

# LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 2 | Community Forum Area report

CFA5 | Northolt Corridor

November 2013

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Department  
for Transport

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# Structure of the HS2 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 Environmental Statement 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 Proposed Scheme and of environmental effects in each area;
- **Volume 3:** Route-wide effects – provides an assessment of the effects of the Proposed Scheme where it is not practicable to describe them within the CFA descriptions in Volume 2;
- **Volume 4:** Off-route effects – provides an assessment of the off-route effects of the Proposed Scheme;
- **Volume 5:** Appendices and map books – contains supporting environmental information and associated map books; and
- **Glossary of terms and list of abbreviations:** contains terms and abbreviations, including units of measurement, used throughout the ES documentation.



# 1 Introduction

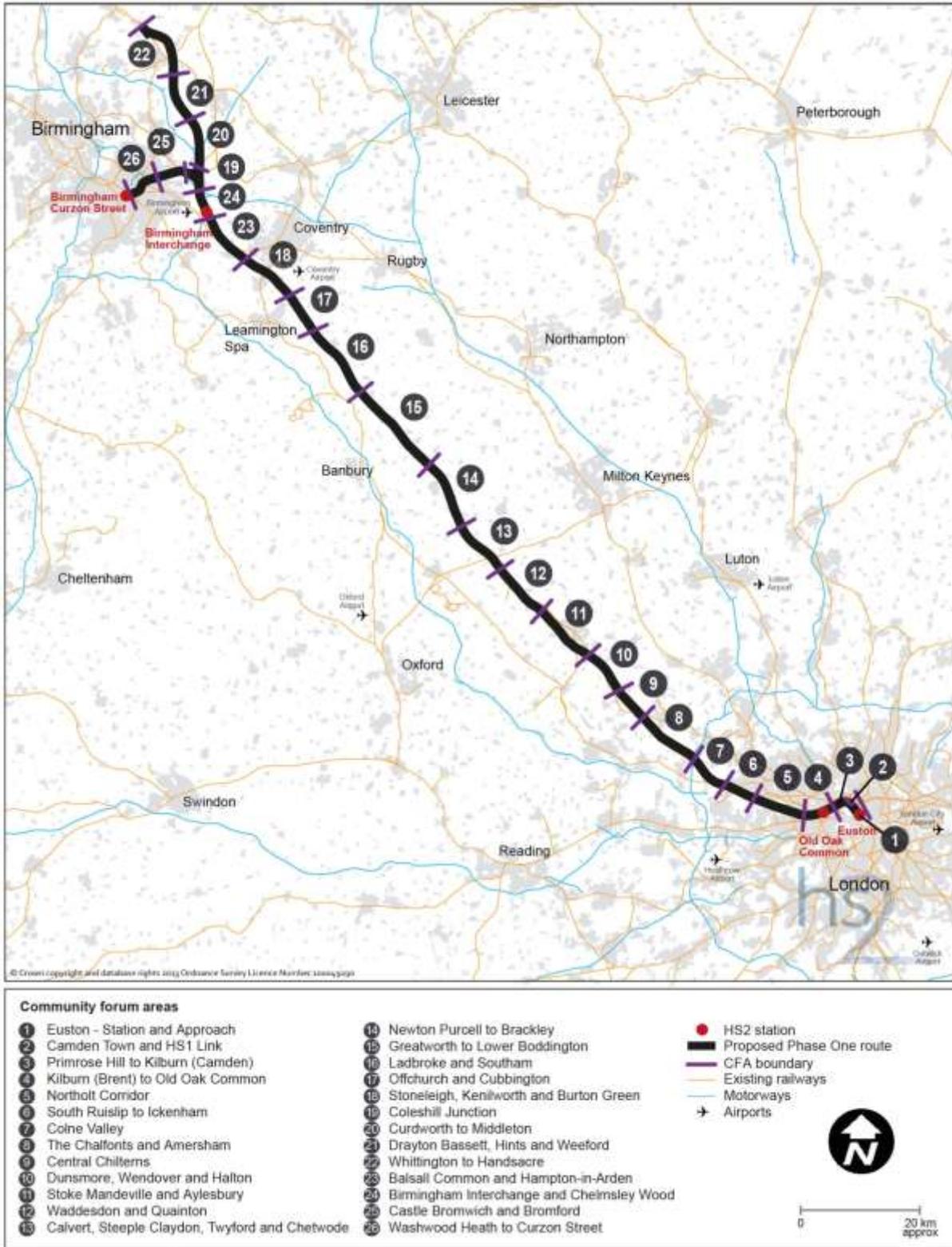
## 1.1 Introduction to HS2

- 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 would 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 (143m) between London and Birmingham. Construction will begin in 2017 and the line will become operational by 2026; with a connection to the West Coast Main Line (WCML) near Lichfield and to the existing HS1 railway line in London.
- 1.1.3 During Phase One beyond the dedicated high speed track, these high speed trains will connect with and run on the existing WCML to serve passengers beyond the HS2 network to destinations to the north. A connection to HS1 would 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 Northolt Corridor area (CFA5), 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 a 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 CFA5 (Northolt Corridor). 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 CFA5.

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 Section 8 of 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 Potential climate change impacts and adaptation measures are only discussed in the relevant environmental topic section. Section 7.6 of Volume 1 and the SMR Addendum include additional information about climate change adaptation and resilience.

1.3.5 The maps relevant to the Northolt Corridor are provided in a separate corresponding document entitled Volume 2: CFA5 Map Book, which should be read in conjunction with this report.

- 1.3.6 The Proposed Scheme described in this report is that shown on the Map Series CT-05 (construction) (Volume 2, CFA5 Map Book) and CT-06 (Volume 2, CFA5 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.
- 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 Northolt Corridor CFA covers approximately 8.7km of the Proposed Scheme. The route extends from Park Royal Road bridge in the east, to a point near Rabournmead Drive in the west. The Proposed Scheme is entirely in tunnel in this area.

2.1.2 The area lies predominantly within the London Borough of Ealing (LBE). The northern tunnel passes through the London Borough of Brent (LBB) to the west of Hanger Lane, whilst the London Borough of Harrow (LBHa) lies adjacent to the route to the north.

2.1.3 The Kilburn (Brent) to Old Oak Common area (CFA4) lies to the east and the South Ruislip to Ickenham area (CFA6) lies to the west, as shown in Figure 2.

#### Settlement, land use and topography

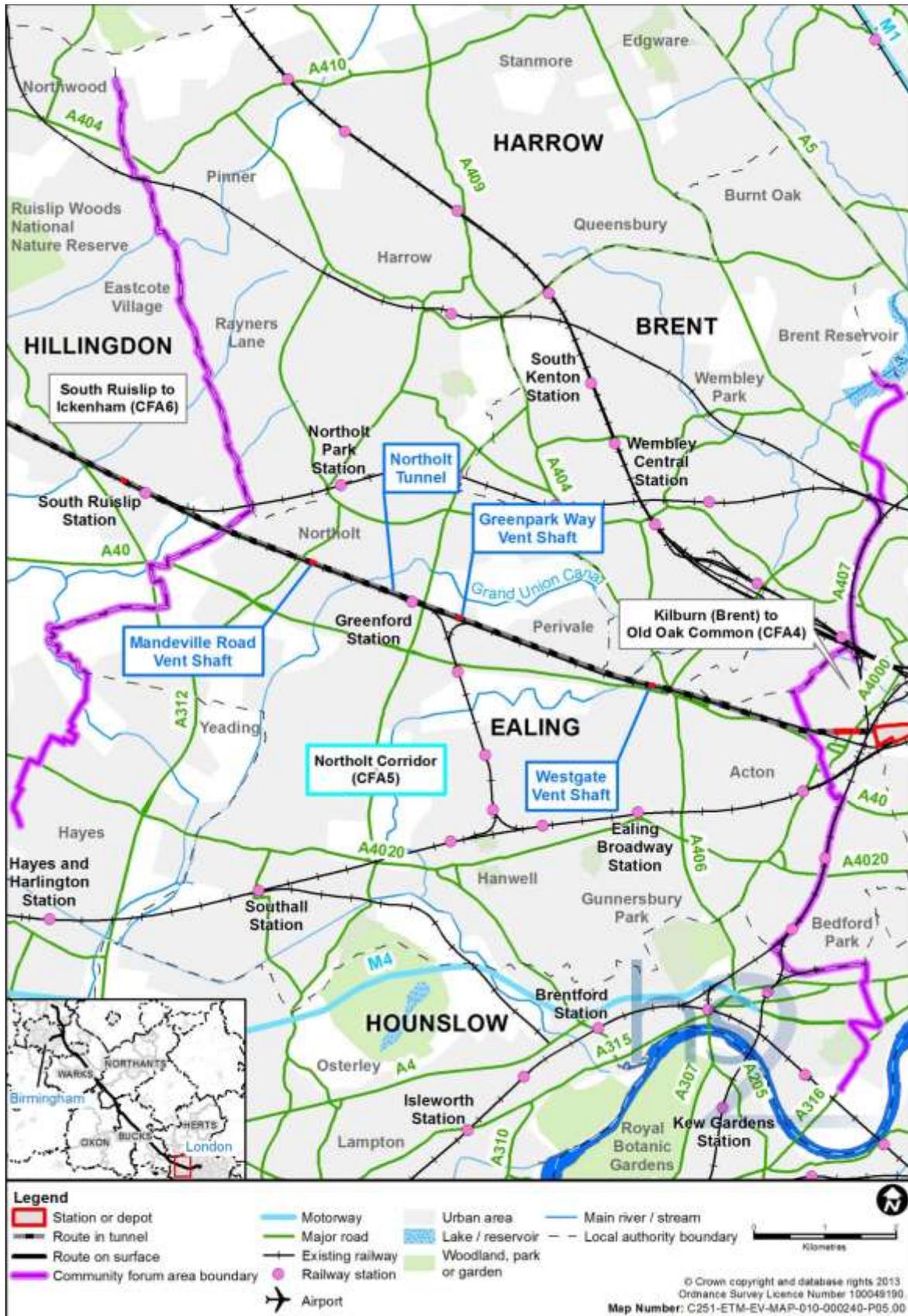
2.1.4 The Northolt Corridor area is predominantly suburban in character and includes the areas of Park Royal, Perivale, West Acton and Northolt (see Maps CT-10-006 to CT-10-008a, Volume 2, CFA5 Map Book).

2.1.5 The largest business park in London is located at Park Royal, to the north and south of the route, with large areas of light industry and commercial use. Perivale also has large areas of light industrial use. The open areas of Horsenden Hill and Sudbury golf course lie to the north, as does Perivale Wood. Ealing golf course is located to the south of the route, adjacent to Western Avenue. West Acton includes part of the Park Royal trading estate, with large areas of late 19th and early 20th century terraced housing to the west. Northolt has more industrial uses along the Grand Union Canal, with housing to the west.

2.1.6 The Grand Union Canal runs in an east to west direction through the area and crosses the route at the Kelvin Industrial Estate. The River Brent also flows in an east to west direction through the area and crosses the route in the vicinity of the Manhattan Business Park. There are also a number of ponds in the area.

2.1.7 The topography of the area is generally flat and any minor changes in topography tend to be masked by overlying urban development.

Figure 2: Area context map



## Key transport infrastructure

- 2.1.8 Throughout this area, the Proposed Scheme will run in an east to west direction broadly parallel and beneath the London Underground Central line. Hanger Lane, Perivale, Greenford and Northolt London Underground stations and Greenford Network Rail (NR) station on the Acton to Northolt Line are located within the area.
- 2.1.9 The A40 Western Avenue runs in an east to west direction through the area to the immediate south of the route. The A4127 Greenford Road runs in a north to south direction and crosses the route between Perivale and Northolt. The A312 Mandeville Road runs in a north to south direction in the Northolt area. The Hanger Lane gyratory is also located in the area and provides a major intersection between the A40 Western Avenue, the A406 North Circular and A4005 Hanger Lane. A number of bus routes serve the area.

## Socio-economic profile

- 2.1.10 To provide a socio-economic context for the area, data for the demographic character areas (DCA) of Perivale, Greenford Broadway, Northolt Mandeville, and Hanger Hill and West Acton<sup>1</sup> is used. In total, the population of the DCAs is approximately 63,200. The area's labour market performance is similar to that for England as a whole; unemployment at 7.8% is slightly higher than the national level of 7.4%, while 72.2% of the population aged 16-74 is economically active compared to the national figure of 69.9%<sup>2</sup>. There are approximately 37,100 people who work within the area<sup>3</sup>.

## Notable community facilities

- 2.1.11 Shops and services are located along main roads including the A406 North Circular, the A4005 Hanger Lane, the A4127 Greenford Road and the A312 Mandeville Road. The Park Royal Metro Centre is a retail and entertainment complex and is located in the area to the north of the route off Arnold Road. The Westway Cross Shopping Park is located adjacent to the north of the route off Greenford Road. There are also neighbourhood shops distributed throughout the residential parts of the area.
- 2.1.12 Community facilities in the area include four community halls, with the closest to the route being Islip Manor Youth and Community Centre, approximately 200m from the centre line of the route. Perivale Community Centre is approximately 360m to the north of the route.
- 2.1.13 The area has eight religious facilities and/or places of worship. Acton Cemetery is located immediately to the east of the area boundary in the Kilburn (Brent) to Old Oak Common area (CFA4).
- 2.1.14 Educational facilities in the area include three early-years educational facilities, five primary schools and two secondary schools (Northolt High School and Eden Independent School), both of which are located to the north of the route on Eastcote Lane.

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

<sup>2</sup>Office for National Statistics (2012), *Census 2011*. Office for National Statistics, London.

<sup>3</sup>Office for National Statistics (2012), *Business Register and Employment Survey 2011*.

- 2.1.15 There are six doctors' surgeries, four medical centres and two dental practices in the area. The Central and Middlesex Hospital is located in Park Royal, approximately 450m to the north of the centre line of the route.

### Recreation, leisure and open space

- 2.1.16 There is a wide range of public and private sports and recreational facilities in the area. Northolt High School has a new sports centre accessible to the general public. The Brentham Sports and Social Club is located in Perivale. In addition, there are eight playing fields, with a variety of recreational uses, and Northolt, Sudbury and Ealing golf clubs.
- 2.1.17 Perivale Wood and Berkeley Fields recreation grounds, Perivale Wood Local Nature Reserve (LNR) and Islip Manor Park are used as informal recreation spaces. There are also local community services, playgrounds and some allotments in the residential parts of the area. These include a play area at Wilsmere Drive, a Scout hut and Perivale Community Centre off Horsenden Lane South and the allotments and play area at Carr Road.
- 2.1.18 There are two public rights of way (PRoW) within the area. At Westgate, a PRoW extends from Western Avenue to Westgate passing under the existing rail bridge. At Greenpark Way, the Capital Ring PRoW runs on the eastern side of Greenford Road, and is segregated by passing under Greenpark Way at its junction with Greenford Road.

### Policy and planning context

#### *Planning framework*

- 2.1.19 Given that HS2 is being developed on a national basis and 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.
- 2.1.20 The London Plan 2011<sup>4</sup> is the regional spatial strategy that is relevant to this area. It sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031 and forms part of the development plan for Greater London. London boroughs' local plans need to be in general conformity with the London Plan, and its policies guide decisions on planning applications by councils and the Mayor.
- 2.1.21 The following local policies have been considered and referred to where appropriate to the assessment:
- LBE Development Core Strategy (2012)<sup>5</sup>;
  - LBE Development Management Development Plan Document, Final Proposals (2013)<sup>6</sup>;

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<sup>4</sup> Mayor of London (2011), *The London Plan: Spatial Developments Strategy for Greater London*, Greater London Authority, London.

<sup>5</sup> London Borough of Ealing (2012), *London Borough of Ealing Development (Core) Strategy*.

<sup>6</sup> London Borough of Ealing (2013), *London Borough of Ealing Development Management Development Plan Document, Final Proposals (Consolidated incorporating further alternations)*.

- LBE Unitary Development Plan (UDP) (Saved Policies 2007)<sup>7</sup>;
- LBB Core Strategy (2010)<sup>8</sup>;
- LBB UDP Saved Policies (2004)<sup>9</sup>;
- LBHa Local Plan Core Strategy (2012)<sup>10</sup>; and
- LBHa Development Management Policies (2013)<sup>11</sup>.

2.1.22 There are a number of key planning and environmental designations in the area, which include air quality management areas (AQMA), scheduled monuments, Grade II listed buildings and parts of conservation areas. These are shown (with the exception of the AQMA) on Maps CT-10-006 to CT-10-008a (Volume 2, CFA5 Map Book). AQMA's are shown on Map AQ-01-005 (Volume 5, Air Quality Map Book).

### *Committed development*

2.1.23 Developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme, are listed in Volume 5: Appendix CT-004-000. Except where noted otherwise in Volume 5: Appendix CT-004-000, it has been assumed that these developments will have been completed by 2017. These are termed 'committed developments' and have been taken into account for the purpose of assessing the likely significant environmental effects of the Proposed Scheme. Where these developments have a particular relevance to an assessment topic, this is noted in the future baseline section for that topic.

2.1.24 There is one major development in the Northolt Corridor area as shown on Maps CT-13-006 to CT-13-008a (Volume 5, Cross Topic Appendix 1 Map Book). This is the First Central, Coronation Road/Lakeside Avenue, Park Royal development, which is subject to an agreement under Section 106 of the Town and Country Planning Act 1990, as amended<sup>12</sup>. Outline planning permission was granted in March 2012 for the construction of:

- 60,000m<sup>2</sup> of office accommodation in three buildings up to a maximum of 10 storeys in height;
- 1,700m<sup>2</sup> of retail, restaurant, hot food take-away floor space;
- up to 2,500m<sup>2</sup> of health and fitness floor space;
- four residential blocks up to nine storeys in height to provide a maximum of 545 residential units, consisting of a mix of one, two and three bedroom apartments for private, rented and shared ownership;
- the provision of two play areas and a multi-use games area; and
- matters to be approved, being access, layout and scale with appearance and landscaping reserved.

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<sup>7</sup> London Borough of Ealing (2007), *Ealing Council Unitary Development Plan*.

<sup>8</sup> London Borough of Brent (2010), *London Borough of Brent Core Strategy*.

<sup>9</sup> London Borough of Brent, (2007), *Brent Unitary Development Plan*.

<sup>10</sup> London Borough of Harrow (2012), *Local Plan Core Strategy*.

<sup>11</sup> London Borough of Harrow (2013), *Development Management Policies*.

<sup>12</sup> *Town and Country Planning Act 1990* (c.8). London, Her Majesty's Stationery Office.

- 2.1.25 This scheme is likely to be built in three stages, two to be completed by 2017 and the remaining stage by 2020, 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.
- 2.1.26 As the Proposed Scheme is in tunnel at this location, this development is not considered likely to be affected by the construction and operation of the Proposed Scheme.
- 2.1.27 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. Description of the Proposed Scheme
- 2.1.28 The following section describes the main features of the Proposed Scheme in the Northolt Corridor 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.
- 2.1.29 The Proposed Scheme will require some land on a permanent basis, key features of which are illustrated on the Map Series CT-06 (Volume 2, CFA5 Map Book). Land that will also be required, but only on a temporary basis for construction, is set out in Section 2.3.
- 2.1.30 In general, in this CFA, features are described from east to west along the route (and south to north for features that cross HS2).
- 2.1.31 Since the draft ES was published, the following changes have been made to the Proposed Scheme:
- the auto-transformer station previously proposed at Greenpark Way is now an express feeder auto-transformer station (see description in Volume 1, Section 5);
  - the land potentially required for construction has been modified to reflect the requirements of utilities works; and
  - the F-sidings satellite construction compound for railway installation works has been included in the Proposed Scheme (see Section 2.3).

## Overview

- 2.1.32 Through this area, the proposed Hs2 route will be approximately 8.7km in length and will comprise the twin-bored Northolt tunnel. The route section will commence from the boundary with Kilburn (Brent) to Old Oak Common (CFA4) at the B4492 Park Royal Road, west of Acton Cemetery. The route will then proceed westwards, connecting with three new ventilation and intervention (vent) shafts. The route will leave the CFA at a point to the south of Roubourne Drive.

2.1.33 Key permanent features of this section will comprise the Northolt tunnel and three vent shafts. These features are shown on Maps CT-06-0010b to CT-06-0015a (Volume 2, CFA5 Map Book) and are described in the following sections.

#### *Northolt tunnel*

2.1.34 The Northolt tunnel is approximately 13.5km in overall length between the Victoria Road crossover box and the West Ruislip portal, of which 8.7km lies within CFA5. The tunnel will start at the western end of the Victoria Road crossover box (located in the Kilburn (Brent) to Old Oak Common area (CFA4)) and after approximately 300m, will enter CFA5 beneath the B4492 Park Royal Road. The Northolt tunnel will then proceed west, before terminating at the West Ruislip portal (located in the South Ruislip to Ickenham area (CFA6)) (see Maps CT-06-015a to CT-06-018 in Volume 2, CFA5 Map Book). The Northolt tunnel will have:

- an approximate internal diameter of each bore of 8.8m;
- a rail depth below ground level varying between approximately 23m and 42m; and
- cross passages between running tunnels at approximately 380m intervals.

#### *Westgate vent shaft*

2.1.35 The vent shaft at Westgate will be located approximately 180m west of Hanger Lane and directly south of Westgate, within the site of an existing builder's merchant (see Map CT-06-011 (Volume 2, CFA5 Map Book)). The vent shaft will be rectangular, approximately 35m long by 20m wide, with a depth from road level of approximately 38m. The vent shaft will be used for tunnel ventilation and to provide emergency intervention from surface to track level. Key features of this vent shaft will include:

- a permanent fenced compound, which will contain the following features:
  - a shaft headhouse building, which will be approximately 44m by 17.5m and approximately 14.7m above existing ground level. It will provide access to the tunnels. Materials and finishes will be subject to detailed design and agreement with the local planning authority;
  - four short connecting tunnels between the base of the vent shaft and the tunnels;
  - an area of hardstanding to the north, east and west of the headhouse building to provide access for maintenance and for the emergency services; and
  - drainage attenuation and fire protection water tanks, located under the area of hardstanding.
- access from the A40 Western Avenue via the A4005 Hanger Lane and Westgate.

2.1.36 Construction of this section will be managed from the Westgate vent shaft main compound (see Section 2.3).

#### *Greenpark Way vent shaft*

2.1.37 The vent shaft at Greenpark Way will be located on vacant land within an existing business park, east of the A4127 Greenford Road on the northern side of the London

Underground Central line (see Map CT-06-013 (Volume 2, CFA5 Map Book)). The shaft will be rectangular, approximately 41m by 26m, with a depth below ground level of approximately 38m. The shaft will be used for tunnel ventilation and providing emergency intervention from surface to track level. Key features of this vent shaft will include:

- a permanent fenced compound, which will contain the following features:
  - a headhouse building approximately 38m by 26.5m and approximately 17.5m high. It will provide access to the tunnels. Materials and finishes of the headhouse building will be subject to detailed design and agreement with the local planning authority;
  - an express feeder auto-transformer station (for HS2 traction power), located immediately to the north of the vent shaft headhouse with dimensions of 70m in length, 40m in width with a height of approximately 5m in height above existing ground level;
  - an area of hardstanding around both the headhouse and express feeder auto-transformer station to provide access for maintenance and the emergency services; and
  - drainage attenuation and fire protection water tanks located under the area of hardstanding.
- access from the A4127 Greenford Road via Greenpark Way and Rockware Avenue.

2.1.38 Construction of this section will be managed from the Greenpark Way vent shaft main compound.

#### *Mandeville Road vent shaft*

2.1.39 The vent shaft at Mandeville Road will be located on an existing railway cutting slope approximately 150m east of the A312 Mandeville Road, on the northern side of the London Underground Central line (Map CT-06-014 (Volume 2, CFA5 Map Book)). The shaft will be rectangular, approximately 35m long by 20m wide, with a depth from the top of the cutting of approximately 43m. The shaft will be used for tunnel ventilation and providing emergency intervention from surface to track level. Key features of this vent shaft will include:

- a permanent fenced compound, which will contain the following features:
  - a headhouse building, approximately 36m by 17.5m. It will provide access to the tunnels. In addition there are two single storey sections (containing mechanical and electrical equipment) attached to the northern edge of the headhouse, one 8m by 18m and one 8m by 26m. The headhouse and associated structures will extend to a maximum of approximately 6.5m above the top of the railway cutting. Materials and finishes will be subject to detailed design and agreement with the local planning authority;
  - four short connecting tunnels between the base of the vent shaft and the tunnels;

- an area of hardstanding to the north of the headhouse to provide access for maintenance and the emergency services;
- drainage attenuation and fire protection water tanks located under the area of hardstanding; and
- access from the A312 Mandeville Road.

2.1.40 Areas for planting have been identified for locations throughout this section of the route, to provide visual screening and habitat reinstatement. Planting areas adjacent to the railway and earthworks throughout this section are illustrated on Maps CT-06-010b to CT-06-015 (Volume 2, CFA5 Map Book).

2.1.41 Construction of this section will be managed from the Mandeville Road vent shaft main compound (see Section 2.3).

## 2.2 Construction of the Proposed Scheme

2.2.1 This section sets out the strategy for the construction of the Proposed Scheme in the Northolt Corridor area including:

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

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

2.2.3 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, CFA5 Map Book). Following construction works, land required temporarily will be prepared for its eventual end use, which will include being returned to its pre-construction use, wherever appropriate.

2.2.4 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

2.2.5 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 and utility works;

- civil engineering works, including: establishment of construction compounds; site preparation and enabling works; main earthworks and structure works;
- construction of tunnels by tunnel boring machine (TBM);
- construction of vent shafts and headhouses;
- railway installation works, including: establishment of construction compounds; railway infrastructure installation; fit-out of tunnels, vent shafts or other buildings; connections to utilities; changes to the existing railway network; and
- railway testing and commissioning.

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

- the approach to environmental management during construction and the role of the Code of Construction Practice (draft CoCP, Section 5);
- working hours (draft CoCP, Section 5);
- the operation of construction compounds (draft CoCP, Section 5);
- the management of utilities diversions (draft CoCP, Section 5);
- the management of construction traffic (draft CoCP, Section 5); and
- the handling of construction materials (draft CoCP, Section 5).

### **Advance works**

2.2.7 Certain advance works, mainly utility diversions and enabling works on the existing railway, are planned to start in 2015, subject to any necessary agreements and consents, with the main works taking place from 2016 to completion of the route and opening of high speed services in 2026.

2.2.8 General information about advance works can be found in Volume 1, Section 6. Advance works will be required before commencing construction works and will typically include:

- further detailed site investigations;
- further detailed environmental surveys;
- habitat creation;
- site establishment with temporary fence construction; and
- utility diversions.

### **Engineering works**

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

- civil engineering works such as earthworks; construction of vent shafts and headhouses;
- construction of tunnels by TBM operating 24 hours a day, seven days a week from dedicated tunnelling sites at Victoria Road crossover box main compound in the Kilburn (Brent) to Old Oak Common area (CFA4) and Northolt tunnel and earthworks main compound in the South Ruislip to Ickenham area (CFA6);
- a small gauge tunnel construction railway forms an essential part of the TBM logistics and support system, supplying the machines with tunnel lining segments and other consumables using rail mounted vehicles. This railway will be twin-tracked to enable two-way traffic and servicing of cross passage construction; and
- railway installation works such as concrete slab track (in tunnels) and tracks, and installing power supply and communications features.

