forestry and Soils Map Book), along with the location of the main farm buildings.
- 3.3.27 Table 3 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, and can 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. Small (less intensively used) units, such as pony paddocks associated with residential properties, have a low sensitivity. 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-001-008.

Table 3: Summary characteristics of holdings

Holding reference/name	Holding type	Holding size (ha)	Diversification	Agri-environment	Sensitivity to change
CFA o8/1 Ashwell's Farm	Grazing	9	None	None	Low
CFA o8/2 Upper Bottom House Farm (Chalfont Valley Equestrian)	Arable, beef cattle and equestrian	162	Milk retail Livery stable	None	Medium
CFA o8/3 * Shardeloes Farm	Arable and equestrian	140	Not known	None	Medium
CFA o8/4 Lower Bottom House Farm	Grazing	121	Clay pigeon shooting, storage	ELS	Low
CFAo8/5 * Bereleigh Farm	Arable	60	Not known	None	Medium
CFAo8/6 * Penn House Estate	Arable	25	Not known	None	Medium

* No Farm Impact Assessment interview conducted; data estimated.

Future baseline

Construction (2017)

- 3.3.28 No significant committed developments have been identified in this area that will materially alter the baseline conditions in 2017 for agriculture, forestry and soils.
- 3.3.29 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)

- 3.3.30 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 The impact of the Proposed Scheme in this area is limited to areas around the three vent shaft sites. As such the magnitude of impact on the various holdings is low and no mitigation measures are proposed to avoid or mitigate those adverse impacts during construction.
- 3.4.2 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 required temporarily and permanently be stripped and stored, so that land required temporarily for construction purposes that 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 would downgrade the quality of disturbed land. Some land with heavier textured soils may require 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 will 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. However, the Proposed Scheme design seeks to minimise disruption of farm structures, 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 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 used will be approximately 27.5ha as shown in Table 4. Of this total, some 19.8ha will be restored and available for agricultural use following construction.

Table 4: Agricultural land required temporarily within study area

Agricultural land quality	Area required (ha)	Percentage of agricultural land	Area to be restored (ha)
Grade 1	0	0	0
Grade 2	5.0	18	4.6
Subgrade 3a	10.9	40	5.3
BMV subtotal	15.9	58	9.9
Subgrade 3b	11.4	41	9.7
Grade 4	0.2	1	0.2
Grade 5	0	0	0
Total agricultural land ²²	27.5		19.8

3.4.9 The disturbance during construction to 15.9ha of land of BMV quality is assessed as an impact of medium magnitude, comprising between 20% and 60% of the agricultural land required. As BMV land in this study area is a receptor of medium sensitivity, the overall effect on BMV land in this area is assessed as a moderate adverse effect of the Proposed Scheme.

3.4.10 Following construction the land required temporarily will be reinstated to its pre-existing agricultural condition. It is estimated that there will not be any significant surplus of topsoil or subsoil material arising from the Proposed Scheme in the area.

Nature of the soil to be disturbed

3.4.11 The sensitivity of the soils is greatest in relation to those that will be disturbed by construction activity and returned to an agricultural or other 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.

3.4.12 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 Soils²³ and will be followed throughout the construction period. The soil associations affected most extensively around the vent shafts are of the Coombe 1 and Marlow associations. Coombe 1 soils are well drained and easily managed whereas the clayey Marlow subsoils need careful handling in wet seasons to avoid damage to soil structure. Compliance with the CoCP will ensure the magnitude of impact on soil is low and there is no significant effect.

²² These figures account for the land close to the River Misbourne that may be required for mitigation purposes (see Section 13), and, as such, this assessment represents a reasonable worst case scenario.

²³ Defra (2009), *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*.

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 during the construction period are summarised in Table 5. This table shows the total area of land required on a particular holding (in absolute terms and as a percentage of the overall 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 and Appendix AG-001-008, Volume 5.
- 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 effects, principally of construction noise 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-001-008, Section 4. Where the area of land summed by ALC grade differs from the area of land summed by holding, the difference is because some holdings include non-agricultural land.

Table 5: 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
CFA o8/1 Ashwell's Farm	3.8ha (43%) High	Negligible	Negligible	Moderate adverse due to the proportion of the holding required but low sensitivity	0.5ha
CFA o8/2 Upper Bottom House Farm (Chalfont Valley Equestrian)	3.1ha (2%) Negligible	Negligible	Noise during road construction Medium	Moderate adverse due upgrading Bottom House Farm Lane and loss of manège	1.4ha
CFA o8/3 Shardeloes Farm	1.1ha (1%) Negligible	Negligible	Negligible	Negligible	0.6ha

Holding reference/name	Total area required	Construction Severance	Disruptive effects	Scale of construction effect	Area to be restored
CFA o8/4 Lower Bottom House Farm	8.8ha (7%) Low	Negligible	Negligible	Negligible	5.3ha
CFAo8/5 Bereleigh Farm	1.1ha (2%) Negligible	Negligible	Negligible	Negligible	1.1ha
CFAo8/6 Penn House Estate	0.2ha (1%) Negligible	Negligible	Negligible	Negligible	0.2ha

3.4.16 Two holdings (Ashwell's Farm and Upper Bottom House Farm) will incur moderate adverse effects during construction, which is significant. Ashwell's Farm is a small holding and the land is let out to others to farm, but the effect is moderate due to the high proportion of the holding affected. Upper Bottom House Farm operates an equestrian livery yard and the general construction noise and disturbance during the widening of Bottom House Farm Lane coupled with the demolition of a manège will require some temporary changes to land management. Access to the farm for users of the livery yard and for milk delivery tankers will be maintained at all times.

3.4.17 No other farm enterprises that are sensitive to noise or vibration emitted during the construction phase, for example intensive poultry houses, have been identified near to the Proposed Scheme.

Cumulative effects

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

Permanent effects

Impacts on agricultural and forestry land

3.4.19 Following construction and restoration, the total net area of agricultural land that will remain permanently removed from agriculture will 7.7ha as shown in Table 6. A further 2.1ha of forestry land will also be permanently removed. The areas in the table refer to agricultural land of a particular grade that is required permanently for the Proposed Scheme, and its proportion of the total area of agricultural land required permanently.

Table 6: Agricultural and forestry land required permanently

Agricultural land quality	Permanent works	
	Area (ha)	% agricultural land
Grade 1	0	0
Grade 2	0.4	6
Subgrade 3a	5.6	72
BMV subtotal	6.0	78
Subgrade 3b	1.7	22
Grade 4	0	0
Grade 5	0	0
Total agricultural land	7.7	
Forestry land	2.1	

3.4.20 Following the completion of the construction process land required temporarily will be restored back to agriculture (where that is the agreed end use) but there will still be a net permanent loss 6.0ha of land of BMV quality. This is assessed as an impact of high magnitude, comprising just over 60% of the overall land requirement (including forestry). As stated previously, BMV land in this study area is a receptor of medium sensitivity, and thus the permanent effect on BMV land would usually be assessed as a major/moderate adverse effect of the Proposed Scheme. However, the loss of 6.0ha of BMV in this area is relatively small, therefore the impact is downgraded to low magnitude and is not a significant effect.

3.4.21 The amount of forestry land required to construct the Proposed Scheme will comprise 2.1ha, out of a total of 46.9ha (including non-agricultural land) and is an impact of low magnitude. As the proportion of forest cover as a land use in the study area is greater than the average national land use forest cover the loss of this area of woodland is not significant.

Impacts on holdings

3.4.22 The permanent residual effects from the construction of the Proposed Scheme on individual agricultural and related interests is summarised in Table 7. 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 degree of impact 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. 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-001-008.

Table 7: Summary of permanent construction effects on holdings

Holding reference/name	Land required	Severance	Infrastructure	Scale of effect
CFA o8/1 Ashwell's Farm	3.3ha (37%) High	Negligible	Negligible	Moderate adverse due to land loss
CFA o8/2 Upper Bottom House Farm (Chalfont Valley Equestrian)	1.7ha (1%) Negligible	Negligible	Loss of manège Medium	Moderate adverse due to loss of infrastructure
CFA o8/3 Shardeloes Farm	0.5ha (<1%) Negligible	Negligible	Negligible	Negligible
CFA o8/4 Lower Bottom House Farm	3.5ha (3%) Negligible	Negligible	Negligible	Negligible
CFAo8/5 Bereleigh Farm	<0.1ha (<1%) Negligible	Negligible	Negligible	Negligible
CFAo8/6 Penn House Estate	0.0ha (0%) Negligible	Negligible	Negligible	Negligible

3.4.23 Overall, it is likely that two holdings will experience moderate permanent adverse effects from the construction of the Proposed Scheme, both of which are considered to be significant. Ashwell's Farm, a smallholding, will lose more than 20% of its land holding and Upper Bottom House Farm is affected due to the demolition of the manège.

3.4.24 Although financial compensation will be available, there can be no certainty that this would be used to reduce the above adverse effects by the purchase of replacement land or construction of replacement infrastructure. Therefore, the above assessment should be seen as the worst-case, which could be reduced if the owner and/or occupier is able, and chooses, to use compensation payments to replace assets.

Cumulative effects

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

Other mitigation measures

3.4.26 Other mitigation measures that are proposed include replacement planting in this area. This planting is described in more detail in the ecology and landscape and visual assessments (Sections 7 and 9). Mitigation will incorporate climate change adaptation and resilience measures, as far as practicable.

Summary of likely significant residual effects

- 3.4.27 A total of two holdings have been identified that will experience moderate permanent adverse effects, which are significant. Of these both are likely to remain as agricultural or rural holdings and the use of compensation payments to purchase replacement land or construct replacement structures could reduce the effects to non-significant. The loss of the manège for the Chalfont Valley Equestrian will reduce the facilities available for livery users but as there will be no loss of stabling the livery business will be able to continue.

3.5 Effects arising from operation

Avoidance and mitigation measures

- 3.5.1 No measures are required 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.

Summary of likely significant residual effects

- 3.5.4 No likely 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 (NO₂), fine particulate matter (PM₁₀, PM_{2.5})²⁴ and dust.
- 4.1.2 With regard to air quality, the main effects are anticipated to result from emissions of the above pollutants from construction activities and equipment, road traffic generated from construction activities and any changes in traffic flows when the proposed scheme is operational.
- 4.1.3 Detailed reports on the air quality data and assessments for this study area, as well as relevant maps are contained within Volume 5. These include:
- Appendix AQ-001-008;
 - Maps AQ-01-008 (Volume 5 Air Quality Map Book); and
 - Maps AQ-02-008-01 to AQ-02-008-02 (Volume 5, Air Quality Map Book).
- 4.1.4 Maps showing the location of the key environmental features can be found in the Volume 2 map books.

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), the SMR Addendum (Appendix CT-001-000/2) and appendices presented in Volume 5: AQ-001-008. 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 based on the methodology 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 within 20m of dust generating activities. Thus, a single property very close to construction activity cannot experience a

²⁴ PM_{2.5} 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*.

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 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 an estimate of the average daily flows in the peak month throughout 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 Chalfonts and Amersham area. The main source of existing air pollutants in the area is emissions from road traffic. The air quality in the Chalfonts and Amersham area is typical of the generally rural nature of this part of Buckinghamshire, with concentrations of airborne pollutants within relevant air quality standards in the large majority of areas. Elevated concentrations occur in only limited locations in busy urban areas and close to major roads.
- 4.3.2 Estimates of background air quality have been obtained from Defra background maps²⁶ for 2012. These data are estimated for 1km grid squares for NO_x, NO₂, PM₁₀ and PM_{2.5}. All average background pollutant concentrations are well below relevant air quality standards.
- 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 route and are not affected by traffic associated with the Proposed Scheme. On this basis, these monitoring data are not considered relevant and are therefore not used to inform this assessment.
- 4.3.4 The available background and monitoring data indicate that all parts of the Chalfonts and Amersham area currently experience concentrations of NO₂, PM₁₀ and PM_{2.5} that meet air quality standards, as supported by the absence within the study area of any Air Quality Management Areas (AQMA) declared for these pollutants. Background map data are shown in Volume 5: Appendix AQ-001-008.

²⁶ Defra (2010), *Based Background Maps for NO_x, NO₂, PM₁₀ and PM_{2.5}*. <http://laqm.defra.gov.uk/maps/maps2010.html>; Accessed July 2013.

- 4.3.5 The closest AQMA has been declared by Chiltern District Council for NO₂ in the town of Chesham (see Map AQ-01-008 Volume 5, Air Quality Map Book). This is located approximately 5km from the route and therefore considered to be too far from the route to be affected by construction activities and will not be affected by traffic associated with 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 construction activity. Notable receptors in close proximity to construction activity are residential properties at Cricket Field Cottages, Turners Wood Farm, Ashwell's Farm, Upper Bottom House Farm, Lower Bottom House Farm and Amersham Hospital. One receptor has been identified with respect to changes in traffic flows during construction; this is Bircham Cottage near the M25 between junctions 16 and 17, close to the temporary slip roads.

Future baseline

- 4.3.7 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 Section 12. In this way, the assessment accounts for cumulative effects.
- 4.3.8 Volume 5: 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 future baseline for the assessment of effects from the construction and operation of the Proposed Scheme.
- 4.3.9 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.

Construction (2017)

- 4.3.10 Future background pollutant concentrations have been sourced from Defra background maps²⁷ for 2017. Defra background maps predict NO₂ and PM₁₀ concentrations 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 maps²⁷ for 2026. Defra background maps predict NO₂ and PM₁₀ concentrations in 2026 to be lower than in the 2012 baseline.

²⁷ Defra: Background Pollutant Concentration Maps Accessed July 2013.

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 measures within 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 (LEMPs) 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 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;
- undertaking inspection and visual monitoring after consultation with the LPA 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 soil 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 NO₂ and PM₁₀. There are no ecological receptors sensitive to dust and nitrogen deposition within the study area.

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

- 4.4.5 In the Chalfonts and Amersham area, the construction of three vent shafts requires an assessment for impacts on air quality. Activities with the potential to generate dust at these sites include the earthworks required for the preparation of the ground, bulk excavation, processing and stockpiling of materials, construction of the vent shafts, landscaping, the construction and use of construction compounds and the movement of vehicles off-site from roadheads onto local roads with an associated possible transfer of dust and mud.
- 4.4.6 With the implementation of mitigation measures contained within the draft CoCP, the assessment of impacts arising from dust emissions has concluded that they will be negligible for all receptors in magnitude and that the effect will not be significant. The basis for this conclusion can be found in Volume 5: Appendix AQ-001-008.
- 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 the M25, between junctions 16 and 17, meets the criteria set out in the SMR (Appendix CT-001-000/1, Volume 5) for assessment. This assessment concluded that impacts on air quality, in respect of NO₂, PM₁₀ and PM_{2.5}, for receptors near this road will be negligible. Consequently there will be no significant effects on any receptors. Full details of this assessment can be found in Volume 5: Appendix AQ-001-008.

Permanent effects

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

Cumulative effects

- 4.4.10 This assessment has considered the potential cumulative air quality effects of the Proposed Scheme and other committed developments. 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 study 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 Chalfonts and Amersham area.

Assessment of impacts and effects

4.5.2 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 Traffic data have been screened to identify roads that require further assessment and to confirm the likely effect of the change in emissions from vehicles using those roads in 2026.

4.5.4 No roads are predicted to have sufficiently large changes in traffic flows to meet the criteria for further assessment. Therefore, no significant effect associated with the Proposed Scheme is predicted.

Cumulative effects

4.5.5 This 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

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

Summary of likely significant residual effects

4.5.7 No significant residual effects are anticipated for receptors as a consequence of changes in 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:

- impacts on amenity for a small number of residential properties in Chalfont St Giles; and
- the permanent loss of land and temporary amenity effects for users at Chalfont Valley Equestrian on Bottom House Farm Lane, Chalfont St Giles.

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-001-008.

5.1.4 Community assessment maps are provided in Volume 5: Maps CM-01-025b to CM-01-028.

5.1.5 The assessment draws on information gathered from regional and local sources including Buckinghamshire County Council, Amersham Hospital and Chalfont Valley Equestrian.

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, 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 boundary of land required for construction.

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. Overall the study area is taken as the area of land that encompasses the likely significant effects of the Proposed Scheme.

- 5.3.3 This study area includes land within the settlements of Horn Hill, Chalfont St Peter, Chalfont St Giles and Amersham Old Town. The area is characterised by farmland interspersed with villages and small towns. Outside these settlements the population is mainly located in farmhouses and rural cottages.

Horn Hill

- 5.3.4 Horn Hill is a small village situated to the north-east of Chalfont St Peter and west of the M25 and Maple Cross; it is centred on the intersections between Old Shire Lane, Rickmansworth Lane and Roberts Lane. There is a village hall and one public house within the village: the Dumb Bell. Old Shire Lane PRoW is a 13.3km circular walk that passes through Horn Hill.

Chalfont St Peter

- 5.3.5 The settlement of Chalfont St Peter is located to the west of the M25 bisected by the A413 Amersham Road and the River Misbourne. Chalfont St Peter is linked to Chalfont Common in the north and to Gerrards Cross to the south via the A413 Amersham Road. Within Chalfont St Peter community facilities include: shops; a playing field with a pavilion located on Chesham Lane; and the Milton Route, a circular cycle path, which passes through Chalfont St Peter. Chalfont St Peter Centre for Epilepsy is located on Chesham Lane and is also home to Queen Elizabeth House nursing home. Gerrards Cross Golf Course and Chalfont Heights Scout Camp (also known as Paccar Scout Camp) lie south-east of the main settlement bordering Denham Lane. The Chiltern Way (CSP/9 and CSG/32) passes north of Chalfont St Giles; this is a circular long distance walk of 214km.

Chalfont St Giles

- 5.3.6 The village of Chalfont St Giles is located to the north of Chalfont St Peter on the edge of the Chilterns. The village has a duck pond, 18th century cottages and a medieval high street and provides a range of local facilities including a library, a post office and the Crown public house. In addition, St Giles's parish church and the Merlin's Cave public house are located on the green, which runs parallel with the High Street. The South Bucks Way (CSG/30 and AM/16) passes through Chalfont St Giles and links the Grand Union Canal at Denham to Coombe Hill near Wendover and is approximately 37km.

- 5.3.7 Chalfont Valley Equestrian is located on Bottom House Farm Lane, approximately 3km north-west of Chalfont St Giles. It is an outdoor equestrian facility and stables.

Amersham Old Town

- 5.3.8 Amersham Old Town is located to the southwest of the town of Amersham and north-west of Chalfont St Giles and provides a range of local facilities outside the study area. Amersham Hospital lies in close proximity to the route. It is the main health care facility in the area with 75 beds and is home to the Buckinghamshire Neuro-Rehabilitation Unit. It is located on Whielden Street, south-west of Amersham and north of the junction between the A413 and A404. Also located off Whielden Street,

west of the A413, is the Chilterns Crematorium and further north off the A413 and School Lane is Amersham Cricket Club.

Future baseline

Construction (2017)

- 5.3.9 Volume 5: Appendix CT-004-000 provides details of the developments that are assumed will have been implemented by 2017. The existing baseline is likely to change due to future development that may introduce new residents and community facilities in this area. The Audley Chalfont St Peter Care Community scheme (Planning reference CH/2011/2026/FA) is likely to be completed prior to the commencement of construction of the Proposed Scheme in 2017. It will be located at the northern end of Chalfont Common, along Chesham Lane, on land currently owned and used by the Epilepsy Society. The Care Community will include 82 units for residents and is approximately 750m from the land required for the construction and operation of the Proposed Scheme (see CFA8/8, Volume 5: Appendix CT-004-000).

Operation (2026)

- 5.3.10 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 draft CoCP also 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):
- 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 minimise 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 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

- 5.4.2 Details of all assessments of community resources are included in Volume 5: Appendix CM-001-008. 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.

Horn Hill

Temporary effects

- 5.4.3 No significant temporary effects have been identified in the community assessment for Horn Hill.

Permanent effects

- 5.4.4 No significant permanent effects have been identified in the community assessment for Horn Hill.

Chalfont St Peter

Temporary effects

- 5.4.5 No significant temporary effects have been identified in the community assessment for Chalfont St Peter.

Permanent effects

- 5.4.6 No significant permanent effects resulting from construction have been identified in the community assessment for Chalfont St Peter.

Chalfont St Giles

Temporary effects

Community infrastructure

- 5.4.7 Chalfont Valley Equestrian is situated on Bottom House Farm Lane, north of Chalfont St Giles. Its principal offer is stabling and it can provide livery packages for 25 horses. It also has an outdoor equestrian centre, show-jumping and cross country fences, which are used by Hodgemoor Riding Association amongst others. The centre is used by approximately ten people, on a daily basis to exercise horses; other users can total up to 40 per week. There are other riding centres within the local area, such as Windmill Farm Equestrian Centre (approximately 1.5km from Chalfont St Giles) and Shardeloes Farm Equestrian Centre (approximately 4km from Amersham and Coleshill), which could be used by residents of these communities.
- 5.4.8 It is expected that Chalfont Valley Equestrian will experience in-combination effects during construction activities associated with the construction of Chalfont St Giles vent shaft, the satellite construction compound and the widening of Bottom House Farm Lane. These in-combination effects are:

- significant visual effects due to the satellite construction compound and stockpiles of excavated materials; and
- a significant increase of HGV vehicles using Bottom House Farm Lane to access the satellite construction compound.

5.4.9 Given that there are alternative equestrian centres within the local area and that the visual and traffic effects are not likely to disrupt activities or facilities at the centre, these in-combination effects will have a minor adverse effect on the amenity of the centre for users. Therefore, this is not considered to be significant.

Permanent effects

5.4.10 As described above, construction of the vent shaft at Chalfont St Giles will involve the widening of Bottom House Farm Lane to make it accessible to construction vehicles. This road widening will require approximately 6,500m² of the manège at the bottom of Bottom House Farm Lane, which is operated by Chalfont Valley Equestrian. The permanent loss of this land will mean the manège will be unable to operate in its current form.

5.4.11 Whilst the stabling that is offered at Chalfont Valley Equestrian will not be directly affected, the manège is an essential complementary facility to the livery packages. As such, the loss of the manège may risk compromising the future viability of the Chalfont Valley Equestrian²⁸.

5.4.12 As outlined above, there are other riding centres within the local area, such as Windmill Farm Equestrian Centre (approximately 1.5km from Chalfont St Giles) and Shardeloes Farm Equestrian Centre (approximately 4km from Amersham and Coleshill), which could be used by residents of these communities.

5.4.13 However, although there are alternative centres nearby these are not directly comparable and given that the manège is used on a daily basis and its loss could compromise the viability of Chalfont Valley Equestrian, the effect will be major adverse and is therefore considered to be significant.

Amersham Old Town

Temporary effects

5.4.14 No significant temporary effects have been identified in the community assessment for Amersham Old Town.

Permanent effects

5.4.15 No significant permanent effects resulting from construction have been identified in the community assessment for Amersham Old Town.

²⁸ However, this does not impact the viability of the agricultural holding.

Cumulative effects

- 5.4.16 No temporary or permanent cumulative effects have been identified for any of the areas during construction.

Other mitigation measures

- 5.4.17 The assessment has concluded there are significant adverse effects arising during construction in relation to community resources.
- 5.4.18 HS2 Ltd will continue to work with the owners of Chalfont Valley Equestrian to assist them with identifying a solution to promote the continued operation of the centre, within the scope of the National Compensation Code. The landowner owns a large area of land and it is understood that there are potential opportunities to replace the facility close to its existing location. This will be subject to further discussion and agreement with the landowner.