2.2.10 The construction of the Proposed Scheme will be subdivided into sections, each of which will be managed from compounds. The compounds will act as the main interface between the construction work sites and the public highway, as well as performing other functions as described below. Compounds will either be main compounds or satellite compounds, which are generally smaller. Some compounds will be used for civil engineering works and others for railway installation works, and in some cases for both.

2.2.11 In the Northolt Corridor area there will be three main compounds and one railway installation satellite compound.

2.2.12 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**

2.2.13 Main compounds will be used for core project management staff (i.e. engineering, planning and construction delivery), and commercial and administrative staff. In general, main compounds will contain:

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

- 2.2.14 Satellite construction compounds will be used as the base to manage specific works along a section of the route. They will usually provide office space for limited numbers of staff, local storage for plant and materials, limited car parking for staff and site operatives, and welfare facilities.
- 2.2.15 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 and the draft CoCP, Section 5.

### *Construction traffic routes*

- 2.2.16 The movement of construction vehicles carrying materials, plant, other equipment and workforce (or moving empty) will take place both within the construction compounds, 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 the sections below.

Figure 3: Schematic of construction compounds for civil engineering works

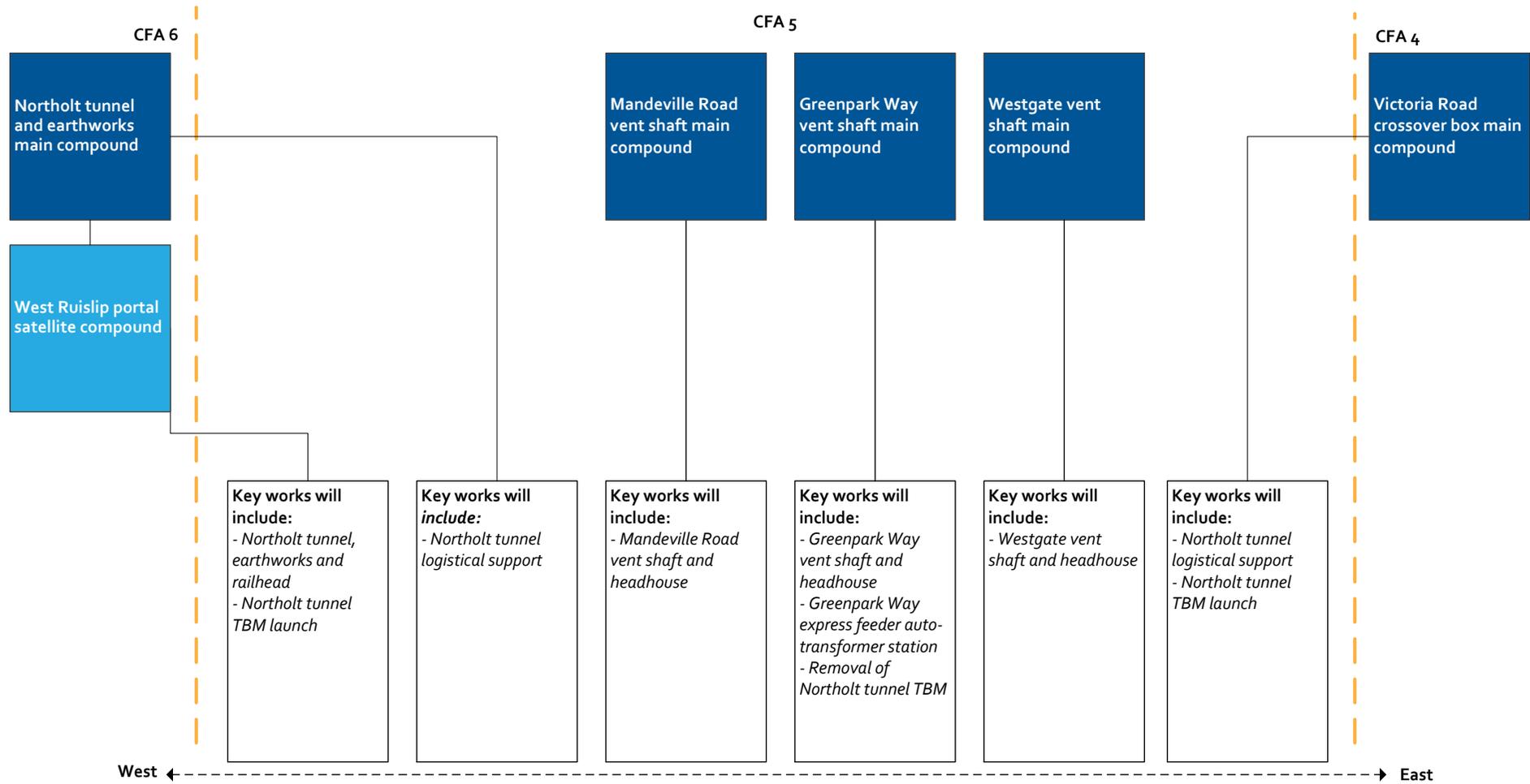
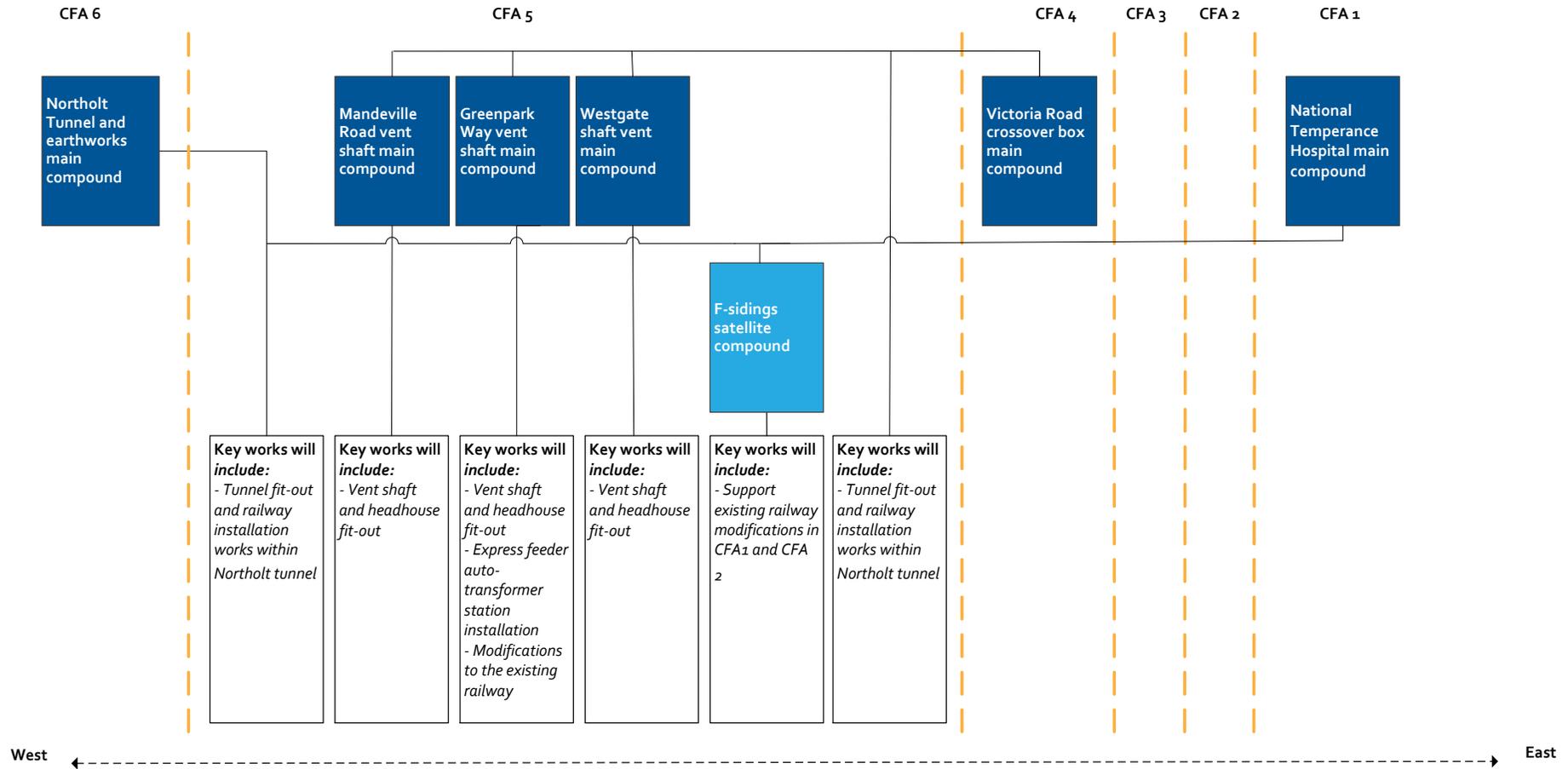


Figure 4: Schematic of construction compounds for railway installation works



### *Victoria Road crossover box main compound*

- 2.2.17 While this compound is located in the Kilburn (Brent) to Old Oak Common area (CFA<sub>4</sub>), it will be used for the logistical support of the TBM used to construct the Northolt tunnel between the Kilburn (Brent) to Old Oak Common area (CFA<sub>4</sub>) and Greenpark Way through CFA<sub>4</sub> and the Northolt Corridor area (CFA<sub>5</sub>). It will also be used for railway installation works and tunnel fit-out within Northolt tunnel. In addition, it will provide administration and site management support for the railway installation works within this study area. The compound will also manage the temporary removal and realignment of the Acton to Northolt Line (ANL) tracks. See Kilburn (Brent) to Old Oak Common (CFA<sub>4</sub>) for more information about this compound.

### *F-sidings satellite compound*

- 2.2.18 While the F-sidings<sup>13</sup> satellite compound is within this area, it will support modifications to existing railway infrastructure in the Euston – Station and Approach area (CFA<sub>1</sub>) and the Camden and HS1 Link area (CFA<sub>2</sub>). Site clearance and enabling works of this disused NR siding will need to be undertaken to make it operational. The compound will:

- be in place for approximately nine years. During this period there will be enabling works to modify the existing sidings for approximately nine months, commencing in 2015, followed by approximately eight years and three months operations;
- support up to 50 workers periodically throughout this period;
- be used for work required to take place at night, weekends or during bank holidays;
- be accessed via Waxlow Road; and
- be managed from the National Temperance Hospital main compound in the Euston – Station and Approach area (CFA<sub>1</sub>).

### *Westgate vent shaft main compound*

- 2.2.19 This compound will be used for construction of a vent shaft and associated railway installation works. The vent shaft will be approximately 20m wide and 35m long, with a depth of 38m below road level. The shaft will be constructed using diaphragm walls (see description in Volume 1, Section 6). The compound will:

- be operational for approximately five years over a six-year period. This will comprise construction of the vent shaft for approximately two years, starting in 2018 and including a suspension of works for three months in 2020 to allow the TBM to pass the shaft. This will be followed by a one-year work suspension period after which the railway installation works and headhouse construction will commence in 2022 and continue for approximately two years and six months;

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<sup>13</sup> The F-sidings satellite compound gets its name from Network Rail's Willesden 'F' Sidings strategic freight site.

- support and provide worker welfare facilities (but no accommodation) for up to 35 personnel each day for a period of approximately two years during the civil construction period, and for approximately five personnel for a period of approximately two years and six months during the railway installation works;
- be used for railway installation works which will be managed from Victoria Road crossover box main compound within the Kilburn (Brent) to Old Oak Common area (CFA4); and
- be accessed from the A40 Western Avenue via the A4005 Hanger Lane and Westgate.

2.2.20 A programme for the key works associated with this compound is shown in Figure 5. Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- building demolition;
- vent shaft construction;
- construction of short cross passages between tunnels. This work will be carried out at depth and may include limited night working over a short period of time;
- internal civil engineering works, including internal shafts and chambers, stair and lift core;
- headhouse construction;
- railway installation works comprising vent shaft and headhouse fit-out; and
- landscaping and planting.

2.2.21 Demolition of one building will be required. This building is a warehouse currently occupied by Selco builder's merchant.

2.2.22 No diversions of roads, footpaths, cycleways and watercourses will be required.

2.2.23 Diversions of eleven utilities and the installation of one new utility may be required, including:

- permanent realignment of two Thames Water treated water distribution mains at Hanger Lane east bridge; a surface water drain at Hanger Lane east bridge; and a clean water trunk main at Westgate bridge;
- permanent realignment of a Thames Water gravity sewer at Westgate bridge/Manhattan Business Park;
- permanent realignment of National Grid gas distribution mains on the bridge at Hanger Lane east bridge; at Westgate Road; and in the road adjacent to the railway on Western Avenue;
- permanent realignment of water mains owned by Affinity Water, located on Hanger Lane east bridge; Hanger Lane east bridge/Twyford Abbey Road; and Hanger Lane east bridge/Western Avenue; and

- permanent new power supply, water and drainage to the Westgate vent shaft.

### *Greenpark Way vent shaft main compound*

- 2.2.24 The Greenpark Way vent shaft main compound is where the TBM being driven from West Ruislip and Victoria Road crossover box will be dismantled and removed from the tunnel. Excavated materials from the tunnel drives westwards towards Greenpark Way will be removed from the tunnels from the Victoria Road crossover box main compound (in the Kilburn (Brent) to Old Oak Common area (CFA4)). The excavated materials from the tunnel drive eastwards towards Greenpark Way will be removed via the worksite at Harvil Road Northolt tunnel and earthworks main compound in the South Ruislip to Ickenham area (CFA6).
- 2.2.25 The Greenpark Way compound will also be used for construction of a vent shaft, express feeder auto-transformer station and modifications to the existing railway lines. The shaft will be approximately 26m wide and 41m long, with a depth of 38m. The shaft will be constructed using diaphragm walls (see Volume 1 Section 6). The compound will:
- be operational for approximately five years over a six-year period. This will comprise construction of the vent shaft for approximately two years and six months, starting in 2019 and including a suspension of works for a year from 2020 to allow removal of the Northolt tunnel boring machines from the shaft. This will be followed by a nine month work suspension period after which the railway installation works and headhouse construction will commence in 2022 and continue for approximately two years and six months;
  - support and provide worker welfare facilities (but no accommodation) for up to 35 personnel each day for a period of approximately two years and six months during the civil construction period and for approximately 15 personnel each day for approximately two years and six months during the railway installation works;
  - be used for railway installation works which will be managed from Victoria Road crossover box main compound within the Kilburn (Brent) to Old Oak Common area (CFA4); and
  - be accessed from the A4127 Greenford Road via Greenpark Way and Rockware Avenue.
- 2.2.26 A programme for the key works associated with this compound is shown in Figure 5. Works in this section of the Proposed Scheme will be carried out in the following broad phases:
- site clearance and enabling works;
  - temporary realignment of the existing railway adjacent to the shaft location for the duration of the works to allow construction of the shaft;
  - vent shaft construction;
  - removal of four tunnel boring machines which are excavating the Northolt tunnel westwards from the Victoria Road crossover box and eastwards from

the West Ruislip portal;

- internal civil engineering works, including internal shafts and chambers, stair and lift core;
- headhouse construction;
- installation of an express feeder auto-transformer station adjacent to Greenpark Way vent shaft;
- reinstatement of the existing railway to its original alignment;
- shaft and headhouse fit-out; and
- landscaping and planting.

2.2.27 No demolitions will be required.

2.2.28 No diversions of roads, footpaths, cycleways or watercourses will be required.

2.2.29 No diversions of existing utilities will be required. However, the Greenpark Way vent shaft will require the permanent installation of power, water and drainage supply.

#### *Mandeville Road vent shaft main compound*

2.2.30 This compound will be used for construction of a vent shaft and associated railway installation works along the Northolt tunnel, between Greenpark Way vent shaft and West Ruislip portal. The shaft will be approximately 20m wide and 35m long, with a depth of 45m. The shaft will be constructed using diaphragm walls (see Volume 1 Section 6). The compound will:

- be operational for approximately six years and six months. This will comprise construction of the vent shaft for approximately two years and six months, starting in 2018. This will be followed by railway installation works and headhouse construction which will commence in 2021 and continue for approximately four years;
- support and provide worker welfare facilities (but no accommodation) for up to 40 personnel each day for a period of approximately three years during the civil construction period and for approximately five personnel for a period of approximately two years and six months during the railway installation works;
- be used for railway installation works which will be managed from the Victoria Road crossover box main compound within the Kilburn (Brent) to Old Oak Common area (CFA4); and
- be accessed via the A312 Mandeville Road.

2.2.31 A programme for the key works associated with this compound is shown in Figure 5. Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- Mandeville Road junction improvements at the compound entrance;

- building demolition;
- vent shaft construction;
- ventilation access and cross passage access between tunnels. This work will be carried out at depth and may include limited night working over a short period of time;
- internal civil engineering works, including internal shafts and chambers, stair and lift core;
- headhouse construction;
- vent shaft and headhouse fit-out; and
- landscaping and planting.

2.2.32 Demolition of three buildings and associated outbuildings will be required as shown in Table 1.

Table 1: Demolitions at Mandeville Road vent shaft main compound

Description	Location
Residential property and associated outbuilding (garage)	41 Mandeville Road
Residential property and associated outbuilding (garage)	39 Mandeville Road
Pumping station and associated office building (owned by Affinity Water)	East of Badminton Close

2.2.33 No diversions of roads, footpaths, cycleways or watercourses will be required. It is likely that a bus stop on Mandeville Road will need to be relocated in close proximity to its existing location.

2.2.34 Diversions of a number of utilities and the installation of new utilities will be required, the key ones being:

- permanent realignment of a Thames Water sewer at Mandeville Road;
- permanent realignment of a water main owned by Affinity Water, which runs from Mandeville Road pumping station, east of Badminton Close, to Mandeville Road;
- re-provision of the existing Affinity Water pumping station; and
- permanent new power supply, water and drainage at Mandeville Road vent shaft.

#### *Northolt tunnel and earthworks main compound*

2.2.35 Although this compound is located within the South Ruislip to Ickenham area (CFA6), it will be used for the logistical support of the TBM used to construct the Northolt tunnel. The compound will also be used for railway installation works and tunnel fit-out within the Northolt tunnel, within the Northolt Corridor area, via the West Ruislip

railhead located within this compound. See the South Ruislip to Ickenham (CFA6) report for more information about the compound and the effects associated with its operation.

### *West Ruislip portal satellite compound*

- 2.2.36 Although this compound is located within the South Ruislip to Ickenham area (CFA6), it will be used principally for the launch of the TBM used to construct the Northolt tunnel, within this area. See the South Ruislip to Ickenham (CFA6) report for more information about the compound and the effects associated with its operation.

### **Construction waste and material resources**

- 2.2.37 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 Northolt Corridor area have been prepared and are presented in Volume 5: Appendix WM-001-000.
- 2.2.38 The majority of excavated material generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme, either with or without treatment.
- 2.2.39 Based on the mitigation earthworks design approach adopted for the Proposed Scheme, local excess or shortfall of excavated material within the Northolt Corridor area will be managed with the aim of contributing to the overall balancing of excavated material on a route-wide basis. The overall balance of excavated material is presented in Volume 3, Section 14.
- 2.2.40 The quantity of surplus excavated material originating from the Northolt Corridor area that will require off-site disposal to landfill as excavation waste is shown in Table 2. This is the forecast quantity of contaminated excavated material that is chemically unsuitable for reuse within the Proposed Scheme and which will be taken from the Northolt Corridor area for off-site disposal to either non-hazardous or hazardous landfill. This represents a proportion of the total quantity of surplus excavated material that will require disposal, which is reported on a route-wide basis in Volume 3, Section 14.
- 2.2.41 The quantities of demolition, construction and worker accommodation site waste that will be reused, 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%.
- 2.2.42 The quantities of demolition, construction and worker accommodation site waste that will require off-site disposal to landfill are shown in Table 2.

Table 2: Estimated construction, demolition and excavation waste

Waste type	Estimated material quantities that will be generated (tonnes)	Estimated quantity of waste for off-site disposal to landfill (tonnes)
Excavation	2,979,550	56,500
Demolition	13,986	1,399
Construction	120,902	12,090
Worker accommodation	0	0
TOTAL	3,114,438	69,989

2.2.43 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

2.2.44 Commissioning is the process of testing the infrastructure to ensure that it operates as expected. This will take place in the year prior to opening. Further details are provided in Volume 1, Section 6.

### Construction programme

2.2.45 A construction programme that illustrates indicative periods for the construction activity in this area is provided in Figure 5.



Construction activity	2015				2016				2017				2018				2019				2020				2021				2022				2023				2024				2025				2026			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				
Commissioning																																																
Test and commissioning of the railway																																																

Key



Construction works



Compound duration

## 2.3 Operation of the Proposed Scheme

### Operational specification

- 2.3.1 Volume 1, Section 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*

- 2.3.2 It is anticipated that initially there will be 11 trains per hour (tph) each way passing through the Northolt Corridor area in the morning and evening peak hours, and fewer during other times. The first trains of the day will leave the terminus stations no earlier than 05:00 Monday to Saturday (and 08:00 on Sundays) and the last will arrive no later than midnight.
- 2.3.3 The frequency of services could rise to 14tph each way during peak hours, and with Phase Two in place the frequency could rise to 18tph each way during peak hours.
- 2.3.4 In this area, HS2 trains will be entirely within tunnel and will run at speeds up to 320kph. The trains will be either single zoom long trains or two zoom long trains coupled together, depending on demand and time of day.

### Maintenance

- 2.3.5 Volume 1, Section 4 describes the maintenance regime for HS2.
- 2.3.6 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

- 2.3.7 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.
- 2.3.8 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.
- 2.3.9 Rolling stock maintenance waste is that which will be generated by the relevant train operating company at rolling stock maintenance facilities. This has only been reported for the areas along the route in which these facilities will be located.
- 2.3.10 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.

2.3.11 The quantity of operational waste that will be reused, recycled and recovered (i.e. diverted from landfill) has been based on landfill diversion performance information from NR and other sources as follows:

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

2.3.12 On this basis, approximately 129 tonnes of operational waste will be reused, recycled and recovered during each year of operation of the Proposed Scheme in the Northolt Corridor area. Approximately 26 tonnes will require disposal to landfill (see Table 3).

Table 3: Operational waste forecast for the Proposed Scheme

Waste source	Estimated quantity of waste generated per annum (tonnes)	Estimated quantity of waste for disposal to landfill per annum (tonnes)
Railway station and train	0	0
Rolling stock maintenance	0	0
Track maintenance	143	21
Ancillary infrastructure	12	5
TOTAL	155	26

2.3.13 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).

## 2.4 Community forum engagement

2.4.1 HS2 Ltd’s approach to engagement on the Proposed Scheme is set out in Volume 1, Section 3.

2.4.2 The engagement undertaken within this community forum area is summarised below. A series of community forum meetings and discussions with individual landowners, local residents, organisations and action groups were undertaken. Community forum meetings were held on:

- 19 March 2012 at Northolt High School;
- 21 June 2012 at Northolt High School;
- 11 September 2012 at Selborne Primary School;
- 28 November 2012 at the Bridge Hotel, Greenford;
- 08 May 2013 at the Bridge Hotel, Greenford; and

- 18 September 2013 at the Bridge Hotel, Greenford.

2.4.3 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, action groups, affected landowners and other interested stakeholders.

2.4.4 The previous surface option (summarised at Section 2.6) was discussed in the community forum meetings in 2012. The main themes at these meetings were the community concerns about this option and these were taken into account in the consideration of alternatives. The Proposed Scheme is now the tunnelled option, as described in Section 2.2.

2.4.5 The main themes concerning the surface option discussed at the forum meetings in 2012 were:

- concerns regarding the reconstruction of more than 20 bridges and the effect on local traffic congestion. The tunnelled route will result in differing effects on roads and local traffic congestion;
- particular concerns regarding the closure of Hanger Lane and extra traffic during construction on already congested roads;
- concerns over noise during construction and operation; and
- concerns regarding property blight and compulsory purchase, including Northolt High School. The tunnelled route will now result in less land required for construction and operation.

2.4.6 In addition to the engagement through the community forums, the draft Environmental Statement and Design Refinement consultations were launched on 16 May 2013 and closed on 11 July 2013. As part of these consultations, the public, community groups and other interested parties were notified, provided with information and invited to engage on issues pertinent to the draft Environmental Statement and the development of the Proposed Scheme. Details of the local consultation events were provided on the HS2 Ltd website, social media, posters at local venues, national and regional advertising and to properties within 1km of the Proposed Scheme. In the Northolt Corridor area, a consultation event on the draft Environmental Statement and on the Design Refinement was held on 17 June 2013 at Perivale Community Centre.

2.4.7 Responses from the draft Environmental Statement consultation have been analysed and an overview of those received and how the Environmental Statement has taken account of responses is contained in the Draft Environmental Statement Consultation Summary Report (Volume 5: Appendix CT-008-000).

## **2.5 Route section main alternatives**

2.5.1 The main strategic alternatives to the Proposed Scheme are presented in Volume 1, Section 10. The main local alternatives considered for the Proposed Scheme within the local area are set out within this section.

- 2.5.2 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.
- 2.5.3 The January 2012 announced scheme proposed a surface railway in this area. Since then, this has been changed to a route entirely in tunnel. A tunnelled scheme will reduce the need for demolitions and eliminate the need for the replacement or provision of more than 20 bridges and other structures along the route. Also, this change will reduce the environmental impacts of the route, particularly with respect to the potential for landscape, visual, sound and vibration impacts during operation and traffic and transport impacts during construction.
- 2.5.4 Section 2.5 explains what consultation was undertaken on the previous surface option, and indicates the concerns of the community relating to such an option. These concerns were taken into account as further alternatives were considered.

### **Main design features**

- 2.5.5 There are two main design features relating to the Northolt Corridor area: the tunnel (its length, depth and alignment); and the vent shafts and headhouses (their location and design) (illustrated on Maps CT-06-010b to CT-06-015 (Volume 2, CFA5 Map Book)).
- 2.5.6 Within this area the main design features are inextricably linked, in that changing one feature would have implications for the other design features. This in turn influenced the design alternatives available for consideration.

### **Tunnel alternatives**

- 2.5.7 The Proposed Scheme will be in tunnel for the whole of the route in this area. In addition to this, HS2 Ltd has also considered two other main alternatives to the Proposed Scheme as follows:
- the January 2012 scheme as announced by the Secretary of State, which was proposed to run on the surface, following the corridor of the London Underground Central line; and
  - a short tunnel from Old Oak Common to the west of Hanger Lane gyratory.
- 2.5.8 The short tunnel option from Old Oak Common would avoid the need to rebuild the Hanger Lane gyratory and potentially other structures between Old Oak Common and Horsenden Lane South, together with the disruption and environmental impacts associated with this. The construction programme would be similar to the January 2012 announced scheme, but the short tunnel option would have been more expensive to build.
- 2.5.9 The full tunnel route from Old Oak Common to West Ruislip was found to cost approximately the same as the January 2012 announced scheme. The additional costs of tunnelling will be offset by the cost savings associated with not having to demolish

and rebuild over 20 bridge structures crossing the route nor having to build the North Acton and East Ruislip tunnel portals.

- 2.5.10 In addition, the full tunnel option will have less environmental impact. There will be less land required for the Proposed Scheme, and significant noise, dust, ecology and other effects during construction will be largely avoided. Similarly, there will be no significant noise impacts during the operation of HS2 because the route will be in tunnel.
- 2.5.11 Both the full tunnel and part tunnel options would substantially increase the volume of excavated material to be removed, compared with the January 2012 announced scheme. The tunnel options also introduce surface settlement impacts and require additional tunnelling/shaft construction compounds. However, it was considered that both of these options would have less environmental impact, overall, than the surface route.
- 2.5.12 For these reasons, the full tunnel through this area was developed as the Proposed Scheme.
- 2.5.13 Once the Proposed Scheme had been identified, a number of alternative tunnelling strategies were considered. The tunnelling strategy chosen was influenced by the ground conditions, the availability of sites from which to launch the TBM, and the ability to remove excavated material from the tunnel drive site. A total of six options were considered, comprising all possible combinations of drive sites and sites for the removal of excavated material.
- 2.5.14 Due to the changing geology along the length of the tunnel, it was considered that neither a single drive from West Ruislip or Old Oak Common was desirable. These single drive options were discounted. Given the volume of excavated material that would be generated during tunnel excavation, the options using an intermediate shaft location for removal of excavated material from the tunnel were considered to have unacceptable environmental impacts. This was because excavated material from the tunnels would need to be transported off site by road in these options. The review of options concluded that the Proposed Scheme should be a twin-bored tunnel driven from West Ruislip in the west and from Victoria Road in the east. There is the opportunity to remove excavated material by rail from both locations.

### **Vent shaft and headhouse alternatives**

- 2.5.15 The Proposed Scheme includes three vent shaft headhouses in this area: at Westgate, Greenpark Way and Mandeville Road.
- 2.5.16 Once the tunnelling strategy was established, the location for the vent shafts and headhouses could be considered. Vent shaft and headhouse locations are dependent on the distance from the portals and/or the next vent shaft. The sites for inclusion in the Proposed Scheme were identified on the basis of these engineering parameters, together with consideration of existing and adjacent land uses along the alignment of the proposed tunnel and the likely environmental impacts of constructing and operating these facilities. Excavated material from the vent shafts will be removed by road. This was a consideration when choosing the vent shaft sites. The locations of vent shafts in the Proposed Scheme are those that would result in fewer

environmental effects, while at the same time meeting the engineering and operational parameters.



## **3 Agriculture, forestry and soils**

### **3.1 Introduction**

- 3.1.1 This environmental topic has been scoped out of the assessment for CFA5 as there are no agricultural or forestry activities affected by the Proposed Scheme in this urban area.



## 4 Air quality

### 4.1 Introduction

- 4.1.1 This section of the report provides an assessment of the impacts and likely significant effects on air quality arising from the construction and operation of the Proposed Scheme, covering nitrogen dioxide (NO<sub>2</sub>), fine particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>)<sup>14</sup> and dust.
- 4.1.2 With regard to air quality, the main potential effects are anticipated to result from the emissions of the above pollutants from construction activities and equipment and road traffic. Dust emissions during construction will be associated with demolition, site preparation works, construction of the vent shafts and the use by construction traffic of routes to and from the sites.
- 4.1.3 Detailed reports on the air quality data and assessments for this study area, as well as relevant maps, are contained in the Volume 5 Appendices. These include:
- Volume 5: Appendix AQ-001-005;
  - Map AQ-01-005 (Volume 5, Air Quality Map Book); and
  - Map AQ-02-01 (Volume 5, Air Quality Map Book).
- 4.1.4 Maps showing the location of the key environmental features can be found in Maps CT-10-006 to CT-10-008a, Volume 2, CFA5 Map Book.

### 4.2 Scope, assumptions and limitations

- 4.2.1 The assessment scope, key assumptions and limitations for the air quality assessment are set out in Section 8 of Volume 1 and in the SMR (Volume 5: Appendix CT-001-000/1) and its addendum (Volume 5: Appendix CT-001-000/2) and appendices, presented in Volume 5: Appendix AQ-001-005. The 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, or from changes in the nature of traffic during construction and operation.
- 4.2.3 The assessment of impacts arising from construction dust emissions has been undertaken using the methodology based on that produced by the Institute of Air Quality Management (IAQM)<sup>15</sup>. 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 significant effect using this methodology. The assessment presented here reaches a conclusion

<sup>14</sup> PM<sub>2.5</sub> and PM<sub>10</sub> 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.

<sup>15</sup> Institute of Air Quality Management (2012), *Guidance on the assessment of the impacts of construction on air quality and the determination of their significance*.

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 based on the highest predicted flows 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 Northolt Corridor area. The main source of existing air pollution in the area is emissions from road traffic, as is the case for nearly all parts of London. Concentrations of road traffic related pollutants are highest in central London and diminish towards the outer boroughs. At places very close to roads where traffic flows are high, the airborne concentrations of the main pollutants are elevated substantially when compared to the 'urban background', as exemplified by locations near the A40 Western Avenue.
- 4.3.2 Estimates for NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> concentrations have been obtained from London-wide modelled pollution maps<sup>16</sup> for 2008 and 2011, published by Greater London Authority (GLA) in 2010. The 2011 maps have been used to characterise the baseline air quality in London, in addition to monitoring data and the background concentration maps<sup>17</sup> produced nationally by the Department for Environment and Rural Affairs (Defra) that have been used in the assessment on other parts of the HS2 route outside London. The GLA maps reflect concentrations at all locations, including at the roadside, whereas the Defra national maps are background concentrations and do not include the effects of individual roads. It is therefore considered that the GLA maps provide a more spatially accurate representation of existing baseline conditions at a local level.
- 4.3.3 The Northolt Corridor area lies predominantly within LBE. The northern tunnel passes through the LBB to the west of Hanger Lane, whilst LBHa lies adjacent to the route to the north.
- 4.3.4 These local authorities maintain 12 automatic monitoring stations, mostly at roadside locations. In addition, there are numerous diffusion tube sites throughout this part of

<sup>16</sup> Greater London Authority (GLA) (2010), *Investigation London Atmospheric Emissions Inventory 2008 Concentration Maps*; <http://data.london.gov.uk/laei-2008-concentration-maps>; Accessed: May 2013.

<sup>17</sup> Department for Environment, Food and Rural Affairs (Defra) (2010), *Defra background pollution concentration maps 2010*; <http://laqm.defra.gov.uk/maps/maps2010.html>; Accessed: July 2013.

London measuring concentrations of NO<sub>2</sub>. For example, LBE currently has nearly 100 such locations. The data collected by the local authorities and the GLA pollution maps show that some parts of the Northolt Corridor area currently experience long-term average concentrations<sup>18</sup> of NO<sub>2</sub> that are above the air quality standard, especially in close proximity to major roads. Air quality standards for PM<sub>2.5</sub> and PM<sub>10</sub> are met in most parts of the study area, but monitoring and mapping data indicate that PM<sub>10</sub> concentrations are above the air quality standards at some major roadside locations, such as Horn Lane and Hanger Lane. Further information for these sites is provided in Volume 5: Appendix AQ-001-005.

- 4.3.5 The LBE has designated the whole borough as an AQMA, in recognition of the widespread NO<sub>2</sub> concentrations in excess of that defined by the air quality standard for the annual average (40µg/m<sup>3</sup>) (see Map AQ-01-005 (Volume 5, Air Quality Map Book)). In addition, much of the southern half of LBB and the whole of LBHa have been declared as AQMA for NO<sub>2</sub> and PM<sub>10</sub>, including the area adjacent to the route.
- 4.3.6 Receptors in this study area are primarily residential properties and some commercial districts near construction activities and roads affected by traffic changes during construction and operation (see Map AQ-01-005 (Volume 5, Air Quality Map Book)).

### Future baseline

- 4.3.7 Section 2 and Volume 5: Appendix CT-004-000 identify developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the future baseline for the assessment of effects from the construction and operation of the Proposed Scheme.
- 4.3.8 The potential cumulative impact from committed developments on air quality acting in conjunction with the effects from the construction and operation of the Proposed Scheme have been considered as part of this assessment. This has been achieved by including changes in traffic predicted as a result of the committed developments within the traffic data used for the air quality assessments for construction and operation, in which the future air quality baselines are defined as the 'without Proposed Scheme scenarios' at each stage.

### Construction (2017)

- 4.3.9 Future background pollutant concentrations have been sourced from Defra background maps for 2017, which predict NO<sub>2</sub> and PM<sub>10</sub> concentrations in 2017 to be lower than in the 2012 baseline. The GLA maps have not been used to define future baseline as they do not predict local concentrations beyond 2015.

### Operation (2026)

- 4.3.10 Future background pollutant concentrations have been sourced from Defra background maps for 2026, which predict NO<sub>2</sub> and PM<sub>10</sub> concentrations in 2026 to be lower than in the 2012 baseline.

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<sup>18</sup> Long-term concentrations are usually described by the annual average concentration. Short-term concentrations refer to those which are measured as daily or hourly averages and for which standards refer to peak concentrations.

## 4.4 Effects arising during construction

### Avoidance and mitigation measures

- 4.4.1 All of the route in the Northolt Corridor area will be in tunnel and areas of construction activity will be confined to three vent shafts. At these sites, emissions to atmosphere will be controlled and managed during construction through the route-wide implementation of the CoCP, where appropriate. The draft CoCP includes a range of mitigation measures that are accepted by the IAQM as being suitable to reduce impacts to as low a level as reasonably practicable. It also makes provision for the preparation of local environmental management plans (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 Section 7 of the draft CoCP (Volume 5: Appendix CT-003-000) will be implemented. Specific measures will include:
- contractors being required to manage dust, air pollution, odour and exhaust emissions during construction works;
  - inspection and visual monitoring after engagement with the local authorities to assess the effectiveness of the measures taken to control 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 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 the completion of earthworks.

### Assessment of impacts and effects

#### *Temporary effects*

- 4.4.3 Impacts from the construction of the Proposed Scheme could arise from dust-generating activities and emissions from construction traffic. As such, the assessment of construction impacts has been undertaken for human receptors sensitive to dust and exposure to NO<sub>2</sub> and PM<sub>10</sub>.
- 4.4.4 An assessment of construction traffic emissions has also been undertaken for two sets of scenarios in the construction period: a 'without the Proposed Scheme' scenario and 'with the Proposed Scheme' scenario that reflects phases of peak activity.
- 4.4.5 In the Northolt Corridor area, dust-generating activities will occur at construction compounds for the vent shafts at Westgate, Greenpark Way and Mandeville Road. Dust emissions are most likely to be associated with demolition, site preparation works, and construction of the vent shafts and the use of construction traffic routes to and from the construction compounds.

- 4.4.6 Given the mitigation measures contained within the draft CoCP, the assessment of impacts arising from dust emissions has concluded that they will be slight adverse or negligible in magnitude and that the effect on receptors will not be significant. The basis for this conclusion can be found in Volume 5: Appendix AQ-001-005.
- 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 diversions.
- 4.4.8 Examination of the changes in traffic flows for the construction period along the affected roads has identified some roads that meet the criteria for a quantitative assessment. The traffic data includes a contribution from committed development. This assessment found that impacts will be negligible or slight adverse at all receptors assessed, for NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>. Full details of this assessment can be found in Volume 5: Appendix AQ-001-005. The effect on receptors will not be significant.

#### *Permanent effects*

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

#### *Cumulative effects*

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

#### **Other mitigation measures**

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

#### **Summary of likely significant residual effects**

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

### **4.5 Effects arising from operation**

#### **Avoidance and mitigation measures**

- 4.5.1 No mitigation measures are proposed during operation in relation to air quality in this study area.

#### **Assessment of impacts and effects**

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

- 4.5.3 The assessment of operational traffic emissions has been undertaken for two scenarios in the operation year 2026: a 'without the Proposed Scheme' scenario and a 'with the Proposed Scheme' scenario. The traffic data includes the additional traffic from committed developments. Full details of this assessment can be found in Volume 5: Appendix AQ-001-005.
- 4.5.4 Traffic data for the Northolt Corridor area has been screened to identify roads that required further assessment and to confirm the likely effect of the change in emissions from vehicles using those roads in 2026. These traffic data include the contribution from future committed development.
- 4.5.5 No roads are predicted to have sufficiently large changes in traffic flows to meet these criteria for further assessment. Therefore, there will be negligible impact on air quality at all receptors assessed for NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> and consequently there is not predicted to be any significant effect associated with the Proposed Scheme for receptors.

#### *Cumulative effects*

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

#### **Other mitigation measures**

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

#### **Summary of likely significant residual effects**

- 4.5.8 No significant residual effects are anticipated for receptors as a consequence of changes to air quality in this area during operation of the Proposed Scheme.

## 5 Community

### 5.1 Introduction

- 5.1.1 This section reports the impacts and likely significant effects on local communities resulting from the construction and operation of the Proposed Scheme.
- 5.1.2 Key issues concerning the community assessment for this study area comprise:
- demolition of two dwellings on Mandeville Road as a result of the construction of the vent shaft at Mandeville Road;
  - impacts on residential amenity for dwellings at Badminton Close and on the south side of Carr Road during construction; and
  - temporary requirement for land at the centre of Northolt.
- 5.1.3 Further details of the community assessments and the open space and recreational public rights of way (PROW) surveys undertaken within the study area are contained in Volume 5: Appendix CM-001-005.
- 5.1.4 Significantly affected community resources are shown in Maps CM-01-013 to CM-01-018a (Volume 5, Community Map Book).
- 5.1.5 The current assessment draws on information gathered from regional and local sources, including information from the LBE.

### 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 500m 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 routing 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 which encompasses the likely significant effects of the Proposed Scheme.
- 5.3.3 The study area includes land around three locations relating to the vent shafts at Westgate Road, Greenpark Way and Mandeville Road, which are the only significant above ground engineering works within this study area. Elsewhere in the Northolt

Corridor area, the Proposed Scheme is in tunnel, and therefore there are not likely to be any significant effects on community resources.

- 5.3.4 The area is suburban with a mixture of industrial and trading estates and areas of late 19th and early 20th century terraced housing within Park Royal, Perivale, West Acton and Northolt. The largest business park in London, Park Royal, is located in the east of the area, extending to the north and south of the route and with large areas of light industry and commercial use.

#### *Westgate Road*

- 5.3.5 The vent shaft at Westgate Road is located within Manhattan Business Park in Hanger Hill and north of the A40. Hanger Lane London Underground station is located to the east of the proposed vent shaft. The nearest dwellings are to the south of the Proposed Scheme, off the A40. There are allotment gardens to the west on the banks of the River Brent, with the Ealing Golf Club further west again and north of the river. There are few community facilities in the area. Lynwood Surgery is a one-doctor surgery located on Lynwood Road, also south of the A40 and outside the area of land required for the construction and operation of the Proposed Scheme.

#### *Greenpark Way*

- 5.3.6 Greenpark Way vent shaft is located within the industrial estate on Greenpark Way, which is bounded to the north by the Grand Union Canal, and the associated Grand Union Canal Walk, and to the west by Westway Cross Shopping Park. Perivale Wood is located to the east of the industrial estate. To the south of the industrial estate is the existing railway corridor, beyond which is a large housing estate. Selborne Primary School is located off Conway Crescent and a sports ground, with an associated pavilion, is located at the southern end of Bennetts Avenue. The closest residential properties to the Greenpark Way vent shaft are on Conway Crescent and Bennetts Avenue.

#### *Mandeville Road*

- 5.3.7 Mandeville Road vent shaft is located to the east of Northolt station, adjacent to the A312 Mandeville Road, in an area dominated by terraced houses. Other than local shops, a police station and swimming pool, there are few community facilities in the area. The area's shops and services are located around the green at the centre of Northolt, along Station Approach/Ealing Road, to the south of the vent shaft site. Northolt Park Baptist Church in Eastcote Lane is located to the west of the Mandeville Road vent shaft site while Northolt Park Social Club on Sussex Crescent, Mandeville School and the nearby swimming pool on Eastcote Lane North are located to the north of the Mandeville Road vent shaft. Further to the west, the route of the tunnel passes Willow Tree Primary School and Lord Halsbury Memorial Playing Fields.

### **Future baseline**

#### *Construction (2017)*

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

### *Operation (2026)*

- 5.3.9 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 (2026).

## **5.4 Effects arising during construction**

### **Avoidance and mitigation measures**

- 5.4.1 The route of the Proposed Scheme is in a tunnel throughout the study area which means a reduction in the surface area of land required for construction of the Proposed Scheme compared to the surface railway scheme announced in January 2012. As such, many potential adverse environmental impacts on residential properties and community facilities have been avoided, particularly with respect to the potential for landscape, visual, sound and vibration impacts during operation and traffic and transport impacts during construction.
- 5.4.2 The draft CoCP includes a range of provisions that will help mitigate community effects associated with construction within this study area, including:
- 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 compounds to reduce nuisance (draft CoCP, Section 5);
  - where reasonably practicable, maintenance of PRow for pedestrians, cyclists and equestrians around the perimeter of construction compounds and across entry and exit points (draft CoCP, Section 5);
  - monitoring and management of flood risk and other extreme weather events which may affect community resources during construction (draft CoCP, Sections 5 and 16);
  - specific measures in relation to air quality and noise will also serve to reduce impacts for the neighbouring communities including discretionary noise insulation for sensitive community resources and, in special circumstances, temporary rehousing (draft CoCP, Sections 7 and 13); and
  - where reasonably practicable, the avoidance of large goods vehicles operating adjacent to schools during drop-off and pick-up periods (draft CoCP, Section 14).

### **Assessment of impacts and effects**

- 5.4.3 Details of all assessments of community resources are included in Volume 5: Appendix CM-001-005. 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.

### **Westgate Road**

- 5.4.4 No temporary or permanent significant effects on the community have been identified in the assessment.

## **Greenpark Way**

- 5.4.5 No temporary or permanent significant effects on the community have been identified in the assessment.

## **Mandeville Road**

### *Temporary effects*

#### **Residential property**

- 5.4.6 Residential properties on the south side of part of Carr Road and in Badminton Close are predicted to experience the following in-combination effects during the construction of the Mandeville Road vent shaft:
- significant visual effects associated with views of construction activity at the Mandeville Road vent shaft main compound; and
  - significant noise effects associated with construction activity at the Mandeville Road vent shaft main compound for approximately two years, affecting approximately 25 dwellings during the day.
- 5.4.7 The combination of these effects, which will coincide for up to two years, will have a major adverse effect on the amenity of residents, which is considered to be significant.

#### **Open space and recreational PRow**

- 5.4.8 To the south of the Mandeville Road vent shaft, the open space between Mandeville Road and Ealing Road provides a focal point for Northolt village. Approximately 25% of this land (on the east side, close to Station Parade) will be required as a utility compound for between one and two years. The surrounding area will remain accessible to the community. The area is well maintained, with paths, benches and formal flower beds. This is the central green area in Northolt and there are few nearby alternatives. The temporary loss of this land is considered to be a moderate adverse effect and is therefore significant.

### *Permanent effects*

- 5.4.9 Construction at the Mandeville Road vent shaft will require the demolition of two dwellings on Mandeville Road (numbers 39 and 41). The permanent loss of these dwellings is not considered to be significant at the community level.

#### **Cumulative effects**

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

#### **Other mitigation measures**

- 5.4.11 The assessment has concluded that there are significant adverse effects arising during construction in relation to community resources. No other mitigation measures are proposed.

#### **Summary of likely significant residual effects**

- 5.4.12 There will be a temporary loss of public open space in the centre of Northolt Village for between one and two years giving rise to a moderate adverse effect. Residential

properties on the south side of Carr Road and in Badminton Close are predicted to experience temporary significant residual effects on amenity during construction of the Mandeville Road vent shaft. The effects are expected to be major adverse.

## **5.5 Effects arising from operation**

### **Avoidance and mitigation measures**

- 5.5.1 The route of the Proposed Scheme is in a tunnel through the study area which means that many potential adverse impacts have been avoided during the operation phase.

### **Assessment of impacts and effects**

- 5.5.2 No significant effects on the community have been identified in the assessment during the operation of the Proposed Scheme.

### **Cumulative effects**

- 5.5.3 No temporary or permanent cumulative effects on the community have been identified in this assessment 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 adverse effects on the community have been identified in this assessment during operation.



## 6 Cultural heritage

### 6.1 Introduction

- 6.1.1 This section of the report provides a description of the current baseline for heritage assets and reports the likely impacts and significant effects resulting from the construction and operation of the Proposed Scheme. Consideration is given to the extent and heritage value (significance) of assets including archaeological and 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 are affected by the Proposed Scheme. Impacts on assets as a result of the Proposed Scheme will occur largely through the physical removal and alteration of assets and changes to their setting.
- 6.1.3 Maps showing the location of the key environmental features can be found in Volume 2: CFA Map Books. Maps showing the location of all designated and non-designated heritage assets can be found in Volume 5, Cultural Heritage Map Books. 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-001-005 - Baseline Report;
  - Appendix CH-002-005 - Gazetteer of Heritage Assets; and
  - Appendix CH-003-005 - Impact Assessment Table.
- 6.1.4 Throughout this section, assets within the study areas are identified with a unique reference code, NORXXX; further detail on these assets can be found in the gazetteer in Volume 5: Appendix CH-002-005.
- 6.1.5 Engagement has been undertaken with the Greater London Archaeological Advisory Service and the English Heritage historic buildings advisor for London 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 in the Zone of Theoretical Visibility (ZTV)<sup>19</sup> of the Proposed Scheme has been considered. The study area within which a detailed assessment of all assets, designated and non-designated, has been carried out, is defined as the land required, temporarily and permanently, to construct the

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<sup>19</sup> The ZTV used for this purpose in Greater London is shown on Map Series CH-02 in Volume 5, Cultural Heritage Map Book. This covers, in places, a smaller area than the ZTV shown on Maps LV-07 and LV-08 (Volume 5, Landscape and Visual Assessment Map Book). It has been concluded that there are no designated assets in the areas outside the cultural heritage ZTV the setting of which could be affected by the Proposed Scheme.

Proposed Scheme plus 250m. For the purposes of this assessment, any assets within the 10mm settlement contour<sup>20</sup> 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 However, 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-001-005.

6.3.2 In addition to collating this baseline data, walkover surveys and site reconnaissance was undertaken 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.

### Designated assets

6.3.3 The following designated heritage assets are located partially or wholly within the land required, temporarily or permanently, for the construction of the Proposed Scheme (see Maps CH-02-006 to CH-02-008a-R1, Volume 5, Cultural Heritage Map Book):

- the Grade II listed building, Perivale London Underground station (NOR027) lies within the 10mm settlement contour;
- the Grade II listed building, IBM distribution centre (NOR040) lies within the 10mm settlement contour; and
- one conservation area, Northolt Village Green (NOR010) partially lies within the area required temporarily or permanently for the construction of the Proposed Scheme.

6.3.4 The following designated assets are located within the ZTV (see Maps CH-02-006 to CH-02-008a-R1, Volume 5, Cultural Heritage Map Book):

- three Grade I listed buildings: the Church of St. Mary the Virgin (NOR004); the Church of St. Mary (NOR010); and the parish church of the Holy Cross (NOR030);
- five Grade II\* listed buildings: The Elms (NOR012); Church of St. Peter (NOR015); Canteen Block to the Hoover Factory (NOR026); Main Block to the Hoover Factory (NOR026); and the Holy Cross New Church (NOR031);

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<sup>20</sup> The area in which ground settlement arising from tunnelling or other below ground works could be more than 10mm in depth.

- thirty Grade II listed buildings: including the 19th century Twyford Abbey and its associated Church of St Mary (NOR002); and
- fourteen conservation areas: Hanger Hill (Haymills) Estate (NOR001); Brunswick (NOR003); Brentham Garden Estate (NOR005); Canalside (NOR008); Hanger Hill Garden Estate (NOR011); Acton Town Centre (NOR012); Creffield (NOR013); Ealing Cricket Ground (NOR014); Montpelier Park (NOR015); Grange and Whiteledges Estates (NOR016); St. Stephens (NOR017); Cuckoo Estate (NOR018); South Hill Avenue (NOR019); and Mount Park Estate (NOR020).

### *Non-designated assets*

6.3.5 The following identified non-designated assets of low value lie partially or wholly within the land required, temporarily or permanently for the construction of the Proposed Scheme, or within the 10mm settlement contour:

- five Greater London archaeological priority zones: Twyford Abbey (NOR002); the River Brent (NOR004); Manor Farm (NOR006); Horsenden Hill (NOR007); and Northolt Village Green (NOR009);
- three locally listed buildings: Hanger Lane London Underground station (NOR036); Greenford General Post Office (NOR039); and Greenford London Underground station (NOR041);
- Northolt London Underground station (NOR042);
- site of Park Royal London Underground station (NOR066);
- Great Western Main Line and Great Central Joint Railway (NOR050); the London Underground Central line (NOR045); the Ealing and Shepherds Bush Railway (NOR046); the Great Western Main Line (NOR050); the Greenford Loop Line (NOR051); the London Underground Piccadilly line (NOR052); and the London Underground District line (NOR053);
- the Grand Union Canal (NOR047); and
- Charville Lane medieval trackway (NOR069).

6.3.6 All non-designated heritage assets within 250m of the land required, temporarily or permanently, for the construction of the Proposed Scheme are listed in the gazetteer in Volume 5: Appendix CH-002-005 and identified in on Maps CH-01-013 to CH-01-018a (Volume 5, Cultural Heritage Map Book). There are a number of built heritage assets, the settings of which have been considered, for example:

- a bridge over the Grand Union Canal, Paddington Arm (NOR033);
- the Ace Café (NOR034);
- a Second World War pillbox (NOR035);
- Stonebridge Park London Underground and London Overground station (NOR036);
- the Fox and Goose public house (NOR038); and

- the Greenford General Post Office (NOR039).