Summary of likely significant residual effects

- 5.4.19 Construction activities associated with the Chalfont St Giles vent shaft will result in a significant residual effect for Chalfont Valley Equestrian due to loss of its manège facility. There will also be temporary adverse amenity effects on Chalfont Valley Equestrian.

5.5 Effects arising from operation

Avoidance and mitigation measures

- 5.5.1 In this area the Proposed Scheme is in a twin-bore tunnel, which will reduce and avoid impacts on local communities.

Assessment of impacts and effects

- 5.5.2 No significant effects have been identified in the community assessment during operation.

Cumulative effects

- 5.5.3 No temporary or permanent inter-project cumulative effects have been identified for any of the areas during operation.

Other mitigation measures

- 5.5.4 The above assessment has concluded there are no significant adverse effects arising during operation, therefore no further mitigation is proposed.

Summary of likely significant residual effects

- 5.5.5 No significant residual community effects are anticipated in this area during operation of the Proposed Scheme.

6 Cultural heritage

6.1 Introduction

- 6.1.1 This section provides a description of the current baseline for heritage assets and reports on 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 heritage value (significance) of assets including archaeological and palaeo-environmental 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 will be 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, CFA8 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-001-008 – Baseline Report;
 - Appendix CH-002-008 – Gazetteer of Heritage Assets;
 - Appendix CH-003-008 – Impact Assessment Table; and
 - Appendix CH-004-008 – Survey Reports.
- 6.1.4 Throughout this section, assets within the study areas are identified with a unique reference code, CHAXXX; further detail on these assets can be found in the gazetteer in Volume 5: Appendix CH-002-008.
- 6.1.5 Engagement has been undertaken with the Buckinghamshire County Council planning archaeologist 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 to temporarily or permanently construct the

Proposed Scheme plus 500m. For the purpose of this assessment, any built heritage assets within the 10mm settlement contour²⁹ 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 LiDAR³⁰ data examined did not encompass the full extent of the study area. This is the only limitation identified.
- 6.2.5 Non-intrusive field survey was undertaken at 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 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-001-008.
- 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-004-008); and
 - a programme of non-intrusive surveys including geophysical surveys (see Volume 5: Appendix CH-004-008).

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 or the 10mm settlement contour (see Volume 5, Cultural Heritage Map Book):
- the Barn at Ashwell's Farm (within grouping CHA017); The Granary south-east of Lower Bottom Farmhouse (within grouping CHA031); Stone Cottage (within grouping CHA019), and the Walls and Buildings of the Kitchen Gardens of Shardeloes (within grouping CHA067) are all Grade II listed buildings of moderate value;

²⁹ The area in which ground settlement arising from tunnelling or other below ground works could be more than 10mm in depth.

³⁰ Light detection and ranging (LiDAR) is a high resolution remote sensing technique to capture 3D data.

- two conservation areas: Chalfont St Giles (grouping CHA019) of moderate value and Shardeloes (grouping CHA067) of high value; and
- Shardeloes Grade II* registered park and garden (CHA067) of high value.

6.3.4 The following designated assets are located within the ZTV (see Volume 2, CFA 8 Map Book and Volume 5, Cultural Heritage Map Book):

- four Grade I listed buildings of high value: Parish Church of St Giles and Milton’s Cottage, Chalfont St Giles (within grouping CHA019); Church of St Mary, Amersham (within grouping CHA058); and Shardeloes House (within grouping CHA067);
- twelve Grade II* listed buildings of high value: High and Over House, Amersham (within grouping CHA060); The Vache (within grouping CHA025); The Old Rectory (within grouping CHA019); Friends Meeting House, Whielden Street (CHA056); Sir William Drake’s Almshouses; The Kings Arms Hotel; Elmodesham House; 56, 58 and 60 High Street; The Gables; and Market Hall (all within grouping CHA058 in Amersham);
- a total of 239 Grade II listed buildings of moderate value. Most of these lie within the conservation areas listed below;
- four conservation areas of moderate value: Chalfont St Giles (CHA019); Amersham (CHA058); Elm Tree (CHA063); and Wellar Green (CHA064);
- one Grade II registered park and garden of moderate value: Milton’s Cottage (CHA020); and
- a total of 21 areas of ancient woodland of high value: Bloom Wood (CHA001); Roberts Wood (CHA002); Bottom Wood (CHA009); Shrubs Wood (CHA016); Pollards and Bailey Wood (CHA027); Bow Wood (CHA034); High Wood (CHA035); Days Wood (CHA036); Hodgemoor Wood (CHA037); Welpley’s Wood (CHA038); Hales Wood (CHA039); Rogers Wood (CHA041); Herts Wood (CHA049); West Wood (CHA050); Second Wood (CHA053); Parsonage Wood (CHA062); Wheatley Wood (CHA065); First Charsleys Wood (CHA068); Second Charsleys Wood (CHA069); Ostler’s Wood (CHA070); and Weedon and High Spring Wood (CHA071).

Non-designated assets

6.3.5 There are no non-designated assets of high value lying wholly or partially within the land required, temporarily or permanently, for the construction of the Proposed Scheme.

6.3.6 Four hedgerows identified as non-designated assets of moderate value lie wholly or partially within the land required, temporarily or permanently, for the construction of the Proposed Scheme. These hedgerows are identified as historically important under the archaeology and history criteria of the Hedgerow Regulations 1997 (CHA072, CHA073, CHA074 and CHA075).

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:

- Tubb’s Farm Cottages (CHA012);
- Skipping’s Farm (CHA013);
- Upper Bottom Farm (CHA032); and
- Hobbs Hole (CHA033).

6.3.8 All of these assets lie within the 10mm settlement contour for the Chiltern tunnel. No other undesignated heritage assets are located within the land required to construct the Proposed Scheme.

6.3.9 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-002-008 and identified on Maps CH-01-25b – CH-01-28 in the Volume 5, Cultural Heritage Map Book. There are no notable non-designated assets with upstanding remains whose setting has been considered.

Cultural heritage overview

6.3.10 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. The area is generally characterised by chalk plateau land, dissected by valleys, notably the River Misbourne. In the southernmost part of the study area close to the Colne Valley the underlying geology comprises chalk overlain by superficial deposits of silt, sand and gravel.

6.3.11 The present settlement character is predominantly one of dispersed settlement comprising farmsteads and small hamlets with small enclosures adjacent to the principal valleys, interspersed with larger settlements such as Amersham and Chalfont St Peter that have grown as part of the expansion of London suburbs during the 20th century. The valley slopes are heavily wooded; much of which is ancient.

6.3.12 It is likely that Palaeolithic (circa 500,000 to 10,000 BC) hominids moved onto and through the Chilterns utilising the Misbourne valley, as indicated by finds of a Palaeolithic hand axe and two smaller flints to the north of Wheatley Wood (CHA076). A further three Palaeolithic hand axes were found in the area of Nortoft Road in Chalfont St Peter and further flint tools at Chalfont St Giles; hand axes have been found in nearly all of the dipslope valleys of the Chilterns. The Clay-with-Flints strata of the Chilterns are the main focus in this area for evidence of Palaeolithic activity but it is debated whether Palaeolithic material found on the surface of the strata can be in-situ or not.

- 6.3.13 The river valleys of the Chilterns, including principally that of the River Misbourne, have yielded Mesolithic flint tools (circa 10,000 to 4,000 BC). Outside the study area discoveries of Mesolithic flints have been made at Chalfont St Giles, at First Wood in Amersham and during excavations ahead of the A413 Amersham bypass in 1982 to 1984. Scatters of flint tools and debris recovered from the surface of ploughed fields around Buckinghamshire and within the study area are widely distributed. These scatters reflect both casual finds and systematic programmes such as fieldwalking and archaeological excavation.
- 6.3.14 During the Neolithic period (circa 4,000 to 2,400 BC) and Early Bronze Age (circa 2,400 to 1,500 BC) ceremonial/burial monuments, such as causewayed enclosures, henges and round barrows were being constructed on the higher plateau/cross ridges. Such features are, however, absent from the Chiltern dip slope and the Misbourne valley. Evidence of Neolithic to Bronze Age (circa 2,400 BC to circa 700 BC) activity has been recorded within the study area from discoveries of flint tools north of Wheatley Wood (CHA076); Mopes Farm (CHA005); Horn Hill (CHA008); and Misbourne Farm (CHA030) where two putative Bronze Age burnt mounds have also been recorded.
- 6.3.15 The Bronze Age pattern of isolated farmsteads shifted in the Iron Age (circa 700 BC to AD 43) when larger settlements such as hillforts and were constructed. Communities during the Iron Age period favoured the higher ground overlooking the river valleys, although evidence of Iron Age settlement in the study area is scarce. Investigations at the possible multi-period archaeological site north of Wheatley Wood (CHA076) have, however, produced Iron Age pottery.
- 6.3.16 Romano-British villas begin to appear in the countryside from the late 1st to early 2nd century AD. They typically occur at 2 to 3km intervals and a number are recorded in the Misbourne valley. A possible villa site has been identified at Misbourne Farm (CHA030), based on artefacts found during fieldwalking. Records of a tessellated floor found during excavation of Shardeloes Lake (CHA068) and further artefacts discovered to the north of Wheatley Wood (CHA076) indicate the presence of another villa. The close proximity of these two sites suggests the possibility that all may have been combined within a single large villa estate complex.
- 6.3.17 The routes of two putative Roman roads are recorded within 500m of the Proposed Scheme; one between Chorleywood and Langley Park (CHA006) and a second from Nash Mills to Flaunden (CHA054).
- 6.3.18 Evidence of material culture from the early medieval period (AD 410 to 1066) is sparse; 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; although Anglo-Saxon inhumations were excavated along with Romano-British inhumations at Mantles Green Meadow in proximity to the study area north of Amersham.

- 6.3.19 The Domesday Book contains entries for Amersham, Chalfont St Giles and Chalfont St Peter. These manors accommodated 25, 20 and 25 households and two, one and six mills respectively, most probably established on the River Misbourne.
- 6.3.20 Evidence for medieval (AD 1066 to AD 1540) settlement is most likely to be found in proximity to the historic cores of the three settlements of Amersham (a medieval planned town), Chalfont St Giles and Chalfont St Peter.
- 6.3.21 Medieval manorial sites have been identified at Shardeloes (CHA067) and The Vache (CHA025). Farmsteads with potential medieval origins have also been recognised at Ashwell's Farm (CHA017), Gellibrands (CHA007), Bowstridge Farm (CHA011), Coldharbour Farm (CHA0044), Woodrow Farm (CHA052) and probably at Lower Bottom Farm (CHA031). Some these may also represent former manorial sites.
- 6.3.22 The broad pattern of landscape and rural settlement that exists in the study area today was laid out during the early medieval and medieval period. Dispersed settlements and isolated farmsteads surrounded by agricultural hinterland predominated, with scattered manors in the surrounding countryside. The landscape was likely to have been at least partially wooded.
- 6.3.23 This pattern of landscape and settlement remained little unaltered until the expansion of the London suburbs, associated with the building of the railways in the late 19th and early 20th centuries. The growth of the settlements of Chalfont St Peter and Amersham was further increased by the establishment of the 'Metrolands' during the mid 20th century. The 'Metrolands' suburbs were designed as an escape from the capital to an idyllic 'countryside' lifestyle, yet crucially connected to the city by rail.

Future baseline

Construction (2017)

- 6.3.24 Volume 5: Appendix CT-004-000 provides details of the developments that are assumed will have been implemented by 2017.
- 6.3.25 None of the identified future committed developments affect the assessment of the Proposed Scheme's likely construction impacts on heritage assets.

Operation (2026)

- 6.3.26 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 for the construction of the Proposed Scheme (draft CoCP, Section 8);
- the use of appropriate equipment and methods to limit ground disturbance and settlement followed by monitoring, protection and remediation (draft CoCP, Section 10);
- 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:

- avoidance of the Grade II listed building of The Granary south-east of Lower Bottom Farm (CHA031), which will not be physically affected by the construction of the Proposed Scheme; and
- the Proposed Scheme will be constructed in a twin-bore tunnel which will avoid impacts on heritage assets.

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. Impacts will occur to assets both within the land required for the 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 Lower Bottom Farm (CHA031) lies partially within and immediately adjacent to the land required, permanently and temporarily, for the construction of the Chalfont St Giles vent shaft and the associated satellite compound. During the period of construction Bottom House Farm Lane will be widened to accommodate construction traffic, which will result in an increase in noise as a result of both the construction works and the increase in construction traffic. The permanent widening of Bottom House Farm Lane will not noticeably alter the character of Lower Bottom Farm and The Granary (which is located within the land required for the construction of the Proposed Scheme). The temporary movement of construction traffic and the associated increase in noise will have an impact upon the setting of Lower Bottom Farm. This is an asset of moderate value and will be subject to a medium adverse impact resulting in a moderate adverse effect.

Cumulative effects

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

Permanent effects

6.4.6 No significant effects will occur as a result of physical impacts within the land required to construct the Proposed Scheme (including the 10mm settlement contour) or changes to the setting of heritage assets within the ZTV.

Permanent cumulative effects

6.4.7 There are no inter-project effects considered to be of specific relevance to the cultural heritage topic.

Other mitigation measures

6.4.8 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

6.4.9 No significant residual effects to cultural heritage assets are anticipated in this area due to construction of the Proposed Scheme.

6.5 Effects arising from operation

Avoidance and mitigation measures

6.5.1 No measures have been required to be incorporated into the design of the Proposed Scheme to reduce the impacts and effects on assets.

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 constructed Scheme and its operation, this is reported in the assessment of operation.

- 6.5.3 There are no significant effects identified within the assessment that result from railway operation.

Cumulative effects

- 6.5.4 Assessment of inter-project effects on cultural heritage assets arising from the interaction of the Proposed Scheme with cumulative development projects has been undertaken. These are listed in Section 2.1 and mapped in Appendix CT-004-000. No significant cumulative effects have been identified in relation to cultural heritage.

Other mitigation measures

- 6.5.5 The Proposed Scheme includes a number of design measures to address potential impacts and significant effects. No additional operational mitigation measures beyond those included within the Proposed Scheme design have been identified.

Summary of likely residual significant effects

- 6.5.6 No significant residual effects to cultural heritage assets are anticipated in this area during operation of the Proposed Scheme.

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 Principal ecological issues in this area are the minor loss of woodland and the removal of hedgerows. 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 EC-004-002); and
 - a register of local/parish effects, which are not described individually in Volume 2 are reported in Volume 5: Appendix EC-005-002.
- 7.1.3 As well as survey data, the assessment draws on existing information gathered from national organisations and from regional and local sources including: the Buckinghamshire and Milton Keynes Environmental Records Centre; the Environment Agency, the Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT); the Chilterns Conservation Board; the Berkshire and South Buckinghamshire Bat Group, and the Buckinghamshire Bird Club.

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 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 reported in Volume 5: Appendices EC-001-002, EC-002-002, EC-003-002 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-001-000/1.
- 7.2.3 It was not possible to access all of the land areas where general habitat surveys (Phase 1 habitat survey) were proposed. Locations with the potential to support key ecological receptors where access could not be gained for survey include the River Misbourne upstream of Shardeloes Lake, the River Misbourne north-east of Chalfont St Giles, and farmland north and south of Bottom House Farm Lane. In addition, access to arable farmland north of Coleshill was not secured 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.

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

7.2.5 The precautionary approach to the assessment has been adopted identifies 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 EC-01 (Volume 5, Ecology Map Book).

7.3.2 Land required for the construction of the Proposed Scheme consists of farmland with mixed arable and improved grassland, bounded by hedgerows. The location of the Chalfont St Peter vent shaft consists of poor semi-improved grassland and is also bounded by grassland to the north and south and arable land to the east. The Chalfont St Giles vent shaft is largely situated on improved grassland, with similar grassland to the north and adjacent to arable fields to the south. This site also includes parts of Bottom House Farm Lane, which has mature hedges. The area of the Amersham vent shaft is dominated by immature plantation woodland and is surrounded by arable land and improved grassland. The River Misbourne flows south to the Chalfonts from Shardeloes Lake in the north of the area.

Designated sites

7.3.3 There is one statutory designated site of national value adjacent to a construction traffic route. Therefore, it is relevant to the assessment, even though it is over 500m from the land required for the construction of the Proposed Scheme.

7.3.4 Hodgemoor Wood Site of Special Scientific Interest (SSSI) (103ha) is designated for an important assemblage of plants, birds and invertebrates. It is one of the largest tracts of semi-natural broadleaved woodland remaining in the Buckinghamshire Chilterns. The plant species include coral root (a nationally scarce³¹ species particularly characteristic of the Chilterns), narrow buckler fern, and a species of hawkweed (all uncommon in Buckinghamshire). Breeding bird species include hawfinch, a Bird of Conservation Concern (BoCC)³² red list species; and woodcock a BoCC amber list

³¹ JNCC (undated). *Conservation Designations for UK Taxa* [on-line]. <http://jncc.defra.gov.uk/default.aspx?page=3408> (accessed September, 2013).

³² Eaton MA, Brown AF, Noble DG, Musgrove AJ, Hearn R, Aebischer NJ, Gibbons DW, Evans A and Gregory RD (2009) *Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man*. *British Birds* 102: 296–341.

species. The woodland qualifies as a habitat of principal importance under Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)³³, and a local Biodiversity Action Plan (BAP) habitat. The site is approximately 750m south of the Chalfont St Giles vent shaft and the associated auto-transformer station but it is adjacent to the A355 Amersham Road, which will be used as a construction traffic route and to Botterells Lane, which will be used as a temporary local traffic diversion.

7.3.5 Four Local Wildlife Sites (LWS) and a single Biological Notification Site (BNS) are relevant to the assessment in this area; each is of county/metropolitan value:

- Shardeloes Lake LWS (15.4ha) – is designated for standing open water and wetland birds. Between 2003 and 2011, the site supported a diverse assemblage of wintering birds, including gadwall, green sandpiper, shoveler, snipe, teal, whooper swan and wigeon. The Chiltern tunnel will pass approximately 20m beneath the lake;
- Brentford Wood LWS (21.7ha) – is designated for semi-natural broad-leaved woodland and also ancient woodland. The site consists of approximately 9ha of semi-natural broad-leaved woodland and ancient woodland, and approximately 11ha of mixed plantation. The Chiltern tunnel will pass to the north-east of the site, east of Coleshill;
- Weedonhill/High Springs/Ostlers Woods LWS (49.9ha) – is designated for semi-natural broad-leaved woodland and ancient woodland. The wood includes both lowland beech woodland and yew woodland and is partly located in this area, with the remainder within the Central Chilterns area (CFAg). The Chiltern tunnel will pass within 70m of the woodland at a depth of approximately 20m in this area, although the tunnel will pass directly underneath the LWS in the Central Chilterns area (CFAg) to the north. The LWS is also adjacent to the land required for the construction of Little Missenden vent shaft in CFAg. Impacts arising from these works are discussed in Volume 2, Report 9;
- Mop End Lane LWS (2.5ha) – is designated for species-rich hedgerows. It is directly adjacent to the southern boundary of the land required for construction of the Proposed Scheme, west of Shardeloes Lake; and
- Chalfont St Giles Churchyard BNS (0.7ha) – is designated for calcareous grassland. It is partly within land potentially required for hydrological mitigation east of Chalfont St Giles.

7.3.6 In addition to the areas of ancient woodland within designated sites, a further four areas of ancient woodland are adjacent to the land required for the construction of the Proposed Scheme. These are:

- Roberts Wood, is ancient semi-natural broad-leaved woodland; it is 60m south of the alignment of the Chiltern tunnel, east of Chalfont St Peter;

³³ *Natural Environment and Rural Communities Act 2006* (Chapter 16). London. Her Majesty's Stationery Office.

- Second Wood and Wheatley Wood are both plantations on ancient woodland sites and are both within 100m of the alignment of the Chiltern tunnel south-west of Amersham;
- Bow Wood is ancient semi-natural woodland. It is adjacent to a part of Bottom House Farm Lane that will be used as a construction traffic route; and
- Hales Wood is a plantation woodland qualifying as ancient replanted woodland adjacent to a part of Bottom House Farm Lane that will be used as temporary traffic diversion.

Habitats

7.3.7 The following habitat types that occur in this area are relevant to the assessment.

Woodland

7.3.8 Hodgemoor Wood has large areas of ancient coppice stools of oak, beech and hornbeam with occasional old standards of oak. There is some mixed and coniferous plantation and an extensive system of woodland rides and glades. Much of it is ancient woodland, a habitat of principal importance and a local BAP habitat. As the principal designating feature of the Hodgemoor Wood SSSI, it is of national importance.

7.3.9 Desk study results confirm the woodlands at Weedonhill Complex LWS and Brentford Wood LWS are both ancient woodland. The Weedonhill Complex LWS has goldilocks buttercup, wood millet, yellow archangel and coralroot among its ancient woodland flora, of which the latter is nationally scarce and largely confined to the Chilterns. The Brentford Wood LWS is also ancient semi-natural broadleaved woodland. There are also a number of relatively small areas of ancient woodland including ancient replanted woodland: Bow Wood (1.9ha), Hales Wood (4.7ha), Roberts Wood (3.6ha), Second Wood (13.9ha), and Wheatley Wood (13.1ha). Such woodland is typical of the Chilterns and likely to be relatively rich in plant species, and examples of woodland types that have a restricted distribution nationally. The Buckinghamshire Chilterns contains extensive ancient woodland. In this context, those close to the Proposed Scheme are each of up to county/metropolitan value.

7.3.10 Field surveys recorded wet woodland around Shardeloes Lake and along the Misbourne valley in the west of this area. This habitat contributes to the overall ecological diversity of the river corridor and appears from aerial photography to be uncommon along the length of the river. As such it is of district/borough value.

7.3.11 Other areas of woodland within 100m of the alignment of the Chiltern tunnel or adjacent to Bottrells Lane, which will be used for construction traffic, are Bellhouse Wood (1.6ha), David's Wood (4.5ha), First Wood (0.6ha), Rushcroft Wood (3.5ha) and Perryfield Plantation (6.6ha) and part of Hales Wood. They are comparatively small, appear from aerial photography to be semi-natural broadleaved woodland and none are ancient woodland. Individually these woodlands are of local/parish value, and collectively of up to district/borough value, as they provide habitat connectivity between other woodlands.

Watercourses

- 7.3.12 The River Misbourne is a chalk stream that is a habitat of principal importance, as it supports distinctive aquatic vegetation dominated by water crowfoot and water starwort. It is also a local BAP habitat. The river has been extensively modified in places and dries completely in certain locations as it is in hydraulic connectivity with groundwater in the chalk aquifer; further details are provided in Section 13. The Chiltern tunnel will pass under the River Misbourne in two places, one at Chalfont St Giles and one upstream of Shardeloes Lake where field surveys recorded a natural channel with marshy margins and wet woodland. Owing to its size, geomorphological characteristics and the rarity and distinctive assemblages of chalk stream species, the River Misbourne is of regional value.