### *Cultural heritage overview*

- 6.3.7 The underlying bedrock geology of the study area is London Clay. There are superficial deposits of alluvium and river terrace Taplow Gravel found along the River Brent and its tributaries. The majority of Palaeolithic artefacts discovered in Greater London are within the River Terrace Gravels and there have been Palaeolithic stone implements found adjacent to the River Brent (NOR061 and NOR064) and are the primary reason for the River Brent Archaeological Priority Zone. There is no further evidence from the early prehistoric or Bronze Age periods, although this may partially be due to a lack of archaeological investigations in this area.
- 6.3.8 The topography of the study area gently rises (between 35m to 40m AOD (above ordnance datum) towards Horsenden Hill and Harrow Hill to the north of the Proposed Scheme. There is a focus of later prehistoric activity, identified by the LBE as an archaeological priority zone, on the Iron Age hillfort at Horsenden Hill (NOR007). The presence of the hillfort indicates that the surrounding landscape is likely to have been managed in the Iron Age and Romano-British period, with planned land divisions and a settlement focus on the river terraces within the wider area. However, no physical evidence has been identified within the study area to support the presence of further occupation in the Iron Age or Roman periods. The lack of Roman remains can partially be attributed to the lack of any major Roman roads from London crossing this area, along with the heavy London Clay, which would have made the area unattractive for settlement.
- 6.3.9 Evidence of Saxon domestic sites and burials has been recorded at Northolt<sup>21</sup> and the site of a deserted village, West Twyford (NOR057), is thought have had its origins in the early medieval period<sup>22</sup>. This indicates that small settlements were established at this time and likely expanded throughout the medieval period<sup>23</sup>.
- 6.3.10 Other small settlements (NOR009, NOR043 and NOR057), isolated moated manors (NOR007 and NOR021) and individual farmsteads have been dated to the medieval period. Charville Lane (NOR069), now Eastcote Lane, is a possible medieval (or earlier) trackway linking Northolt to Hillingdon. The historic core of Northolt, identified as the Northolt Village Green Archaeological Priority Zone, was medieval in origin and centred on the St. Marys Church (NOR004) built circa AD 1300.
- 6.3.11 The settlement pattern established in the early medieval and medieval periods remained largely unchanged until the early 19th century. The Grand Union Canal was constructed through the study area in 1801 (NOR047) and the first section of the Great Western Railway which ran through the study area (NOR043) was opened in 1838. However, the majority of the study area remained rural in character up to the 1930's, when industrial and residential development occurred due to the gradual expansion of London, hastened by the construction of a road network, including the A40 Western

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<sup>21</sup> Baker, T.F.T., Cockburn, J.S and Pugh R.B (1971), *A History of the County of Middlesex: Volume 4: Harmondsworth, Hayes, Norwood with Southall, Hillingdon with Uxbridge, Ickenham, Northolt, Perivale, Ruislip, Edgware, Harrow with Pinner Victoria County History.*

<sup>22</sup> Baker, T.F.T. and Elrington, C. R. (editors) (1982), *A History of the County of Middlesex: Volume 7: Acton, Chiswick, Ealing and Brentford, West Twyford, Willesden.*

<sup>23</sup> Hamerow H (2002), *Early Medieval Settlements, The Archaeology of Rural Communities in Northwest Europe 400-900*, Oxford University Press, Oxford.

Avenue in 1927 and the North Circular Road in 1934-35. Notable industry included Hoover, whose art deco building (NOR026) is notable for its design, and the Guinness brewery and the Guinness Sports Club (NOR055) which was built for the use of the brewery workers and was used in the 1948 Olympics. Some of the post-medieval rural character is retained as open spaces within the study area, which are now used as community facilities, including two golf courses and a cemetery, rather than for agricultural purposes.

## Future baseline

### *Construction (2017)*

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

### *Operation (2026)*

- 6.3.13 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:
- the construction of the Proposed Scheme in tunnel has avoided temporary and permanent impacts on heritage assets throughout the study area; and
  - Mandeville Road vent shaft has been designed to be in keeping with the height of neighbouring residential properties. This will ensure that there is no change to the setting of the Northolt Village Green Conservation Area (NOR010).

## 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 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, as well as other construction factors.
- 6.4.4 No significant effects will occur as a result of temporary impacts on the setting of designated or non-designated heritage assets within the study areas.

### *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 on heritage assets within the land required, temporarily and permanently, for the construction of the Proposed Scheme.
- 6.4.7 As the Proposed Scheme is in tunnel with limited surface features, no significant permanent construction effects on the setting of heritage assets have been predicted in this assessment.

### *Permanent cumulative effects*

- 6.4.8 There are no inter-project effects on cultural heritage.

## Other mitigation measures

- 6.4.9 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.

## Summary of likely residual significant effects

- 6.4.10 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.

## 6.5 Effects arising from operation

### Avoidance and mitigation measures

- 6.5.1 No measures will be required 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, although 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 As the Proposed Scheme is in tunnel, there will be no additional noise or visual impacts from the operation of the railway. As such, there are no significant operational effects.

### **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 and mapped in Maps CT-13-006 to CT-13-008a (Volume 5, Cross Topic Appendix 1 Map Book).

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

### **Other mitigation measures**

- 6.5.6 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. Potential opportunities for further mitigation have not been identified, but will be considered as part of the detailed design process.

### **Summary of likely residual significant effects**

- 6.5.7 No mitigation beyond that described above has been identified and consequently the residual effects are the same as those reported in the assessment of impacts and effects section.
- 6.5.8 No significant residual effects have been identified in this assessment.



# 7 Ecology

## 7.1 Introduction

- 7.1.1 This section describes the ecological baseline and identifies likely impacts and significant ecological effects that will arise from the construction and operation of the Proposed Scheme. These include impacts on species, habitats and sites designated for their importance for nature conservation.
- 7.1.2 The principal ecological issues in this area are: the loss of habitat and reduction of connectivity of the Railside Habitats: Harlesden to Wembley Central, including Wembley Brook Site of Borough Importance Grade 1 (SBI.I); Central Line, West Ruislip Branch Site of Borough Importance Grade 2 (SBI.II); Acton Railsides SBI.I; and the loss of small areas of terrestrial habitat for great crested newt in land south of Carr Road.
- 7.1.3 Volume 5 of the ES contains supporting information to the ecological assessment reported in this section, including:
- results of ecological surveys (Volume 5: Appendices EC-001-001, EC-002-001, EC-003-001 and EC-004-001); and
  - register of local/parish level effects which are not reported individually in Volume 2 (Volume 5: Appendix EC-005-001).
- 7.1.4 As well as survey data, the assessment draws on existing information gathered from national organisations and from regional and local sources including Greenspace Information for Greater London, London Wildlife Trust and London Bat Group.

## 7.2 Scope, assumptions and limitations

- 7.2.1 The scope and methodology of the ecological assessment are introduced in the SMR (Volume 5: Appendix CT-001-000/1) and SMR Addendum (Volume 5: Appendix CT-001-000/2). Further detail, including the study area for individual surveys, is provided within the SMR Addendum. 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-001-001, EC-002-001, EC-003-001, and EC-004-001.
- 7.2.2 A Water Framework Directive assessment has been undertaken in conjunction with the environmental assessment. Details of this assessment are presented in Volume 5: Appendix WR-001-000.
- 7.2.3 It should be noted that the baseline information provided in this section does not include descriptions of designated sites, habitats and species above the bored tunnel which extends through the whole area, and where no impacts on ecological receptors are expected.
- 7.2.4 In this area, a deviation from the standard survey methodology for reptiles was necessary on operational railway land due to restrictions on the placing of tin artificial refugia. As a consequence, the surveys utilised roofing felt refugia only. It is not considered the deviation had any effect on the results of the survey.

- 7.2.5 The scheme design, the urban location of the Proposed Scheme and the absence or limited extent of suitable habitats mean that some species and species groups have been scoped out of the assessment. This is because the habitats that support them are not present (badger and dormouse), or due to other reasons (the invasive species which indicates white-clawed crayfish are unlikely to be present). In addition, as no impacts are expected on aquatic invertebrates and fish they were removed from the survey scope. Further information is presented in Volume 5: Appendices EC-001-001, EC-002-001, EC-003-001, and EC-004-001.
- 7.2.6 Access was not obtained to all of the land area where general habitat survey (Phase 1 habitat survey) was proposed. Partial Phase 1 habitat survey was carried out from PRoW<sup>24</sup> for areas where access was not permitted. Locations with the potential to support key ecological receptors where access could not be gained for survey include the land proposed for the F-sidings satellite compound north-west of Old Oak Common, the Greenpark Way vent shaft main compound; the River Brent; the reedbed south of Carr Road; and some buildings and trees within or adjacent to the Proposed Scheme in the vent shaft construction compounds. Further details are provided in Volume 5: Appendices EC-001-001, EC-002-001, EC-003-001, and EC-004-001.
- 7.2.7 Where data are limited, a precautionary baseline has been built up according to the guidance provided in Volume 5: Appendix CT-001-000/2. This constitutes a 'reasonable worst case' basis for the subsequent assessment.
- 7.2.8 The precautionary approach to the assessment has been adopted to identify the likely significant ecological effects of the Proposed Scheme.

## 7.3 Environmental baseline

### Existing baseline

- 7.3.1 This section describes the ecological baseline relevant to the assessment: the designated sites, habitats and species recorded in this area. Further details are provided in the reports and maps presented in Volume 5 (Appendices EC-001-001, EC-002-001, EC-003-001, and EC-004-001 and Maps EC-01 to EC-12 in Volume 5, Ecology Map Book CFA 5). Statutory and non-statutory designated sites are shown on Map EC-01 (Volume 5, Ecology Map Book CFA 5).
- 7.3.2 Land required for the construction of the Proposed Scheme and that adjacent to it consists of a mixture of suburban residential development, light industrial areas, small urban parks and larger open spaces. Some of the open spaces contain remnants of the kind of woodland and grassland habitats that might be expected in more rural areas. Wildlife habitat exists along the railway corridor, the Grand Union Canal at Greenford and the River Brent. Towards the western edge of the area at Northolt there are some agricultural paddocks and fields.

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<sup>24</sup> For ease of discussion, PRoW has been used throughout the document to describe pavements alongside public highways.

### Designated sites

7.3.3 There are four statutory designated sites located within 500m of the land required for the construction of the Proposed Scheme<sup>25</sup>. These are:

- Fox Wood LNR – a remnant of ancient woodland to the west of Hanger Hill Park. One of the few remaining woodland areas in Ealing, particularly valuable because of ancient woodland species at the northern end of the site supporting wild flowers, birds and animals. The site is approximately 300m south of land that will be required for utilities works associated with the Proposed Scheme and is of district/borough value;
- Perivale Wood LNR – comprises an 11ha site of ancient oak-ash woodland with an understorey of coppiced hazel. In addition to the wood, there is uncultivated grassland, grazed pasture land, a small area of damp scrub, three ponds and two small streams as well as several hedgerows. A number of protected bird, invertebrate, reptile and mammal species have been recorded in the reserve. The site supports over 600 species of fungi, 300 species of moth and 40 species of regularly breeding birds including several species of principal importance identified on Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)<sup>26</sup> and London Biodiversity Action Plan (BAP) species<sup>27</sup>. The LNR is approximately 50m north-east of land that will be required for utilities works associated with the Proposed Scheme and is of district/borough value;
- Islip Manor LNR – comprises meadow grassland managed for nature conservation supporting various common grass species with a woodland understorey developing beneath planted horse chestnut, hornbeam and common lime trees. The LNR is approximately 210m south of the land required for construction of the Mandeville Road vent shaft and is of district/borough value; and
- Northolt Manor LNR – is the site of a 14th century moated manor which supports varied habitat that includes meadows, scrub, woodlands, wetlands, ponds and small lakes. The LNR is approximately 150m south of the land that may be required for utilities works associated with the Proposed Scheme and is of district/borough value.

7.3.4 There are 11 Local Wildlife Sites (LWS) relevant to the assessment (within or adjacent to the three vent shafts and utilities). They are:

- Perivale Wood Site of Metropolitan Importance (SMI) – comprises ancient oak-ash woodland with an understorey of coppiced hazel, uncultivated grassland, grazed pasture land, a small area of damp scrub, three ponds and two small streams as well as several hedgerows. It is bounded on the northern edge of the wood by the Grand Union Canal. This site is adjacent to land that may be required for utilities works associated with the Proposed Scheme and is of county/metropolitan value;
- London Canals SMI – this stretch of the Grand Union Canal is a section of the

<sup>25</sup> Designated sites above the tunnel are not anticipated to be subject to impacts and as such are not included here.

<sup>26</sup> *Natural Environment and Rural Communities (NERC) Act 2006* (c.16). London, Her Majesty's Stationery Office.

<sup>27</sup> London Biodiversity Partnership; London's BAP Priority Species; <http://www.lbp.org.uk/londonpriority.html>; accessed 2.10.13

wider London Canals SMI. The London Canals SMI supports a number of scarce wetland plants and uncommon plants on banks, brickwork and towpaths. The SMI supports bird, invertebrate, fish species and in some areas water vole and otter. Where the London Underground Central line crosses the canal at Northolt, there is a small area of fen with common reed and other tall wetland plants south of Carr Road. Part of the site is within the land required for construction of the Proposed Scheme. The site is of county/metropolitan value;

- Acton RAILSIDES SBI.I – comprises wide rail cuttings with areas dominated by woodland and scrub and other more open areas dominated by grassland and tall herb habitats, managed to prevent woody species establishing. Piles of sand and bare ground provide habitat for reptiles and many invertebrates. Part of the site is within the land required for construction of the Proposed Scheme. The site is of district/borough value;
- RAILSIDE HABITATS: Harlesden to Wembley Central, including Wembley Brook SBI.I – comprise part of the network of railside habitats in Brent. The railside supports a mosaic of scattered trees, scrub, semi-improved neutral grassland, tall herbs and bare ground, the proportions depending on the substrate and the frequency and nature of management. Three main types have been identified within the railway land comprising varying complexes of scrub, rough grassland tall-herb ruderal vegetation and bare ground. Part of the site is within the land required for construction of the Proposed Scheme. The site is of district/borough value;
- Central Line West Ruislip Branch SBI.II – this site is well vegetated and wide throughout most of its length, occurring on embankment and cutting. Habitats are varied and include woodland, scrub and grassland suitable for a range of species. Part of the site is within the land required for construction of the Proposed Scheme at Westgate Business Park and Greenpark Way and Mandeville Road vent shaft main compounds. The site is of district/borough value;
- Former Guinness Mounds SBI.II – comprise two mounds on both sides of a railway cutting on which habitats have developed on waste construction material. Habitats comprise secondary woodland, scrub, semi-improved neutral grassland, scattered trees, ruderal vegetation, tall herbs and areas of bare ground. Part of the site is within the land that may be required for the Proposed Scheme. The site is of district/borough value;
- River Brent at Hanger Lane SBI.II – comprises a canalised section of the River Brent with strips of semi-natural habitat adjacent along the south bank supporting scrub, scattered trees and ruderal vegetation. The site is adjacent to land that may be required for utilities works associated with the Proposed Scheme and is of district/borough value;
- Abbey Road Mound and Bestway Park SBI.II – comprises a grassy embankment alongside a footpath. Scrub, semi-improved grassland, tall herbs and ruderal vegetation are present along with planted ornamental and native shrubs. The site is adjacent to land that may be required for utilities works associated with the Proposed Scheme and is of district/borough value;

- Victoria Road Railway Banks SBI.II – comprises an extensive area of scrub and trees around a railway junction and surrounding a waste transfer station. More open areas close to the railway support diverse rough grassland and ruderal habitats. The site is likely to be utilised by birds, mammals and a wide range of invertebrates. The site is adjacent to the land that may be required for utilities works associated with the construction of the Proposed Scheme and is of district/borough value;
- Ealing Central Sports Ground Site of Local Importance (SLI) – comprises a stream/ditch which is largely in an underground pipe, but supports marginal vegetation where it surfaces and a large outgrown hedge which may be a remnant of the field boundaries in the former countryside. Both are located on the edge of a large area of amenity grassland, Ealing Central Sports Ground. The site is within land that may be required for utilities works associated with the Proposed Scheme and is of local/parish value; and
- Hanger Lane Gyratory SLI – comprises a small area of land surrounded by Hanger Lane gyratory road junction. Habitats present include secondary woodland, scrub, semi-improved neutral grassland, amenity grassland, scattered trees and areas of bare ground. Part of the site is within land that may be required for utilities works associated with the Proposed Scheme. The site is of local/parish value.

### *Habitats*

- 7.3.5 The following habitat types which occur in this area are relevant to the assessment (within or adjacent to the three vent shafts and utilities).

#### **Woodland**

- 7.3.6 Woodland is present at Perivale Wood and alongside the railway.
- 7.3.7 Perivale Wood, an ancient woodland, comprises semi-natural broad-leaved woodland and a small area of wet woodland. The woodland in Perivale Wood is of county/metropolitan value and qualifies as a Section 41 habitat of principal importance<sup>28</sup> lowland mixed deciduous woodland. Woodland is a London BAP habitat<sup>29</sup>, woodland (including scrub) is an Ealing BAP<sup>30</sup> habitat, and Perivale Wood is identified as a critical natural capital habitat in the Ealing BAP.
- 7.3.8 Woodland is present on railsides, such as at Mandeville Road, and other locations including embankments at Hanger Lane. The woodland is secondary woodland regenerating from scrub. The network of railside woodland is of district/borough value.

#### **Grassland**

- 7.3.9 The grassland south of Perivale Wood is grazed and of conservation interest due to the presence of locally uncommon plants. Neutral grassland is an Ealing BAP habitat. The grassland south of Perivale Wood is of district/borough value.

<sup>28</sup> Ealing Council (1999), *Ealing Biodiversity Action Plan*; [http://www.ealing.gov.uk/info/200588/nature\\_conservation/630/biodiversity\\_action\\_plan](http://www.ealing.gov.uk/info/200588/nature_conservation/630/biodiversity_action_plan).

<sup>29</sup> London Biodiversity Partnership; London's BAP Priority Habitats; <http://www.lbp.org.uk/londonhabssp.html#HAPlist>; accessed 2.10.13

<sup>30</sup> Ealing Council (1999), *Ealing Biodiversity Action Plan*; [http://www.ealing.gov.uk/info/200588/nature\\_conservation/630/biodiversity\\_action\\_plan](http://www.ealing.gov.uk/info/200588/nature_conservation/630/biodiversity_action_plan); accessed 2.10.13

- 7.3.10 Rough grassland forming mosaics with bramble, scrub, ephemeral and ruderal vegetation is present on the railsides. This grassland is of local/parish value.
- 7.3.11 Strips of weedy rough grassland derived from amenity-turf are present by the towpath of the Grand Union Canal. Amenity grassland is an Ealing BAP habitat. This grassland is of local/parish value.

### **Swamp**

- 7.3.12 A small area of reed-swamp strongly dominated by common reed is located between the northern side of the railway and the western side of the Grand Union Canal at Greenford. Reedbeds are an Ealing BAP habitat and the reedbed identified is likely to qualify as a habitat of principal importance. The swamp is a locally scarce habitat, part of the London Canals SMI and is therefore of county/metropolitan value despite its small size.
- 7.3.13 Open areas in wet woodland in the southern part of Perivale Wood contain swamp. The swamp is a locally scarce habitat and therefore of district/borough value.

### **Watercourses**

- 7.3.14 The River Brent, including River Brent at Hanger Lane SBI.II, is a relatively wide but shallow river in a partly straightened and engineered channel. Parts of the bank are lined and shaded by trees, and have shade-tolerant plants. North of the A40 Westway, the river banks are steep and covered in dense, eutrophic, tall-herb ruderal vegetation (with brambles and scattered bushes) that includes invasive species such as Japanese knotweed and giant hogweed. Rivers and streams are a London BAP habitat and rivers, streams and canals are an Ealing BAP habitat. The River Brent may qualify as a habitat of principal importance if otter are confirmed to be present<sup>31</sup>. The watercourse is of district/borough value.

### **Water bodies**

- 7.3.15 The Grand Union Canal is a body of very slow-moving eutrophic fresh water. The water body supports submerged stands of aquatic plants and sparse water-margin vegetation. Rivers, streams and canals are an Ealing BAP habitat. The Grand Union Canal forms part of a London-wide site that, as a whole, is of county/metropolitan value.
- 7.3.16 There are several small ponds surrounded by reed-swamp vegetation and wet woodland south of Perivale Wood LNR and within the SMI. A pond with extensive water-margin vegetation in grassland is located at Brentham Meadows. A pond is present in fields near Islip Manor LNR within the South Ruislip to Ickenham area (CFA6) but adjacent to this study area, and two further ponds are present in Islip Manor LNR. Ponds supporting great crested newt are a habitat of principal importance, standing water is a London BAP habitat, and ponds are an Ealing BAP habitat. These ponds are individually of district/borough value.

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<sup>31</sup> UK Biodiversity Action Plan; Priority Habitat Descriptions. BRIG (ed. Ant Maddock) 2008.  
<http://www.ukbap.org.uk/library/UKBAPPriorityHabitatDescriptionsfinalAllhabitats20081022.pdf>

## Mosaic and transition habitats

7.3.17 Three main habitat types have been identified within the railway land comprising varying complexes of scrub, rough grassland tall-herb ruderal vegetation and bare ground. This habitat occurs in Acton RAILSIDES SBI.I, RAILSIDE Habitats: Harlesden to Wembley Central, including Wembley Brook SBI.I, Central Line West Ruislip Branch SBI.II, and Victoria Road Railway Banks SBI.II. Railway land, while not identified as a local BAP habitat, has a Habitat Statement within the Ealing BAP, and railside habitats are a Brent BAP<sup>32</sup> habitat. These complexes of scrub, rough grassland and ruderal vegetation collectively are of district/borough value.

### Other habitats

7.3.18 All other habitats are of local/parish value or below. Full descriptions are provided in Volume 5: Appendices EC-001-001, EC-002-001, EC-003-001 and EC-004-001.

### Protected and/or notable species

7.3.19 A summary of the species relevant to the assessment (within or adjacent to the three vent shafts and utilities) is provided in Table 4.

Table 4: Protected and/or notable species

Species/ species group	Value	Receptors	Baseline and rationale for valuation
Bats	Up to regional	Bat assemblages roosting, foraging and commuting at Perivale Wood	Field survey and desk study indicate potential for roost sites of common and rarer bat species including noctule and Myotis bats in semi-natural ancient woodland with connectivity to the Grand Union Canal (which in this area contains tracts of riparian woodland and scrub) and habitat mosaic at Horsenden Hill. The presence of maternity roosts of noctule bats cannot be ruled out due to survey limitations.  Noctule bats are a species of principal importance <sup>33</sup> .
	Up to district/borough	Bat assemblages foraging and commuting at the Grand Union Canal at Greenford	The transect surveys recorded a good intensity of use of the canal with more than five foraging pipistrelle bats recorded on more than one occasion and with occasional recordings of Nathusius' pipistrelle and Myotis species.
	Up to local/parish	Bat assemblages foraging and commuting along railway land and potentially roosting in a small number of buildings and trees at the Westgate, Greenpark Way and Mandeville Road vent shaft main compounds, both within and adjacent to rail land	The field survey recorded two buildings with moderate potential however some buildings and trees could not be viewed.  The transect surveys recorded regular, very low level, dispersed commuting and foraging activity from common and soprano pipistrelle bats with occasional passes also recorded from Nathusius' pipistrelle, noctule and Myotis species bats.  Desk study and transect surveys along the rail land indicate small numbers of common bat species are present in the local urban environment.  Soprano pipistrelle is a species of principal importance. All

<sup>32</sup> Brent Council (2007), *Brent Biodiversity Action Plan*; <http://www.brent.gov.uk/media/325129/Brent's%20Biodiversity%20Action%20Plan%202007.pdf> (version 1.6 12.07.2007) First accessed: August 2013.

<sup>33</sup> Natural Environment and Rural Communities (NERC) Act 2006. Section 41: Species of Principal Importance in England.

Species/ species group	Value	Receptors	Baseline and rationale for valuation
			bats are London BAP species.
Birds	County/ metropolitan	Breeding hobby	The desk study reported a record of a pair of breeding hobby within this area. In 2010 there were eight confirmed pairs and ten possible breeding pairs of hobby in Greater London <sup>34</sup> and therefore the pair is important in the London context.  Birds of prey are an Ealing BAP species.
	Local/parish	Breeding bird assemblages within Perivale Wood	No field surveys were undertaken at Perivale Wood. The desk study indicated that 40 species have bred at Perivale Wood. The assemblage contains three red listed and seven amber species listed in the Birds of Conservation Concern (BoCC) <sup>35</sup> , although most are common and widespread. The assemblage is of local/parish value.
	Local/parish	Breeding bird assemblages in railway land at Hanger Lane and Westgate vent shaft main compound	A pair of linnets was recorded at the survey area at railway land near Hanger Lane. Linnets are a red listed species in the BoCC. The breeding bird community comprised of common and widespread species adapted to living in a built-up environment. Linnet is a species of principal importance.  The total number of species recorded at railway land at Hanger Lane and Westgate vent shaft main compound was 33. Of these 11 were notable species, with three red listed species and 8 amber listed species.
	Local/parish	Breeding bird assemblages in railway land at Greenpark Way vent shaft main compound	The total number of species recorded at railway land at Greenpark Way vent shaft main compound was 39. Of these 14 were notable species, with five red listed species and nine amber listed species.
	Local/parish	Breeding bird assemblages in railway land at Mandeville Road vent shaft main compound	The total number of species recorded at railway land at Mandeville Road vent shaft main compound was 39. Of these 14 were notable species, with five being red listed species and nine being amber listed species. The breeding bird community in the hedgerows and scrub along the railway at the vent shaft locations showed some diversity and is of local interest.
	Local/parish	Breeding bird assemblages in the reedbed at the Grand Union Canal crossing at Greenford	No field survey was undertaken of the reedbed at Carr Road however the desk study reported reed bunting, which is amber listed in the BoCC and it is likely other common species will use this habitat, potentially for breeding.
	Local/parish	Wintering bird assemblages in Perivale Wood	Seven notable species were recorded at Perivale Wood including three species red listed in BoCC and four amber list species.  All wintering assemblages were of common and wide spread species and none were significant in terms of diversity or numbers.

<sup>34</sup> Holling, M. and the Rare Breeding Birds Panel. British Birds 105 (July 2012), *Rare and breeding birds in the United Kingdom 2010*, pp. 352–416. <http://www.rbbp.org.uk/downloads/rbbp-report-2010.pdf>

<sup>35</sup> Eaton, M.A. et al., British Birds 102 (2009). *Investigation Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man*, pp.296-341.

Species/ species group	Value	Receptors	Baseline and rationale for valuation
	Local/parish	Wintering bird assemblages in Islip Manor fields	<p>Along PRoW through Islip Manor fields and nearby fields five notable species were recorded, including three red list species and two amber list species.</p> <p>All wintering assemblages were of common and wide spread species and none were significant in terms of diversity or numbers.</p>
	Local/parish	Wintering bird assemblages in Lord Halsbury Memorial Playing Fields	<p>At Lord Halsbury Memorial Playing Fields ten notable species were recorded, including five BoCC red listed species and seven amber listed BoCC species.</p> <p>All wintering assemblages were of common and wide spread species and none were significant in terms of diversity or numbers.</p>
Water vole	Up to county/ metropolitan	Potential water vole population at wetland south of Carr Road at the crossing of the Grand Union Canal at Greenford	<p>Field survey comprising partial habitat assessment from PRoW recorded habitat with the potential to support water vole at the Grand Union Canal at Greenford and at an adjacent area of reed-swamp and ditch network. Desk study data reports records of water vole but aerial photography shows suitable habitat is limited in the local area. Water vole are scarce in London.</p> <p>Water vole is a species of principal importance and an Ealing BAP species.</p>
Otter	Up to county/ metropolitan	Potential otter population utilising the River Brent, and the Grand Union Canal at Greenford	<p>Field survey found no evidence of otter and desk study data indicate the species is rare in London. It is unlikely to be present. If it is present the Grand Union Canal and the River Brent provide a link to areas of potential breeding habitat (e.g. wetland south of Carr Road, Perivale Wood/Horsenden Hill area or further south along the River Brent). Otter are not a London BAP priority species, however they are listed as other important species, and are a species of principal importance.</p>
Amphibians	Up to county/ metropolitan	Potential great crested newt populations at ponds north of Islip Manor LNR and at wetland south of Carr Road at the crossing of the Grand Union Canal at Greenford	<p>Although access to these areas for field surveys was not available, the desk study reported small numbers of great crested newt at ponds north of Islip Manor and suitable habitat at wetland south of Carr Road. It has been assumed that a medium population size class is present at both locations. Great crested newt is not common in London.</p> <p>Great crested newt is a species of principal importance.</p>
Terrestrial invertebrates	Up to county/ metropolitan	Terrestrial invertebrate assemblages in land south of Carr Road	<p>Interpretation of aerial photography suggests an area of land south of allotments on Carr Road, and north of the Grand Union Canal at Greenford comprises reedbed /swamp, scrub, trees, ruderal vegetation and grassland. No desk study records were returned and access was not available for survey. As these habitats are known to support species of conservation interest, and are relatively rare habitats in London, it is assumed this area may support species of interest at up to the county/metropolitan value.</p>
	Up to district/ borough	Terrestrial invertebrate assemblages in railway land at the Westgate, Greenpark Way and Mandeville Road vent	<p>Eleven protected notable species were recorded during field survey within the areas of rail land. Collectively they form a movement corridor and habitat feature likely to be important to invertebrate populations across this area of London.</p>

Species/ species group	Value	Receptors	Baseline and rationale for valuation
		shaft main compounds	
	Local/parish	Terrestrial invertebrates assemblages in other habitats	The other habitats are considered to be of low interest for terrestrial invertebrate assemblages.
Common reptiles	Local/parish	Populations on suitable railway land habitat throughout the area	<p>Field survey indicates low populations of common reptiles, including slow worm, in the small areas of rail land adjacent to Greenpark Way vent shaft and Mandeville Road vent shaft.</p> <p>Desk study records of grass snake, slow worm and common lizard have been reported from a number of locations including Grand Union Canal at Greenford, railway land, Perivale Wood and fields north of Islip Manor LNR and SMI.</p> <p>Slow worm, adder, grass snake and common lizard are species of principal importance and London BAP priority species. Slow worm is an Ealing BAP species.</p>

## Future baseline

### *Construction (2017)*

- 7.3.20 A summary of the known developments which are assumed to be mostly built and occupied prior to construction of the Proposed Scheme is provided in Volume 5: Appendix CT-004-000. None of these developments will affect the character and value of the baseline ecological resources.

### *Operation (2026)*

- 7.3.21 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 route has been placed in tunnel which reduces impacts on railside habitats, and mainly limits habitat loss to vent shaft locations and utilities.
- 7.4.2 The assessment also assumes implementation of the measures set out within the draft CoCP (Volume 5: Appendix CT-003-000), which includes translocation of protected species where appropriate.

### Assessment of impacts and effects

#### *Designated sites*

- 7.4.3 The construction works at the F-sidings will result in the loss of approximately 1.8ha of the Railside Habitats: Harlesden to Wembley Central, including Wembley Brook SBI.I, representing 15% of the site. The loss of this habitat will result in partial fragmentation of the SBI and disruption to the function of the SBI as a corridor habitat that will represent a permanent adverse effect on site integrity that is significant at the district/borough level.

- 7.4.4 The construction works at Westgate, Greenpark Way and Mandeville Road for the vent shafts and works for utilities throughout this area will result in the loss of approximately 6ha of the Central Line, West Ruislip Branch SBI.II, representing 11% of the site. The loss of this habitat will result in partial fragmentation of the SBI at the location of the vent shafts. The habitat connectivity along the south of the SBI, and therefore the function of the SBI as a corridor habitat will be maintained. Nevertheless, there will be a permanent adverse effect on integrity of the SBI which will be significant at the district/borough level.
- 7.4.5 The works for utilities will result in the loss of approximately 1.8ha of Acton Railsides SBI.I representing 4% of the site. The SBI.I is also concurrently being adversely affected by works in the adjacent Kilburn (Brent) to Old Oak Common area (CFA4), resulting in the loss of a further approximately 9.2ha, amounting to 23% of the SBI.I overall. The loss of this area of habitat will result in fragmentation of the SBI.I at the location of the works, though some partial connectivity will be retained. In combination, these impacts will result in a permanent adverse effect on site integrity that is significant at the district/borough level.
- 7.4.6 The works for utilities will result in the loss of 0.2ha of Hanger Lane Gyrotory SLI representing 18% of the site. The loss of habitat will adversely affect the integrity of the SLI and will result in a permanent adverse effect that is significant at the local/parish level.
- 7.4.7 No significant impacts are expected for the following designated sites: Fox Wood LNR, Perivale Wood LNR, Northolt Manor LNR, Islip Manor LNR, Perivale Wood SMI, London Canals SMI, Former Guinness Mounds SBI.II, River Brent at Hanger Lane SBI.II, Ealing Central Sports Ground SLI, Abbey Road Mound and Bestway Park SBI.II, and Victoria Road Railway Banks SBI.II.

### *Habitats*

- 7.4.8 The construction works at Westgate, Greenpark Way and Mandeville Road for the vent shafts and works for utilities throughout this area will result in the loss of approximately 1.8 ha of mosaic and transition habitats which fall in Acton Railsides SBI.I, Railside Habitats: Harlesden to Wembley Central, including Wembley Brook SBI.I, and Central Line, West Ruislip Branch SBI.II. Habitat loss will occur along approximately 2.5km of the railway within this area. In addition, further areas of mosaic and transition habitat will be lost, approximately 3ha along 2.1km of railway in the Kilburn to Old Oak Common area (CFA4).
- 7.4.9 While these individual areas of loss of mosaic and transition habitat will have not more than local/parish effects on the conservation status of this habitat, the cumulative loss and subsequent adverse effects on the functionality and connectivity will result in an adverse effect on the conservation status of the habitat that is significant at the district/borough level.
- 7.4.10 The construction works at the Mandeville Road vent shaft will result in the loss of approximately 1ha secondary woodland habitat which partly lie in the Central Line, West Ruislip Branch SBI.II. This will result in a permanent adverse effect on the conservation status of the habitat significant at the district/borough level.

- 7.4.11 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-005-001.

### *Species*

- 7.4.12 The removal or disturbance of habitat features that are utilised by bats during breeding, hibernation or migrating between roosts are considered to have the potential to result in adverse effects on the bat populations or assemblages during construction. However, the point at which such impacts are considered likely to result in a significant adverse effect on the conservation status of the population concerned will differ depending on the status of the species concerned.
- 7.4.13 Losses of other habitat within the land required for the construction of the Proposed Scheme may require some bats to travel further, and expend more energy during day to day foraging and movement throughout their home range for the duration of construction. However, such effects alone are for all species considered unlikely to result in sufficient disturbance of the populations concerned to result in an adverse effect on their conservation status.
- 7.4.14 The vent shaft construction works and utilities at Westgate, Greenpark Way and Mandeville Road and along the existing railway corridor will involve the demolition of a small number of buildings some of which have moderate potential for roosting bats, and removal of trees which may result in the loss of roosts. There are however alternative roost sites in the local area. In addition these works will remove parts of the rail land habitats, however transect surveys indicate this corridor is not an important resource for foraging and commuting bats and whilst the bats may be forced to deviate from their usual route, it is likely that they will continue to use the retained habitat during the works. Nevertheless, this will result in an adverse effect on the conservation status of these populations that is significant at the local/parish level.
- 7.4.15 There are no impacts expected on bat populations and assemblages at Perivale Wood or bats foraging at the Grand Union Canal at Greenford.
- 7.4.16 The following describes the effect of the permanent loss of ponds and terrestrial habitat on great crested newt populations.
- 7.4.17 The utilities works at land south of Carr Road and adjacent to the Grand Union Canal at Greenford will result in the loss of approximately 0.7ha of supporting terrestrial habitat which appears from desk study to comprise mainly tree scrub along the existing railway bank and canal, and rough grassland. The works will not affect the water bodies at this location. This represents approximately 35% of suitable habitat in the surrounding 250m radius of the breeding ponds used by this assumed medium population of great crested newt. The works are located adjacent to the reedbed and ditches which appear to hold water at certain times of the year and may provide suitable breeding habitat. This will result in a permanent adverse effect on the conservation status of this assumed medium population of great crested newt that is significant at up to a county/metropolitan level.
- 7.4.18 The utilities works to the south of the railway at Lord Halsbury Memorial Playing Fields will result in the loss of approximately 0.5ha of supporting terrestrial habitat including semi-improved grassland and scrub, representing approximately 5% of

suitable habitat in the surrounding 250m radius of the breeding ponds north of Islip Manor used by this assumed medium population of great crested newt. The works are located over 80m from the closest breeding ponds and it is considered unlikely that this will result in an adverse effect on the conservation status of this assumed medium population of great crested newt.

- 7.4.19 The laying of utilities at land south of Carr Road adjacent to the Grand Union Canal at Greenford may result in the small scale loss of habitats suitable for water vole burrows, representing a small area of suitable habitat in the area used by this assumed population of water vole. The limited scope of these impacts will result in a permanent adverse effect on the conservation status of this assumed population of water vole that will be significant at up to a local/parish level.
- 7.4.20 There are no significant impacts reported for otter as there are no direct impacts to potential breeding habitat or obstruction of commuting routes on the Grand Union Canal at Greenford, including habitat south of Carr Road or the River Brent.
- 7.4.21 There are no impacts expected on hobby potentially breeding in this area.
- 7.4.22 It is considered unlikely that any other effects on species receptors at more than the local/parish level will occur. Effects at the local/parish level are listed in Volume 5: Appendix EC-005-001.

### Other mitigation measures

- 7.4.23 This section describes additional measures designed to reduce or compensate for significant ecological effects. These include habitat reinstatement and wetland habitat creation at Wormwood Scrubs in the Kilburn (Brent) to Old Oak Common area (CFA<sub>4</sub>).
- 7.4.24 Mitigation for the loss of approximately 1.8ha of habitat within the Railside Habitats: Harlesden to Wembley Central, including Wembley Brook SBI.I for the construction works at F-sidings will include the re-instatement of mosaic and transition habitat.
- 7.4.25 Mitigation for the loss of approximately 6ha of the Central Line, West Ruislip Branch SBI.II at Westgate, Greenpark Way and Mandeville Road vent shaft locations and utilities throughout this area will include the re-instatement of the mosaic and transition and native broadleaved woodland habitats.
- 7.4.26 Mitigation for the loss of approximately 1.8ha of Acton Railsides SBI.I and further cumulative loss in the Kilburn (Brent) to Old Oak Common area (CFA<sub>4</sub>) will include the re-instatement of mosaic and transition habitats.
- 7.4.27 Mitigation for the loss of approximately 0.2ha of the Hanger Lane gyratory SLI, will include the re-instatement of the same area of grassland, woodland and mosaic and transition habitats.
- 7.4.28 Given that opportunities to enhance restored habitats at the site of the impact are limited along the railway land and at the location of the vent shafts, a compensatory area of new wetland planting will be provided in the southern part of Wormwood Scrubs at a site which is within the boundaries of the Proposed Scheme. This will include the creation of seasonal pools and scrapes with swales planted with locally appropriate species such as rushes and sedges and areas of wildflower grassland and

native shrubs. The new habitats will be sited appropriately to allow continued use of the recreational sports pitches within the defined area, linking to existing areas of woodland and grassland habitats (see CT-06-008-L1, Permanent Features).

7.4.29 These measures will compensate for the loss of the designated sites reducing the effects to a level that is not significant.

7.4.30 Compensatory habitat to address adverse effects on great crested newt populations at the fields north of Islip Manor and land south of Carr Road will be provided in:

- the 0.7ha restored habitat at the land south of Carr Road; and
- the 2ha ecological habitat creation area to the west of Lord Halsbury Memorial Playing Fields.

7.4.31 This mitigation will be carried out in accordance with the ecological principles of mitigation in the SMR Addendum (Volume 5: Appendix CT-001-000/2). This will include the provision of replacement terrestrial habitat and hibernation habitat sufficient to maintain the favourable conservation status of the population affected.

7.4.32 The loss of any bat roosts in buildings, structures and trees will be compensated for by the provision of alternative compensatory roosts in accordance with the ecological principles of mitigation in the SMR Addendum (Volume 5: Appendix CT-001-000/2). The restoration of rail land habitats including mosaic and transition habitats and native broadleaved woodland equivalent to the area lost will mitigate the loss of foraging and commuting habitat for the assemblage of common bats.

7.4.33 Following the implementation of these measures proposed, any adverse impacts on bats during the construction of the Proposed Scheme will be reduced to a level at which they will not result in any significant effect on the conservation status of the species concerned.

7.4.34 Water vole mitigation will include the restoration of an equivalent area of habitat which will be lost at land south of Carr Road. These measures will be provided in accordance with the ecological principles of mitigation in the SMR Addendum (Volume 5: Appendix CT-001-000/2). Following the implementation of the measures proposed, any adverse impacts on water vole will be reduced to a level at which they will not result in a significant effect on the conservation status of the species concerned.

### **Summary of likely residual significant effects**

7.4.35 The mitigation, compensation and enhancement measures described above will reduce the effects to a level that is not significant at the construction stage.

## **7.5 Effects arising from operation**

### **Avoidance and mitigation measures**

7.5.1 No measures have been included as part of the design of the Proposed Scheme to avoid or reduce impacts on features of ecological value.

### **Assessment of impacts and effects**

7.5.2 No significant effects at operation have been identified.

### **Other mitigation measures**

7.5.3 No additional mitigation measures for the operational stage are required.

### **Summary of likely residual significant effects**

7.5.4 No significant residual effects have been identified at the operational stage.



## 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. Consideration is given to land that potentially contains contamination and land that has special geological significance, either from a scientific, mining or mineral resources point of view including: geological sites of special scientific interest (SSSI), local geological sites (LGS), areas of current underground or opencast mining, and areas of designated mineral resources. Mitigation measures are presented and any residual effects are summarised.
- 8.1.2 Potentially contaminated areas of land have been identified that could affect, or be affected by, the construction of the Proposed Scheme (for example contaminated soils may need to be removed or the construction may alter existing contamination pathways). Each of these areas has been studied to evaluate the scale of potential impacts caused by existing contamination (if present) and what needs to be done to avoid significant consequences to people and the wider environment. In addition, a review has been undertaken to establish whether the operation of the Proposed Scheme will lead to contamination of its surrounding environments and what needs to be done to prevent such contamination.
- 8.1.3 The main environmental features of this area include:
- residential areas of land;
  - groundwater quality within Secondary A or Principal aquifers at a depth that are within or close to vent shaft and tunnel construction in the eastern part of the Proposed Scheme; and
  - the River Brent and the Grand Union Canal.
- 8.1.4 The main land quality issues in this area include the presence of former potentially contaminating activities at each of the three vent shaft sites.
- 8.1.5 Details of baseline information and the land quality assessment methodology are presented in the following appendices (presented in Volume 5):
- the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2); and
  - Volume 5: Appendix LQ-001-005: Land Quality.
- 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: Water resources and flood risk assessment. Issues regarding the disposal of waste materials, including contaminated soils, are addressed in Volume 3: Section 16.
- 8.1.7 Engagement has been undertaken with the LBE, the LBB, the Ministry of Defence (MoD) and Environment Agency regarding contaminated land. Information has been

received from the LBB and is summarised in Volume 5: Appendix LQ-001-005. No information was received from the LBE or the MoD.

- 8.1.8 Engagement was also undertaken with the London Fire Brigade regarding the on-site storage of petroleum and the information received is summarised in Volume 5: Appendix LQ-001-005.

## 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 (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). 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 areas of utility work in the highway and proposed offline train stabling areas) 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. 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-001-005.

## 8.3 Environmental baseline

### Existing baseline

- 8.3.1 Unless otherwise stated, all features described in this section are presented in Maps LQ-01-006 to LQ-01-008a (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-02-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 8.3.3 Made ground has not been indicated as present on the geological map<sup>36</sup>. A cover of made ground is however likely to be present throughout the majority of the study area due to previous cycles of development.
- 8.3.4 Superficial deposits are present in the eastern part of the Northolt Corridor where they comprise alluvium and River Terrace Deposits (Taplow Gravel and Kempton Park Gravel) associated with the River Brent which crosses the route in this area.

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<sup>36</sup> Geological Survey of Great Britain, 2006, North London, Sheet 256, Solid and Drift Edition, 1:50,000 series, Ordnance Survey, Southampton.

- 8.3.5 A further narrow ribbon of Alluvium is also present in the western part of the Northolt Corridor (adjacent to Greenford station) which is associated with an unnamed drainage ditch.
- 8.3.6 Alluvium is typically a soft to firm compressible silty clay, but can contain layers of silt, sand, peat and may include basal gravel. Thickness is highly variable. The Kempton Park Gravel is described by the British Geological Survey (BGS) as comprising sand and gravel, with local lenses of silt, clay or peat.
- 8.3.7 Superficial deposits are indicated as being absent from the remainder of the study area.
- 8.3.8 The bedrock geology underlying the entirety of the Northolt Corridor is the London Clay Formation of the Thames Group. Typically, this is a stiff grey and weathering to brown clay with thin beds of sand and pebbles at the base.
- 8.3.9 To the south-west of Park Royal, close to the Hanger Lane gyratory, geological mapping shows an outcrop of the Claygate Beds to be present. The Claygate Beds is the uppermost unit of the London Clay and comprises interbedded fine-grained sand, silt and clay.
- 8.3.10 The geological succession beneath the London Clay dips at a shallow angle to the east leading to a variation in depth of strata across the Northolt Corridor. The geological succession generally comprises the following:
- the Harwich Formation, a thin sandy deposit (potentially only very localised);
  - the Lambeth Group (also termed the Woolwich and Reading Formations) which comprises a mixture of clay, sand and occasional pebble beds;
  - the Thanet Sand Formation is a dense green sand potentially very thin and very localised in this area, although in the most part likely to be absent; and
  - the Chalk Group, which is a soft white limestone.
- 8.3.11 The Westgate vent shaft will be entirely located in the London Clay, and the Greenpark Way and Mandeville Road vent shafts will extend close to the base of the Lambeth Group. It is anticipated that the tunnel section will be situated in the London Clay in the east of the study area crossing into the Lambeth Group in the Perivale area.

### *Groundwater*

- 8.3.12 The alluvium and River Terrace Deposits are both designated by the Environment Agency as Secondary A aquifers.
- 8.3.13 The London Clay Formation is classified by the Environment Agency as an unproductive strata (i.e. is not considered to represent a usable groundwater resource). The Claygate Member which outcrops close to Hanger Lane is classified by the Environment Agency as a Secondary A aquifer.
- 8.3.14 The Lambeth Group and the Thanet Sand Formation which underlie the London Clay Formation, are classified as Secondary A aquifers, whilst the Chalk is classified as a

Principal aquifer. The lower part of the Lambeth Group, the Thanet Sand Formation and the Chalk in the London area are collectively known as the 'lower aquifer'.

- 8.3.15 The Environment Agency reports that there are five licences for groundwater abstractions at eight locations within the study area. There are no public water supplies (PWS) or associated Source Protection Zones (SPZ) in this study area. Details regarding the abstractions are provided in Volume 5: Appendix WR-002-005 and are shown on Map WR-02-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 8.3.16 Further detail on the groundwater beneath the Proposed Scheme can be found in Section 13.

### *Surface waters*

- 8.3.17 Water bodies within this study area include the River Brent (below Silk Stream and down to the River Thames), the Grand Union Canal (Paddington Branch) and the Yeading Brook (Eastern Arm) as well as a number of un-named drains, ponds and culverts. In this study area the route is entirely in tunnel and will pass beneath all of the watercourses named above.
- 8.3.18 Further information on surface waters is provided in Section 13.

### *Current and historical land use*

- 8.3.19 Current land uses of note along the route in the study area are summarised below. The information was gained by a site reconnaissance of the study area from publicly accessible areas.
- 8.3.20 The route is situated almost entirely beneath an existing railway corridor. A series of industrial estates are located between North Acton (see Map LQ-01-006, H6 (Volume 5, Land Quality Map Book)) and Park Royal (see Map LQ-01-006, F7 (Volume 5, Land Quality Map Book)). The industrial estates consist largely of warehouses and trade and retail parks. Industry within these areas is varied and includes, but is not limited to, logistics, electrical contracting, vehicle retailers, telecommunications, industrial cleaners, wholesalers, builder's merchants and a cement works.
- 8.3.21 The Proposed Scheme includes three vent shafts within the Northolt Corridor area, two of which will be located within areas of current industrial land use. These are the Westgate vent shaft, within the Manhattan Business Park to the east of the River Brent (see Map LQ-01-006, C6 (Volume 5, Land Quality Map Book)), and the Greenpark Way vent shaft within Greenpark Way Business Park (see Map LQ-01-007, D6 (Volume 5, Land Quality Map Book)).
- 8.3.22 The Mandeville Road vent shaft is located within an area of railway land to the west of the study area, adjoining Mandeville Road (see Map LQ-01-008a, F6 (Volume 5, Land Quality Map Book)). Within the surrounding study area, other adjacent land uses to the route include a series of industrial parks with some interspersed residential estates, largely located to the north, and with residential properties and small areas of recreational land largely located to the south. Industry within these areas is varied and includes, but is not limited to: vehicle workshops, lighting wholesalers, a medical research facility, brand distribution and development and specialist plastics and distribution outlets.

- 8.3.23 Within the Perivale Industrial Estate to the north of the route (see Map LQ-01-007, G6 (Volume 5, Land Quality Map Book)), industries include electroplating, printing, electrical engineering and various product manufacturing facilities.
- 8.3.24 Within the Kelvin Industrial Estate in Northolt (see Map LQ-01-008a, I6 (Volume 5, Land Quality Map Book)) and adjoining industrial areas to the south of the route and west of the Greenpark Way vent shaft, the key potentially contaminating land use comprises a polythene and polypropylene products manufacturer. Several other unspecified manufacturing facilities and warehousing are also present.
- 8.3.25 Historically, the land above the route principally comprised railway use from the beginning of the 20th century, having been undeveloped farmland prior to this. The land beside the railway comprised factories and printing works from at least the 1920s and is presently still in light industrial/commercial use.
- 8.3.26 Within the surrounding areas, historical mapping indicates that between Acton Cemetery and Park Royal, industry in the manufacturing sector was prevalent during the early to mid-20th century. Engineering works dominated, although scrap metal/metal storage yards, printing works and machinery works can all be highlighted as potential sources of contamination.
- 8.3.27 Where the route crosses the River Brent (see Map LQ-01-007, J6 (Volume 5, Land Quality Map Book)), industrial land uses were also historically present either side of the railway. In the Perivale area, a cluster of manufacturing industries was present since the early 20th century on the northern side of the railway. Notable industries included engineering, pharmaceuticals, paint and perfume works, research laboratories (paint and electrical), chemical works, an abattoir and electrical component factories.
- 8.3.28 At the proposed Greenpark Way vent shaft, a large glass works, approximately 15ha in extent, and a much smaller white lead works were present in the early part of the 20th century (see Map LQ-01-007, D6 (Volume 5, Land Quality Map Book)).
- 8.3.29 Where the route crosses the Grand Union Canal (see Map LQ-01-008a, H6 (Volume 5, Land Quality Map Book)), a series of food and beverage factories and warehouses were built in the mid-20th century, much of which is still present today.
- 8.3.30 Sites which may pose a contaminative risk for the Proposed Scheme and identified by the review are (from east to west):
- the business park by the proposed Westgate vent shaft (see Map LQ-01-006, C6 (Volume 5, Land Quality Map Book));
  - the former white lead works, glass works and existing light industrial/commercial units and railway land around the proposed Greenpark Way vent shaft (see Map LQ-01-007, D6 (Volume 5, Land Quality Map Book)); and
  - railway land at the location of the proposed Mandeville Road vent shaft (see Map LQ-01-008a, F6 (Volume 5, Land Quality Map Book)).
- 8.3.31 All potentially contaminated sites identified from both current and historical land uses are shown on Maps LQ-01-006 to LQ-01-008a (Volume 5, Land Quality Map Book).

### *Other regulatory data*

- 8.3.32 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).
- 8.3.33 There were no notable regulatory data entries within the immediate vicinity of the route itself. A relatively large number of entries are located in the 250m buffer relating to the various industries that were highlighted in earlier sections. The entries highlight the industrial and former industrial nature of much of the study area.

### *Mining and mineral areas*

- 8.3.34 There are no active mining or mineral sites or Minerals Safeguarding Areas (MSA) within the study area. Additionally, no planned extraction sites are shown by the minerals planning authority.

### *Geo-conservation resources*

- 8.3.35 There are no geological conservation resources identified within the study area.

### *Receptors*

- 8.3.36 The sensitive receptors that have been identified within this study area are summarised in Table 5.

Table 5: Summary of receptors

Issue	Receptor type	Receptor description	Receptor sensitivity
Land contamination	People	Residents	High
		Workers	Moderate
	Controlled waters	Grand Union Canal	High
		Secondary A aquifer in the Alluvium, River Terrace Deposits	Moderate
		Secondary A aquifer in Lambeth Group/Thanet Sand Formation	Moderate (high where in continuity with underlying Chalk)
		Principal aquifer in Chalk	High
	Built environment	Buildings and property	Low to high
		Underground structures and services	Low

### **Future baseline**

- 8.3.37 As part of the assessment of the potential future baseline, a search was undertaken of all relevant permitted planning applications within the study area. There are currently no identified committed development sites within the study area which are likely to change the land quality baseline during either construction or operation of the Proposed Scheme. The sites identified are all located outside the land required to construct the Proposed Scheme and thus considered unlikely to affect land quality within the land required for the Proposed Scheme.

## 8.4 Effects arising during construction

### Avoidance and mitigation measures

- 8.4.1 The construction assessment takes into account the mitigation measures contained within the draft CoCP (see Volume 5: Appendix CT-003-000). The draft CoCP sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme. Its requirements in relation to work in contaminated areas will ensure the effective management and control of the work. Such requirements include:
- methods to control noise, waste, dust, odour, gasses and vapours (draft CoCP, Sections 5, 7, 13 and 15);
  - methods to control spillage and prevent contamination of adjacent areas (draft CoCP, Section 5);
  - the management of human exposure for both construction workers and people living and working nearby (draft CoCP, Section 11);
  - methods for the storage and handling of excavated materials (both contaminated and uncontaminated) (draft CoCP, Sections 7 and 15);
  - management of any unexpected contamination found during construction (draft CoCP, Section 11);
  - a post-remediation permit to work system (draft CoCP, Section 11);
  - storage requirements for hazardous substances such as oil (draft CoCP, Section 16);
  - traffic management to ensure that there is a network of designated haul roads to reduce compaction/degradation of soils (draft CoCP, Section 7 and 14); and
  - methods to monitor and manage flood risk and other extreme weather events which may affect land quality during construction (draft CoCP, Section 16).
- 8.4.2 The draft CoCP requires that prior to and during construction a programme of further investigations, which may include both desk-based and site-based work, will take place in order to confirm the full extent of areas of contamination and a risk assessment undertaken to determine what, if any, site specific remediation measures will be required to allow the Proposed Scheme to be constructed safely and to prevent harmful future migration of contaminants (draft CoCP, Section 11). The investigation and assessment of potentially contaminated sites will be undertaken in accordance with:
- 8.4.3 Environment Agency CLR11 Model Procedures for the Management of Land Contamination (2004)<sup>37</sup>; and
- 8.4.4 British Standard BS10175 Investigation of Potentially Contaminated Sites (2011)<sup>38</sup>.
- 8.4.5 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

<sup>37</sup> Environment Agency (2004), *CLR11 Model Procedures for the Management of Land Contamination*.