Water bodies

- 7.3.13 Shardeloes Lake is a large area of open water with swamp dominated by reed sweet grass and greater reedmace at its margins. Sixteen species of macrophyte were recorded during surveys at Shardeloes Lake. Though it was dominated by filamentous green algae (indicating high nutrient levels), it had low turbidity, with excellent water clarity and no shade. Shardeloes Lake is likely to depend on inflow during dry periods, rather than upward seepage from the chalk aquifer; further details are provided in Section 13. As an uncommon habitat in the Chilterns the lake is of county/metropolitan value.
- 7.3.14 There is a single pond in land required for construction of the Proposed Scheme (west of Shardeloes Lake). This did not contain a sufficient diversity of plants to qualify for a detailed pond survey. There are three ponds, which are adjacent to land required for construction of the Proposed Scheme (close to Ashwell's Farm near the Chalfont St Peter vent shaft). One of the three ponds, which is adjacent to the Proposed Scheme contains great crested newt making it a habitat of principal importance. However, none was sufficiently diverse in plant species to qualify for a detailed pond survey. Each of these ponds is of local/parish value.
- 7.3.15 There are a further ten ponds within 100m of the alignment of the Chiltern tunnel but could not be accessed for a survey. For the purpose of this assessment and as they are within similar habitat to the ponds that were surveyed, they are considered to be of up to local/parish value.

Hedgerows

- 7.3.16 The species-rich hedgerows within Mop End Lane LWS qualify as being 'important' under the wildlife and landscape criteria in the Hedgerows Regulations³⁴ and as the principal designating feature of the LWS are assumed to be of county/metropolitan value.

³⁴ The Hedgerows Regulations 1997 (1997 No. 1160). London. Her Majesty's Stationery Office. 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 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 chapters of this report.

- 7.3.17 This area includes small fields with diverse hedges without gaps and good numbers of hedgerow trees. About 3km of hedgerows are present in land required for construction of the Proposed Scheme, principally around the Chalfont St. Peter vent shaft and the Chalfont St. Giles vent shaft. Of those surveyed, approximately 1km of hedgerow habitat qualifies as an important hedgerow under the Hedgerows Regulations. All hedgerows in this area are likely to qualify as a habitat of principal importance and a local BAP habitat. Hedgerows are common and widespread in the wider area, as such the relatively small extent of hedgerows habitat in the land required for construction of the Proposed Scheme is of local/parish value.

Grassland

- 7.3.18 There is approximately 0.7ha of grassland at Chalfont St Giles Churchyard BNS, which as part of a precautionary assessment, is assumed to be unimproved calcareous grassland and to qualify as a habitat of principal importance. As the principal habitat within this BNS, it is assumed to also be of county/metropolitan value.
- 7.3.19 Other grassland is restricted to improved grassland (approximately 7ha) and poor semi-improved grassland (approximately 9ha) throughout nearby farmland. It is of local/parish value.

Protected and/or notable species

- 7.3.20 A summary of the species relevant to the assessment is provided in Table 8.

Table 8: Protected and/or notable species

Species/Species group	Value	Receptor	Baseline and rationale for valuation
Birds	County/metropolitan	Breeding birds associated with Shardeloes Lake	Field surveys recorded 65 species. Notable records included a breeding pair of gadwall, three breeding pairs of little grebe, and the presence of shoveler, pochard, spotted flycatcher, little egret and a foraging barn owl. One red kite nest was recorded in this area. Desk study records include firecrest, lapwing, kingfisher, marsh tit, lesser spotted woodpecker, turtle dove and peregrine falcon. Gadwall and little grebe breeding populations were of county importance (more than 1% of county population).
	Local/parish	Wintering birds associated with Shardeloes Lake	Field surveys recorded 23 bird species. Two gadwall and two shoveler were the only notable wintering species. Desk study records indicate common and widespread species typical of open water and arable and pasture habitat, the exception being a single whooper swan. No significant populations of rare birds were recorded.
	Local/parish	Breeding birds assemblages north of Chalfont St Peter	Breeding bird surveys recorded 38 bird species, of which a passing red kite was the single notable species. Desk study records also include hobby, oystercatcher, cuckoo, grasshopper warbler and little ringed plover. Generally records include common and widespread species typical of open countryside comprising hedgerows, arable and grassland. These habitats are common in the wider area.
Fish	County/	Assemblage of fish	Brown trout (a species of principal importance) and

Species/Species group	Value	Receptor	Baseline and rationale for valuation
	metropolitan	species associated with the River Misbourne	bullhead (listed on Annex II of the Habitats Directive) were recorded in the River Misbourne during field surveys downstream of Shardeloes Lake. 217 rudd were also recorded. Surveys close to the Chalfont St Giles crossing point found a more coarse-fish dominated community and bullhead was present. Desk study records indicate that there is a self-sustaining population of brown trout in the river.
	Local/parish	Assemblage of fish species associated with Shardeloes Lake	Two species of fish were caught during surveys, common rudd and three-spined stickleback. Rudd were recorded in high numbers. Two other species of fish were also observed; rainbow trout and chub.
Water vole	Up to county/metropolitan	Water vole population associated with the River Misbourne	Field surveys recorded suitable habitat around Shardeloes Lake and along the River Misbourne. No water voles were recorded during surveys at Shardeloes Lake but desk study records confirm recent presence at the River Misbourne. There are eight desk study records from between 2008 and 2009, about 750m downstream of the land required at Chalfont St Giles. Given availability of habitat and the recent desk study records, it is assumed, as part of the precautionary assessment, that water voles are present within land required for the construction of the Proposed Scheme. A sustainable population qualifies for the designation of a local wildlife site in Buckinghamshire ³⁵ .
Terrestrial invertebrates	District/borough	Invertebrates associated with habitat surrounding Shardeloes Lake	Field surveys recorded <i>Hilara lugubris</i> (a species of empid fly), which is nationally scarce and associated with stream and water margins near Shardeloes Lake. The desk study records confirm the presence of another nationally scarce ³⁶ species (<i>Platypalpus stabilis</i>) and nine UK species of principal importance associated with grassland or woodland. These include the blood vein moth, mouse moth and dot moth. The land surrounding Shardeloes Lake exceeds the threshold for local/parish value (no nationally scarce species) but does not exceed the threshold for county/metropolitan value ³⁷ .
Plants	District/borough	White helleborine at Second Wood	Desk study records included a single record for white helleborine, a species of principal importance at Second Wood. The species is also listed as vulnerable by the IUCN ³⁸ but is not rare or scarce in Buckinghamshire.
Otter	District/borough	Otter population utilising the River Misbourne	Field survey results identified an otter spraint on the River Misbourne to the west of Shardeloes Lake, on the boundary with the Central Chilterns area (CFA 9). Habitat around Shardeloes Lake is highly suitable for holts though none were found. There are no desk study records of otter within 5km of the Proposed Scheme. Otters may use the River Misbourne and Shardeloes Lake for foraging and as a movement route. However,

³⁵ Buckinghamshire and Milton Keynes Environmental Records Centre (BMERC) and Thames Valley Environmental Records Centre (TVERC) (2009). *Criteria for the Selection of Local Wildlife Sites in Berkshire, Buckinghamshire and Oxfordshire*.

³⁶ Invertebrate species which are found in between 16 and 100 10km x 10km grid squares across the UK. 'Nationally Scarce' does not equate with national importance.

³⁷ Colin Plant Associates (2006) *Invertebrates and Ecological Assessment*. Unpublished Report to the Institute of Ecology and Environmental Management.

³⁸ *The Vascular Plant Red Data List for Great Britain – 2006* Cheffings, C. and Farrell, L. (Editors) and *A tool for assessing the current conservation status of vascular plants on SSSIs in England – May 2006*, ENRR 690 Leach and Rusbridge.

Species/Species group	Value	Receptor	Baseline and rationale for valuation
			based on current information, the records do not exceed the threshold for county significance ²⁹ (confirmed breeding holt).
Amphibians	Local/parish	Two small great crested newt populations near the Chalfont St Peter and Chalfont St Giles vent shafts	Field surveys recorded small population size class (one individual each) at two ponds; one near Ashwell's Farm 40m outside the Proposed Scheme and one south of Hill Farm Lane, approximately 500m from the Proposed Scheme. The desk study confirmed the presence of great crested newts in low numbers. There are few ponds, and the limited suitable terrestrial habitat there is in the area is severed by Chalfont St Giles and Chalfont St Peter.
Bats	Local/parish	Bat assemblage using a linear strip of woodland, hedgerows and a tree-lined road near the Chalfont St Peter vent shaft	Static detector surveys recorded activity indicative of commuting and foraging behaviour by common pipistrelle (high numbers), soprano pipistrelle (low to moderate numbers) and <i>Myotis</i> sp including confirmed Daubenton's bat (low numbers) between April and July. Low numbers of passes for noctule, Leisler's or serotine bats (automated bat recordings were inconclusive for identification to species level) indicative of individuals passing through the landscape were recorded during May, June and July. The diversity, species and numbers of bats in the assemblage is likely to be representative of similar habitat that is abundant in this part of Buckinghamshire.
	Local/parish	Potential bat assemblage using a network of well-connected hedgerows and patchwork of woodland around the other vent shaft locations for foraging and commuting	Based on the results of static detector surveys, the bat assemblage present as described is likely to be using woodland blocks and hedgerows in the landscape for foraging and commuting. The diversity, species and numbers of bats in the assemblage is representative of similar habitat that is abundant in this part of Buckinghamshire.
	Local/parish	Brown long-eared population associated with roosts at Lower Park and Ashwell's Farm	Field survey records confirmed two building roosts for brown long-eared bats. One was a feeding perch at Lower Park House, the other a transient/summer roost at Ashwell's Farm. Evidence suggests both support low numbers of bats. Although no desk study records for roosts exist in the area, brown long-eared bats are common and widespread in Buckinghamshire and similar roosts are likely to be numerous in the area.
Reptiles	Local/parish	Grass snake population near the Chalfont St Peter vent shaft	Field surveys recorded a medium population of grass snake. This species is frequent and widespread in the valley of the River Misbourne.
	Local/parish	Grass snake population at Shardeloes Lake	Although surveys in this area did not record any reptiles, the habitat in this area is suitable for grass snake and the species is frequent and widespread locally.
	Local/parish	Reptiles elsewhere in this area	Habitat suitable for reptiles is present throughout and small populations of common species are likely to be present.

Species/Species group	Value	Receptor	Baseline and rationale for valuation
Aquatic invertebrates	Local/parish	Aquatic invertebrates associated with Shardeloes Lake and the River Misbourne	Field surveys at the two Chiltern tunnel crossing points recorded a low diversity of macro-invertebrate taxa. Families recorded include freshwater shrimp, mayfly, and a variety of caddisfly larvae. Desk study data indicate that species diversity has been very variable over time, suggesting the river has been under particular stress, particularly in times of drought. A total of 13 macro-invertebrate families were recorded from Shardeloes Lake, which was dominated by water boatmen, freshwater snails and mayflies. Low species diversity is likely to be due to poor habitat quality rather than water quality issues.
Badger	Up to local/parish	Potential for small populations throughout the area	Field surveys recorded a single outlier sett in habitat suitable for badgers. The desk study records confirmed low numbers of badgers within 500m of all three vent shafts. Badgers are common and widespread in Buckinghamshire and the UK, and populations are not threatened or vulnerable.
White-clawed crayfish	Negligible		Signal crayfish are known to be present in the River Misbourne and they were recorded in 2013 during fish surveys. As there are no recent records for white-clawed crayfish remaining in the area and the presence of signal crayfish is confirmed for the catchment, surveys at the crossing points were not deemed necessary. Signal crayfish were also recorded in very high densities during fish surveys at Shardeloes lake.
Hazel dormouse	Negligible		Field surveys recorded no evidence of dormice. There is a single desk study record for this species from Rushmeade near Brentford Wood, which is about 1km south of the vent shaft near Amersham. The data indicates that dormice are unlikely to be present.

Future baseline

Construction (2017)

- 7.3.21 A summary of the known developments that are assumed will be mostly built and occupied prior to construction of the Proposed Scheme is provided in Volume 5: Appendix CT-004-000.
- 7.3.22 There are no known proposed developments likely to alter the baseline for assessment of either construction or operation of the Proposed Scheme.

Operation (2026)

- 7.3.23 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 is in a twin-bore tunnel (the Chiltern tunnel) so habitat loss has largely been avoided, with surface impacts only at the three vent shaft locations and associated auto-transformer station and satellite construction compounds.
- 7.4.2 The assessment 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 Hodgemoor Wood SSSI is adjacent to A355 Amersham Road, which would be used by construction traffic to reach the Chalfont St Giles vent shaft satellite compound. There will be no significant increases in air pollution and any increase in noise will be temporary and highly localised. Given this and because less than 1% of the SSSI will be within 100m of the construction traffic road, there will be no likely significant adverse effect on the integrity of the site.
- 7.4.4 No likely significant water effects have been identified for the River Misbourne and Shardeloes Lake. However, land has been identified for access to allow possible precautionary risk management measures to be undertaken in the unlikely event that they are required (as described in Section 13). This land is partially in the Shardeloes Lake LWS and the Chalfont St Giles Churchyard BNS. The extent of the works, if required, would be limited and habitat loss at these locations is unlikely. This would not permanently affect the integrity of either site.
- 7.4.5 It is considered unlikely that significant effects on site integrity will occur at the following designated sites: the Brentford Wood LWS, the Weedonhill Wood/High Springs/Ostlers Woods LWS, and the Mop End Lane LWS. This is because of the distance between them and the construction works, or because the route will be in a twin-bore tunnel.

Habitats

- 7.4.6 The Chiltern tunnel passes beneath the River Misbourne to the south-east of Chalfont St Giles and at Shardeloes Lake. There is the potential for ground settlement and loss of flow from the river to the chalk aquifer due to possible fractures in the chalk, however, the risk of this is low and no likely significant water effects have been identified. Therefore any indirect impacts on ecology are unlikely.
- 7.4.7 No impacts are anticipated on other habitats, including ancient woodlands, as the majority of the Proposed Scheme will be in the Chiltern tunnel.

- 7.4.8 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

- 7.4.9 As the Proposed Scheme will be in twin-bore tunnels throughout the Chalfonts and Amersham area, it is unlikely that there will be any effects on species receptors significant 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

- 7.4.10 No mitigation is required as no significant effects on ecological receptors, as a consequence of construction, have been identified.

Summary of likely residual significant effects

- 7.4.11 No significant residual effects to ecology in this area during the construction of the Proposed Scheme are considered likely.

7.5 Effects arising from operation

Avoidance and mitigation measures

- 7.5.1 The Proposed Scheme will be in twin-bore tunnels throughout the Chalfonts and Amersham area, which will maintain habitat connectivity and reduce impacts on features of ecological value.

Assessment of impacts and effects

- 7.5.2 As the Proposed Scheme will be in twin-bore tunnels throughout the Chalfonts and Amersham area, potential operation effects will be restricted to the three Ventilation Shaft sites. Vent shaft compounds will be landscaped to reflect the existing environment and maintenance works will be infrequent. For these reasons, no significant effects on ecological receptors during operation of the Proposed Scheme are considered likely.

Other mitigation measures

- 7.5.3 No mitigation is required as no significant effects on ecological receptors as a consequence of operation have been identified.

Summary of likely residual significant effects

- 7.5.4 No significant residual effects to ecology in this area during operation of the Proposed Scheme are considered likely.

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 construction and operation of the Proposed Scheme.
- 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, Shardeloes Lake, and the Chilterns AONB at the northern end of the Chalfonts and Amersham study area.
- 8.1.4 The main land quality issues in this area include:
- the Source Protection Zone (SPZ₁, SPZ₂ and SPZ₃) and associated private and public groundwater abstractions;
 - three landfills, at Warren Farm, Froghall Brickworks and Round Dell Wood;
 - Froghall Brickworks geological SSSI; and
 - Minerals Safeguarding Areas and Mineral Consultation Area for sand and gravel.
- 8.1.5 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-001-008: Land quality appendix.
- 8.1.6 Land contamination issues are closely linked with those involving water resources and waste. Issues regarding groundwater resources are addressed in Section 13. Issues regarding the disposal of waste materials, including contaminated soils, are addressed in Volume 3, Section 16.
- 8.1.7 Engagement has been undertaken with the Chiltern District Council and Three Rivers District Council and the Environment Agency regarding land contamination, and Hertfordshire and Buckinghamshire County Councils with regards to mineral policy.

To date, information has been received on potential land contamination (including Part 2A sites³⁹), mineral extraction (operational and applications pending), Mineral Safeguarding Areas, and current and historical landfills (May 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 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, excluding utility works on the highway 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.
- 8.2.3 Familiarisation 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. In addition, visits to key sites have been undertaken to validate the data collected. 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-001-008.

8.3 Environmental baseline

Existing baseline

- 8.3.1 Unless otherwise stated, all features described in this section are presented in Maps LQ-01-013b to LQ-01-016 (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-02-008 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 8.3.3 The route in this study area mostly crosses agricultural land; however, a cover of made ground may be present in built up areas of the study area as a result of previous cycles of development.
- 8.3.4 Geological mapping shows infilled ground in an area of 'disused workings' immediately to the south of the route, at the start of this area on West Hyde Lane, east of Chalfont St Peter. This is likely to be associated with Warren Farm Landfill.

³⁹ Part 2A Environmental Protection Act 1990.

8.3.5 At the southern end of the area, superficial deposits comprise sand and gravel or River Alluvium associated with the River Misbourne. Superficial deposits are generally absent from the northern half of the area although a small area of Clay-with-Flints is evident to the west of Amersham Old Town. The route will also cross a line of Head, described as gravel that outcrops along Whielden Lane, extending under the hospital and towards Amersham Old Town.

8.3.6 Bedrock geology comprises Cretaceous White Chalk (a soft limestone) with limited outcrops of the Lambeth Group, comprising clays, silts and sands near Coleshill and to the east of Chalfont St Giles, where it overlies the White Chalk.

Groundwater

8.3.7 The superficial deposits comprising glacial sand and gravel and alluvium are both designated Secondary A aquifers and the Clay-with-Flints is designated unproductive strata. The Chalk is a Principal aquifer and where the Lambeth Group are present over the Chalk, they are designated a Secondary A aquifer.

8.3.8 The majority of the study area through the Chalfonts and Amersham area will be within a groundwater Source Protection Zone (SPZ), as shown in Map WR-02-008 (Volume 5, Water resources and flood risk assessment Map Book), a mixture of SPZ₁, SPZ₂ and SPZ₃.

8.3.9 A search for groundwater abstractions within the study area confirmed that there are:

- six Public Water Supply (PWS) abstractions with source protection zones within 1km of the Proposed Scheme; and
- one private licensed abstraction (excluding PWS) and two unlicensed abstraction as reported by the Environment Agency.

Surface waters

8.3.10 The route will pass in twin-bore tunnels beneath the River Misbourne at Chalfont St Giles and at Shardeloes Lake.

8.3.11 There are no licensed surface water abstractions within the study area.

8.3.12 Further information on surface waters is provided in Section 13.

Current and historical land use

8.3.13 Current potentially contaminative land uses include small individual works such as car workshops (Map LQ-01-014, D7, Land quality Map Book) and unspecified works and workshops (Map LQ-01-013b, C7; Map LQ-01-014, G6 and D7, Land Quality Map Book).

8.3.14 Historical potentially contaminative land uses include historical landfills as detailed in Table 9.

- 8.3.15 Contaminants commonly associated with these uses could include metals, semi-metals, asbestos, organic and inorganic chemicals. Landfill sites may emit gases such as carbon dioxide, methane and volatile organic compounds (VOC).

Table 9: Landfill sites located within the study area

Name	Location	Description
Warren Farm Landfill complex (4 sites)	Warren Farm at the southern end of the area. (Map LQ-01-013b Centred on Grid Reference G8)	Comprises Warren Farm, Colony Quarry, Richard Biffa Ltd and Warren Quarry Landfill Sites. Accepted a mixture of industrial, commercial, household and inert waste. An enforcement notice was served to ensure restoration of the landfill by mid-summer 2011.
Froghall Brickworks Landfill	Located 180m south of the route at Froghall Brickworks. (Map LQ-01-014 Grid Reference C8)	Accepted inert, commercial and household waste. Last waste deposited 1972.
Round Dell Wood Landfill	Located 120m north of the route near Amersham Old Town (Map LQ-01-016 Grid Reference H5)	Completed filling in 1974. No further information available.

- 8.3.16 All potentially contaminated sites (identified from both current and historical land uses) are shown on Maps LQ-01-013b to LQ-01-016 (Volume 5, Land Quality Map Book).

Other regulatory data

- 8.3.17 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). A number of these have been recorded in the study area. Notable data includes three Local Authority Pollution Prevention Controls for air pollution: a crematorium, a facility for re-spraying of road vehicles and a petrol filling station.

Mining/mineral resources

- 8.3.18 The Buckinghamshire Minerals and Waste Core Strategy DPD, 2012 shows that the route passes through a Minerals Safeguarding Area. Policy CS1 states that development proposals in this area, other than those involving minerals extraction, will need to demonstrate that it will not sterilise the mineral resource, or that consideration has been given to prior extraction of the protected mineral or that the need for the proposed development outweighs the economic value of the mineral resource.
- 8.3.19 The southern end of the Chalfonts and Amersham area is located within a Minerals Safeguarding Area and Mineral Consultation Area for sand and gravel, both of which cover the same area, as designated by Buckinghamshire County Council.

- 8.3.20 There is an existing planning application at Froghall Brickworks for brick earth extraction; however, there are no records of current mineral extraction.

Geo-conservation resources

- 8.3.21 The Chiltern Core Strategy Policy, 2011, Policy CS24 and Chiltern Local Plan, 1997, Saved Policy NC1, both seek to prevent development that will significantly harm non-statutory Biological and Geological Notification Sites (Alert Sites), Regionally Important Geological and Geomorphological Sites as well as other sites of international, national, regional or local importance for geology.
- 8.3.22 The Froghall Brickworks geological SSSI is located approximately 260m from the route, although its lateral extent has the potential to lie partially within the study area. It has been designated of high importance due to the exposure of Westland Green Gravel.

Receptors

- 8.3.23 The sensitive receptors that have been identified within this study area are summarised in Table 10.

Table 10: Summary of sensitive receptors

Issue	Receptor type	Receptor description	Receptor sensitivity
Land Contamination	People	Residents in existing properties	High
		Workers e.g. in industrial facilities	Moderate
	Controlled waters	Principal aquifers of the Chalk	High
		Secondary A aquifer of the Lambeth Group.	High
		Secondary A aquifer of the Alluvium and Beaconsfield Gravel	High
		River Misbourne	High
	Built environment	Buildings and property	Low to high
		Underground structures and services	Low
Mineral resources	Mineral resources of sand and gravel	Low	
Impacts on mining/mineral sites (severance and sterilisation of mineral sites)	Mineral resources	Mineral resource of sand and gravel	Low
Impacts on geo-conservation	Natural environment	Froghall Brickworks SSSI	High

Future baseline

- 8.3.24 There are currently no identified committed development sites within the study area that are likely to change the land quality baseline during either construction or operation of the Proposed Scheme. The only committed development is for housing for the elderly, which is unlikely to impact land quality beyond its site boundary.

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 and 15);
- 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 15);
- traffic management to ensure that there is a network of designated haul roads to minimise 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 to confirm 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 assessment of potentially contaminated sites will be undertaken in accordance with:

- Environment Agency CLR11 Model Procedures for the Management of Land Contamination (2004)⁴⁰; and
- British Standard BS10175 Investigation of Potentially Contaminated Sites (2011)⁴¹.