<sup>38</sup> *British Standard BS10175 (2011) Investigation of Potentially Contaminated Sites*.

UK's publication A Framework for Assessing the Sustainability of Soil and Groundwater Remediation (2010)<sup>39</sup>. The preferred option will then be developed into a remediation strategy, in consultation with regulatory authorities prior to implementation.

- 8.4.6 Contaminated soils excavated from the site, wherever feasible, 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 compound (for treatment, as necessary, and reuse) or to a permitted landfill.

### **Assessment of impacts and effects**

- 8.4.7 The Proposed Scheme within this study area will be entirely located in tunnel at considerable depth beneath the existing railway corridor. The tunnel will be situated within the London Clay in the east of the area, will pass into the Lambeth Group in the Perivale area and approach the boundary of the underlying Chalk near the western edge of the study area.
- 8.4.8 There will be three vent shaft sites which are proposed at the following locations (from east to west):
- the Westgate vent shaft (Map LQ-01-006, C6 (Volume 5, Land Quality Map Book));
  - the Greenpark Way vent shaft (Map LQ-01-007, D6 (Volume 5, Land Quality Map Book)); and
  - the Mandeville Road vent shaft (Map LQ-01-008a, F6 (Volume 5, Land Quality Map Book)).
- 8.4.9 Temporary construction compounds will be located at each vent shaft site and will include area administration and support for construction works of the vent shaft, storage of construction materials and facilities to support workers, as well as TBM removal at the Greenpark Way vent shaft.
- 8.4.10 These construction compounds will be located within areas of current and former potentially contaminative land uses as described in the baseline in Section 8.3.

### **Land contamination**

- 8.4.11 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). This identifies 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, 29 areas were considered during this screening process; seven of these areas were taken forward to more detailed risk assessments (Stages C and D), in which the potential risks were assessed more fully. All areas assessed are shown on Maps LQ-01-006 to LQ-01-008a (Volume

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<sup>39</sup> Sustainable Remediation Forum UK (2010), A Framework for Assessing the Sustainability of Soil and Groundwater Remediation (2010).

5, Land Quality Map Book) and those considered as potentially posing a risk to the Proposed Scheme are also labelled with a reference number.

8.4.12 Conceptual site models (CSM) have been produced for the seven areas taken to Stage C and D assessments. The detailed CSM are provided in Volume 5: Appendix LQ-001-005 (Section 3) and the results of the baseline risk assessments are summarised in this section. Potentially contaminated areas have been grouped and considered together, where appropriate. The following factors have determined the need for Stage C and D assessments:

- whether the area is on or off the Proposed Scheme or associated offline works, e.g. roads;
- the vertical alignment, i.e. whether the Proposed Scheme is in cut or on embankment;
- the presence of underlying Principal or Secondary A aquifers or nearby watercourses; and
- the presence of adjacent residential properties or sensitive ecological receptors.

8.4.13 A summary of the baseline CSM is provided in Table 6. 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 6: Summary of baseline CSM<sup>40</sup> for sites which may pose a contaminative risk for the Proposed Scheme

Area reference(1)	Receptor type	Receptor description	Receptor sensitivity(2)
5-114, 5-104	Existing on-site railway land and business park at the location of Westgate vent shaft  Map LQ-01-006, C6 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters	Moderate/low
		Potential impact on human health off-site from contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dust	Low
		Impact from lateral migration of contaminants in groundwater and discharge to surface waters as base flow(2)	Low
		Impact from leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater in Secondary A Superficial aquifers	Low
5-113, 5-105, 5-69, 5-68	Current and historical on-site contaminative land uses at the Greenpark Way vent shaft  Map LQ-01-007, D6	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters	Moderate/low
		Impact from lateral migration of contaminants in groundwater and discharge to surface waters as base flow(3)	Low

<sup>40</sup> CSM have been prepared as part of the detailed land contamination methodology (refer to Volume 5) for baseline, construction and post-construction. Sites have been grouped where appropriate.

Area reference(1)	Receptor type	Receptor description	Receptor sensitivity(2)
	(Volume 5, Land Quality Map Book)	Potential impact to groundwater within the 'lower aquifer' (Secondary A/Principal Bedrock aquifer)	Low
		Potential impact on property from contaminants in soil and surface water/groundwater	Low
5-112	Existing on-site railway land at the proposed Mandeville Road vent shaft  Map LQ-01-008a, F6 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters	Moderate/low
		Potential impact on human health off-site from contamination by inhalation of migrating ground gas and volatile vapours from contaminated soil/water	Very low
		Potential impact on human health off-site from contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dust	Low
		Potential impact to groundwater within the 'lower aquifer' (Secondary A/Principal Bedrock aquifer)	Low
		Potential impact on property from contaminants in soil and surface water/groundwater	Low

(1) Each site is assigned a unique identification number (see Volume 5: Appendix LQ-001-005).

(2) 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.

(3) Applies to 5-104 only.

(4) Applies to 5-105 and 5-69 only.

## Temporary effects

- 8.4.14 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.
- 8.4.15 Table 7 presents the summary of the construction effects obtained from a comparison of the baseline and construction impacts. The construction risk assessment takes into account the implementation of the mitigation measures set out within the draft CoCP. The details of these comparisons are presented in Volume 5: Appendix LQ-001-005.
- 8.4.16 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 7: Summary of temporary (construction) effects

Area ref	Area name	Main baseline risk	Main construction risk	Temporary effect and significance
5-114, 5-104	Existing on-site contaminative land uses at the location of Westgate vent shaft  Map LQ-01-006, C6 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters - moderate/low  Impact from leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater in Secondary A (superficial) aquifers - low risk	N/A – receptor not present  Low	Negligible (not significant)
5-113, 5-105, 5-69, 5-68	Current and historical on-site contaminative land uses at the Greenpark Way vent shaft  Map LQ-01-007, D6 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters - moderate/low  Potential impact to groundwater within the 'lower aquifer' (Secondary A/Principal (bedrock) aquifer) from construction through the London Clay Formation - low	N/A – receptor not present  Low	Negligible (not significant)
5-112	Existing on-site railway land at the proposed Mandeville Road vent shaft  Map LQ-01-008a, F6 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters - moderate/low  Potential impact on property from contaminants in soil and surface water/groundwater - low  Potential impact to groundwater within the 'lower aquifer' (Secondary A/Principal (bedrock) aquifer) from construction through the London Clay Formation - low	N/A  Low  Low	Negligible (not significant)

8.4.17 The main construction risk is the risk from the construction of the Proposed Scheme assuming that any mitigation measures as set out in the draft CoCP have been implemented. The temporary effect and significance has been determined by calculating the change in risk between the main baseline risk and the main construction risk. Therefore, 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 deemed to be high.

- 8.4.18 Table 7 indicates that during construction activities there will be an overall negligible effect on identified receptors.
- 8.4.19 The main potential risks identified are associated with on-site human health where current and historical potentially contaminating activities are affected by the Proposed Scheme. It is expected that the measures adopted within the draft CoCP will ensure that risks to human health will not be increased over baseline conditions and in some instances may improve during construction as remediation is progressed.
- 8.4.20 Risks to groundwater quality in the lower aquifer from piling or vent shaft construction works will be managed in accordance with the draft CoCP and good practice, including the Environment Agency guidance on piling and penetrative ground improvement. It is therefore also expected that there will be a negligible effect on the groundwater quality within the lower aquifer during construction<sup>41</sup>.
- 8.4.21 Construction compounds located in this study area will include staff welfare facilities, maintenance facilities for plant and machinery and fuel storage in bunded tanks. As such, construction compounds will store and use potentially contaminative materials such as fuels, oils and solvents. The measures outlined in the draft CoCP will manage risks from the storage of such materials.
- 8.4.22 The compounds may also be used for temporary storage of potentially contaminated soils. The measures outlined in the draft CoCP will manage risks from the storage of such materials.
- 8.4.23 It is considered unlikely that additional remediation works will be required over and above the mitigation measures contained as standard within the draft CoCP.
- 8.4.24 There are anticipated to be no significant cumulative temporary effects from construction.

### Permanent effects

- 8.4.25 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.
- 8.4.26 Table 8 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-001-005.

Table 8: Summary of permanent (post-construction) effects

Area ref	Area name	Main baseline risk	Main post-construction risk	Post-construction effect and significance
5-114, 5-104	Existing on-site contaminative land uses at the	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of	Low	Negligible to minor beneficial

<sup>41</sup> Environment Agency (2001), *Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*, National Groundwater and Contaminated Land Centre, Project NC/99/73, Solihull.

Area ref	Area name	Main baseline risk	Main post-construction risk	Post-construction effect and significance
	location of proposed Westgate vent shaft  Map LQ-01-006, C6 (Volume 5, Land Quality Map Book)	contaminants in soil and soil-derived dust and contaminated waters - moderate/low  Impact from leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater in Secondary A (Superficial) aquifers – moderate/low to low risk	Very low	(not significant)
5-113, 5-105, 5-69, 5-68	Current and historical on-site contaminative land uses at the Greenpark Way vent shaft  Map LQ-01-007, D7 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters - low to moderate/low  Potential impact to groundwater within the 'lower aquifer' (Secondary A/Principal (Bedrock) aquifer) – low	Very low to low  Low	Negligible to minor beneficial (not significant)
5-112	Existing on-site railway land at the proposed Mandeville Road vent shaft  Map LQ-01-008a, F6 (Volume 5, Land Quality Map Book)	Potential impact on human health on-site from contamination by direct contact, ingestion and inhalation of contaminants in soil and soil-derived dust and contaminated waters – moderate/low  Potential impact on property from contaminants in soil and surface water/groundwater - low  Potential impact to groundwater within the 'lower aquifer' (Secondary A/Principal (Bedrock) aquifer) - low	Low  Very low  Low	Negligible to minor beneficial (not significant)

- 8.4.27 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.
- 8.4.28 Table 8 shows that the Proposed Scheme results in either a reduction or no change in the level of risk already existing at each site for both on site and off site receptors.
- 8.4.29 Table 8 indicates that following remediation set out in the draft CoCP, there will be overall negligible to minor beneficial effects, but none of the post-construction effects of land contamination impacts predicted are significant. Depending on the type of remediation undertaken, the beneficial effect for some sites is most likely to be an

improvement in underlying groundwater quality or removal of contamination sources/soils together with removal of direct contact or dust pathways through construction of new hardstanding or other infrastructure.

8.4.30 There will be no likely significant cumulative permanent effects.

#### *Mining/mineral sites*

8.4.31 There are no mining or mineral sites or mineral safeguarding areas located within this study area.

#### *Geo-conservation sites*

8.4.32 There are no geo-conservation sites located within this study area.

#### **Other mitigation measures**

8.4.33 No additional mitigation measures are considered necessary at this stage to mitigate risks from land contamination at the construction stage beyond those set out in the draft CoCP and implemented as part of required remediation strategies.

#### **Summary of likely significant residual effects**

8.4.34 With the application of the mitigation measures previously described, there will be no likely significant residual effects.

### **8.5 Effects arising from operation**

8.5.1 Users of the Proposed Scheme (i.e. rail passengers) will at all times be within a controlled environment and have therefore been scoped out of the assessment.

#### **Avoidance and mitigation measures**

8.5.2 Maintenance and operation of the Proposed Scheme will be in accordance with environmental legislation and good practice whereby appropriate spillage and pollution response procedures will be established.

8.5.3 Assessment of impacts and effects

8.5.4 An express feeder auto-transformer station will be located within the compound at the Greenpark Way vent shaft. An express feeder auto-transformer station can, in principle, be a source of contamination through accidental discharge or leaks of coolant. However, the proposed express feeder auto-transformer station, in common with other modern substations, will use secondary containment appropriate to the level of risk.

8.5.5 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.

8.5.6 It is unlikely that there will be any cumulative effects on land quality receptors due to the environmental controls that will be placed on operational procedures.

#### **Other mitigation measures**

8.5.7 There may be ongoing monitoring requirements following remediation works carried out during construction. Such monitoring, including monitoring of groundwater

quality or ground gas, could extend into the operational phase of the Proposed Scheme.

### **Summary of likely significant residual effects**

8.5.8 No significant residual effects are likely to arise from the operation of the Proposed Scheme.



## 9 Landscape and visual assessment

### 9.1 Introduction

9.1.1 This section reports the assessment of the likely significant landscape and visual effects. It starts by summarising the baseline conditions found within and around the route of the Proposed Scheme and goes on to describe the significant effects that will arise during construction and operation on landscape character areas (LCA) 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 The Proposed Scheme will be in tunnel throughout this section of the route within the Northolt Corridor area. Vent shafts and associated headhouses will be constructed at Westgate, Greenpark Way and Mandeville Road. Principal landscape and visual issues in the area include:

- temporary effects to LCA and visual receptors during construction, arising from the presence of the construction plant, including cranes, the demolition of a commercial building, dwellings and the pumping station at Mandeville Road and the removal of existing vegetation; and
- permanent landscape and visual effects during operation, arising from the presence of three vent shaft headhouse structures and associated security fencing and lighting. Permanent effects will reduce over time where planting establishes as part of the Proposed Scheme matures.

9.1.4 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-001-005, which comprises the following:

- 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 were provided to the LBB and the LBE for comment. Summer field surveys, including photographic studies of LCA and visual assessment of viewpoints, were undertaken from June to October 2012 and in May 2013. Winter surveys were undertaken from January to March 2013.

### 9.2 Scope, assumptions and limitations

9.2.1 The assessment scope, key assumptions and limitations for the landscape and visual assessment are set out in Section 8 of Volume 1, the SMR (Volume 5: Appendix CT-

0001-000/1) and the SMR Addendum (Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

- 9.2.2 The study area has been informed by the construction and operational phase zones of theoretical visibility (ZTV), which are shown in Maps LV-07-011b to LV-07-019a and LV-08-011a to LV-08-019b (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 visibility of the Proposed Scheme. In some locations (for example Horsenden Hill and Perivale), lack of data on vegetation cover may mean the actual visibility is substantially less than that shown in the ZTV.
- 9.2.3 LCA and visual receptors within approximately 500m of the Proposed Scheme have been assessed as part of the study area. Long distance views of up to 1km have been considered at locations such as Horsenden Hill.

### **Limitations**

- 9.2.4 During the baseline survey there were some areas which were inaccessible (such as private land, commercial premises and residential buildings). In these instances, views were obtained from PRow and 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 corridor of the River Brent and the Grand Union Canal follow the broad valley between the Barnet Plateau to the north, including the local high point at Horsenden Hill, and the end of the Hampstead Ridge to the south-east. However, the landform is largely masked by dense urban development. Land use within the study area includes extensive areas of post-war housing estates, together with industrial and commercial areas at Park Royal, Perivale, Greenford and Northolt. The openness of golf courses, recreational and sports grounds, cemeteries and allotments is in contrast to the tight enclosure of the built up areas. Horsenden Hill and Perivale Park/Brent River Park are the two main open areas in the study area, each containing open space, PRow and a golf course.
- 9.3.2 The Grand Union Canal and River Brent are flanked by dense mature trees and shrubs and form distinctive green corridors. Pedestrian access is possible along the length of the canal and sections of the River Brent incorporate part of the Capital Ring recreational path. There is also a dense network of transport infrastructure, which includes the A40 Western Avenue, running in an east to west direction close to the London Underground Central line. The A40 is a dominant feature in the landscape particularly in the Hanger Lane area. The existing railway, the London Underground Central line runs between embankment and deep cutting with well vegetated banks within the Northolt Corridor area.

- 9.3.3 The LCA have been determined with reference to the London Landscape Framework<sup>42</sup>. The London Landscape Framework aims to highlight the large variety of London’s natural landscapes and influence decisions about the future of its network of open spaces within the existing urban areas.
- 9.3.4 Descriptions of all LCA are provided in Volume 5: Appendix LV-001-005 Part 2. For the purposes of this assessment the study area has been sub-divided into nine discrete LCA, none of which are likely to be significantly affected. A description of the baseline character of the LCA is provided below. The LCA are shown in Maps LV-02-011b to LV-02-019a (Volume 5, Landscape and Visual Assessment Map Book).

### *Visual baseline*

- 9.3.5 Descriptions of the identified representative viewpoints are provided in Volume 5: Appendix LV-001-005 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-03-011b to LV-03-019a and LV-04-011b to LV-04-019a (Volume 5, Landscape and Visual Assessment Map Book). The viewpoints are numbered to identify their locations. In each case, the middle number (xxx.x.xxx) identifies the type of receptor that is present in this area; 1: Protected views; 2: Residential, 3: Recreational, 4: Transport and 6: Employment.
- 9.3.6 A protected view is identified in the Northolt Village Green Conservation Area Appraisal<sup>43</sup> looking over the green and has a high sensitivity to change.
- 9.3.7 Residential receptors have a high sensitivity to change and are located on both sides of the existing railway corridor throughout the study area. However, the extents of views are largely contained by dense urban development, elevated railway structures and busy thoroughfares such as the A40 and Hanger Lane gyratory which create both a physical and visual barrier.
- 9.3.8 People travelling on main roads, including the A4006, A40 and A312, in the urban area have a low sensitivity to change.

### **Future baseline**

- 9.3.9 A summary of the committed developments which are assumed to be built and occupied prior to either the construction or operation of the Proposed Scheme is provided below, along with the consequential effect on the character of LCA and nature of views. Developments which would introduce new visual receptors which may be significantly affected are also described. These developments are shown in Maps CT-13-006 to CT-13-008a (Volume 5, Cross Topic Appendix 1 Map Book).

### *Construction (2017)*

- 9.3.10 The planned First Central, Coronation Road/Lakeside Avenue development at Park Royal, LBB, will introduce new mixed use commercial, retail, residential development up to 10 storeys in height to the North Acton Industrial and Commercial Zone LCA. The development will be largely characteristic of the commercial setting and the overall sensitivity of the LCA will be unchanged for the assessment during

<sup>42</sup> Natural England (2011), *London Regional Landscape Framework*.

<sup>43</sup> Ealing Council (2007) *Northolt Village Green Conservation Area Appraisal*.

construction. Views of the construction activities associated with the Westgate vent shaft main compound may be possible from the upper floors of the tower blocks of this development. However, potential receptors will be over 650m from the Proposed Scheme and views will be over a densely developed urban area, where the works will be a small part of the wider landscape. Therefore no additional viewpoints have been introduced.

- 9.3.11 Development of land adjacent to 65 Belvue Road, Northolt (CFA5/31) will introduce a new small-scale residential development to the Northolt Residential LCA. It will consist of a single, three-storey building, car park and garden and will be largely characteristic of the residential setting. The overall sensitivity of the LCA will be unchanged for the assessment during construction. Views of the construction activities associated with the Mandeville Road vent shaft main compound may be possible from the upper floors of this development and are considered under the viewpoint 035.2.001.

#### *Operation (year 1 – 2026)*

- 9.3.12 By 2026, the tree planting at the First Central, Coronation Road/Lakeside Avenue development will locally alter the character of North Acton Industrial and Commercial Zone LCA, through the introduction of orderly and well-maintained urban space and some tree planting. Overall the sensitivity will remain unchanged for the assessment of effects during operation. No additional viewpoints have been introduced.
- 9.3.13 By 2026, any planting associated with the new residential development on Belvue Road will be established. Due to the small scale of the development, the overall sensitivity of the Northolt Residential LCA will remain unchanged for the assessment of effects during operation. Views from the new development are considered under the viewpoint 035.2.001.

## **9.4 Temporary effects arising during construction**

- 9.4.1 The construction works that have been taken into account in determining the effects on landscape and visual receptors includes:
- demolition of a warehouse at the Westgate vent shaft main compound, two dwellings with outbuildings at the Mandeville Road vent shaft main compound and a pumping station at the Mandeville Road main compound;
  - construction of the Westgate headhouse: approximately 44m long by 17.5m wide, extending to 14.7m above existing ground level;
  - construction of the Greenpark Way headhouse: approximately 38m long by 26.5m wide, with a height of 17.5m above existing ground level;
  - construction of the Mandeville Road headhouse: approximately 36m long by 17.5m wide, with an additional two sections (containing mechanical and electrical equipment) attached to the northern edge of the headhouse, each 8m wide and varying between 18m and 26m in length. The headhouse will extend to 6.5m above the top of the railway cutting; and
  - construction compounds at Westgate, Greenpark Way and Mandeville Road vent shafts, including storage of construction materials and welfare facilities.

## Avoidance and mitigation measures

- 9.4.2 As is commonplace with major infrastructure works, the scale of the construction activities means that works will be visible in many locations and will have the potential to give rise to significant temporary effects which cannot be mitigated practicably. Such effects are temporary and vary over the construction period depending on the intensity and scale of the works at the time. The assessment of landscape and visual effects has been based on the activities occurring during the peak construction phase, which is defined as the period during which the 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 study area will generally be considered to be long-term given the construction programme (see Section 2.3). Overall, civil engineering works in this area will be undertaken between the start of 2016 and the end of 2023. The Westgate, Greenpark Way and Mandeville Road vent shaft compounds will be in place for between approximately three and four 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.
- 9.4.3 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):
- placing the route in bored tunnel which will limit the landscape and visual impacts to the locations of vent shafts and utility works;
  - appropriate measures to reduce landscape and visual impacts associated with temporary compound offices, vehicles, construction plant and compounds, will be implemented (draft CoCP, Section 12);
  - 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);
  - protection of landscape features adjacent to the construction compounds from damage by movement of construction vehicles and machinery (draft CoCP, Section 12);
  - designing lighting to avoid unnecessary intrusion onto adjacent buildings and other land uses (draft CoCP, Section 5); 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 key changes to landscape character and viewpoints during construction will relate to the temporary presence of construction plant and the removal of existing landscape elements. This includes the demolition of buildings and the removal of

existing trees and shrubs. Most views of construction will be from locations in close proximity to the construction activity due to the presence of intervening buildings and vegetation. Changes will be most notable at the Mandeville Road vent shaft main compound, due to the loss of existing vegetation from the northern edge of the railway corridor, coupled with the close proximity of construction activity to sensitive visual receptors. The construction activity associated with the vent shafts at Westgate and Greenpark Way will be noticeable, although the construction compounds will be within an industrial/commercial setting.

- 9.4.6 The effect of works associated with underground utilities has been assessed. Utility works will be temporary in nature and are a common occurrence in urban areas. Trees which have amenity value (including TPO) will be retained where possible, in line with the draft CoCP (Section 12), and disturbance minimised. Where vegetation is removed, there will be appropriate replanting and no significant effects are anticipated.

#### *Landscape assessment*

- 9.4.7 Given the limited and localised changes to the existing character, no significant effects on LCA have been identified during construction. All LCA within the study area considered to experience a non-significant effect (minor adverse or negligible) are described in Volume 5: Appendix LV-001-005 Part 4.

#### *Visual assessment*

- 9.4.8 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-001-005 Part 4.
- 9.4.9 The number identifies the viewpoint locations which are shown in Maps LV-03-011b to LV-03-019a (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 – 1: Protected view, 2: Residential, 3: Recreational, 4: Transport and 6: Employment.
- 9.4.10 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 035.4.002: View east from Mandeville Road and Northolt station**

- 9.4.11 Users of Mandeville Road and the access ramps to Northolt London Underground station will have elevated views of the construction activity associated with the Mandeville Road vent shaft main compound in the foreground located adjacent to the bridge. The hoarding will be located approximately 10m away from the bridge and the headhouse structure will be approximately 140m to the east. Construction works will be highly visible due to the removal of existing semi-mature vegetation covering the

northern slope of the cutting. Therefore, the magnitude of change is considered to be high.

- 9.4.12 The high magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect.

**Viewpoints 035.2.003: View west from Station Parade/Ealing Road and 035.1.004: View south from north tip of village green<sup>44</sup>**

- 9.4.13 The presence of the utilities compound and material storage, located approximately 20m away from the receptors, will temporarily affect the view from the residential properties on Station Parade/Ealing Road and foreshorten the view of the village green from the notable viewpoint identified in the Northolt Village Green Conservation Area Appraisal. The clock tower and ornamental planting areas will be unaffected. The hoarding will be a prominent element in the view but as the mature trees on the village green will be retained, the construction elements will be partially screened. The magnitude of change is considered to be medium.

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

**Viewpoint 036.4.001: View north-west from PRow(footbridge 70) over the railway**

- 9.4.15 The removal of existing vegetation on the northern cutting slope will allow framed but open views of the construction activity (approximately 100m away) associated with the Mandeville Road vent shaft. Where retained, the cutting vegetation will partially filter views. The magnitude of change is considered to be medium.

- 9.4.16 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect.

**Viewpoint 036.2.002: View south from residential properties on Carr Road**

- 9.4.17 Views from the ground floor towards the construction activity, located approximately 35m to the south of the compound boundary, will be largely screened by garden sheds, vegetation and construction compound hoardings in the foreground. The removal of existing semi-mature vegetation on the northern railway cutting will be notable in the middle ground of the view. Cranes, HGV and other tall machinery will be visible from upper floors, in the middle and background. The large-scale construction works which will include the presence of plant and equipment, demolition of the pumping station and outbuildings in close proximity to residential properties, the construction of the vent shaft and headhouse building, and the loss of existing vegetation to the north of the tracks, will result in substantial changes to the view. Therefore, the magnitude of change is considered to be high.

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

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<sup>44</sup> Ealing Borough Council, (2007) *Northolt Village Green Conservation Area Appraisal*.

### **Viewpoint 036.2.003: View south from residential properties on Badminton Close**

- 9.4.19 The removal of existing vegetation to the north of the railway line will open up views of construction activities and to properties beyond seen through the existing vegetation on the southern cutting of the London Underground Central line. The demolition of the pumping station and outbuildings will be visible in the middle ground and the access track and plant movement from Mandeville Road will be visible in the foreground. Cranes, HGV and other tall machinery will be visible from upper floors, in the middle and background associated with the construction of the headhouse. Therefore, the magnitude of change is considered to be high.
- 9.4.20 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a major adverse effect.

#### **Cumulative effects**

- 9.4.21 Section 2.1 and Volume 5: 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.
- 9.4.22 There are no known committed developments which are assumed to be under construction at the same time as the Proposed Scheme which will result in a consequential cumulative effect on LCAs or visual receptors. Cumulative developments which have been considered in the assessment are shown in Maps CT-13-006 to CT-13-008a (Volume 5, Cross Topic Appendix 1 Map Book).

#### **Other mitigation measures**

- 9.4.23 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 landscape mitigation sites which would have the additional benefit of providing some visual screening. However, not all landscape and visual effects can be practicably mitigated due to the visibility of construction activity and the sensitivity of surrounding receptors. Therefore, no other mitigation measures are considered practicable during construction.

#### **Summary of likely residual significant effects**

- 9.4.24 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 main roads within the study area.

## **9.5 Permanent effects arising during operation**

- 9.5.1 The route will be in tunnel throughout the Northolt Corridor area. The specific elements of the Proposed Scheme that have been taken into account in determining the effects on landscape and visual receptors are associated with the vent shaft headhouses at Westgate, Greenpark Way and Mandeville Road as described above

and in Section 2. An area of hardstanding for maintenance access will be located adjacent to each of the headhouses.