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)⁴². 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 Construction of the Proposed Scheme through this area will be mostly below ground in the twin-bore tunnel through the Chalk. Three associated vent shafts will be located 50m from Chesham Lane to the south of Ashwell's Farm, approximately 300m south-west of Upper Bottom House Farm and at the junction of A404 Whielden Lane and A413, south of Amersham Hospital. All of these are in green field locations which are unlikely to be affected by contamination. Works are described in detail within Section 2.

8.4.6 An auto-transformer station will be located at the Chalfont St Giles vent shaft.

Land contamination

8.4.7 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, 21 areas were considered during this screening process; two 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 sites going forward are historical landfills. All areas assessed are shown on

⁴⁰ Environment Agency (2004), *CLR11 Model Procedures for the Management of Land Contamination*.

⁴¹ British Standard BS10175 *Investigation of Potentially Contaminated Sites* (2011).

⁴² Sustainable Remediation Forum UK *A Framework for Assessing the Sustainability of Soil and Groundwater Remediation* (2010).

Maps LQ-01-13b to LQ-01-016 (Volume 5, Land Quality Map Book) and those considered as potentially posing a risk to the Proposed Scheme are labelled with a reference number.

8.4.8 Conceptual site models (CSM) have been produced for the two areas taken to Stage C and D assessments. The detailed CSM are provided in Volume 5 (Appendix LQ 001-017, 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 cutting 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.

8.4.9 A summary of the baseline CSM is provided in Table 11. 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 11: Summary of baseline CSM for sites that may pose a contaminative risk for the Proposed Scheme

Area ref (1)	Area name	Main potential impacts	Main baseline risk (2) (3)
8-1	Inert, industrial, commercial and household waste Landfill at Warren Farm (Map LQ-01-013b Centred on Grid Reference G8)	Exposure of on and off-site human receptors (residential) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts	Moderate/low risk
		Exposures of on and off-site human receptors (residential) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/low risk
		Exposure of on and off-site human receptors (residential) to asphyxiative or explosive gases.	Moderate
		Exposure of secondary A Gerrards Cross Gravel aquifer and principal Chalk aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	High
		Exposure of on-site properties to lateral migration and build-up of asphyxiative or explosive gases.	Moderate
		Exposure of on-site properties to direct contact of property with contaminants in soil and groundwater.	Very low risk

8-6	Round Dell Wood Landfill (Map LQ-01-016 Grid Reference H5)	Exposure of principal Chalk aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	High
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(1) Each area is assigned a unique identification number (See Volume 5: Appendix LQ-001-008).

(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

8.4.10 An assessment of the effects of contamination has been undertaken by comparing the CSM developed for potential contaminated areas at baseline, construction and post-construction stages. The baseline and construction CSM have been compared to assess effects at the construction stage.

8.4.11 Table 12 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 CoCP. The details of these comparisons are presented in Volume 5 (Appendix LQ-001-008).

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 12: Summary of temporary (construction) land quality effects

Area ref.	Area name	Main Baseline risk	Main Construction Risk (1)	Construction Effect – Significant? (Y/N)
8-1	Inert Landfill at Warren Farm	Very low to high	Very low to high	Negligible (N)
8-6	Round Dell Wood Landfill	High	High	Negligible (N)

(1) The high risks identified reflect the uncertainty in existing baseline information. Whilst there are unlikely to be properties or receptors that experience the reported high risk in the absence of site investigation a precautionary, worst case risk is reported in the table. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.

8.4.13 During construction of the vent shafts, there will be potential for adverse effects on receptors associated with contaminated soil disturbance and migration of contaminants at locations of historical contamination impact. However, only the vent shaft at Amersham will be constructed in the vicinity of any potential land

contamination, approximately 100m from Amersham Hospital, which was previously the site of a road haulage depot.

8.4.14 The construction phase is not expected to have a significant effect on receptors, as the relevant part of the Proposed Scheme will be in tunnel, within the chalk and at a depth sufficient to prevent disturbance of the Round Dell and Warren Farm landfill area. In addition, the vent shafts will be constructed on greenfield sites with low contamination potential.

8.4.15 There is a possibility that rainwater may currently pass through the wastes in the Warren Farm landfill above the tunnel and percolate down through the chalk as a weak leachate. In addition, there may be some gas migration from the landfill through the chalk, which could enter into the future tunnel excavation. Any leachate or gas entering the tunnel will be dealt with by measures set out in the draft CoCP, including drainage to an appropriate location and ventilation of the enclosed space.

8.4.16 Table 12 indicates that based upon the assessment, no significant effects have been identified during the construction phase, in relation to potential land contamination.

Permanent effects

8.4.17 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.

8.4.18 Table 13 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 001-008).

Table 13: Summary of permanent (post-construction) land quality effects

Area ref.	Area name	Main baseline risk	Main post-construction risk (1)	Post-construction effect – significant? (Y/N)
8-1	Inert Landfill at Warren Farm	Very low to high	Very low to high	Negligible (N)
8-6	Round Dell Wood Landfill	High	High	Negligible (N)

(1) The high risks identified reflect the uncertainty in existing baseline information. Whilst there are unlikely to be properties or receptors that experience the reported high risk in the absence of site investigation a precautionary, worst case risk is reported in the table. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.

8.4.19 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.

- 8.4.20 Table 13 shows that the Proposed Scheme results in no change in the level of risk already existing at each site for both on site and off site receptors. Therefore, none of the post-construction effects of land contamination impacts predicted are significant. However, in the event that unexpected contamination is encountered during the construction of the Proposed Scheme in this area, this will be remediated as described in the CoCP and will result in an overall beneficial effect.

Mining/mineral resources

- 8.4.21 Construction of the Proposed Scheme has the potential to impact existing mineral resources and proposed areas of mineral exploitation. This could occur by sterilisation of the resource, direct excavation during construction of the Proposed Scheme or through temporary and/or permanent severance⁴³ that may occur during the construction phase of the Proposed Scheme, possibly continuing through to the operation.

Temporary effects

- 8.4.22 All effects on mining and mineral sites are permanent effects. Given the nature of these resources, there are no purely temporary effects (such as effects from temporary use of mineral sites as construction compounds).

Permanent effects

- 8.4.23 Of the three vent shafts, the Chalfont St Giles and Chalfont St Peter vent shafts Map LQ-01-014 (Volume 5, Land Quality Map Book) are potentially within the mineral safeguarding areas, although only Chalfont St Peter vent shaft located 50m from Chesham Lane to the south of Ashwell's Farm is shown by geological mapping to be on sands and gravels, which can result in a loss of a resource in the area immediately surrounding the vent shafts if extraction does not occur before the construction of the Proposed Scheme. As the extent of the vent shaft is small compared with the mineral safeguarding area, the effect is not significant.

Geo-conservation sites

Temporary effects

- 8.4.24 The Froghall Brickworks geological SSSI is located approximately 260m from the route. It is a high value site due to the exposure of Westland Green Gravel. However, it is highly unlikely that construction of the tunnel at depth will have an impact on the SSSI and so there is no likely significant temporary effect on the SSSI.

Permanent effects

- 8.4.25 Likewise the operation of the Proposed Scheme is not assessed as having a significant permanent effect on the SSSI.

⁴³In this context, severance refers to the Proposed Scheme splitting an actual or proposed mining/mineral site into two or more areas, such that separate accesses would be required to work the whole site.

Other mitigation measures

- 8.4.26 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.
- 8.4.27 Mitigation of the effects on mineral resources could include prior extraction of the resource for use within the project or elsewhere. Extraction may be limited to vent shaft sites and landscaping areas adjacent to the route, as the route is in tunnel below these areas. A plan will be discussed and agreed in advance of the construction works with the landowner, the mineral planning departments at Hertfordshire or Buckinghamshire County Councils, and any other interested parties to assist in achieving an effective management of minerals in this location

Summary of likely significant residual effects

- 8.4.28 With the application of the mitigation measures detailed above, no likely significant adverse land quality effects are anticipated during construction of the Proposed Scheme.

8.5 Effects arising from operation

- 8.5.1 Users of the Proposed Scheme (i.e. rail passengers), whilst within trains, are at all routine times 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 An auto-transformer station will be constructed next to Chalfont St Giles vent shaft. 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 or in-combination effects on receptors because of 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 Chalfonts and Amersham 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 land quality effects are anticipated to arise from 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 describing 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, removal of existing vegetation, earthworks profiling and severance of agricultural land; and
 - permanent landscape and visual effects during operation arising at point locations and will be associated largely with vent shaft compounds at Chalfont St Peter, Chalfont St Giles and Amersham, and the Chiltern tunnel south portal near the M25. In the majority of cases, permanent effects will reduce over time as planting matures.
- 9.1.4 An assessment of effects on the character of the Chilterns AONB as a whole 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-001-008, 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, South Bucks District Council, Buckinghamshire County Council, Three Rivers District Council and Chilterns Conservation Board. Summer field surveys, including photographic studies of LCAs 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, the SMR (Volume 5: Appendix CT-0001-000/1) and the SMR Addendum (Volume 5: Appendix CT-0001-000/2). 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 on Maps LV-07-027 to LV-07-032 and LV-08-027 to LV-08-032 (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 LCAs and visual receptors within approximately 500m of the Proposed Scheme have been assessed. Long distance views of up to 1.4km have been considered at locations such as residential properties and transport corridors on Denham Lane, New Road and south of Amersham Old Town and a PRoW to the south-west of Amersham. The study area extends beyond land required for the Proposed Scheme.

Limitations

- 9.2.4 During the baseline survey there were some areas that were inaccessible (such as private land, commercial premises and residential buildings). 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 The extensive dip slope of the Chilterns is incised by numerous dry valleys, creating a characteristic landscape pattern of valleys and ridges. Chalk is the underlying geology of the area with remnants of chalk downland on escarpment and valley sides. There are a wide range of land uses including intensely managed arable farmland of typically medium sized fields, defined by mature hedgerow boundaries and large areas of woodland which cover surrounding hill tops. There are three golf courses and one registered park and garden within the study area. The Chilterns AONB lies to the north of Chalfont St Giles, covering the western part of the area; the majority of the Chalfonts and Amersham area lies within green belt land. The three relatively large settlements of Chalfont St Peter, Chalfont St Giles and Amersham are located within

the study area. In numerous locations woodland blocks form the urban fringe between settlements and open countryside beyond. Scattered villages and farmsteads, many of which comprise traditional vernacular building styles and materials, are located along the valley floor and sides between larger settlements. The M25 passes to the south-east of the area. The A413 forms the main road route through the Misbourne valley connecting larger settlements to smaller villages and farmsteads within more rural parts of the LCA via minor subsidiary routes.

- 9.3.2 The LCA have been determined with reference to the Hertfordshire Landscape Character Assessment⁴⁴, the Buckinghamshire Landscape Character Assessment⁴⁵, and the Chilterns AONB Management Plan⁴⁶.
- 9.3.3 Descriptions of all LCAs are provided in Volume 5: Appendix LV-001-008 Part 2. For the purposes of this assessment the study area has been sub-divided into eight discrete LCAs, four of which are most likely to be affected. A summary of these four LCAs is provided below. The LCAs are shown in Maps LV-02-27b to LV-02-32a (Volume 5, Landscape and Visual Assessment Map Book).

Maple Cross Slopes North LCA

- 9.3.4 The area has pronounced east-facing slopes with twisting dry valleys pushing westwards. Visually prominent urban developments on lower slopes and along the A412 corridor include the villages of Maples Cross, up towards Rickmansworth and Chorleywood. The majority of land use is agricultural, characterised by both arable and grazing fields, punctuated in places by well-established woodland blocks. Woodland areas are also concentrated on the slopes of narrow dry valleys to the west. The M25, with its associated traffic and infrastructure, forms a prominent feature as it moves up through the LCA, reducing both visual and audible tranquillity within the area. Views from upper slopes look east across the Colne Valley towards Mount Pleasant and Harefield. Located within the green belt, the landscape character is considered to be of regional value and therefore has a medium sensitivity to change.

Chalfont St Peter North LCA

- 9.3.5 The characteristic landform comprises steep sided valleys with protruding spurs and a strong convex profile to the upper slopes of this elevated and undulating landscape. Land use includes the urban area of Chalfont St Peter, although arable farmland is dominant. Agricultural fields are interspersed with individual and small groups of properties. A number of small to medium woodland plots can be found throughout the LCA, Bottom Wood being the largest. The Old Shire Lane long distance path and other PRoW cross the area. The M25 forms the eastern boundary of the LCA as it passes through the landscape in cutting. Other roads within this area are more rural in nature linking Chalfont St Peter with Maple Cross and the eastern side of the Colne Valley. Tranquillity is considered low due to the M25 transport corridor and associated

⁴⁴ Hertfordshire County Council, 2001, *Hertfordshire Landscape Character Assessment*.

⁴⁵ Buckinghamshire County Council, 2001, *Landscape Plan for Buckinghamshire Part 1: Landscape Character Assessment*.

⁴⁶ Chilterns Conservation Board, 2008, *Chilterns AONB Management Plan*.

vehicular traffic. The LCA lies within green belt and is considered of regional value and therefore has a medium sensitivity to change.

Misbourne Upper South LCA

- 9.3.6 This LCA follows one of the largest valleys cut into the Chilterns dip slope. The majority of the valley is rural in character with the exception of Amersham Old Town and the southern edge of Amersham. Numerous prominent woodland blocks including ancient woodlands are scattered throughout the LCA. Un-wooded valley sides are largely used for intensive arable production. Fields are typically medium to large, regular in shape and bounded by strong hedges that follow the landform. The valley contains the River Misbourne, the A413 Road and the Marylebone to Aylesbury Line. Narrow winding roads with strong hedgelines run up the valley slopes connecting with woodland blocks. The LCA contains a small part of the Grade II* registered park and garden of Shardeloes. The predominantly rural character containing some urban settlements with notable transport routes results in an area of medium tranquillity. The LCA is within green belt as well as the Chilterns AONB and is considered to be of national value. Therefore, this area has a high sensitivity to change.

Penn South LCA

- 9.3.7 Penn South LCA is characterised by large scale, rolling topography. The dip slope of the Chilterns is incised by numerous dry valleys creating an undulating pattern of valleys and ridges. The landscape comprises arable and pastoral fields with large blocks of woodland, some of which are ancient, including Brentford Wood, West Wood, Herts Wood and the large Hodgemoor Wood. Settlements are generally small or individual properties. Winchmore Hill and Coleshill are the two main settlements within this area. Shardeloes, the large registered park and garden, is located within the LCA and sits within the wider designation of the Chilterns AONB. The predominantly rural landscape and woodland blocks creates areas of isolation and seclusion, resulting in an area of medium tranquillity. The A413 and A335 traverse the landscape, linked by interconnecting narrow winding country roads and tracks. Pylons through the area bring a strong vertical element to the rolling landscape. The LCA has a dense network of PRoW including the Chiltern Way, which offers attractive recreational opportunities. The area is also within green belt and the Chilterns AONB and is considered of national value. Therefore, this area has a high sensitivity to change.

Visual baseline

- 9.3.8 Descriptions of the identified representative viewpoints are provided in Volume 5: Appendix LV-001-008 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-07-027 to LV-07-032 and LV-08-027 to LV-08-032 (Volume 5, Landscape and Visual Assessment Map Book). The viewpoints are numbered to identify their locations, which are shown in Maps LV-02-027 to LV-02-032 and LV-07-027 to

LV-07-032). 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.

- 9.3.9 No protected views have been identified within the study area.
- 9.3.10 Viewpoints have been selected to represent residential, recreational and transport receptors within this area.
- 9.3.11 Residential receptors have a high sensitivity to change and are located to the north of Chalfont St Peter, north and east of Chalfont St Giles, west of the M25 in areas such as Horn Hill, at dispersed properties on Bottom House Farm Lane and to the southern periphery of Amersham Old Town. Typical views are varied; however an undulating agricultural and vegetated scene dominates in the most part, intersected in places by transport corridors and pockets of settlement.
- 9.3.12 Recreational receptors also have a high sensitivity to change and are concentrated along PRow dispersed throughout the valley farmland. These potential receptors include users of PRow near the eastern periphery of Chalfont St Giles, as well as users of the South Bucks Way long distance PRow near the north side of Hodgemoor Woods and within Shardeloes registered park and garden. Many of the recreational routes typically afford rural views across a predominantly agricultural landscape.
- 9.3.13 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 and Whielden Lane, where rural views are afforded. Views from people travelling along main roads including the A413 and A335 are considered to have a low sensitivity to change. As with other key receptors, views are often focused upon an agricultural and well vegetated landscape.

Future baseline

- 9.3.14 Volume 5: Appendix CT-004-000 provides details of the developments that are assumed will have been implemented by 2017. There is one committed development that is assumed would be partly built and occupied prior to either the construction or operation of the Proposed Scheme.
- 9.3.15 The redevelopment of the former Buckinghamshire University College at Newland Park, Chalfont Common would provide residential units for the elderly. Construction is proposed to take place between 2015 and 2019 (see CFA8/11, Volume 5: Appendix 004-000/1).
- 9.3.16 Newland Park is located on the north face of a hill with the crest of the hill to the south, which screens views of the Proposed Scheme. As such, there are no known developments that would introduce new visual receptors that would 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 that cannot be mitigated practicably. Such effects are temporary and vary over the construction period depending on the intensity and scale of the works at the time. The assessment of landscape and visual effects has been based on the activities occurring during the peak construction phase, which is defined as the period during which the main civil engineering works will take place, including establishment of compounds, tunnelling and works at vent shafts. 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 start of 2017 and the end of 2022. The satellite compounds at Chalfont St Peter vent shaft, Chalfont St Giles vent shaft and Amersham vent shaft will be in place for between approximately two and three years and the Chiltern tunnel main compound (located in CFA 7) will be in place for approximately six years during the civil engineering phase. 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.

9.4.2 The construction works that have been taken into account in determining the effects on landscape and visual receptors includes:

- construction of the vent shafts and the presence of the main construction site compound to the east of the M25, in the Colne Valley area (see CFA Report 7 for more information);
- construction of the entry slip road to the M25 clockwise and the associated local road realignment from Shire Lane/Chalfont Lane to Maple Cross;
- construction of the Chalfont St Peter vent shaft;
- excavation and construction of the Chalfont St Giles vent shaft and auto-transformer station;
- permanent widening of Bottom House Farm Lane to accommodate construction and permanent access to the Chalfont St Giles vent shaft (see Section 2.2 for more detail);
- excavation and construction of Amersham vent shaft and adjacent hard standing;
- satellite construction sites are located in the following locations: south-east of the M25; adjacent to the Chalfont St Peter vent shaft accessed from Chesham Lane; adjacent to the Chalfont St Giles vent shaft accessed from widened Bottom House Farm Lane and adjacent to Amersham vent shaft accessed from the A413 and A404;
- increased construction traffic including large articulated vehicles in proximity to local residential areas; and

- compounds required to construct features of the Proposed Scheme and associated plant (high cranes will be used to construct the vent shafts).

Avoidance and mitigation measures

9.4.3 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):

- requirement for contractors to monitor and manage flood risk and other extreme weather events which may affect landscape resource during construction (draft CoCP Section 16);
- 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); 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).

9.4.4 These measures have been taken account of in the assessment of the construction effects below.

Assessment of temporary impacts and effects

9.4.5 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; as well as the introduction of temporary material stockpiles required in order to accommodate construction sites, vent shaft and tunnel portal construction.

9.4.6 Changes will be most notable to the east of Horn Hill due to the presence of a large construction site at the tunnel southern portal in the adjacent Colne Valley LCA. The construction of the Chalfont St Peter vent shaft will involve earthworks, the removal of hedgerows, materials storage and other construction activity. Similarly, the vent shaft at Chalfont St Giles will result in earthworks, materials storage and vehicle movement. To enable construction, a section of existing hedgerow adjacent to Bottom House Farm Lane will require removal. The construction of the vent shaft at Amersham will result in the loss of semi-mature trees and introduce construction activity, as well as earthworks, materials storage and vehicle movement. The vent shaft at Little Missenden will be constructed to the north-west in the Central

Chilterns area and features will be visible and perceptible within the Chalfonts and Amersham area.

- 9.4.7 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

- 9.4.8 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-001-008 Part 4.

Maple Cross Slopes North LCA

- 9.4.9 The setting of Maple Cross Slopes North LCA will be impacted by the Chiltern tunnel south portal and associated construction works in the Colne Valley, which lie within CFA7. These are described in Volume 2, Section 9 CFA7 report, but they are highly visible from Horn Hill within the Chalfonts and Amersham area.
- 9.4.10 A large proportion of agricultural land to the east of the M25 in the adjacent LCA (CFA 7) will form part of a construction compound and will impact upon the rural landscape of Maple Cross LCA. Excavated material will be stockpiled and permanently redistributed in this location and associated infrastructure will be clearly visible. Much of the landscape is relatively tranquil although the major transport corridor of the M25 passes through the LCA. The introduction of notable changes will introduce a prominent element within the landscape during construction and will result in tranquillity within Maple Cross LCA remaining at a low level.
- 9.4.11 The medium magnitude of change, assessed alongside the medium sensitivity of the character area, will result in a moderate adverse effect.

Chalfont St Peter North LCA

- 9.4.12 The setting of the Chalfont St Peter North LCA will be affected by the south portal and associated construction works in CFA7. The works are described in Volume 2, Section 2.3 CFA Report 7, but are highly visible from Horn Hill and from the elevated land to the east of Chalfont St Peter within the Chalfonts and Amersham area.
- 9.4.13 The excavation and construction works associated with the Chalfont St Peter vent shaft will directly impact upon the rural landscape adjacent to Chesham Lane. The introduction of plant and vent shaft components will form prominent elements within the existing setting and noticeably alter the tranquillity of the character area. There will also be an adverse effect arising from the frequency of construction traffic along Chesham Lane. Construction of the vent shaft will require plant activity, reducing

tranquillity for the duration of the construction period, and will result in a medium magnitude of change.

- 9.4.14 The medium magnitude of change, assessed alongside the medium sensitivity of the character area, will result in a moderate adverse effect.

Misbourne Upper South LCA

- 9.4.15 The Proposed Scheme will run through the LCA within a twin-bore tunnel. The Amersham vent shaft will be located south of Amersham and will be constructed using cranes and other large plant. An area of existing semi-mature trees will be removed to accommodate the works. The vent shaft will be located within a busy road network, vegetated by semi-mature trees. The sound of construction work will be audible against the background of the existing traffic noise, which already has a detrimental effect upon local tranquillity. The surrounding vegetation will assist in screening the construction activity. Excavated material will be temporarily stockpiled along the eastern, western and southern boundaries of the field to the north-west of the vent shaft headhouse which will also reduce the perceptibility of construction.
- 9.4.16 The construction of the Chalfont St Giles vent shaft headhouse and auto-transformer station including cranes and temporary material stockpiles on adjacent fields will introduce prominent new features within the rural landscape. Construction of the Little Missenden vent shaft in neighbouring Central Chilterns (CFA9) will also be perceptible from high ground to the east. The addition of prominent new features associated with construction works will bring about a noticeable change in landscape character within Misbourne Upper South LCA and therefore result in a medium magnitude of change.
- 9.4.17 The medium magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect.

Penn South LCA

- 9.4.18 The Proposed Scheme will be in twin-bore tunnel whilst passing through the Penn South LCA. A vent shaft headhouse will be located near Bottom House Farm Lane in a secluded agricultural area; it will be accessed via a lightly trafficked road that services a number of small farmsteads. The Amersham vent shaft will be constructed to the north, within the adjacent Misbourne Upper South LCA, and large plant including cranes and temporary material stockpiles on adjacent fields will introduce prominent new features within the rural landscape. The increase in construction plant and associated traffic levels will reduce tranquillity within the LCA. Therefore the magnitude of change is considered to be medium.
- 9.4.19 The medium magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect.

Visual assessment

- 9.4.20 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, would be in leaf. Representative viewpoints within the study area considered to experience a non-significant effect (minor adverse or negligible) are described in Volume 5: Appendix LV-001-008 Part 4.
- 9.4.21 The number identifies the viewpoint locations which are shown on Maps LV-07-27a to LV-07-32b (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.
- 9.4.22 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 061.2.001: View north-east from Denham Lane to the north-east of Chalfont St Peter

- 9.4.23 During construction, filtered background views (approximately 630m) will be available across open agricultural land, and the M25 motorway towards a large area of temporary material stockpiles, which will be deposited within local agricultural fields. A large construction site compound, works and associated plant and machinery will also be visible, including tall cranes on the sky line. Although the construction area will form a large proportion of the view, views will be filtered through intervening vegetation and landform. Therefore the magnitude of change is considered to be medium.
- 9.4.24 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.
- 9.4.25 Additional lighting associated with construction of the Proposed Scheme will not result in significant effects. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 061.2.002: View east from properties adjacent to Shire Lane

- 9.4.26 During construction, there will be filtered views through adjacent roadside vegetation, across the motorway towards a large area of temporary material stockpiles in the middle ground that will be deposited within agricultural fields. A large construction site compound, works and associated plant and machinery will also be visible including tall cranes. The closest activity will be the construction of the Chiltern tunnel south portal (approximately 150m). Construction activities will fill a large proportion of the view and therefore the magnitude of change is considered to be high.

- 9.4.27 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.
- 9.4.28 Existing M25 corridor lighting located in front of the Proposed Scheme will partially diffuse light impacts during the construction phase. The predominant light source during construction will be the Chiltern tunnel portal main construction site in CFA7. It will be viewed in the context of other sources of light including the M25, in the middle and background of the view; therefore the magnitude of change is considered to be medium, giving rise to a moderate adverse night-time effect.

Viewpoint 064.2.001: View south-east from Hornhill Road, Shire Lane Path representative of residential properties on the southern edge of Horn Hill

- 9.4.29 The construction of the M25 exit slip road will be visible in the middle ground (approximately 120m). Filtered background views across the motorway towards the M25 compound and portal construction site will also be available, including earthworks stockpiles, an excavated materials bund along a temporary highway realignment, as well as construction plant and equipment. Although the views are filtered through vegetation, the construction will form a large proportion of the view. Therefore 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.
- 9.4.31 Existing M25 corridor lighting located in front of the Proposed Scheme will partially diffuse light impacts during the construction phase. The predominant construction light source will be the Chiltern tunnel portal main construction compound in CFA7, which will be active 24 hours a day. It will be viewed in the context of other sources of light in the middle and background of the view, including the M25, therefore the magnitude of change is considered to be medium giving rise to a moderate adverse night time effect.

Viewpoint 065.3.001: View north from PRow (Footpath CSG/32)

- 9.4.32 Chalfont St Peter vent shaft construction works, including landscape earthworks, and large construction plant including cranes, will be clearly visible within the foreground of this view (approximately 50m). The substantial change in close proximity to the receptor will result in a high magnitude of change.
- 9.4.33 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 065.4.002: View west from Chesham Lane

- 9.4.34 Immediate views (approximately 20m) of Chalfont St Peter vent shaft satellite compound will be afforded through field boundary vegetation and an open site entrance, currently a field access gate. Tall cranes, other plant, lorry movements and temporary material stockpiled approximately 3m high will be visible. The addition of the construction works in immediate proximity to the receptor will be clearly visible

and will represent a substantial change to the existing view. Therefore, the magnitude of change is considered to be high.

- 9.4.35 The high magnitude of change assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 065.2.003: View north from Chesham Lane at the northern edge of Chalfont St Peter

- 9.4.36 Chalfont St Peter vent shaft satellite compound and associated cranes and plant will form the background of the view (approximately 270m). During this time, the addition of new features such as plant and machinery will be clearly visible and greatly alter the existing view. The magnitude of change is considered to be high.

- 9.4.37 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

- 9.4.38 Additional lighting associated with construction of the Proposed Scheme will not result significant effects. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 071.2.001: View north-west from Bottom House Farm Lane

- 9.4.39 Chalfont St Giles vent shaft satellite compound and associated large plant and excavated material stockpiles will be visible in the background (approximately 500m), but will be filtered by tree lined boundaries near to Bottom House Farm Lane. Although the views looking north will be filtered, the construction site will be a substantial change and a dominant feature within the view. Therefore, the magnitude of change is assessed as medium.

- 9.4.40 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

- 9.4.41 The effects of additional lighting associated with construction of the Proposed Scheme will not be significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 071.3.002: View north from PRow (Footpath Col/2/2)

- 9.4.42 Chalfont St Giles vent shaft satellite compound, cranes and deposited temporary material stockpiles will be visible in the middle ground of the view (approximately 270m) but partially filtered by tree lined field boundaries. Temporary earthworks and stockpiling to accommodate the vent shaft headhouse will also be visible. Although filtered by intervening vegetation, this will result in a substantial difference in the view resulting in a high magnitude of change.

- 9.4.43 The high magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.

Viewpoint 072.2.001: View west from Bottom House Farm Lane

- 9.4.44 During construction, middle ground views (approximately 300m) of construction plant will be filtered by field boundary vegetation from Bottom House Farm. However, the tops of cranes will be clearly visible from this location. Increased construction traffic along Bottom House Farm Lane and temporary material stockpiles in the adjacent agricultural field will result in a substantial change in the view. Therefore the magnitude of change is considered to be medium.
- 9.4.45 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a major adverse effect.
- 9.4.46 Additional lighting associated with construction of the Proposed Scheme will not result in significant effects. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 077.4.002: View west from Whielden Lane to the south of Amersham Old Town

- 9.4.47 The Amersham vent shaft satellite compound will be clearly visible in the foreground (approximately 10m) from Whielden Lane. The tall cranes and removal of an area of semi-mature trees will be clearly visible from this receptor, as will earthworks profiling and construction of the vent shaft headhouse itself. This will result in a high magnitude of change.
- 9.4.48 The high magnitude of change assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 078.2.001: View south-west from Piggotts Orchard

- 9.4.49 The Amersham vent shaft satellite compound will be visible in the middle ground (approximately 530m) but the view will be partially filtered by intervening vegetation. Large construction plant, including cranes, and the clearance of a well-established group of semi-mature trees will be clearly visible from this location. Construction activity will result in a substantial change in the view, the magnitude of change is therefore considered to be medium.
- 9.4.50 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 078.3.002: View west from PRow (Footpath AMS/21/3) to the south of Amersham Old Town

- 9.4.51 The view of the Proposed Scheme from this location during construction is illustrated in the photomontage shown in Figure LV-01-186 (Volume 2, Landscape and Visual Assessment Map Book).
- 9.4.52 The Amersham vent shaft satellite compound will be partially visible in the middle ground (approximately 250m) beyond the roadside vegetation along Whielden Lane. The removal of an area of semi-mature trees adjacent to the vent shaft worksite,

earthworks and stockpiling and large construction plant will also be clearly visible from this location. The construction will be set within the context of existing highway infrastructure. Although partially filtered by intervening vegetation, the Amersham vent shaft satellite compound will result in a substantial difference in the view, resulting in a medium magnitude of change.

- 9.4.53 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Viewpoint 081.3.001: View north-west from PRow (Footpath AMS/26/3), South Bucks Way within the grounds of Shardeloes

- 9.4.54 The Little Missenden vent shaft satellite compound will be visible in views, partially filtered by intervening vegetation, in the middle ground (approximately 400m) and located in the Central Chilterns (CFA 9). Vegetation removal, temporary earthworks stockpiling and large construction plant will be visible above the intervening vegetation. The magnitude of change is considered to be medium.

- 9.4.55 The medium magnitude of change assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect.

Cumulative effects

- 9.4.56 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 baseline for the construction of the Proposed Scheme. The cumulative effect of this development on LCA's and viewpoints is described below.

- 9.4.57 There are no receptors that would be significantly affected by the construction of the Proposed Scheme when combined with the presence of construction activity and plant associated with the development at Newland Park.

Other mitigation measures

- 9.4.58 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 that 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

- 9.4.59 These effects 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 are listed as follows:

- Chalfont St Peter vent shaft will be located at the northern edge of Chalfont St Peter. The vent shaft will include a shaft headhouse building with a height of approximately 4m above ground level. It will have an associated hard standing area measuring approximately 550m² and will be accessible from the public highway, Chesham Lane. The vent shaft compound will have a landscaped perimeter;
- Chalfont St Giles vent shaft and auto-transformer station, including a shaft headhouse building approximately 4m in height and with an approximately 550m² hard standing. It will be accessible from the public highway, Bottom House Farm Lane. The vent shaft will have a landscaped perimeter;
- Amersham vent shaft located to the south of Amersham Old Town, at the junction of the A413 and A404, and a shaft headhouse building with a height of approximately 4m and with an approximately 550m² hard-standing. The vent shaft will be accessible from the public highway, Whielden Lane. The vent shaft site will have a landscaped perimeter; and
- fencing, lighting and other associated infrastructure.

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:

- land drainage areas will be integrated into the landscape to alleviate flooding and where possible will also provide opportunities for biodiversity;
- planting adjacent to Hornhill Road will be integrated into the existing field boundary vegetation, to form a more substantial visual screen. Proposed planting types will reflect tree and shrub species native to the local area and will reflect the local landscape character;
- planting to the west of the Chalfont St Peter vent shaft will screen views from Chalfont St Giles and planting to the south of the vent shaft will screen views from Chalfont St Peter;
- planting at the Chalfont St Giles vent shaft is designed to integrate the development into the landscape and screen potential views towards the Proposed Scheme. The existing woodland belt to the east of the vent shaft will be extended towards Bottom House Farm Lane, screening views from Upper Bottom House Farm. To the north and west, a belt of shrubs and trees will screen views and link with the existing woodland. The hedgerow removed along Bottom House Farm Lane will be reinstated;

- landscape earthworks at Chalfont St Peter and Chalfont St Giles vent shafts will screen and integrate the vent shafts into the landscape;
- planting associated with the Amersham vent shaft will include tree and shrub planting to the west of Whielden Lane to integrate the shaft site with existing vegetation and provide screening. Wherever practicable, existing vegetation within the immediate vent shaft site will be retained; and
- earth embankments around the Amersham vent shaft will screen lower level views and hedgerow planting on the east side of Whielden Lane will re-establish the vegetated field boundary removed during construction.

9.5.3 These measures have been taken into account 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 vent shaft sites and associated infrastructure; the introduction of a tunnel portal on the eastern boundary within neighbouring CFA7; and the introduction of highway infrastructure into the rural environment. The Proposed Scheme is within tunnel within this area although some views will be afforded of the Proposed Scheme in neighbouring CFA7, prior to the Proposed Scheme entering tunnel. The majority of visual impacts are therefore limited to the introduction of vent shafts. Landscape and visual impacts associated with the scheme will reduce over time as any mitigation planting establishes and provides screening of the new vent shaft structures.

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-001-008 Part 4.

9.5.6 The assessment of effects in year 15 assumes 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.

9.5.7 None of the eight LCA within this area will be significantly affected by operation of the Proposed Scheme.

Visual assessment

9.5.8 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-001-008 Part 4.

9.5.9 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.

- 9.5.10 No significant effects at night time arising from additional lighting have been identified.
- 9.5.11 The number identifies the viewpoint locations, which are shown on Maps LV-08-027 to LV-08-032 (Volume 5, Landscape and Visual Assessment Map Book). In each case, the middle number (061.2.002) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport.
- 9.5.12 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.
- 9.5.13 The view of the Proposed Scheme from viewpoint 078.3.002 (illustrated in the photomontage shown in Figure LV-01-229) (Volume 2, CFA8 Map Book) would not be significantly affected due to the intervening mitigation planting.

Viewpoint 061.2.002: View east from properties adjacent to Shire Lane

- 9.5.14 The Proposed Scheme will be located in cutting and on embankment in the middle ground of this view (approximately zoom). The Chiltern tunnel south portal, Tilehouse Lane bridge and its associated embankments will be visible from this elevated location. Overhead line equipment and trains will also be visible where the cutting is shallower; therefore the magnitude of change is considered to be medium.
- 9.5.15 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.
- 9.5.16 In the summer of year 1, mitigation planting will not have established; however, existing vegetation will filter views of the Proposed Scheme during summer months, resulting in a reduction of magnitude of change from medium to low. This will reduce the effects to non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.
- 9.5.17 Additional lighting associated with the operation of the Proposed Scheme will result in no significant effects at Year 1 and beyond. These are reported in Volume 5: Appendix LV-001-008 Part 4.
- 9.5.18 By year 15 and beyond to year 60 of operation, planting around the Chiltern tunnel south portal will have matured, providing additional screening to features of the Proposed Scheme. The effects will remain non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint o64.2.001: View south-east from Hornhill Road, Shire Lane Path representative of residential properties on the southern edge of Horn Hill

- 9.5.19 The view of the Proposed Scheme from this location during year 1 of operation is illustrated in the photomontage shown in Figure LV-01-033 (Volume 2, CFA8 Map Book).
- 9.5.20 From this elevated location, there will be views of the Proposed Scheme as it passes in cutting and on embankment in the middle ground (approximately 800m). The view will be partially filtered by the intervening garden and M25 vegetation and hedgerows on field boundaries. Access roads, overhead lines, portal buildings and auto-transformer station will also be visible.
- 9.5.21 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.
- 9.5.22 During the summer of year 1 of operation, intervening vegetation will further screen the view, resulting in a low magnitude of change and a minor adverse impact.
- 9.5.23 Additional lighting associated with the operation of the Proposed Scheme will result in no significant effects at Year 1 and beyond. These are reported in Volume 5: Appendix LV-001-008 Part 4.
- 9.5.24 By year 15 and beyond to year 60 of operation, planting established around the Chiltern tunnel south portal will have matured, enclosing the structure and the route in cutting, and providing additional screening of the scheme from views to the west. This will reduce effects to not significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.
- 9.5.25 The view of the Proposed Scheme in the summer of year 15 of operation is illustrated on the photomontage shown in Figure LV-01-228 (Volume 2, CFA8 Map Book).

Viewpoint o65.3.001: View north from PRow (Footpath CSG/32)

- 9.5.26 The Chalfont St Peter vent shaft will be visible in foreground views (approximately 75m) despite the presence of existing intervening vegetation between the PRow (Footpath CSG/32) and the Proposed Scheme. The vent shaft is designed to integrate into the landscape by being set partially below ground level. Landscape earthworks will in part provide screening of part of the vent shaft from this viewpoint; however the earthworks themselves will form a change in the immediate view. Therefore, the magnitude of change is considered to be medium.
- 9.5.27 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.
- 9.5.28 Mitigation planting will not have established by year 1 and therefore the vent shaft will still be visible during the summer of year 1 operation. It will however be screened in part by the presence of new earthwork bunds. Given the presence of the vent shaft

and newly formed topography, the magnitude of change is considered to remain medium and the effects will be unchanged.

- 9.5.29 By year 15 and beyond to year 60 of operation, planting around the perimeter of the vent shaft site will have matured, providing effective screening of much of the vent shaft from this location. This will reduce effects to not significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 065.4.002: View west from Chesham Lane

- 9.5.30 The view of the Proposed Scheme from this location during year 1 of operation is illustrated in the photomontage shown in Figure LV-01-034 (Volume 2, CFA8 Map Book).
- 9.5.31 The Chalfont St Peter vent shaft, associated earthworks and mitigation planting located immediately adjacent to Chesham Lane will be visible in the immediate foreground of the view (approximately 20m). The vent shaft will sit in a small field currently enclosed by well-established field boundary vegetation, and consequently the magnitude of change is considered to be medium.
- 9.5.32 The medium magnitude of change assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.
- 9.5.33 Mitigation planting will not have formed an effective screen in the summer of year 1 of operation. The existing adjacent roadside vegetation will further filter views of the vent shaft, but not sufficiently to change the assessment during the summer months.
- 9.5.34 By year 15 and beyond to year 60 of operation, mitigation planting around the vent shaft will have matured providing an effective screen. This will reduce effects to not significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 065.2.003: View north from Chesham Lane at the northern edge of Chalfont St Peter

- 9.5.35 The vent shaft headhouse will be visible in the background of this view (approximately 350m). The vent shaft headhouse will more readily integrate into the existing landscape with part of the structure underground, aided by earthworks and mitigation planting. There will be partially filtered views through existing field boundaries. The magnitude of change is therefore considered to be medium.
- 9.5.36 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.
- 9.5.37 During summer of year 1 of operation new planting will yet to have established, however existing vegetation in gardens and along field boundaries will further filter views towards the vent shaft. This will reduce effects to non-significant.

- 9.5.38 Additional lighting associated with the operation of the Proposed Scheme will result in no significant effects at Year 1 and beyond. These are reported in Volume 5: Appendix LV-001-008 Part 4.
- 9.5.39 By year 15 and beyond to year 60 of operation, planting established as part of the Proposed Scheme will have matured, providing additional screening of the vent shaft. This will reduce effects to non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 071.2.001: View north-west from Bottom House Farm Lane

- 9.5.40 The Chalfont St Giles vent shaft and auto-transformer station will be visible through tree lined field boundaries in the middle ground of the view (approximately 500m). Existing vegetation on the periphery of the vent shaft site will only very partially screen views of the Proposed Scheme from this elevated location, leading to a medium magnitude of change.
- 9.5.41 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.
- 9.5.42 Newly planted vegetation will not form an effective visual screen by the summer of year 1 of operation. However, existing intervening field boundary vegetation will further screen views of the vent shaft during the summer months, reducing the effect to non-significant.
- 9.5.43 By year 15 and beyond to year 60 of operation, the expansion of the existing woodland block to the north and east of the site will screen views of the Proposed Scheme and associated infrastructure from properties along Bottom House Farm Lane. This will reduce effects to being non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 071.3.002: View north from PRoW (Footpath CSG/47)

- 9.5.44 The Chalfont St Giles vent shaft will be visible in the middle ground of this elevated view (approximately 475m). The associated auto-transformer station will also be visible. Field boundary vegetation along Bottom House Farm Lane will filter lower level views of the Proposed Scheme. Therefore, the magnitude of change is considered to be medium.
- 9.5.45 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.
- 9.5.46 Intervening vegetation along Bottom House Farm Lane will offer only a limited element of screening during the summer of year 1 operation. As such, the magnitude of change will remain medium and the overall effects moderate adverse.
- 9.5.47 By year 15 and beyond to year 60 of operation, planting established directly adjacent to the vent shaft site will have matured, increasing screening of the Proposed

Scheme. This will reduce effects to non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 072.2.001: View west from Bottom House Farm Lane

- 9.5.48 The Chalfont St Giles vent shaft and auto-transformer station, approximately 4m in height above ground level and will be visible in middle ground filtered views (approximately 60m). Earthworks immediately surrounding the vent shaft area will partially screen low level views of the headhouse. Therefore, the magnitude of change is considered to be medium.
- 9.5.49 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.
- 9.5.50 In the summer of year 1 of operation, screening vegetation will not have established an effective visual screen and existing intervening vegetation will only partially screen views of the vent shaft and auto-transformer station from this location. The magnitude of change will therefore remain medium and the overall impact will be unchanged.
- 9.5.51 Additional lighting associated with the operation of the Proposed Scheme will result in not significant effects at Year 1 and beyond. These are reported in Volume 5: Appendix LV-001-008 Part 4.
- 9.5.52 By year 15 and beyond to year 60 of operation, planting established in the vicinity of the Proposed Scheme will have matured, providing additional screening to the headhouse. This will reduce effects to non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 077.4.002: View west from Whielden Lane to the south of Amersham Old Town

- 9.5.53 The Amersham vent shaft will be visible in the immediate foreground of the view (approximately 10m). The vent shaft headhouse will be partially below ground level with the top 2m visible above ground. The view will be partially filtered by existing intervening vegetation, therefore the magnitude of change is considered to be medium.
- 9.5.54 The medium magnitude of change assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.
- 9.5.55 Mitigation planting will not have established by the summer of year 1 of operation. However, intervening roadside vegetation will partially screen features of the vent shaft site, although there will be open views through gaps in the roadside vegetation. The magnitude of change will therefore remain medium and the overall impact will be unchanged.
- 9.5.56 By year 15 and beyond to year 60 of operation, planting around the vent shaft site will have become well established, providing further screening of the vent shaft thereby

reducing effects to non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 078.2.001: View south-west from Piggotts Orchard

- 9.5.57 The Amersham vent shaft will be visible within existing vegetation in the middle ground (approximately 650m). The vent shaft will be set in the context of other built form on the periphery of Amersham, and enclosed in part by surrounding rising landform. However, areas of removed vegetation will enable views through to the vent shaft headhouse and compound layout. Additional mitigation planting intended to integrate the structure into the wooded setting will not have become established by year 1 of operation. Therefore, the magnitude of change is considered to be medium.
- 9.5.58 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.
- 9.5.59 In the summer of year 1 of operation, mitigation planting will not have established. However, intervening garden and roadside vegetation will partially filter views to the vent shaft site during the summer months, reducing the magnitude of change to low, resulting in no significant effects.
- 9.5.60 By year 15 and beyond to year 60 of operation, mitigation planting directly adjacent to the vent shaft will have matured, providing additional screening. This will reduce effects to non-significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Viewpoint 078.3.002: View west from PRow (Footpath AMS/21/3) to the south of Amersham Old Town

- 9.5.61 The view of the Proposed Scheme from this location during year 1 of operation is illustrated in the photomontage shown in Figure LV-01-035 (Volume 2, CFA8 Map Book).
- 9.5.62 The Amersham vent shaft will be visible in the middle ground (approximately 230m), although partially filtered by the existing vegetation along A404 Whielden Lane. The loss of vegetation to accommodate the works will enable views of the vent shaft. However, the vent shaft headhouse will be partially below ground and earthworks will integrate the structure into the surrounding landscape. The headhouse will be viewed within the context of existing highway infrastructure and therefore, the magnitude of change is considered to be medium.
- 9.5.63 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.
- 9.5.64 In summer of year 1 of operation mitigation will not have matured and the intervening vegetation located along Whielden Lane will only partially filter views through to the

vent shaft. The magnitude of change will therefore remain medium and the overall impact will be unchanged.

- 9.5.65 By year 15 and beyond to year 60 of operation, planting enclosing the vent shaft site will have established, providing effective visual screening of the Proposed Scheme from this viewpoint. This will reduce effects to not significant. These are reported in Volume 5: Appendix LV-001-008 Part 4.

Cumulative effects

- 9.5.66 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 baseline for the operation of the Proposed Scheme. The consequential cumulative effect of these committed developments on LCAs and viewpoints is described below. These developments are shown on Maps CT-13-013b to CT-13-016 (Volume 5, Cross Topic Appendix 1 Map Book).
- 9.5.67 No significant adverse effects will arise due to the combined presence of the development at Newland Park and the Proposed Scheme.