### **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:

- retaining some of the existing trees to the north of the London Underground Central line railway corridor will help to screen some of the construction works from the residential receptors to the north of the route at Mandeville Road. At this location screening will be provided from year 1 rather than waiting for establishment following planting. Where this is not reasonably practicable, maximising the opportunities for replanting particularly on the railway cutting at Mandeville Road and adjacent to Badminton Close;
- planting, where appropriate, including trees and shrubs, will be implemented around the headhouses to replace lost vegetation and to screen the Proposed Scheme, particularly from neighbouring residential properties and users of adjacent PRoW at the Mandeville Road site; and
- designing the headhouses to be in keeping with the character, scale and massing of the surrounding buildings. Detailed designs and materials will be agreed with the local planning authority. It has been assumed for the assessment that the building finishes will be in neutral colours that will blend the buildings into their surroundings.

9.5.3 These measures have been taken account of in the assessment of the operational effects below.

### **Assessment of impacts and effects**

9.5.4 The likely significant effects on landscape character and visual receptors during operation relate to the presence of new structures/elements in the landscape including the vent shaft headhouses. Headhouses at Westgate and Greenpark Way will be located in industrial and commercial areas where they will be in keeping with the surroundings. No viewpoints related to these two sites will be significantly affected.

### *Landscape assessment*

9.5.5 No significant effects on LCA have been identified during year 1 (2026), year 15 and year 60 of operation. Non-significant effects on LCA are presented in Volume 5: Appendix LV-001-004 Part 4.

9.5.6 The assessment of effects by year 15 assume proposed planting has grown by approximately 450mm a year (i.e. trees would be 7-7.5m high). The assessment of effects by year 60 assumes all planting has reached its fully mature height.

### *Visual assessment*

- 9.5.7 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-001-004 Part 4.
- 9.5.8 For each viewpoint the following assessments have been undertaken:
- effects during winter of year 1 (2026) of operation;
  - effects during summer of year 1 (2026) of operation;
  - effects during summer of year 15 of operation; and
  - effects during summer of year 60 of operation.
- 9.5.9 No significant effects at night time arising from additional lighting have been identified.
- 9.5.10 The number identifies the viewpoint locations which are shown in Maps LV-04-011b to LV-04-019a (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 – 1: Protected view, 2: Residential, 3: Recreational, 4: Transport and 6: Employment.
- 9.5.11 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.
- 9.5.12 The view of the Proposed Scheme from viewpoint 032.6.001 (illustrated in the photomontage shown in Figure LV-01-021 (Volume 2, CFA5 Map Book)) will not be significantly affected as although the Greenpark Way vent shaft headhouse will be continuously visible, it will be in keeping with the warehouses and other commercial buildings adjacent and largely characteristic of the existing view. The view of the Proposed Scheme from viewpoint 035.4.002 illustrated in year 15 will not be significantly effected as the proposed planting will be established and soften the appearance of the Mandeville Road vent shaft headhouse and reinstate the existing wooded corridor (illustrated on the photomontage shown in Map LV-01-222 (Volume 2, CFA5 Map Book)).

#### **Viewpoint 035.4.002: View east from Mandeville Road and Northolt station**

- 9.5.13 The Proposed Scheme will lie approximately 120m east of the Mandeville Road bridge, within the existing London Underground Central line corridor. Users of Mandeville Road and the access ramps to the London Underground Northolt station, will have elevated, views of the noticeable Mandeville Road vent shaft headhouse along the railway corridor in the middle ground of the view. The lack of existing vegetation to the north of the tracks will result in significant changes to the existing view making the headhouse a prominent element in the view. The headhouse design and materials will be agreed with the local planning authority. The magnitude of change is considered to be medium.

- 9.5.14 The view of the Proposed Scheme from this location during the winter of year 1 (2026) is illustrated on the photomontage shown in Figure LV-01-022 (Volume 2, CFA5 Map Book Landscape).
- 9.5.15 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect.
- 9.5.16 In the summer of year 1 (2026) when operation of the Proposed Scheme commences, effects will be unchanged as the proposed planting will not be sufficiently established to provide screening.
- 9.5.17 By year 15 and beyond to year 60 of operation, planting established on the slopes of the cutting will have matured, further screening the Proposed Scheme. This will reduce effects to being non-significant. These are reported in Volume 5: Appendix LV-001-005 Part 4.

**Viewpoint 036.4.001: View north-west from PRow(footbridge 70) over the railway**

- 9.5.18 The new headhouse will be visible in the middle ground of the view from the footbridge, approximately 180m to the west. Where retained, the existing vegetation in the foreground and along the railway cutting will help to filter views. Although the headhouse will be prominent it will be within an urban railway cutting and therefore largely compatible with the existing setting. The headhouse design and materials will be agreed with the local planning authority, which will help to blend the new structure with the retained and new planting on the cutting slope. Therefore, the magnitude of change is considered to be medium.
- 9.5.19 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect.
- 9.5.20 In summer of 2026 when operation of the Proposed Scheme commences, effects will be unchanged as the new planting will not be sufficiently established to provide screening.
- 9.5.21 By year 15 and beyond to year 60 of operation, planting established on the slopes of the cutting will have matured, providing further screening to the Proposed Scheme. This will reduce effects to being non-significant. These are reported in Volume 5: Appendix LV-001-005 Part 4.

**Viewpoint 036.2.002: View south from residential properties on Carr Road**

- 9.5.22 Views towards the new headhouse, approximately 60m to the south, will be partially screened by the existing vegetation and structures in back gardens from the ground floor level. Open views southwards to the upper parts of the new headhouse in the middle ground within the cutting will be possible from the upper floors as a consequence of demolition of outbuildings and a pumping station. Therefore, the magnitude of change is considered to be medium.
- 9.5.23 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect.

- 9.5.24 In the summer of 2026 when operation of the Proposed Scheme commences, effects will be unchanged, as the proposed planting will not be sufficiently established to provide screening.
- 9.5.25 By year 15 and beyond to year 60 of operation, planting established on the slopes of the cutting as part of the Proposed Scheme will have matured, providing further screening of the Proposed Scheme. This will reduce effects to being non-significant. These are reported in Volume 5: Appendix LV-001-005 Part 4.

### **Viewpoint 036.2.003: View south from residential properties on Badminton Close**

- 9.5.26 There will be views from these three-storey residential properties, adjacent to the route of the Proposed Scheme, south and eastwards towards the new headhouse. At 6.5m high, the headhouse will form a prominent element in the view, emphasised by the loss of vegetation on the railway cutting. The headhouse designs and materials will be agreed with the local planning authority. However, the magnitude of change is still considered to be high.
- 9.5.27 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a major adverse effect.
- 9.5.28 In the summer of 2026 when operation of the Proposed Scheme commences, effects will be unchanged as the proposed planting will not be sufficiently established to provide screening.
- 9.5.29 By year 15 and beyond to year 60 of operation, planting established on the slopes of the cutting as part of the Proposed Scheme will have matured, further screening the Proposed Scheme. This will reduce effects to being non-significant. These are reported in Volume 5: Appendix LV-001-005, Part 4.

### *Cumulative effects*

- 9.5.30 None of the LCA or visual receptors will be significantly affected by the operation of the Proposed Scheme when considering the combined presence of operational activity from nearby developments.

### **Other mitigation measures**

- 9.5.31 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**

- 9.5.32 In most cases, significant effects will reduce over time as the proposed mitigation planting matures and reaches its designed intention. Therefore, on the basis that the proposed other mitigation measures are delivered no significant residual effects have been identified following year 15 of operation.

# 10 Socio-economics

## 10.1 Introduction

10.1.1 This section reports the likely significant economic and employment effects during the construction and operation of the Proposed Scheme.

10.1.2 The need for a socio-economic assessment results from the potential for the Proposed Scheme to affect:

- existing businesses and community organisations and thus the amount of local employment;
- local economies, including employment; and
- planned growth and development.

10.1.3 The beneficial and adverse socio-economic effects of the Proposed Scheme are reported at two different levels: route-wide and CFA. Effects on levels of employment are reported at a route-wide level in Volume 3. Localised effects on businesses and observations on potential local economic effects are reported within each CFA report.

### Construction

10.1.4 The construction works will have the following relevance in terms of socio-economics:

- premises demolished with their occupants and employees needing to relocate to allow for construction of the Proposed Scheme; and
- potential employment opportunities arising from construction in the local area (including in adjacent CFA).

### Operation

10.1.5 The operation of the Proposed Scheme will have relevance in terms of socio-economics, in relation to the potential employment opportunities created by new business opportunities.

## 10.2 Scope, assumptions and limitations

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

10.2.2 There have been no variations to the socio-economic assessment methodology arising from engagement with stakeholders and community organisations.

## 10.3 Environmental baseline

### Existing baseline

#### *Study area description*

10.3.1 Section 2 of this report provides a general overview of the Northolt Corridor area which includes data of specific relevance to socio-economics, notably demographic

and employment data. The following provides a brief overview in terms of employment, economic structure, labour market, and business premises available within the area<sup>45</sup>.

- 10.3.2 The Northolt Corridor area comprises a collection of residential and business communities and activities lying mostly within the LBE and partly within the LBB. Where possible, baseline data has been gathered on DCA<sup>46</sup> to provide a profile of local communities. Map SE-02-005 and SE-02-006 (Volume 5, Socio-economics Map Book) shows the location of these DCA. The area contains Perivale, Greenford Broadway, Northolt Mandeville and Hanger Hill and West Acton DCA.

### *Business and labour market*

- 10.3.3 Within the LBE there is a spread of business types reflecting a diverse range of commercial services. The professional, scientific and technical services sector accounts for the largest proportion of businesses (15%), with the information and communication (13%), retail (11%) and construction (10%) sectors also accounting for relatively large numbers of businesses within the borough<sup>47</sup>. The sectors with the largest proportion of businesses in the LBB are professional, scientific and technical (14%), information and communication, construction and retail (all 11%). This is shown in Figure 6<sup>48</sup>.
- 10.3.4 For comparison within London, the professional, scientific and technical services sector accounts for the largest number of businesses (20%), with the information and communication (11%), retail (10%), and arts, entertainment, recreation and other services (8%) sectors also accounting for relatively large numbers of businesses<sup>49</sup>.

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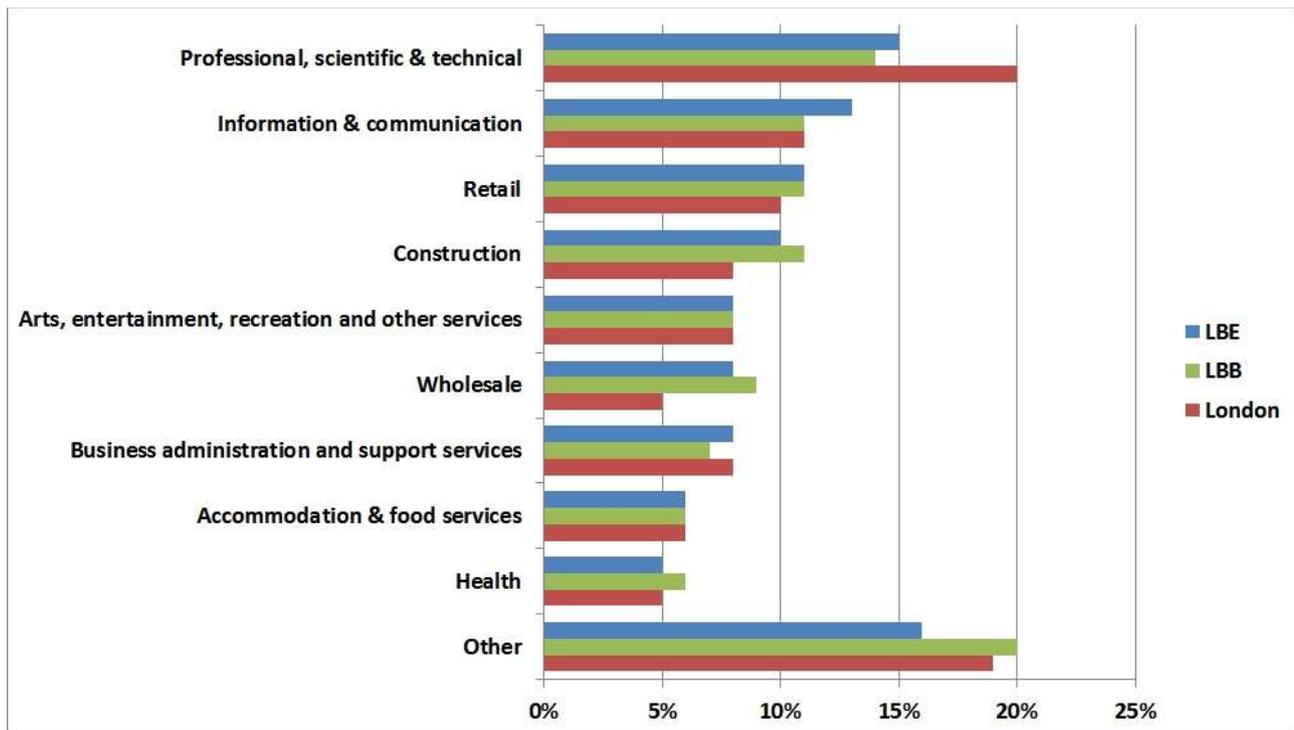
<sup>45</sup> Further information on the socio-economics baseline, with regard to business and labour market profile, within the area is contained in the Volume 5: Appendix SE-001-000.

<sup>46</sup> 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).

<sup>47</sup> Office for National Statistics (ONS) (2012), *UK Business: Activity, Size and Location 2011*, Office for National Statistics, London. Please note 2011 data has been presented to provide an appropriate comparison with 2011 Census data.

<sup>48</sup> The figure presents the proportion of businesses within each business sector in the borough but not the proportion of employment by sector.

<sup>49</sup> Office for National Statistics (ONS) (2012), *UK Business: Activity, Size and Location 2011*, Office for National Statistics, London.

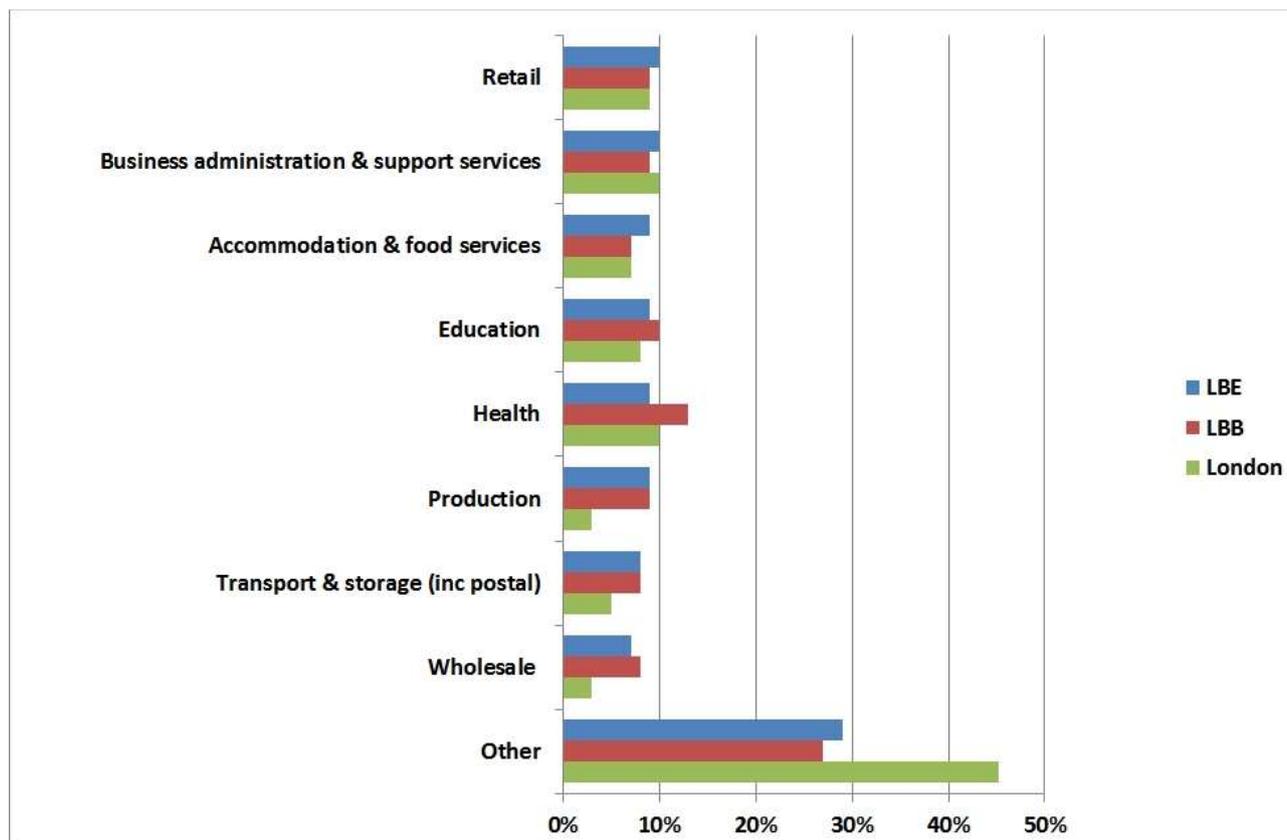
Figure 6: Business sector composition in the LBE, LBB and London<sup>50</sup>

- 10.3.5 Approximately 118,000 people work in the LBE and 98,000 within the LBB while 6,600 people work within Perivale DCA, 8,500 within Greenford Broadway DCA, 6,700 within Northolt Mandeville DCA and 15,300 within Hanger Hill and West Acton DCA<sup>51</sup> in 2011.
- 10.3.6 According to the Office for National Statistics (ONS) Business Register and Employment Survey 2011<sup>51</sup>, the sector accounting for the highest proportion of employment in the LBE is retail (10%). This is a similar proportion to that recorded across London and England (9% and 10% respectively). Employment in business administration and support services accounts for 10% of employment in the LBE compared with 10% recorded for London and 8% for England. The sectors with the highest proportions of employment in the LBB are health (13%), retail (9%) and education (9%), which account for broadly similar proportions of employment to that recorded for London as a whole (10%, 9% and 8% respectively). This is shown in Figure 7.
- 10.3.7 Key sectors, in terms of employment, for Perivale DCA are wholesale (19%) and transport and storage (including postal) (15%). For the Greenford Broadway DCA, transport and storage (including postal) (26%), and production (16%), are the two lead sectors. Accommodation and food services accounts for the majority of employment (72%) in Northolt Mandeville DCA. Key sectors in Hanger Hill DCA and West Acton DCA are production (16%) business administration support services (15%) and professional, scientific and technical (11%).

<sup>50</sup> 'Other' includes agriculture, forestry and fishing, production, motor trades, transport and storage, finance and insurance, property, public administration and defence and education sectors.

<sup>51</sup> Office for National Statistics (2012), *Business Register and Employment Survey 2011*, Office for National Statistics, London.

Figure 7: Proportion of employment by industrial sector in the LBE, LBB and London<sup>52</sup>



10.3.8 According to the 2011 Census<sup>53</sup>, the employment rate<sup>54</sup> within the LBE in 2011 was 65% (which represents approximately 165,000 people) and 63% within the LBB (which represents approximately 147,000 people). This is comparable to 65% recorded for both London and England as a whole. The employment rate in the Perivale DCA was 67%, 68% in Greenford Broadway DCA and Hanger Hill and West Acton DCA and 63% in Northolt Mandeville DCA.

10.3.9 The unemployment rate for the LBE and the LBB in 2011 stood at 9% and 10% respectively, which was higher than the England average of 7%. The unemployment rate in both the Perivale and Greenford Broadway DCA was 8%, 10% in Northolt Mandeville DCA and 7% in Hanger Hill and West Acton DCA.

10.3.10 According to the 2011 Census, 37% of LBE residents and 33% of LBB residents aged 16 and over were qualified to National Vocational Qualification Level 4 (NVQ4). This is compared to 38% in London and 27% in England. No qualifications were held by 17% of LBE residents and 19% of LBB residents. This was comparable to that recorded for London (18%) but lower than England (23%). In 2011 31% of Perivale DCA residents aged 16 and over were qualified to NVQ4 level, compared to 30% in Greenford Broadway DCA, 26% in Northolt Mandeville DCA and 49% in Hanger Hill and West Acton DCA. The proportion of residents with no qualifications was 17% in Perivale

<sup>52</sup> 'Other' includes agriculture, forestry and fishing, construction, motor trades, information and communication, finance and insurance, property, professional, scientific and technical, public administration and defence and arts, entertainment, recreation and other services.

<sup>53</sup> Office for National Statistics (2012), *Census 2011* Office for National Statistics, London.

<sup>54</sup> 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.

DCA, 18% in Greenford Broadway DCA, 22% in Northolt Mandeville DCA and 10% in Hanger Hill and West Acton DCA.

- 10.3.11 The four DCA (Perivale, Greenford Broadway, Northolt Mandeville and Hanger Hill and West Acton) are each predominantly residential areas. Perivale, Greenford Broadway and Hanger Hill and West Acton have high rates of employment, low unemployment and high qualifications attainment. Northolt Mandeville is relatively less prosperous compared to the other DCA in the Northolt Corridor area, experiencing relatively high unemployment and lower skills levels.

### *Property*

- 10.3.12 Data for quarter three of 2012, published by Jones Lang LaSalle<sup>55</sup>, indicated there was approximately 1.7 million square metres of industrial and warehousing floorspace available (i.e. vacant) in Greater London. For the same period, data published for the West London market estimated that approximately 10% (760,000 square metres) of the industrial/warehousing stock in the area was vacant<sup>56</sup>.
- 10.3.13 Average vacancy for industrial and warehousing property in the LBE in July 2013 has been assessed as 8% based on marketed space against known stock<sup>57</sup>. Overall, this suggests moderate to good availability of alternative accommodation.

### **Future baseline**

#### *Construction (2017)*

- 10.3.14 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2017. Implementation of all outstanding development consents and land allocations would result in an additional 1,570 jobs<sup>58</sup> in the area by 2017. The existing composition and numbers of employers, employees and economic sectors in the area are likely to change over time in ways that cannot be accurately forecast.

#### *Operation (2026)*

- 10.3.15 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2026. There are no consents or allocations in this area which are expected to accommodate material additional employment 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.

<sup>55</sup> Jones Lang LaSalle (2012), *UK Industrial Property Trends Today: Issue 3 (December 2012)*, Jones Lang LaSalle, London.

<sup>56</sup> Jones Lang LaSalle (2012), *Western Corridor Industrial and Warehouse Market Autumn 2012*, Jones Lang LaSalle, London.

<sup>57</sup> Vacant space is based on marketed space identified from Estates Gazette data (EGi); stock data is taken from information supplied by the Valuation Office (VOA)

<sup>58</sup> Potential employment has been estimated through employment floor space and the Homes and Communities Agency (HCA) Employment Densities Guide 2nd Edition (2010). The estimate is calculated using standard employment density ratios and estimates of floor areas.

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

- consulting businesses located close to hoardings on the design, materials used and construction of the hoarding, to reduce impacts on access to and visibility of their premises (draft CoCP, Section 5);
- minimising nuisance through sensitive layout of construction sites (draft CoCP, Section 5);
- applying best practicable means (BPM) during construction works to minimise noise, vibration and dust generation at sensitive receptors (including local businesses) (draft CoCP, Section 13);
- requiring contractors to monitor and manage flood risk and other extreme weather events which may affect socio-economic resources during construction (draft CoCP, Sections 5 and 16); and
- site-specific traffic management measures including requirements relating to the movement of traffic from business and commercial operators of road vehicles, including goods vehicles (draft CoCP, Section 14).

## Assessment of impacts and effects

### *Temporary effects*

#### **Change in business amenity value**

10.4.3 No businesses have been identified within the area which are expected to experience significant amenity effects as a result of the Proposed Scheme.

#### **Isolation**

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

#### **Construction employment**

10.4.5 A number of construction compounds for the Proposed Scheme will be located within the Northolt Corridor area, and will include main compounds at Westgate vent shaft, Greenpark Way vent shaft and Mandeville Road vent shaft. These locations are set out in Section 2.3 of this report.

10.4.6 The use of these sites could result in the creation of up to 800 person years of construction employment<sup>59</sup> opportunities, or approximately 80 full-time equivalent jobs<sup>60</sup>, that, 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).

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<sup>59</sup>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.

<sup>60</sup>Based on the convention that 10 employment years is equivalent to one full time equivalent job.

- 10.4.7 Direct construction employment created by the Proposed Scheme could also lead to opportunities for local businesses to supply the project or to benefit from expenditure of construction workers. The impact of the indirect construction employment creation has been assessed as part of the route-wide assessment (Volume 3).

### **Cumulative effects**

- 10.4.8 No committed (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).

### *Permanent effects*

#### **Businesses**

- 10.4.10 Businesses directly affected, i.e. those that lie within land which will be acquired for the construction of the Proposed Scheme, are reported in groups where possible to form defined resources, based on their location and operational characteristics. A group could contain either one or a number of businesses reflecting the fact that a building may have more than one occupier or that similar businesses/resources are clustered together.
- 10.4.11 Two business accommodation units within the Northolt Corridor area will be directly impacted upon by the Proposed Scheme: a builder's warehouse at Westgate, Hanger Lane, and a pumping station east of Badminton Close. However, from an employment perspective, no significant direct effects on employment have been identified within the Northolt Corridor area.
- 10.4.12 It is estimated that land required for the construction of the Proposed Scheme will result in the displacement or possible loss of approximately 35 jobs<sup>61</sup> in the Northolt Corridor area. Taking into account the availability of alternative premises and the total employed within the district, the displacement or possible loss of jobs is considered to be modest compared to the scale of economic activity and opportunity in the area, and is therefore not significant.

### **Cumulative effects**

- 10.4.13 No committed (intra-project) developments have been identified that are considered to interact with the Proposed Scheme.
- 10.4.14 Cumulative effects arise in relation to the accumulation of individual resource based job displacement/losses on a local labour market. These effects are dealt with as part of the route-wide assessment (Volume 3).

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<sup>61</sup> Employment within businesses has been estimated through a combination of sources, e.g., surveys of businesses, the Experian employment dataset, employment floor space and the Homes and Communities Agency (HCA) Employment Densities Guide 2nd Edition (2010). The estimate is calculated using standard employment density ratios and estimates of floor areas and may vary from actual employment at the sites.

### **Other mitigation measures**

- 10.4.15 The assessment has concluded that there are no significant adverse effects arising during construction in relation to businesses directly affected by the Proposed Scheme.
- 10.4.16 Businesses displaced by the Proposed Scheme will be fully compensated within the provisions of the Compensation Code. HS2 Ltd recognises the importance of displaced businesses being able to relocate to new premises and will therefore provide additional support over and above statutory requirements to facilitate this process.
- 10.4.17 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 residual significant effects**

- 10.4.18 No residual significant socio-economic effects are likely 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.

#### *Change in business amenity*

- 10.5.3 No businesses have been identified within the area which are expected to experience significant amenity effects as a result of the Proposed Scheme.