Other mitigation measures

- 9.5.68 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

- 9.5.69 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 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 relevance in terms of socio-economics, in relation to potential employment opportunities arising from construction in the local area (including in adjacent CFAs).

Operation

10.1.5 The proposed 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 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 Chalfonts and Amersham area, which includes data of specific relevance to socio-economics notably

demographic and employment data.⁴⁷ The following provides a brief overview in terms of employment, economic structure, and labour market within the area.

- 10.3.2 The Chalfonts and Amersham area, located within Chiltern District, is a predominantly rural area including agricultural land but also covers the residential areas of Chalfont Common, Chalfont St. Giles and the old town of Amersham.
- 10.3.3 Where possible, baseline data has been gathered on demographic character areas (DCA)⁴⁸ to provide a profile of local communities. Maps SE-02-009 (Volume 5, Socio-economics Map Book) shows the location of the DCA. The area contains three DCA – Chalfont St Peter and Chalfont Common, Chalfont St Giles, and Amersham Old Town.

Business and labour market

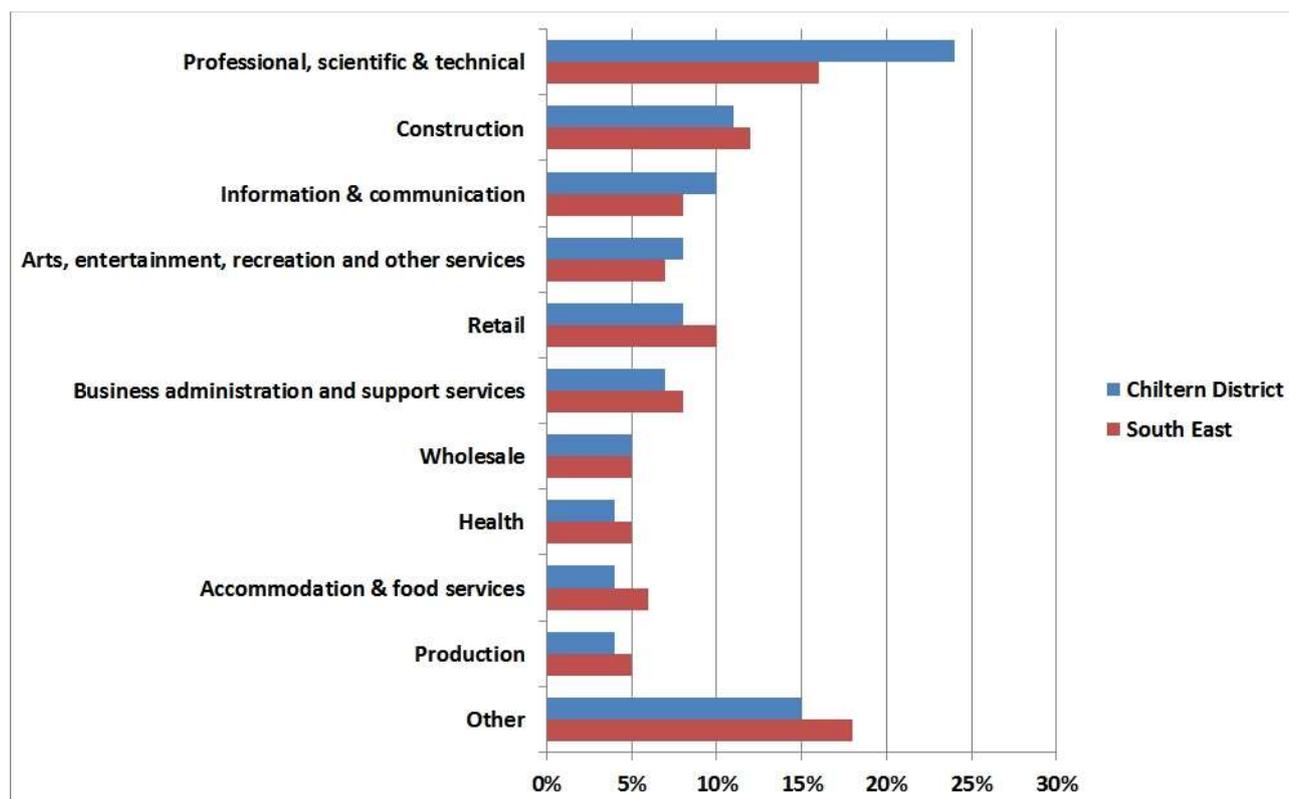
- 10.3.4 Within Chiltern District, the professional, scientific and technical services sector accounts for the largest proportion of businesses (24%), with the construction (11%), information and communication (10%), and arts, entertainment, recreation and other services and retail (8%) sectors also accounting for relatively large numbers of businesses. This is shown in Figure 6⁴⁹. 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%), and retail (10%) sectors also accounting for large numbers of businesses within the region⁵⁰.

⁴⁷ Further information on the socio-economics baseline, with regard to business and labour market profile, within the area is contained in the Volume 5: Appendix SE-001-000.

⁴⁸ 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 (LSOAs).

⁴⁹ The Figure presents the proportion of businesses within each business sector in the district but not the proportion of employment by sector.

⁵⁰ Office of National Statistics (ONS) (2011), *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^{51,52}

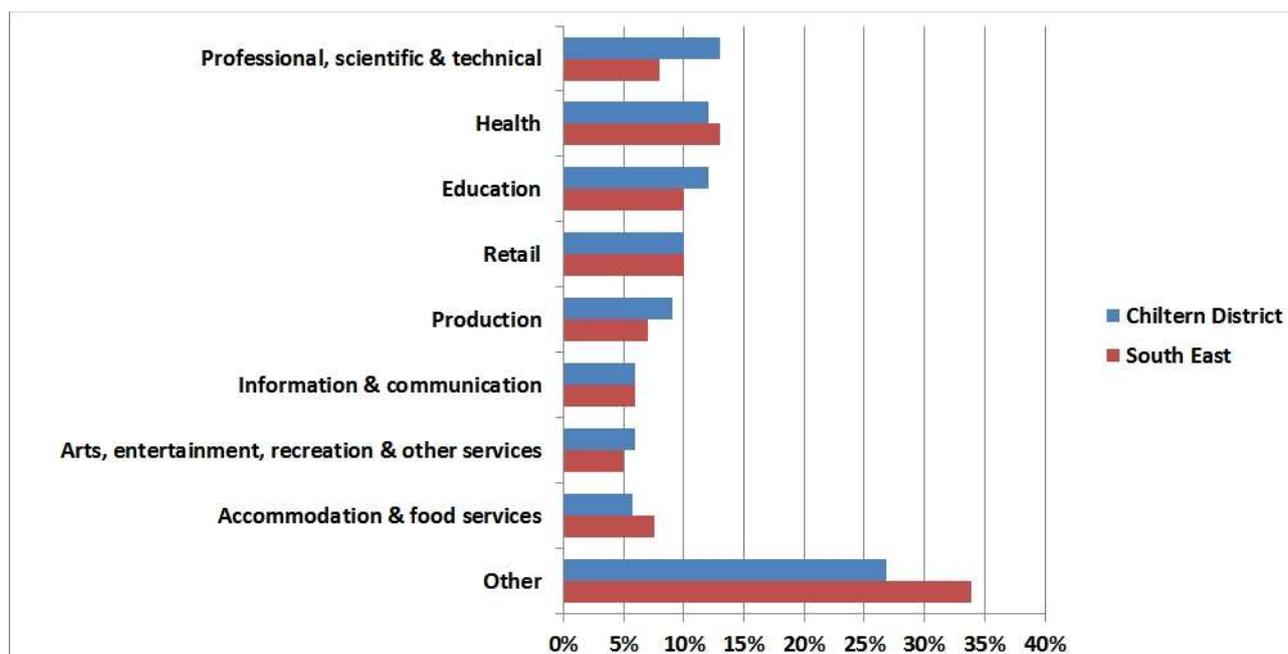
- 10.3.5 Approximately 33,000 people worked in Chiltern District while 2,200 people worked within Chalfont St Peter and Chalfont Common DCA, 1,000 within Chalfont St Giles DCA and 2,200 within Amersham Old Town DCA⁵³.
- 10.3.6 According to the ONS Business Register and Employment Survey 2011, the sector with the highest proportion of employment in the district is professional, scientific and technical at 13%, with this sector accounting for 8% in both the South East and England. The health sector also accounts for a high proportion of employment in the district at 12%, which is slightly less than the 13% it accounts for at both the regional and national levels. The education sector is the third largest sector in the district by employment, accounting for 12% of jobs, and so at a level comparable to that recorded for the South East as a whole, which is also 10%. This is shown in Figure 7.
- 10.3.7 Key sectors, in terms of employment, for Chalfont St Peter and Chalfont Common DCA are health (28%) and professional, scientific and technical (15%). In Chalfont St Giles the key sector is information and communication (29%). In Amersham Old Town DCA, key sectors are health (24%) and retail (21%).

⁵¹ 'Other' includes agriculture, forestry and fishing; motor trades; transport and storage (including postal); finance and insurance; property; public administration and defence; and education sectors.

⁵² ONS (2012), UK Business: Activity, Size and Location 2011, ONS, London.

⁵³ ONS (2011), Business Register and Employment Survey 2011, ONS, London.

Figure 7: Employment by industrial sector in Chiltern District and the South East^{54,55}



10.3.8 According to the Census 2011⁵⁶, the employment rate⁵⁷ within the district in 2011 was 69% (which represents 45,000 people), slightly higher than the 68% recorded for the South East and 65% for England as a whole. The district has high levels of out-commuting as shown by the discrepancy between the number of jobs in the district and the number of residents in employment. The employment rate recorded for both the Chalfont St Peter and Chalfont Common DCA, and Chalfont St Giles DCA was 69%, and 72% in Amersham Old Town DCA.

10.3.9 The unemployment rate for the district in the 2011 stood at 4%, which was lower than the England average of 7%. The unemployment rate in each of the three DCA was also 4%⁵⁸.

10.3.10 According to the Census 2011, 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 is lower than that recorded both for South East (19%) and England (23%). In 2011 40% of Chalfont St Peter and Chalfont Common DCA residents aged 16 and over were qualified to NVQ4 level, compared to 42% in Chalfont St Giles DCA, and 44% in Amersham Old Town DCA. The proportion of residents with no qualification was 15% in Chalfont St Peter and Chalfont Common DCA, 14% in Chalfont St Giles DCA, and 17% in Amersham Old Town DCA.

⁵⁴ 'Other' includes business administration and support services, wholesale, construction, property, financial and insurance, motor trades, public administration and defence, transport and storage (including postal), and agriculture, forestry and fishing.

⁵⁵ ONS (2011), *Business Register and Employment Survey 2011*, ONS, London.

⁵⁶ ONS (2012), *Census 2011*, ONS, London.

⁵⁷ 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.

⁵⁸ Unemployment figures have been rounded to the nearest whole number. DCA unemployment rates are presented for each DCA in this section while in Section 2 they are shown in aggregate.

- 10.3.11 The three DCA (Chalfont St Peter and Chalfont Common, Chalfont St Giles, and Amersham Old Town) are each predominantly residential areas, set within a predominantly rural environment, recording high rates of employment, low unemployment and high qualifications attainment.

Future baseline

Construction (2017)

- 10.3.12 Volume 5: Appendix CT-004-000 provides details of the developments that are assumed will have been implemented by 2017. There are no consents or allocations in this area that are expected to result in a material change to the baseline by 2017.

Operation (2026)

- 10.3.13 Volume 5: Appendix CT-004-000 provides details of the developments that are assumed will have been implemented by 2026. There are no consents or allocations in this area that are expected to result in a material change to the baseline between 2017 and 2026.

10.4 Effects arising during construction

Avoidance and mitigation measures

- 10.4.1 In order to avoid or minimise 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 socio-economic effects associated with construction within this area, including the following (see Volume 5: Appendix CT-003-000):
- consulting businesses located close to hoardings on their design, materials and construction 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, Sections 5 and 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 businesses⁵⁹ are expected to experience significant amenity effects as a result of the Proposed Scheme have been identified within the area.

Isolation

10.4.4 No non-agricultural businesses are expected to experience significant isolation effects as a result of the Proposed Scheme have been identified within the area.

Construction employment

10.4.5 Construction compounds for the Proposed Scheme will be located at the following locations within the area:

- Chalfont St Peter vent shaft satellite compound;
- Chalfont St Giles vent shaft satellite compound; and
- Amersham vent shaft satellite compound.

10.4.6 The use of these sites could result in the creation of 290 person years of construction employment opportunities⁶⁰, equivalent to 29 full time equivalent jobs⁶¹, 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 (see Volume 3).

Cumulative effects

10.4.8 No committed (intra-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).

⁵⁹ Possible employment loss in agricultural businesses as a result of the Proposed Scheme is being estimated at the route-wide level.

⁶⁰ 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.

⁶¹ Based on the convention that 10 employment years is equivalent to one full time equivalent job.

Permanent effects

Businesses

- 10.4.10 Businesses directly affected, i.e. those that lie within land which will be used 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.
- 10.4.11 From an employment perspective, no significant direct effects on non-agricultural employment⁶² have been identified and the Proposed Scheme is not anticipated to result in the displacement or possible loss of jobs within this area.

Cumulative effects

- 10.4.12 No committed (intra-project developments have been identified that are considered to interact with the Proposed Scheme.
- 10.4.13 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 (see Volume 3).

Other mitigation measures

- 10.4.14 The assessment has concluded that there are no significant adverse effects arising during construction in relation to businesses directly affected by the Proposed Scheme.
- 10.4.15 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

- 10.4.16 No residual significant socio-economic effects are likely to arise during construction of the Proposed Scheme.

10.5 Effects arising during operation

Avoidance and mitigation measures

- 10.5.1 No mitigation measures are proposed 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.

⁶² Effects arising from the demolition of the Chalfont Valley Equestrian manège are assessed in Section 3: Agriculture, forestry and soils.

Change in business amenity

- 10.5.3 No non-agricultural businesses are expected to experience significant amenity effects as a result of the Proposed Scheme within the area

Operational employment

- 10.5.4 Operational employment will be created at locations along the route including stations, train crew facilities and infrastructure/maintenance depots, which are considered unlikely to be accessed by residents within the area.
- 10.5.5 Direct operational employment created by the Proposed Scheme could lead to indirect employment opportunities for local businesses in terms of supplying the Proposed Scheme or benefiting from expenditure of directly employed workers on goods and services. Some of these employment opportunities will be accessible to residents in the locality.
- 10.5.6 The impact of operational employment creation has been assessed as part of the route-wide assessment (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 Proposed Scheme 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 the Chalfonts and Amersham area on:

- people, primarily where they live ('residential receptors') in terms of a) individual dwellings and b) on a wider community basis, including shared community open areas⁶³; 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'⁶⁴.

11.1.2 The assessment of likely significant effects from operational 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 during construction or once the railway becomes operational.

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).

⁶³ 'Shared community open areas' are those that the National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park to local green space) that is nearby.

⁶⁴ 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.

11.1.7 More detailed information and mapping regarding the sound, noise and vibration assessment for Chalfonts and Amersham is available in the relevant appendices in Volume 5:

- sound, noise and vibration, route-wide assumptions and methodology (Appendix SV-001-000);
- sound, noise and vibration baseline (Appendix SV-002-008);
- sound, noise and vibration construction assessment (Appendix SV-003-008);
- sound, noise and vibration operation assessment (Appendix SV-004-008); 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 Proposed Route is entirely in tunnel through this area and therefore baseline sound measurements have been focused around the three vent shafts located in the area.

11.2.2 In the south-east of this area, north-east of Chalfont St Peter, the dominant sound source is constant road traffic on the M25 motorway. Other audible sources of sound include intermittent traffic on local roads and natural sources.

11.2.3 At locations close to the Chalfont St Peter vent shaft the sounds from cars regularly passing nearby on Chesham Lane. For properties on Chesham Lane, daytime sound levels are typically around 55 to 60dB⁶⁵.

11.2.4 The Chalfont St Giles vent shaft is located in a rural area away from major roads and characterised by natural sources, where typical daytime sound levels are 45 to 50dB. The sounds of aircraft flying overhead can also sometimes be heard.

11.2.5 In the area surrounding the Amersham vent shaft the main sound sources are road traffic on the nearby busy A413 and A404 roads and intermittent local traffic on Whielden Lane, yielding daytime sound levels of around 65dB⁶⁶ at local properties.

11.2.6 Sound levels in the study area reduce during the night-time period due to the reduction in traffic movements on local roads, giving night-time noise levels⁶⁷ typically between 5 to 10dB below daytime levels, with the smaller 5dB difference generally applying in the quiet locations located distant from existing road traffic.

11.2.7 Further information on the existing baseline, including baseline sound levels and baseline monitoring results, is provided for this area in Volume 5: Appendix SV-002-008.

⁶⁵ Quoted dB values at residential areas refer to the equivalent continuous sound level, LpAeq,16hr.

⁶⁶ Quoted dB values at residential areas refer to the equivalent continuous sound level, LpAeq,16hr.

⁶⁷ The equivalent continuous sound level, LpAeq,8hr.

- 11.2.8 It is likely that the majority of receptors adjacent to the line of route are not currently subject to appreciable vibration. 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

- 11.2.9 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, where engine sound dominates. On higher speed roads⁶⁸, tyre sound dominates and hence the expected growth in traffic is likely to continue to increase ambient sound levels.

Construction (2017)

- 11.2.10 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.

Operation (2026)

- 11.2.11 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.

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 Tunnel boring machines (TBM) will be used to excavate the tunnels. Materials (including tunnel lining segments), people and equipment will be transported from the surface to each TBM using small construction trains, which will travel at relatively low speeds. Excavated material from each TBM will be transported to the surface by

⁶⁸ Tyre noise typically becomes the dominant sound source for steady road traffic at speeds above approximately 30mph.

conveyor. It has been assumed that significant noise and vibration effects arising from use of the temporary railway will be avoided through appropriate design and maintenance specification. Other methods material movement may be employed; however, these would result in lower ground-borne noise and vibration.

11.3.3 The construction activities will all generally take place during the core daytime hours. This will include excavation and supply of materials. However, at certain times excavation and concrete supply for sprayed concrete lined cross passage tunnels will need to be undertaken during the evening and night-time for reasons of safety, and 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-002-008.

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; and then
 - screening: for example local screening of equipment or perimeter hoarding;
- where, despite the implementation of BPM, the noise exposure exceeds the criteria defined in the draft CoCP, noise insulation or ultimately temporary re-housing will be offered in accordance with the draft CoCP’s 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

noise, including control of working hours, and provide a further assessment of construction noise and vibration including confirmation of noise insulation/temporary re-housing provision;

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

11.3.7 In addition to this mitigation, taller screening as described in the draft CoCP⁶⁹ has been assumed along the edge of the construction site boundary vent shaft compounds a Chalfont St Peter, Chalfont St Giles and Amersham.

Assessment of impacts and effects

Residential receptors: direct effects – individual dwellings

11.3.8 The mitigation measures will reduce noise inside all dwellings such that it does not reach a level where it would significantly affect⁷⁰ residents.

Residential receptors: direct effects – communities

Airborne noise

11.3.9 With regard to noise outside dwellings, the assessment of temporary adverse effects⁹ takes account of construction noise relative to existing sound levels.

11.3.10 In locations with lower existing sound levels⁷¹, construction noise effects 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.

11.3.11 In this area, the mitigation measures reduce the effects of outdoor construction noise on the acoustic character around the local residential communities such that the adverse effects identified are considered to be not significant.

Ground-borne noise and vibration

11.3.12 TBMs 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 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.

⁶⁹ 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.

⁷⁰ Information is provided in the emerging National Planning Practice Guidance – Noise <http://planningguidance.planningportal.gov.uk>

⁷¹ Further information is provided in Volume 5: Appendix SV-001-000.

- 11.3.13 The effects of vibration from TBMs 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

- 11.3.14 Significant noise effects on residential receptors arising from construction traffic are unlikely to occur in this area.

Non-residential receptors: direct effects

- 11.3.15 Significant construction noise or vibration effects on non-residential receptors are unlikely to occur in this area.

Non-residential receptors: indirect effects

- 11.3.16 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

- 11.3.17 This assessment has considered the potential cumulative construction noise effects of the proposed scheme and other committed developments⁷². In this area, construction noise or vibration from the Proposed Scheme is unlikely to result in any significant cumulative noise effects.

Summary of likely residual significant effects

- 11.3.18 The avoidance and mitigation measures reduce noise inside all dwellings from the construction activities such that it does not reach a level where it would significantly affect⁷⁰ residents.
- 11.3.19 The measures also reduce the effect⁷⁰ of outdoor construction noise on the acoustic character around the local residential communities such that the effects are not considered to be significant.
- 11.3.20 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.

⁷² Refer to Volume 5: Appendix CT-004-000.

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 1⁷³. 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 14. 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 14.

Table 14: 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 in tunnel	0700-2100 hours	18 (14)	320kph

Avoidance and mitigation measures

- 11.4.3 The development of the Proposed Scheme has, as far as reasonably practicable, kept the alignment away from main communities. These avoidance measures have protected many communities from likely significant noise or vibration effects.

Airborne noise

- 11.4.4 Significant noise effects from the operational static sources such as mechanical ventilation at vent shafts will be avoided through their design and the specification of noise emission requirements (for further information please see Volume 5: Appendix SV-001-000).

Ground-borne noise and vibration

- 11.4.5 Significant ground-borne noise or vibration effects will be avoided or reduced through the design of the track and track-bed.

⁷³ The change in noise and vibration effects between the different passenger services is assessed in Volume 1.

Assessment of impacts and effects

Residential receptors: direct effects – individual dwellings

- 11.4.6 The mitigation measures will reduce airborne noise, ground-borne noise and ground-borne vibration inside all dwellings such that it will not reach a level where it would significantly affect residents.

Residential receptors: direct effects – communities

- 11.4.7 The avoidance and mitigation measures in this area will avoid ground-borne noise and vibration effects on all residential communities in this area.

Residential receptors: indirect effects

- 11.4.8 The assessment of operational noise and vibration indicates that significant indirect effects on residential receptors are unlikely to occur in this area.

Non-residential receptors: direct effects

- 11.4.9 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

- 11.4.10 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

- 11.4.11 The mitigation measures reduce noise and vibration generated inside all dwellings by the operation of the Proposed Scheme such that it will not reach a level where it would significantly⁷⁰ affect residents.
- 11.4.12 The mitigation measures in this area avoid ground-borne noise and vibration adverse effects⁷⁰ on all residential communities and sensitive receptors in this area.

12 Traffic and transport

12.1 Introduction

- 12.1.1 This section describes the likely impacts on all forms of transport and the consequential effects on transport users arising from the construction and operation of the Proposed Scheme through the Chalfonts and Amersham area.
- 12.1.2 With regard to traffic and transport, the main issues as a result of implementation of the Proposed Scheme are traffic generated during construction and the temporary closures of PRoW, with associated diversions.
- 12.1.3 The effects on traffic and transport have been assessed quantitatively, based on baseline conditions and future projection scenarios. A detailed report on traffic and transport and surveys undertaken within the area is contained in Volume 5 Appendix TR-001-000 Transport Assessment. Figure 2 shows the location of existing key transport infrastructure in this area.
- 12.1.4 Engagement has been undertaken with the key transport authorities including the Highways Agency (HA), Buckinghamshire County Council (BCC) and Hertfordshire County Council (HCC).

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, 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.
- 12.2.2 The study area is bounded by the M25 to the east and includes the A413 Amersham Road/Gravel Hill/London Road/London Road East/Amersham bypass, A355 Amersham Road/Gore Hill/Park Lane/London Road, A404 Whielden Lane and local roads that are affected by the Proposed Scheme.
- 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 (TEMPO), for future forecast road traffic growth in the area. The assessment covers the 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 commercial services may change in the future.
- 12.2.5 Forecast future year traffic flows with and without the Proposed Scheme have been based on an approach that does not take account of wider effects such as the redistribution and reassignment of traffic, modal shift and peak spreading. As a consequence adverse transport effects may be over-stated.

12.3 Environmental baseline

Existing baseline

- 12.3.1 Existing conditions in the Chalfonts and Amersham 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 of all roads crossing or potentially affected by the route were undertaken during June and September 2012, and February 2013. The surveys comprised of automatic traffic counts, junction turning counts and queue surveys. These were supplemented by traffic and transport data obtained from other sources where available, including from the HA, BCC and HCC.
- 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 are used by no more than 20 people per day apart from Chalfont Lane and public Footpath CSG/28/4, which are used by no more than 40 and 70 people per day respectively. The Proposed Scheme is in tunnel within this area, and as such it affects three PRow in this area, and goes under 15 PRow. In addition to the 15 PRow, the Proposed Scheme goes under 11 roads.
- 12.3.4 The main strategic roads and local roads affected by the Proposed Scheme are the M25, A413 Amersham Road/London Road East/Amersham bypass, A355 Amersham Road/Gore Hill, A404 Whielden Lane/Amersham Road, Chesham Lane, Denham Lane, Joiners Lane, Bottom House Farm Lane, Silver Hill, Pheasant Hill, High Street (Chalfonts St Giles) and Bottrells Lane.
- 12.3.5 Relevant accident data for the road network subject to assessment has been obtained from the HA for the five year period from 2007 to 2011 and, BCC and HCC for the three year period from 2009 to 2011. This has been assessed and no significant accident clusters were identified within this area.
- 12.3.6 Frequent passenger rail services operate along the Marylebone to Aylesbury Line and the Chiltern Main Line serving stations within the area, including Amersham, Chalfont and Latimer, Chorleywood, Gerrards Cross, Seer Green, Beaconsfield and High Wycombe stations.
- 12.3.7 The following 11 public bus services operate along roads that were subject to traffic and transport assessment:
- Route 1 – connecting High Wycombe to Codmore Cross and serving Hazlemere, Holmer Green and Amersham;

- Route 36c – connecting Chesham to Bourne End and serving Chesham Bois, Amersham, Holmer Green, Hazlemere, High Wycombe, and Flackwell Heath;
- Route 52 – connecting High Wycombe to Chesham and serving Hazlemere, Holmer Green, Amersham, and Chesham Bois;
- Route 72 – connecting Penn Street to Amersham and serving Winchmore Hill;
- Route 177 – connecting Chesham to Great Missenden and serving Chartridge, Ballinger Common and South Heath;
- Route 73 – connecting Ley Hill to Coleshill and serving Chesham, Chesham Bois, and Amersham;
- Route 336/X336 – connecting High Wycombe to Watford and serving Beaconsfield, Amersham, Little Chalfont, Chorleywood, Rickmansworth, and Croxley Green;
- Route 580 – connecting High Wycombe to Uxbridge and serving Loudwater, Wooburn Moor, Beaconsfield, Seer Green, Chalfont St Giles, Chalfont St Peter, Gerrards Cross, and Denham;
- Route 335 – connecting Chalfont Common to Slough and serving Chalfont St Peter, Gerrards Cross, Wexham, and George Green;
- Route 353 – connecting Sough to Hemel Hempstead and serving Stoke Poges, Gerrards Cross, Chalfont St Peter, Chalfont St Giles, Amersham, Chesham Bois, Chesham, Lye Green, Whelpley Hill, Bovingdon, and Felden; and
- Route A30 – connecting Chesham to Uxbridge and serving Chesham Bois, Amersham, Chalfont St Giles, Chalfont St Peter, Gerrards Cross, and Denham.

12.3.8 Four of these services operate along A404 Whielden Lane, with a combined peak frequency of up to six buses an hour, with Route 52 being a Sunday only service. Three of these services operate along the A413 Amersham bypass with a combined peak frequency of up to three buses an hour. Two of these services operate along the A355 Amersham Road/Gore Hill, with a combined peak frequency of up to two buses an hour. Four of these services operate along the A413 Gravel Hill/Amersham Road through Chalfont St Peter, with a combined peak frequency of up to four buses an hour. Route 355 operates along Chesham Lane, at a peak frequency of one bus an hour.

12.3.9 There are no waterways frequently used by waterborne craft that will be affected by the Proposed Scheme and consequently these are not 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. 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 9% and 10% 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 18% 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 32% and 37% 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) have been included as part of the engineering design of the Proposed Scheme and will avoid or reduce effects on transport users:
- the majority of roads crossing the Proposed Scheme will be kept open during construction resulting in a reduced number of significant diversions of traffic onto alternative routes;
 - provision of temporary alternative routes and/or building structures early to maintain connectivity for PRow closed during construction to reduce loss of amenity; and
 - HGV routing as far as reasonably practicable along the strategic road network and using designated routes for access, as shown in Map TR-03-052 (Volume 5, Traffic and Transport Map Book).
- 12.4.2 The draft CoCP (see Volume 5: Appendix CT-003-000) includes measures that seek to reduce the impacts and effects of deliveries of construction materials and equipment, including reducing 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 work force and visitors) will be reduced by encouraging alternative modes of transport or vehicle sharing. This will be supported by an over-arching framework travel plan⁷⁴ that will require travel plans to be used along with a range of potential

⁷⁴ 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.

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, in the rural context, this will encourage the use of sustainable modes of transport or vehicle sharing.

- 12.4.4 The measures in the draft CoCP (Section 14.2) 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, bridleways, footpaths and other PRoW affected by the Proposed Scheme as necessary.
- 12.4.5 Core site operating hours will be 08:00 to 18:00 on weekdays and 08:00 to 13:00 on Saturdays. Therefore site staff and workers will generally arrive before the morning peak hour and depart after the evening peak hour (although assessment has assumed that some work journeys to the construction sites take place within the morning and evening peak hours to reflect 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 site compounds; and
 - PRoW closures and associated diversions.
- 12.4.8 Construction vehicle movements required to construct the Proposed Scheme will include the delivery of plant and materials, movement of excavated materials, and construction workforce 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 15. This represents the periods when the construction traffic flows will be greater than 50% of the peak 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 the average during the peak month.

Table 15: Typical vehicle trip generation for construction site 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	Chalfont St Peter vent shaft	Chesham Lane via Denham Lane and Joiners Lane and A413 Amersham Road	2018	Six years and nine months	Eight months	90-100	<10-20
Satellite	Chalfont St Giles vent shaft	Upgraded Bottom House Farm Lane via the A413 Amersham Road	2018	Six years and nine months	12 months	80-100	20-40
Satellite	Amersham vent shaft	A404 Whielden Lane via A413 and A355 Gore Hill	2018	Six years and six months	Six months	80-100	90-100

- 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 15. Consequently the peak traffic movements will not generally occur at the same time, although there may be some overlap.
- 12.4.11 Where construction routes serve more than one compound, the combined vehicle flows have been assessed.
- 12.4.12 Construction of the Proposed Scheme will result in changes in traffic flows and delays to vehicle users due to increased traffic flows from works and construction vehicles accessing compounds and also temporary road closures and diversions.
- 12.4.13 These changes in traffic flows will lead to significant increases in delays to vehicle users and congestion⁷⁵ at the following junctions:

⁷⁵ In assessing significant effects of traffic changes on congestion and delays, a major adverse effects 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

- A413 with School Lane (Amersham Old Town) and Shardeloes (moderate adverse effect); and
- A413 Amersham Bypass with A404 Whielden Lane (moderate adverse effect).

12.4.14 The construction activities will result in the closure of Bottom House Farm Lane, although access will be maintained throughout construction to Upper Bottom House Farm. For general traffic the closure will require a traffic diversion of approximately 5.5km, via Bottrells Lane, Silver Hill, High Street, Pheasant Hill and A413 Amersham Road for a period of up to approximately six months. However the traffic flow is less than 40 vehicles per day and therefore will not be significant.

12.4.15 Construction of the Proposed Scheme is forecast to result in substantial increases in traffic flow (i.e. more than 30% for HGV or all vehicle). These are generally daily HGV flow (except where noted otherwise). These will cause a significant increase in traffic related severance⁷⁶ for non-motorised users movements at the following locations:

- A413/A413 Amersham Bypass, between A404 Whielden Lane and B485 Frith Hill/Chesham Road (moderate adverse effect);
- A355 Gore Hill/Amersham Road between A413 Amersham Bypass and M40 (moderate adverse effect);
- Bottom House Farm lane between vent Chalfont St Giles vent shaft satellite compound and A413 Amersham Road (moderate adverse effect) due to an increase in HGV flow as well as all traffic flow;
- Bottrells Lane/Silver Hill/High Street (Chalfont St Giles)/Pheasant Hill, between Bottom House Farm Lane and A413 London Road (moderate adverse effect);
- A413 Amersham Road/Gravel Hill between Bottom House Farm Lane and Joiners Lane (major adverse effect);
- Chesham Lane/Denham Lane, between Joiners Lane and Chalfont St Peter vent shaft satellite compound (major adverse effect); and
- Joiners Lane (major adverse effect).

12.4.16 Except where set out above, these traffic flow increases will not result in increases in congestion and delays.

12.4.17 Utilities works, including diversions, have been assessed in detail 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 will have only localised impacts and are expected to short-term in duration. Utilities works are not expected to result in significant additional adverse effects.

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.

⁷⁶ 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, a 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.

- 12.4.18 The effect on accident and safety risk will not be significant as there are no locations where there are existing clusters of accidents and where there are substantial increases in traffic during construction.
- 12.4.19 No significant effects on parking or loading have been identified during construction in this area.
- 12.4.20 There will be minor adverse effects to non-motorised users due to increased travel distance for two of the temporary PRow diversions, at CSP/10 (footpath), with the length of PRow diversions being approximately 100 metres. The South Bucks Way is maintained throughout construction
- 12.4.21 Apart from general congestions, there will be no effect on bus services, or disruption at stations or interchanges that will result from construction of the Proposed Scheme.

Cumulative effects

- 12.4.22 The assessment includes the cumulative effects of planned development during construction, by taking this into account within the background traffic growth.
- 12.4.23 The assessment also includes for in combination effects by taking into account traffic and transport impacts of works being undertaken in neighbouring areas. From the CFAs to the north, including the Central Chilterns area (CFA9) and Dunsmore, Wendover and Halton area (CFA10) the cumulative average construction traffic flows of approximately 420 cars/LGVs per day (two way) and 100 HGVs per day (two way) have been included in the assessment for this area.

Permanent effects

- 12.4.24 Any permanent effects of construction have been considered in the operations assessment for traffic and transport 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 operations need to be considered together.

Other mitigation measures

- 12.4.25 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 these travel plan measures have not been included in the assessment, which will mean that adverse effects may be over-stated.
- 12.4.26 No further traffic and transport mitigation measures during construction of the Proposed Scheme are considered necessary based on the outcomes of this assessment.

Summary of likely significant residual effects

- 12.4.27 Increased traffic during the most intensive periods of construction will cause additional intermittent traffic congestion and delay at the junctions at: A413 with

School Lane (Amersham Old Town) and Shardeloes, and A413 Amersham Bypass with A404 Whielden Lane.

- 12.4.28 Increased traffic during the most intensive periods of construction, particularly HGV traffic, will affect non-motorised users crossing and using: A413/A413 Amersham Bypass, between A404 Whielden Lane and B485 Frith Hill/Chesham Road; A355 Gore Hill/Amersham Road between A413 Amersham Bypass and M40; Bottom House Farm lane between vent Chalfont St Giles vent shaft satellite compound and A413 Amersham Road; Bottrells Lane/Silver Hill/High Street (Chalfont St Giles)/Pheasant Hill, between Bottom House Farm Lane and A413 London Road; A413 Amersham Road/Gravel Hill between Bottom House Farm Lane and Joiners Lane; Chesham Lane/Denham Lane, between Joiners Lane and Chalfont St Peter vent shaft satellite compound; and Joiners Lane.
- 12.4.29 Temporary closure and associated diversion of two PRoW (CSP/10/1 and CSG/32/1) during construction will affect non-motorised users due to the increased travel distances required by associated diversions.
- 12.4.30 The significant effects that result of construction of the Proposed Scheme are shown on Maps TR-03-052 (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 all roads crossing the Proposed Scheme in, or close to, their current location; and
 - retaining all PRoW crossing the Proposed Scheme, with only localised realignments or diversions.

Assessment of impacts and effects

- 12.5.2 In 2026 and 2041, traffic flows with the Proposed Scheme are expected to be similar to those forecast without the Proposed Scheme. The only changes to traffic will be occasional traffic that may access areas of the Proposed Scheme for maintenance purposes. However, these infrequent vehicle movements are expected to be very low and will have no significant effect, including no effects on travel times or non-motorised users.
- 12.5.3 Changes to roads and PRoW have no significant effect on travel distance or other significant effects.
- 12.5.4 There are no permanent operational traffic and transport impacts or significant environmental effects within this area.

Cumulative effects

- 12.5.5 The assessment includes cumulative effects of planned development during operation, by taking this into account within the background traffic growth.
- 12.5.6 There will be no additional traffic in this area resulting from the operation of the Proposed Scheme in neighbouring areas.

Other mitigation measures

- 12.5.7 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

- 12.5.8 No likely residual significant traffic and transport effects are anticipated during operation of the Proposed Scheme in this area.

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, its associated catchment and floodplain;
- Shardeloes Lake – an online lake on the River Misbourne;
- a number of identifiable ponds located outside the route alignment but within 1km of the Proposed Scheme, together with numerous small agricultural ponds within 1km of the Proposed Scheme; and
- licensed private and public water supply groundwater abstractions and associated source protection zones (SPZ).

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;
- the potential for an increase in flow losses from the River Misbourne and Shardeloes Lake to the Chalk aquifer as a result of settlement due to tunnelling activities;
- the impact of dewatering during vent shaft construction on localised groundwater flows, and surface water levels and flows in the River Misbourne and Shardeloes Lake; and
- potential impact on the risk of surface water flooding in dry valleys at the Chalfont St Giles vent shaft and the Amersham vent shaft.

13.1.4 Volume 5: Appendix WR-001-000/1 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 Directive⁷⁷ (WFD) compliance assessment; and
- a route-wide Flood Risk Assessment (FRA).

13.1.5 Detailed reports on water resources and flood risk within this area are also contained in the Volume 5 appendices. These include:

- Appendix WR-002-008: Water Resources Assessment report; and
- Appendix WR-003-008: Flood Risk Assessment.

13.1.6 Map Series WR-01 to WR-03 show some of the details, environmental baseline and design features referred to in this report and those in Volume 5 and are contained in the Volume 5 Map Appendices.

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 of this report.

13.1.8 Discussions regarding the River Misbourne and groundwater flooding have been undertaken with the Environment Agency, the Chilterns Society, the Misbourne River Action Group, private borehole owners and Buckinghamshire County Council (as Lead Local Flood Authority).

13.1.9 Discussions have been undertaken, and will continue, with the Environment Agency and Affinity Water⁷⁸, with regard to the PWS abstractions and the water resources management plan within this and the adjacent areas (CFA7 and CFA9).

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, the SMR (Volume 5: Appendix CT-0001-000/1) and the SMR Addendum (Volume 5: Appendix CT-0001-000/2). 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.

⁷⁷ 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.

⁷⁸ Affinity Water Limited.

- 13.2.3 Site visits were undertaken in the vicinity of the River Misbourne at the following times:
- September 2012; as part of an overview of the whole scheme from the Colne Valley to Greatworth and Lower Boddington; and
 - June 2013; to assess the general water level and flows with regard to seasonal 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 surface water bodies that do not have a WFD status class shown in the relevant River Basin Management Plan (RBMP), the status class has been taken as the status class for the first downstream water body for which a status class is reported. Where groundwater does not have a WFD status class shown in the relevant RBMP, these are referred to as 'not assessed by the Environment Agency'.
- 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, where appropriate, 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 tunnel boring machine 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 hydraulic modelling 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-003-008.

13.3 Environmental baseline

Existing baseline – surface water resources

Surface water features

- 13.3.1 All water bodies within this study area, including the River Misbourne, fall within the Colne sub-catchment of the River Thames. This sub-catchment falls within the Thames River Basin District (RBD) as set out within the RBMP⁷⁹.
- 13.3.2 Maps WR-01-009 and WR-01-010 (Volume 5, Water resources and flood risk assessment Map Book) show the current surface water baseline and all surface water features within the study area are assessed within Volume 5: Appendix WR-002-008. Table 16 includes features potentially affected by the Proposed Scheme.

⁷⁹ Environment Agency (2009) *River Basin Management Plan, Thames River Basin District*.

- 13.3.3 Chalk streams or winterbournes such as the River Misbourne frequently dry out and disappear during the summer due to a lowering of the water table and/or seepage into the underlying chalk strata. In the case of the River Misbourne this is further complicated by abstractions for public water supply (PWS).

Table 16: Surface water features potentially affected by the Proposed Scheme

Water Feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book)	Watercourse classification ⁸⁰	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁸¹
River Misbourne	Crosses twice, east of Chalfont St Giles (SWC-CFA8-01) and north of Shardeloes Lake (SWC-CFA8-02)	Main river	Misbourne (GB106039029830) Poor	Good potential	High
Shardeloes Lake	In line lake formed by damming of River Misbourne north-west of Amersham	Main river	Misbourne (GB106039029830) Poor	Good potential	High
Brentford Grange Moat	North-west of Brentford Grange Farm	Not applicable	Not applicable	Not applicable	Moderate
Numerous identifiable ponds	Various locations (see Volume 5: Appendix WR-002-008 for details)	Not applicable	Not applicable	Not applicable	Low

Water Framework Directive status

- 13.3.4 The Environment Agency has classified the River Misbourne as a Heavily Modified Water Body.
- 13.3.5 The Environment Agency predicts the ecological status under the WFD of the River Misbourne by 2027 to be Good potential, which is an improvement from the current status of Poor.
- 13.3.6 The Thames RBD RBMP reports that the main pressure on the water body is abstraction for water supply. The Environment Agency is working with stakeholders to establish river flow objectives and identify options for improving flows.

⁸⁰ 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.

⁸¹ For examples of receptor value see Table 43 in the SMR addendum (Volume 5: Appendix CT-0001-000/2).

Abstractions and permitted discharges

- 13.3.7 There are no licensed surface water abstractions⁸² within 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.
- 13.3.8 The Environment Agency reports that there is one current consented surface water discharge within 1km of the Proposed Scheme in the study area (details in Volume 5: Appendix WR-002-008). This consent to discharge to the River Misbourne (TEMP.1611) is 359m from the route, and is associated with a sewage pumping station.

Existing baseline – groundwater resources

Geology and hydrogeology

- 13.3.9 The geological formations within this area are described further, with a schematic geological cross-section in Volume 5: Appendix WR-002-008.
- 13.3.10 The location of private abstractions, geological formations and indicative groundwater levels are shown on Map WR-02-008 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 13.3.11 A summary of the superficial and bedrock geology and hydrogeology is presented in Table 17. Unless otherwise stated, the geological groups listed are all crossed by the route.

Table 17: Summary of geology and hydrogeology in CFA8

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						
River Terrace Deposits	In the eastern part of CFA8 (crossed by the route)	Permeable gravel, sandy and clayey in part	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Diamicton (Clay-with - Flints)	Limited pocket in the west of the CFA (limited portion crossed by the route)	Clay-with-Flints	Unproductive	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Low

⁸² Surface water abstractions for public supply are not included.

Geology	Distribution	Formation description	Aquifer classification	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value
Alluvium	Along the River Misbourne within the CFA, thin outcrop (crossed by the route)	Mainly sand, silt and clay	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Head Deposits	Small pockets in the western part of the CFA near Amersham Old Town (limited portion crossed by route)	Permeable sands, gravels and silts	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Bedrock						
Lambeth Group (Reading and Woolwich Formations)	Small patches outcrop in the CFA, but these are not laterally extensive (limited crossing by the route at the western end of the CFA).	Lenses and interbedded layers of clay, silty sand and shelly silty clay at the top, sand and gravel towards the base	Unproductive (top)/Secondary A (base)	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Low/ Moderate
Cretaceous White Chalk (White Chalk [Seaford, Newhaven, Lewes Nodular and New Pit formations])	Throughout the CFA	Generally soft limestone with white hard nodular chalk, occasionally with flint seams and flaser, laminated, marls	Principal	Mid Chilterns Chalk (GB40601G601200) Poor	Good	High (no SPZ1 crossed)

Superficial deposits

- 13.3.12 Geological mapping shows an area of 'disused workings' immediately to the south of the Proposed Scheme, east of Chalfont St Peter (see Map LQ-01-013b, G8, Volume 5, Land Quality Map Book). This is likely to be associated with Warren Farm Landfill (see Section 8). At the southern end of the Proposed Scheme, superficial deposits comprise sand and gravel (River Terrace Deposits) or Alluvium associated with the River Misbourne. Superficial deposits are generally absent from the northern half of

the Proposed Scheme section although a small area of Diamicton (Clay-with-Flints) is evident to the west of Amersham Old Town. The route will also cross an area of head deposits, described as gravel that outcrops along Whielden Lane, extending under the hospital and towards Amersham Old Town (as illustrated in Map WR-02-008, Volume 5, Water Resources and Flood Risk Assessment Map Book).

Bedrock aquifers

- 13.3.13 Bedrock geology in the majority of this CFA comprises the Cretaceous White Chalk (a soft limestone) and the Lambeth Group, comprising clays, silts and sands, outcropping where it overlies the White Chalk.
- 13.3.14 The regional hydrogeological map shows that the very low Chalk groundwater levels measured in autumn 1976 (known to be a regional drought period) were 57mAOD (at Chalfont St Peter), rising to 91.5mAOD near Amersham (at the boundary between CFA8 and CFA9). The map indicates the direction of groundwater flow in the vicinity of the Proposed Scheme to be towards the south-east. Other groundwater level data, such as the groundwater levels from South West Chilterns Groundwater Model⁸³ and data provided by Affinity Water, support this conclusion.
- 13.3.15 The Environment Agency borehole monitoring data indicates that maximum recorded groundwater levels were measured in winter 2000/2001 at 67m AOD at Chalfont St Peter, rising to 97m AOD near Amersham (at the boundary between CFA8 and CFA9 boundary). This suggests that peak groundwater levels are above the tunnel elevation. The tunnel elevation along the route in this area will be, of between 37.6m AOD near Chalfont St Peter, 59.8m AOD near Amersham and 78.1m AOD near Little Missenden, along the route in this area. This suggests that peak groundwater levels will be approximately 20-30m above the tunnel elevation.

Water Framework Directive status

- 13.3.16 No WFD classification has been given to the superficial deposits or the Lambeth Group. The few Lambeth Group deposits, which are on higher ground, are above the water table in the Chalk.
- 13.3.17 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

- 13.3.18 There are five groundwater abstractions for PWS protected by SPZ protecting groundwater abstractions for PWS in the study area. Further details of the SPZ protecting these PWS are provided in Volume 5: Appendix WR-002-008 and shown on Map WR-02-008 (Volume 5, Water Resources and Flood Risk Assessment Map Book). Three of the SPZ protecting the PWS are largely located to the north of the route, although and two SPZ are in the south and extend northwards across the route. The

⁸³ Atkins, 2007. *South West Chilterns Phase 1 Conceptual Model Final Report*. February 2007.

location of the PWS sources ranges from approximately 150m up to approximately 3.3km from the route. Two of the five SPZ that will be crossed by the route are for sources in the adjacent study area (CFA7). These are discussed in more detail in Volume 5: Appendix WR-002-007.

- 13.3.19 The Environment Agency reports that there is one private licensed abstraction; there are two unlicensed abstractions within this area as set out in Volume 5: Appendix WR-002-008. There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m³ per day.
- 13.3.20 The Environment Agency reports that there are fifteen current consented discharges to ground or groundwater within the study area as set out in Volume 5: Appendix WR-002-008.

Surface water/groundwater interaction

- 13.3.21 There are no springs, issues or seepages shown on ordnance survey maps within the study area.
- 13.3.22 The River Misbourne is a chalk fed stream, which is in hydraulic connectivity with groundwater in the Chalk aquifer. However, in dry conditions, the groundwater level can be several metres below the base of the river in mid catchment (around 10m lower in the reach between Amersham and Chalfont St Peter – see Volume 5: Appendix WR-002-008 for more details). As a result, the River Misbourne loses water to groundwater in some stretches through seepage downwards to the Chalk aquifer, and can dry out completely in reaches between Amersham and Chalfont St Peter.
- 13.3.23 The River Misbourne is considered an over-abstracted catchment by the Environment Agency. Groundwater abstractions in the catchment began in 1901 and by 1997/98 abstractions were having such a marked impact on river flow that an Alleviation of Low Flow scheme was put in place leading to significant cuts in abstraction and a recovery of river flows.
- 13.3.24 Shardeloes Lake, which is upstream of Amersham, is likely to depend on inflows from further upstream during dry periods rather than groundwater contributions through the base of the lake. Information available indicates that groundwater levels will often be at or above the base of Shardeloes Lake, particularly following periods of rainfall and high groundwater levels. The recorded water levels in the area also suggest groundwater levels are rising in response to a reduction in licensed groundwater abstraction. This is expected to have changed the surface water–groundwater interaction in recent years.
- 13.3.25 Groundwater flow is generally to the south-east with a local pattern of flow towards the River Misbourne when groundwater levels are high and the reverse during dry 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.

- 13.3.26 Further discussion on the River Misbourne and surface water/groundwater interactions can be found in Volume 5: Appendix WR-002-008. In addition, further information on the upper reaches of the River Misbourne above Shardeloes Lake can be found in Volume 5: Appendix WR-002-009.

Water dependent habitats

- 13.3.27 The Proposed Scheme will pass beneath the River Misbourne, which is a local BAP habitat (see Section 7 ecology for further details regarding this habitat). The river is fed by groundwater from the Chalk aquifer.
- 13.3.28 Shardeloes Lake Local Wildlife Site (LWS) is designated for open standing water. However, in dry periods, it will be dependent on surface flow from the River Misbourne.

Existing baseline – flood risk

River flooding

- 13.3.29 The agreed data set for river flooding is the Environment Agency Flood Zone Mapping. The River Misbourne is a designated main river, and the route will pass under the river in a twin-bore tunnel at Chalfont St Giles (see Map WR-01-009 SWC-CFA8-001), and again at the Shardeloes Estate at the northern end of the study area (see Map WR-01-010 SWC-CFA8-02).
- 13.3.30 Environment Agency records show historic flooding within the study area, predominantly along the Misbourne valley (Maps WR-01-009 and WR-01-010, Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 13.3.31 The Proposed Scheme will pass in tunnel under approximately 410m of Flood Zones, therefore the potential for an increased risk of flooding from the River Misbourne is negligible.
- 13.3.32 A tributary channel of the River Misbourne (ordinary watercourse) runs alongside Bottom House Farm Lane. An area along the lane from the river to Upper Bottom House Farm lies within Flood Zones 2 and 3.

Surface water flooding

- 13.3.33 The agreed dataset for surface water flooding is the Environment Agency Flood Map for Surface Water (FMfSW)⁸⁴. In addition the Chiltern Strategic Flood Risk Assessment (SFRA)⁸⁵ has been used in assessing surface water flooding and other sources of flooding in this study area; and
- 13.3.34 Areas at risk of surface water flooding in a 1 in 200 annual probability (0.5%) rainfall event are shown on Map WR-01-009 and WR-01-010 (Volume 5, Water Resources and Flood Risk Assessment Map Book). The maps show surface water is generally

⁸⁴ Environment Agency (2010) *Flood Map for Surface Water (FMfSW)*: http://www.geostore.com/environment-agency/WebStore?xml=environment-agency/xml/dataLayers_FMSW.xml. Accessed 1 February 2013.

⁸⁵ Chiltern District Council (2008), *Strategic Flood Risk Assessment (SFRA)*.

collected in rural parts of the study area at low points in topography such as following open drainage channel networks associated with the watercourses. This shows the route will pass under a number of dry valleys and tributary ditches of the River Misbourne

- 13.3.35 As the Proposed Scheme comprises mainly tunnel within this area, the surface water flood risk has only been considered at the locations of permanent above-ground infrastructure. Dry valleys that are shown to be at risk of surface water flooding are located close to the Chalfont St Giles vent shaft and the Amersham vent shaft. The ChDC SFRA and BuCC PFRA contain records of historical surface water flooding in urban areas, but not at the specific locations of the Chalfont St Giles vent shaft and the Amersham vent shaft.

Sewer flooding

- 13.3.36 The agreed datasets for sewer flooding are the Buckinghamshire PFRA and the Chiltern SFRA.
- 13.3.37 The Buckinghamshire Preliminary Flood Risk Assessment⁸⁶ (PFRA) states that properties and infrastructure within Chiltern District are at risk of flooding due to the surcharging of the underground sewer system which results in overland flow.
- 13.3.38 The Chiltern SFRA notes that Thames Water's sewer flooding records show that there have been a small number of sewer flooding incidents within the study area. Precise locations are not recorded within either the SFRA or PFRA; however the SFRA data indicates that only a few houses were flooded in each location. The Chiltern SFRA therefore concludes that sewer flooding in the region appears to be sporadic and rare.

Artificial water bodies

- 13.3.39 The agreed data set for flooding from artificial water bodies is the Environment Agency Reservoir Inundation Map⁸⁷.
- 13.3.40 Flooding from artificial systems may occur from failure of a retaining structure that impounds water.
- 13.3.41 The probability of flooding occurring from the failure of a reservoir or large water body created by impoundment of water, by a dam or other retaining structure is extremely low. The Environment Agency Reservoir Inundation Map shows that there is a residual risk of flooding due to the failure of the embankment forming the Shardeloes Lake to the west of Amersham. The closest point of the Shardeloes Lake embankment to the route is about 120m (see Map WR-01-010, D5).
- 13.3.42 The maximum extent of flooding follows the valley of the River Misbourne downstream of the lake. Since the Proposed Scheme will be in tunnel through this

⁸⁶ Buckinghamshire County Council (2011) *Buckinghamshire Preliminary Flood Risk Assessment*. Jacobs.

⁸⁷ 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&lq=1,&scale=10>. Accessed: 1 February 2013.

area, and in particular at crossing locations of the River Misbourne, there is no risk of flooding due to failure of Shardeloes Lake or any other artificial sources.

- 13.3.43 Further details can be found in the flood risk assessment (Volume 5: Appendix WR-003-008).

Groundwater flooding

- 13.3.44 The agreed data set for groundwater flooding is the Buckinghamshire PFRA. Where the PFRA does not include sufficient information on the risk of flooding from groundwater the Chiltern SFRA showing the susceptibility to groundwater flooding has been reviewed.
- 13.3.45 Flooding from groundwater occurred within the Chilterns in the winter of 2000/01 and the Chiltern SFRA notes that there have been flooding incidents recorded in Old Amersham due to rising groundwater levels. Rising groundwater levels in the district have directly caused, or exacerbated, flooding in basements within Amersham Old Town, and at the foot of Gravel Hill in Chalfont St Peter.
- 13.3.46 Both the Chalfont St Giles and Amersham vent shafts will be located within areas identified as susceptible to groundwater flooding by the Buckinghamshire PFRA. The area of vulnerability follows the River Misbourne valley, where groundwater is likely to emerge, together with dry valleys and tributaries.

Future baseline

- 13.3.47 Volume 5: 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 these committed developments⁸⁸ 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.
- 13.3.48 All developments are required to comply with the National Planning Policy Framework (NPPF)⁸⁹, development plans and other legislation and guidance. As such committed developments should have a neutral effect on the water resources and flood risk baseline.
- 13.3.49 WFD future status objectives are set out in Table 16 and Table 17. This potential change in baseline is not considered to result in the effects from the Proposed Scheme changing in significance.
- 13.3.50 The River Misbourne is considered an over-abstracted catchment by the Environment Agency and in relation to WFD targets the Environment Agency is seeking to improve

⁸⁸ See Committed Developments, Section 2.1.

⁸⁹ Department for Communities and Local Government (2012), *National Planning Policy Framework Technical Guidance*.

the water body status by reducing net PWS abstraction volumes. This process is ongoing and is likely to result in further changes to the hydrological and hydrogeological regime of the River Misbourne and the aquifer respectively.

- 13.3.51 The Environment Agency predicts the overall WFD status of the River Misbourne to be 'Good potential' by 2027.

Climate change

- 13.3.52 Current projections to the 2080s 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 changes to the reported effects from the Proposed Scheme.
- 13.3.53 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 during flood events are expected to increase, potentially causing greater depths and extents of flooding.
- 13.3.54 When considering the influence that climate change may have on the future baseline, against which the impacts from the Proposed Scheme on flood risk during 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 NPPF. The sensitivity testing undertaken allows for variations in climate change factors included in other national guidance.
- 13.3.55 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 Table 13 of 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, Section 9.
- 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-002-008 and WR-003-008.
- 13.4.3 With regard to surface water features, the route in CFA8 will be entirely in twin-bore tunnel minimising the assessed impacts to surface water receptors, such as the River Misbourne and Shardeloes Lake and flood risk.

- 13.4.4 The alignment of the tunnels will cross under the river in two locations at depth (see Map WR-01-09 SWC-CFA08-01 and see Map WR-01-10 SWC-CFA08-02), and to reduce the risk of hydraulic pathways developing, a minimum cover of two tunnel diameters depth has been provided between the river bed of the River Misbourne and the top of the tunnel. At Shardeloes Lake (Map WR-01-10 SWC-CFA08-02), the tunnel alignment is sufficiently far from the dam embankment to minimise the risk of significant movement at the dam as indicated by predicted settlement contours (see Volume 5 WR-002-008 for details).
- 13.4.5 The following measures will reduce potential impacts to groundwater that could arise from construction.
- 13.4.6 The tunnel boring machine will be operated in a closed face mode when tunnelling within water bearing strata and the tunnel lining will be designed to a leakage rates to a minimum, thereby reducing the requirements for dewatering and drainage.
- 13.4.7 The use of a TBM will reduce the potential for settlement since the machine will stabilise the face, which will reduce the risk of changing the existing surface water/groundwater interactions where the route passes beneath the River Misbourne.
- 13.4.8 The method of piling/diaphragm walling (such as use of temporary surface casing and cast in situ piles) for the vent shafts and lined tunnels will be selected to avoid creating hydraulic pathways, such as cracks and cavities between the tunnel construction and the natural rock.
- 13.4.9 Groundwater from dewatering at vent shafts will be discharged back into the groundwater via recharge wells within 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 each shaft.
- 13.4.10 The following measures will reduce potential impacts to flood risk that could arise from construction.
- 13.4.11 Drainage has been designed to reduce the rate and volume of run-off from the railway and associated infrastructure to avoid an increase in flood risk. The drainage arrangements 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. Surface water runoff from permanent infrastructure at the Chalfont St Peter, Chalfont St Giles and Amersham vent shafts and access roads will be collected in swales allowing infiltration of the surface water back into the ground at a controlled rate in accordance with the necessary approvals. Tunnel drainage will be pumped to the Chalfont St Peter and Amersham vent shafts for disposal to sewer. Consents to discharge will be obtained prior to construction from Thames Water Utilities Limited (TWUL) to ensure that there is sufficient capacity

in the receiving infrastructure. This will prevent any increase in the risk of surface water or sewer flooding to local receptors.

- 13.4.12 Improvements to Bottom House Farm Lane are required as part of the Proposed Scheme in this 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 body for both flow and water quality during the detailed design stage using the Design Manual for Roads and Bridges⁹⁰ and CIRIA guidance⁹¹ to control run-off rates and water quality in accordance with the necessary approvals.
- 13.4.13 The draft CoCP 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.
- 13.4.14 The following examples illustrate how measures in the draft CoCP will reduce potentially adverse effects arising during construction on water resources and flood risk.
- 13.4.15 With regard to surface water, Section 16 of the draft CoCP requires contractors to obtain the necessary approvals to enable discharge of any dewatering and surface water runoff to watercourses or to the public sewer network from construction sites, including the vent shafts and their associated satellite compounds. This will ensure that the potential for any impact on flow or water quality to the River Misbourne via surface water drainage will be minimised.
- 13.4.16 Baseline monitoring of river flows, and monitoring during construction, immediately upstream and downstream of crossing points will be undertaken where this is viable and appropriate, by installation of suitable flow gauging equipment. Appropriate trigger levels will be required, subject to agreement with the Environment Agency, in order to underpin prompt decision making in relation to further mitigation following any reduction in flow.
- 13.4.17 With regard to groundwater, 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 the 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 reduced.

⁹⁰ [Department for Transport \(2013\). Design Manual for Roads and Bridges, Volume 4, Section 2 f.](#)

⁹¹ Murname, E., Heap, A. and Swain, A., 2006, *C648 Control of Water Pollution from Linear Construction Sites*, CIRIA, London, UK.

- 13.4.18 Any groundwater dewatering will be in compliance with the draft CoCP, Section 16.
- 13.4.19 The route will not pass within the inner or outer protection zones of the private licensed groundwater abstraction identified in the study area. Impacts are predicted to be negligible due to application of the draft CoCP.
- 13.4.20 In accordance with the draft CoCP, Section 16 monitoring will be undertaken, as required, pre-construction to establish baseline water quality conditions for watercourses; and to confirm the effectiveness of agreed temporary and permanent mitigation measures.
- 13.4.21 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. The monitoring of ground settlement will be undertaken in the areas where the route passes beneath the River Misbourne and Shardeloes Lake, and for a suitable distance up and downstream, in order to underpin prompt decision making in relation to further mitigation.
- 13.4.22 Monitoring of groundwater levels close to the River Misbourne crossings, to be undertaken before and during construction, will also assist in providing a better indication of the magnitude of any impact due to tunnelling.
- 13.4.23 With regard to flood risk, the Chalfont St Giles vent shaft and Amersham vent shaft construction compounds 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. If temporary stockpiles are to be located within the area at risk of surface water flooding at both the Chalfont St Giles and the Amersham vent shafts they will be profiled to ensure they do not block overland flow paths. Construction activities on site will be managed in accordance with the draft CoCP and will not impact on the risk of flooding from surface water to local receptors.
- 13.4.24 The permanent structure of the Chalfont St Giles vent shaft, and its associated access hard-standing and landscaping, will intersect a dry valley shown on the FMfSW to be at risk of 'deep' (>0.3m) surface water flooding in the 1 in 200 year annual probability (0.5%) rainfall event. Landscape earthworks around the proposed vent shaft have been designed to reprofile the dry valley and ensure that overland flow paths are maintained to the downstream catchment and that the vent shaft is not at risk of flooding. The site specific flood risk management plans described under Section 16 of the draft CoCP will take into account the reprofiling.

Assessment of impacts and effects

- 13.4.25 This section describes the significant effects following the implementation of avoidance and mitigation measures. The issues addressed are the impacts on surface

water due to tunnelling causing settlement which might affect the bed of the River Misbourne and Shardeloes Lake, the impacts on groundwater from tunnelling and vent shafts, and some limited temporary impacts on flood risk from construction of surface works.

- 13.4.26 Further details of the potential impacts that will not have significant effects are provided in the Water Resources Assessment report in Volume 5: Appendix WR-002-008 and Flood Risk Assessment in Appendix WR-003-008.
- 13.4.27 An assessment of the impact on the WFD status 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 As the Proposed Scheme will be in tunnel and the surface works for the vent shafts will be well away from existing abstractions or discharges the assessment has identified no significant effects on abstractions or discharges from and to surface waters likely during construction.

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 will be negligible. Surface water features 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 (even where these are in the neighbouring CFA7), 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 TH027 and TH028 are substantial distances down gradient from the area where the route crosses the aquifer zone that provides groundwater to the abstraction sites. As a result natural attenuation is likely to make any impact negligible, resulting in neutral and not significant effects. The sources protected by SPZ TH011, TH171 and TH181 are much closer to the route, and as a result of this proximity the risk of turbid water entering these abstraction points is greater, and would result in major impacts that would be a significant effect.

Flood risk

- 13.4.33 As the Proposed Scheme will be largely below the ground in the study area there are no anticipated significant temporary impacts on the risk of flooding from rivers, surface water and sewers.
- 13.4.34 Settlement contours for the tunnel will only marginally encroach on the southern side of Shardeloes Lake itself. The settlement contour on the northern side of the tunnel will be approximately 100m south of the Shardeloes Lake dam embankment and the risk of damage to the dam is considered negligible. The effect of the Proposed Scheme on the residual risk of the lake dam embankment failing will therefore be neutral and not significant.
- 13.4.35 The assessment has concluded that there will be no impact on groundwater flood risk.
- 13.4.36 More detailed information is contained in the Flood Risk Assessment (Volume 5: Appendix WR-003-008).

Cumulative effects

- 13.4.37 There are no committed developments that have been identified which will result in significant cumulative effects.

Permanent effects

Surface water

- 13.4.38 Where the tunnels pass under the River Misbourne (see Map WR-01-009 SWC-CFA08-01 and Map WR-01-010 SWC-CFA08-02) there could be the potential for ground settlement to occur during or soon after construction. Ground settlement could locally increase vertical permeability by activating fractures in the bed of the river. However, although the value of the River Misbourne is high the risk of this impact occurring is low, given the limited extent over which it might occur, and the tunnelling methodology proposed.
- 13.4.39 When the River Misbourne has water in it (it is frequently dry) the river water is not always in hydraulic connectivity with groundwater in the underlying chalk. In this condition the river is 'perched' above the groundwater table. At other times groundwater levels rise to the same level as the river bed and then the river water is hydraulically connected to the groundwater. At such times any increased fractures in

the river bed would not lead to significant losses from the river and the river might actually gain additional water from groundwater. Volume 5 Appendix WR002-008 contains more detailed explanation of where and when these situations might occur along the River Misbourne.

- 13.4.40 Perched river conditions are known to occur in the area of the downstream crossing (see Map WR-01-009 SWC-CFA08-01) but are less likely at the upstream crossing (see Map WR-01-010 SWC-CFA08-02) since this is a generally 'gaining' area. Some, and possibly all of the losses, would re-appear as groundwater discharges to the river further downstream resulting in a neutral impact in the lower reaches of the River Misbourne.
- 13.4.41 The predicted settlement contours at the downstream crossing (see Map WR-01-009 SWC-CFA08-01) indicate no more than 260m of the River Misbourne could be at risk of fractures being activated. At the crossing upstream of Shardeloes Lake (see Map WR-01-010 SWC-CFA08-02) the potential length of river and lake that might be affected by settlement is about 540m (including a small area of the upstream parts of Shardeloes Lake). Shardeloes Lake is a high value receptor, however, in this area the lake bed sediments are likely to prevent significant outflows to the Chalk if perching occurs. It is also anticipated that the river is likely to be gaining groundwater, so increased fracture openings would be unlikely to cause losses to groundwater. Therefore, overall there will be a relatively small stretch of the total river length where there is a low risk that settlement could affect ground conditions and therefore surface water in the River Misbourne.
- 13.4.42 It is unlikely that additional loss of water will occur and consequently the predicted impact on the river and the lake will be negligible and the effect neutral, and therefore not significant. The monitoring of ground settlement and river flows will be undertaken in the areas where the route passes beneath the River Misbourne and Shardeloes Lake, and for a suitable distance up and downstream, in order to underpin prompt decision making should other mitigation be necessary.
- 13.4.43 There are no other anticipated issues related surface water resources.

Groundwater

- 13.4.44 There are no anticipated significant permanent effects to groundwater as a result of construction. This includes the hydrogeology, abstractions and permitted discharges and water dependent habitats.

Flood risk

- 13.4.45 No permanent adverse effect on the risk of flooding from any sources has been identified.

Cumulative effects

- 13.4.46 There are no committed developments that have been identified which will result in significant permanent cumulative effects.

Other mitigation measures

- 13.4.47 Although not a likely significant effect risk management measures will be implemented for any potential loss of flow from the River Misbourne and Shardeloes Lake. If monitoring proves there are identifiable losses due to HS2 Ltd then appropriate remedial measures will be implemented if required by the Environment Agency. Remedial action would most likely involve sealing fractures in the bed of the river which connect to the underlying strata. This will reduce water losses to acceptable levels so the permanent impact will be negligible, resulting in no significant residual effect.
- 13.4.48 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. Such a programme and appropriate mitigation measures will ensure no adverse significant effects occur.
- 13.4.49 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, CFA7 and 9. 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 watercourse 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 outage⁹²) to manage the impacts from the Proposed Scheme.

13.4.50 Since private abstractions may be used for drinking water, the monitoring programme will identify if there is an adverse impact on groundwater quality within the vicinity of the Proposed Scheme near the private abstraction. Further mitigation for private abstractions is likely to comprise the provision of water from a public water supply source unless another alternative will also achieve negligible impact.

Summary of likely significant residual effects

13.4.51 There are no likely significant residual effects from construction of the Proposed Scheme on surface water, the Mid-Chilterns Chalk groundwater body and flood risk that have been identified within the assessment.

13.4.52 Until a management strategy is agreed with the Environment Agency in consultation with Affinity Water, as described above, there is the potential for a likely significant temporary residual effect on the Affinity Water groundwater abstractions.

13.5 Effects arising from operation

Avoidance and mitigation measures

13.5.1 Generic examples of design measures that will mitigate impacts so that there will be no significant adverse effects on the quality and flow characteristics of surface water courses and groundwater bodies during operation and management of the Proposed Scheme are described in Volume 1, Section 9.

⁹² Outage refers to periods where there is an unavailability or decrease in the level of service or abstraction.

- 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 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

- 13.5.4 There are considered to be no likely significant adverse effects to surface water, groundwater or flood risk arising from operation of the Proposed Scheme.

Other mitigation measures

- 13.5.5 There are considered to be no further measures required to mitigate adverse effects to surface water resources, groundwater resources or flood risk.

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