#### *Operational employment*

- 10.5.4 Operational employment will be created at locations along the route including stations, train crew facilities and infrastructure/maintenance depots which could be accessed by residents of the area, particularly given its proximity to Old Oak Common (in CFA<sub>4</sub>) and Euston – Station and Approach area (in CFA<sub>1</sub>).
- 10.5.5 Direct operational employment created by the Proposed Scheme could also lead to indirect employment opportunities for local businesses in terms of supplying the project or benefiting from expenditure of directly employed workers on goods and services.
- 10.5.6 Some of these employment opportunities will be accessible to residents in the locality and, given the transport accessibility of the area within the London travel to work area, residents living further afield.

- 10.5.7 The impact of operational employment creation has been assessed as part of the route-wide assessment (Volume 3).

*Cumulative effects*

- 10.5.8 No committed developments have been identified that are considered to interact with the Proposed Scheme.

**Other mitigation measures**

- 10.5.9 The assessment has concluded that operational effects within this section of the route will be either negligible or beneficial and therefore mitigation is not needed.

**Summary of likely residual significant effects**

- 10.5.10 No residual significant socio-economic effects are likely 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 Northolt Corridor area on:

- people, primarily where they live ('residential receptors') in terms of a) individual dwellings and b) on a wider community basis, including any shared community open areas<sup>62</sup>; 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'<sup>63</sup>.

11.1.2 The assessment of likely significant effects from noise and vibration on community, cultural heritage, or ecological receptors and the assessment of tranquillity are presented in Sections 5, 6, 7 and 9 of this report respectively.

11.1.3 In this assessment 'sound' is used to describe the acoustic conditions which people experience as a part of their everyday lives. The assessment considers how those conditions may change through time and how sound levels and the acoustic character of community areas is likely to be modified through the introduction of the Proposed Scheme. Noise is taken as unwanted sound and hence adverse effects are noise effects and mitigation is, for example, by noise barriers.

11.1.4 Effects can either be temporary from construction or permanent from the operation of the Proposed Scheme. These effects may be direct, resulting from the construction or operation of the Proposed Scheme, and/or indirect e.g. resulting from changes in traffic patterns on existing roads or railways that result from the construction or operation of the Proposed Scheme.

11.1.5 This section sets out the means to avoid or reduce the adverse effects that may occur.

11.1.6 The approaches to assessing sound, noise and vibration and appropriate mitigation are outlined in Volume 1 and scope and methodology are defined in the following documents:

- Scope and Methodology Report (SMR) (Appendix CT-001-000/1); and
- SMR addendum (Appendix CT-001-000/2).

<sup>62</sup> 'shared community open areas' are those that the emerging National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park to local green space) that is nearby.

<sup>63</sup> Quiet areas are defined in the Scope and Methodology Report as either Quiet Areas as identified under the Environmental Noise Regulations or are resources which are prized for providing tranquillity (further information is provided in Volume 5: Appendix SV-001-000).

11.1.7 More detailed information and mapping regarding the sound, noise and vibration assessment for Northolt Corridor 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-002-005);
- sound, noise and vibration construction assessment (Appendix SV-003-005);
- sound, noise and vibration operation assessment (Appendix SV-004-005); 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 Northolt Corridor area is subject to a wide range of sound sources including road traffic, trains, aircraft, industrial and commercial operations, domestic and community activities.
- 11.2.2 The existing baseline sound environment consequently varies considerably from location to location, dependent upon the nature and setting of local sound sources. However, at a large number of locations the sound of road traffic on the A40 Western Avenue and, to a lesser extent, London Underground trains (the Central line runs over ground in this area) is dominant.
- 11.2.3 The route is entirely in tunnel through this area and therefore the existing baseline sound assessment is focused around the vent shafts at Westgate, Greenpark Way and Mandeville Road.
- 11.2.4 In the area around the Westgate vent shaft, the sound environment is dominated by the sound of road traffic on the A40 Western Avenue and other nearby roads (daytime sound levels are typically around 75dB<sup>64</sup> for properties near the A40, Western Avenue and around 60dB for properties off Westgate). Sound from trains on the London Underground Central line also contributes, but is generally not the dominant source.
- 11.2.5 The main sound sources in the area surrounding the Greenpark Way vent shaft are trains running on the nearby London Underground Central line and local road traffic. Daytime sound levels in this area are typically 50 to 55dB for properties on Greenpark Way and Conway Crescent. Sound from nearby commercial and industrial activities is also audible in some locations.
- 11.2.6 In the vicinity of the Mandeville Road ventilation shaft the main sound sources are traffic on the A312 Mandeville Road and trains on the London Underground Central

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<sup>64</sup> Quoted dB values at residential areas refer to the free-field 16 hour daytime (07:00 to 23:00) equivalent continuous sound pressure level,  $L_{pAeq,16hr}$ .

line. Daytime sound levels are typically around 50dB to the rear of properties on Carr Road and 50 to 55dB to the rear of properties on Belvue Road.

- 11.2.7 Night-time sound levels<sup>65</sup> across the area are typically around 5dB lower than the daytime. The night-time sound environment continues to be characterised by road traffic.
- 11.2.8 Further information on the existing baseline, including baseline sound levels and baseline monitoring results, is provided for this area in Volume 5: Appendix SV-002-005.
- 11.2.9 It is likely that the majority of receptors adjacent to the line of route are not currently subject to appreciable vibration<sup>66</sup>, save for those receptors closest to existing railways. On a reasonable worst-case basis, vibration from the Proposed Scheme has therefore been assessed at all receptors using specific thresholds, below which receptors will not be affected by vibration, as described in Volume 1, Section 8. No vibration baseline measurements have therefore been undertaken.

### Future baseline

- 11.2.10 Without the Proposed Scheme, existing sound levels in this area are likely to increase slowly over time. This is primarily due to road traffic growth. Changes in car technology may offset some of the expected sound level increases due to traffic growth on low speed roads. On higher speed roads<sup>67</sup>, tyre sound dominates and hence the expected growth in traffic is likely to continue to increase ambient sound levels.

### *Construction (2017)*

- 11.2.11 The assessment of noise from construction activities assumes a baseline year of 2017 which represents the period immediately prior to the start of the construction period. As a reasonable worst case, it has been assumed that no change in baseline sound levels will occur between the existing baseline (2012/13) and the future baseline year of 2017. The assessment of noise from construction traffic assumes a baseline year of 2021, representative of the middle of the construction period when the construction traffic flows are expected to be at their peak. Further information can be found in the Traffic and Transport assessment.

### *Operation (2026)*

- 11.2.12 The assessment is based upon the predicted change in sound levels that result from the Proposed Scheme. The assessment initially considered a worst case (that would overestimate the change in levels) by assuming that sound levels would not change from the existing baseline year of 2012/2013. Where significant effects were identified on this basis, the effects have been assessed using a baseline year of 2026 to coincide

<sup>65</sup> Night-time sound levels refer to the free-field 8 hour night-time (23:00 to 07:00) equivalent continuous sound pressure level,  $L_{pAeq,8hr}$ .

<sup>66</sup> Further information is available in the Volume 5: Appendix SV-001-000, the SMR and its Addendum.

<sup>67</sup> Tyre noise typically becomes the dominant sound source for steady road traffic at speeds above approximately 30mph

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 TBMs 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 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 Surface activities associated with construction of short connections between the shaft and the main tunnel (comprising the operation of pumps and generator sets) will need to be undertaken during the evening and night-time for reasons of safety, engineering practicability or to reduce the impact on existing transport.
- 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-002-005.

#### Avoidance and mitigation measures

- 11.3.6 The assessment assumes the implementation of the principles and management processes set out in the draft CoCP, CT-003-000, Section 13, 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<sup>68</sup>; 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 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;
- contractors will undertake and report such monitoring as is necessary to assure and demonstrate compliance with all noise and vibration commitments. Monitoring data will be provided regularly to and be reviewed by the Nominated Undertaker and will be made available to the local authorities; and
- contractors will be required to comply with the terms of the draft CoCP and appropriate action will be taken by the Nominated Undertaker as required to ensure compliance.

11.3.7 In addition to this mitigation, taller screening as described in the draft CoCP<sup>69</sup> has been assumed along the edges of the construction site boundary adjacent to commercial properties at the Westgate and Manhattan Business Parks and Greenford Mail Centre, and alongside residential communities on Conway Crescent, Perivale.

## 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 affect<sup>70</sup> residents.

### *Residential receptors: direct effects – communities*

#### **Airborne noise**

11.3.9 The avoidance and mitigation measures in this area will avoid airborne construction noise adverse effects<sup>70</sup> on the majority of receptors and communities. Residual temporary noise or vibration effects are identified in the rest of this section.

<sup>68</sup> Warning signals that consist of bursts of noise.

<sup>69</sup> 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.

<sup>70</sup> Department for Communities and Local Government, *National Planning Practice Guidance – Noise*.

<http://planningguidance.planningportal.gov.uk/blog/guidance/noise/when-is-noise-relevant-to-planning/>. Accessed: 2013. – refer to the table summarising the noise exposure hierarchy.

- 11.3.10 With regard to noise outside dwellings, the assessment of temporary effects takes account of construction noise relative to existing sound levels.
- 11.3.11 In locations with lower existing sound levels<sup>71</sup>, construction noise effects<sup>70</sup> are likely to be caused by changes to noise levels outside dwellings. These may be considered by the local community as an effect on the acoustic character of the area and hence be perceived as a change in the quality of life. These effects are considered to be significant when assessed on a community basis taking account of the local context<sup>72</sup> as identified in Table 9.

Table 9: Direct adverse effects on residential communities and shared open areas that are considered to be significant on a community basis

Significant effect number (see Volume 5 Appendix SV-003-005)	Type of significant effect	Time of day	Location	Cause (construction activities)	Assumed approximate duration of impact and details
CSV05-C01	Noise	Daytime	Northolt. Approximately 10 dwellings on Carr Road	Mandeville Road vent shaft – shaft construction works and shaft internal works) with typical and highest monthly noise levels of 65-70dB and around 70dB	9 months commencing 2019 and 8 months commencing 2020
		Daytime	Northolt. Approximately 15 dwellings on Carr Road and Badminton Close	Mandeville Road vent shaft (shaft construction works and shaft internal works) with typical and highest monthly noise levels of around 60dB and 65dB	1 month commencing 2019 and 1 month commencing 2020
		Daytime	Northolt. Approximately 15 dwellings on Badminton Close	Mandeville Road vent shaft (shaft construction works and shaft internal works) with typical and highest monthly noise levels of around 60dB and 70dB	1 year commencing 2019 and 8 months commencing 2020

<sup>71</sup> Further information is provided in Volume 5: Appendix SV-001-000.

<sup>72</sup> Further information is provided in SV-001-000 and SV-003-005.

Significant effect number (see Volume 5 Appendix SV-003-005)	Type of significant effect	Time of day	Location	Cause (construction activities)	Assumed approximate duration of impact and details
CsV05-Co2	Noise	Daytime	Northolt.  Approximately 40 dwellings on Belvue Road	Mandeville Road vent shaft (shaft construction works and shaft internal works) with typical and highest monthly noise levels of 65-70dB and around 70dB	9 months commencing 2019 and 8 months commencing 2020

### 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.
- 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 have been identified on a worst-case basis on the following non-residential receptors:
- Westgate House, Westgate London (CSV05-No1). Significant noise effects<sup>73</sup> have been identified during the daytime with noise levels at times rising to around 75dB<sup>74</sup> during the construction of the Westgate vent shaft;
  - Westgate Media and Broadcast Ltd Westgate London (CSV05-No2). Significant noise effects have been identified during the daytime with noise

<sup>73</sup> Activity disturbance, especially for activities that require good conditions for verbal communication

<sup>74</sup> Equivalent continuous sound level,  $L_{pAeq, 0800-1800}$ .

levels rising at times to around 75dB<sub>74</sub> during the construction of the Westgate vent shaft;

- AGB House Westgate, London (CSV05-No3). Significant noise effects have been identified during the daytime with noise levels rising at times to around 75dB<sup>74</sup> during the construction of the Westgate vent shaft;
- Commercial operations in Westworld Westgate, London W5 1EL (CSV05-No4). Significant noise effects have been identified during the daytime with noise levels rising at times to around 80dB<sup>74</sup> during the construction of the Westgate vent shaft;
- Manhattan House, Manhattan Business Park (CSV05-No5). Significant noise effects have been identified with noise levels rising at times to around 80dB<sub>74</sub><sup>1</sup> during the construction of the Westgate vent shaft;
- Greenford Mail Centre (CSV05-No6). Significant noise effects have been identified during the daytime with noise levels rising to around 70dB<sup>74</sup> during the construction of the Greenpark Way vent shaft; and
- ITV studios, Clausen House, Perivale Business Park (CSV05-No7). A significant effect has been identified due to ground-borne noise and vibration from the operation of TBMs. The effects would be short term (a matter of days).

#### *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 developments<sup>75</sup>. 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 affect<sup>70</sup> residents.
- 11.3.19 The measures reduce any adverse effects from construction noise outdoors on the majority of residential communities such that they are not considered significant, except at the residential communities closest to the works in the following areas:
- Carr Road and Badminton Close, Northolt; and
  - Belvue Close and Belvue Road; Northolt.

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<sup>75</sup> Refer to Volume 5: Appendix CT-004-000.

- 11.3.20 On a worst-case basis, noise from specific construction activities has been identified as resulting in significant residual temporary effects on the following commercial properties:
- Westgate House; Westgate Media and Broadcast and AGB House, Westgate;
  - Commercial operations in Westworld, Westgate;
  - Manhattan House, Manhattan Business Park;
  - Greenford Mail Centre; and
  - ITV studios, Clausen House, Perivale Business Park.
- 11.3.21 HS2 Ltd will continue to seek reasonably practicable measures to further reduce or avoid these significant effects. In doing so HS2 Ltd will continue to engage with stakeholders to fully understand the receptor, its use and the benefit of the measures. The outcome of these activities will be reflected in the Environmental Minimum Requirements.

## 11.4 Effects arising during operation

### Local assumptions and limitations

#### *Local assumptions – service pattern*

- 11.4.1 The effects of noise and vibration from the operation of the Proposed Scheme have been assessed based on the highest likely train flows, including the Phase Two services. Trains are expected to be 400m long during peak hours and a mix of 200m and 400m long trains at other times.
- 11.4.2 The expected passenger service frequency for both Phase One, and Phase One with Phase Two services are described in Volume 1<sup>76</sup>. 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 10. 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 10.

Table 10: 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	07:00-21:00 hours	18 (14)	300kph with speeds reducing towards Old Oak Common station

<sup>76</sup> The change in noise and vibration effects between the different passenger services is assessed in Volume 1.

### **Avoidance and mitigation measures**

- 11.4.3 The development of the Proposed Scheme has, as far as reasonably practicable, kept the 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.

### **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 significantly affect<sup>70</sup> residents.

- 11.4.12 The mitigation measures in this area will also avoid ground-borne noise and vibration adverse effects<sup>70</sup> on all residential communities and sensitive receptors.

## 12 Traffic and transport

### 12.1 Introduction

- 12.1.1 This traffic and transport 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 in the Northolt Corridor area, from the B4492 Park Royal Road in the east to a point near Rabournmead Drive in the west.
- 12.1.2 With regard to traffic and transport, the only issues in this area are increases in traffic due to construction movements for the Proposed Scheme.
- 12.1.3 The effects on traffic and transport have been assessed quantitatively, based on baseline traffic conditions and future projection scenarios.
- 12.1.4 A detailed report on traffic and transport and surveys undertaken within the area is contained within Volume 5: Appendix TR-001-000, Transport Assessment.
- 12.1.5 Figure 2 (Section 2) shows the location of the key transport infrastructure in this area.
- 12.1.6 Engagement has been undertaken with the key transport authorities, including Transport for London (TfL).

### 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 extends from Park Royal Road in North Acton to the boundary between Ealing and Hillingdon near Rabournmead Road. It includes the A40 Western Avenue, the A406 North Circular Road, the A4005 Hanger Lane, the A4127 Greenford Road and the A312 Mandeville Road.
- 12.2.3 A number of transport modelling tools have been used to inform the assessment, including TfL's WeLHAM (West London Highways Assessment Model). The assessment covers the morning (08:00-09:00) and evening (17:00-18:00) peak periods for an average weekday.

### 12.3 Environmental baseline

#### Existing baseline

- 12.3.1 Existing conditions in the Northolt Corridor area have been determined through site visits, specially commissioned transport surveys and liaison with TfL to source transport models and information on public transport, PRow and traffic accident data.
- 12.3.2 Traffic surveys of all roads crossing the route, or potentially affected, were undertaken in June and July 2012, comprising junction turning counts, automatic traffic counts, pedestrian counts, parking accumulation surveys and journey time information. All transport modes have been surveyed, including private vehicles, public transport,

walking, cycling and taxis. This was supplemented by traffic and transport data obtained from other sources, including regional and local transport models from TfL. The highway peak hours in the study area were 08:00-09:00 and 17:00-18:00.

- 12.3.3 PRow surveys were undertaken in September 2012 to establish the nature of the PRow and their usage by pedestrians and cyclists (non-motorised users). The surveys included all PRow and roads that will cross the route of the Proposed Scheme and any additional PRow and roads that will be affected by the Proposed Scheme. Within the study area there are two PRow. At Westgate, a PRow extends from Western Avenue to Westgate, passing under the existing rail bridge. At Greenpark Way, the Capital Ring PRow runs on the eastern side of Greenford Road and is segregated by passing under Greenpark Way at its junction with Greenford Road. Within the study area, pedestrian movements at Mandeville Road were the busiest in the morning peak hour from 08:00-09:00, with over 500 movements through all arms of the Mandeville Road/Eastcote Lane North junction.
- 12.3.4 There are several strategic routes that pass through the study area. The east to west A40 Western Avenue connects the M40 and M25 motorways with central London. The A312 Mandeville Road runs between the A40, to the south, and Harrow, to the north. The A406 North Circular Road connects with the M4 at Chiswick and runs in an orbital route to the east of London via the Hanger Lane gyratory.
- 12.3.5 The Hanger Lane gyratory is the busiest and most strategically important intersection in the area, being the intersection between the A40 and the A406 North Circular Road.
- 12.3.6 The Westway Retail Park is located on the eastern side of Greenford Road. The retail park access road is subject to a 20mph speed restriction and a 5.1m height restriction imposed by a bridging section of the existing IBM distribution centre development. Rockware Avenue to the south is a business park access road.
- 12.3.7 The A312 Mandeville Road is a dual-carriageway as it passes over the existing rail bridge.
- 12.3.8 The main local roads affected by the Proposed Scheme are Westgate Road, which leads to commercial, office and retail premises; Rockware Avenue, which leads to warehouses, offices and a Royal Mail centre; and Mandeville Road, which leads to the A40 Western Avenue.
- 12.3.9 The strategic roads within the area are busy at peak times and delays can be experienced on the A40, the A406 and the A312.
- 12.3.10 Safety and accident data has been obtained from TfL for the three-year period from March 2009 to March 2012. This has been assessed and any identified clusters have been examined. Within the study area, the clusters are mostly along the A40 Western Avenue and the Hanger Lane gyratory, the A4127 Greenford Road and on Mandeville Road.
- 12.3.11 There are no public bus services on Westgate Road. Hanger Lane gyratory to the immediate east carries five bus routes (routes 83, 95, 112, 487 and 226) at a maximum combined frequency of approximately 30 buses per hour in peak periods. These bus services provide connections to Ealing Hospital, Golders Green, Shepherd's Bush,

Southall, Brent Cross Shopping Centre, Ealing Broadway, South Harrow and Willesden Junction.

- 12.3.12 A bus stop serving the Westway Retail Park is located on the southern side of Greenpark Way near the junction with Greenford Road. This is the first stop on bus service 395 towards Harrow Bus Station and runs at a frequency of five per hour in peak periods. Five bus services run along Mandeville Road within the study area at a combined frequency of approximately 55 buses per hour in peak periods. Bus services along Mandeville Road provide connections to Harrow, Harrow Weald, Hounslow, Heathrow, Ealing, Rickmansworth, Feltham and Greenford.
- 12.3.13 Rail and London Underground services are accessible via Greenford station. Hanger Lane London Underground station is located in the centre of the Hanger Lane gyratory. Northolt London Underground station is located on Mandeville Road and is accessed from the existing rail bridge. A southbound bus stop is located on the eastern side of Mandeville Road, to the immediate north of the bridge. Perivale London Underground station and Greenford London Underground station are some distance from any of the construction routes.
- 12.3.14 There is a high degree of segregation between pedestrians/cyclists and vehicular traffic in the vicinity of the strategic roads in the area, particularly the A40. Numerous other segregated and non-segregated cycle routes are located on streets to the north of the A40 in the vicinity of the construction compounds.
- 12.3.15 Northolt London Underground station is accessed from the Mandeville Road railway bridge. Surveys recorded over 700 entry or exit movements in the morning peak hour between 08:00-09:00.
- 12.3.16 Hanger Lane is subject to Red Route 'no stopping at any time' restrictions. Westgate is subject to a mix of waiting restrictions, including double yellow line, 'no waiting at any time', 'no waiting from 07:00-19:00', car club permit holder bays and sections of unrestricted parking. Greenpark Way and Rockware Avenue are subject to 'no waiting at any time' restrictions for their entire length and a large private car park occupies part of the proposed construction compound. Mandeville Road is subject to 'no waiting at any time' restrictions in the vicinity of the access lane.
- 12.3.17 The Grand Union Canal and River Brent pass through the area. The Grand Union Canal crosses the route at the Kelvin Industrial Estate and cycling is permitted on its towpath. The River Brent crosses the scheme to the west of the Hanger Lane Gyratory.

### Future baseline

- 12.3.18 The forecast future baseline traffic volumes have been incorporated within the TfL WeLHAM model for the future construction and operational years and include allowance for planned growth, including any major locally consented schemes. No other changes to the traffic and transport baseline are anticipated in the study area.

### Construction

- 12.3.19 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 are forecast to grow by typically 2.5 to 3.0% by 2021 compared to 2012.

#### *Operation (2026)*

12.3.20 Future baseline traffic volumes in the peak hours are forecast to grow by typically 4.5 to 5.5% by 2026 compared to 2012.

#### *Operation (2041)*

12.3.21 Future baseline traffic volumes in the peak hours are forecast to grow by typically 8.5 to 9.5% by 2041 compared to 2012.

## **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 Proposed Scheme through this area will be in tunnel, so impacts are limited. The tunnelling strategy avoids excavated material from tunnels being extracted from vent shafts. Instead this will be transported off site mainly by rail, reducing HGV movements on the road network; and
- HGVs are routed, as far as reasonably practicable, along the strategic road network and using designated roads for access, as shown on Maps TR-03-006 to TR-03-008 (Volume 5, Traffic and Transport Map Book).

12.4.2 The draft CoCP (see Volume 5: Appendix CT-003-000) includes measures which seek to reduce the impacts and effects of deliveries of construction materials and equipment, including reducing construction lorry trips during peak background traffic periods. The draft CoCP includes HGV management and control measures.

12.4.3 The measures in the draft CoCP include clear controls on vehicle types, hours of site operation and routes for heavy goods vehicles, to reduce the impact of road based construction traffic. In order to achieve this, generic and site-specific traffic management measures will be implemented during the construction of the Proposed Scheme on or adjacent to public roads, footpaths and other PRow affected by the Proposed Scheme as necessary.

12.4.4 Specific measures will include:

- core site operating hours will be 08:00-18:00 on weekdays and 08:00 to 13:00 on Saturdays and site staff and workers will therefore generally arrive before the morning peak hour and depart after the evening peak hour (although the assessment has assumed that some work journeys to the construction compounds take place within the morning and evening peak hours to reflect a reasonable worst-case scenario) (draft CoCP, Section 5); and
- excavated material will be reused wherever reasonably practicable along the alignment of the Proposed Scheme which is expected to reduce the effects of construction vehicles on the public highway (draft CoCP, Section 15).

- 12.4.5 Where reasonably practicable, the number of private car trips to and from the construction compounds (both workforce and visitors) will be reduced by encouraging alternative modes of transport or vehicle sharing. A key method of achieving this includes an over-arching framework travel plan<sup>77</sup> that will require travel plans to be used along with a range of potential measures to mitigate the impacts of traffic and transport movements associated with construction of the Proposed Scheme. As part of this, a construction workforce travel plan will be put into operation with the aim of reducing workforce commuting by private car, especially sole occupancy car travel.

## 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 the Northolt Corridor area will be due to construction vehicle movements to/from the vent shaft main construction compounds at Westgate, Greenpark Way and Mandeville Road. It is expected that the F-sidings satellite compound will generate negligible volumes of traffic, mostly during night-time, weekends and bank holiday periods.
- 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 compound worker trips.
- 12.4.9 Details of construction compounds are provided in Section 2. The duration of when there will be busy transport activity at each construction compound is shown in Table 11. 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 shows the daily flows in the peak month. The assessment scenario has assumed the peak month for the combination of activities, i.e. not necessarily the peak activity at each individual site.

Table 11: Typical vehicle trip generation for construction compounds in this area

Compound type	Location	Access to/from compound	Indicative start/set up date	Estimated duration of use (Years)	Estimated duration with busy vehicle movements (Months)	Average daily combined two-way vehicle trips during busy period and within peak month of activity	
						Cars/LGV	HGV
Main compound	Westgate vent shaft	Westgate Road	September 2018	5.5	4-6 months	10-20	90-110

<sup>77</sup>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.

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	
Main compound	Greenpark Way vent shaft	Rockware Avenue/ Greenpark Way	January 2019	5.5	4-6 months	10-20	90-110
Main compound	Mandeville Road vent shaft	Mandeville Road	July 2018	6.5	4-6 months	10-20	95-110
Satellite compound	F-sidings compound	Waxlow Road	2015	9	4-6 months	<5	<5

- 12.4.10 Details of the construction phasing are provided in Section 2.3. The phasing of the construction works at the vent shaft compounds will mean that not all of the HGV movements will occur at the same time and the timing of peak construction works at each compound will, in practice, not be simultaneous.
- 12.4.11 The route is in tunnel in this area and there will be few traffic and transport impacts apart from those related to the construction compounds at Westgate Road, Greenpark Way and Mandeville Road.
- 12.4.12 It is envisaged that the A40 Western Avenue, M25 motorway and TfL Road Network will provide the primary HGV access and egress routes.
- 12.4.13 Temporary partial road closures on Westgate, Rockware Avenue and the A312 Mandeville Road may be needed during the advance works. These are not expected to result in full road closures and will have no associated traffic diversions or related significant effects.
- 12.4.14 Construction of the Proposed Scheme is forecast to result in increases in daily traffic flow (i.e. more than 30% for HGV or all vehicles) as a result of traffic diversionary impacts associated with the Proposed Scheme at Old Oak Common in the CFA4 Kilburn (Brent) to Old Oak Common area). This is expected to cause a major adverse significant effect in traffic-related severance<sup>78</sup> in Friary Road between Horn Lane and the A40 Western Avenue (HGV only);
- 12.4.15 The impact of diversions related to road closures at Old Oak Common in the adjacent Kilburn (Brent) to Old Oak Common area (CFA4) is expected to result in an increase in congestion<sup>79</sup> and delays to vehicle users in Horn Lane/Friary Road. This is expected to constitute a minor adverse effect.

<sup>78</sup> 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 or 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.

<sup>79</sup> In assessing significant effects of traffic changes on congestion and delays, a major adverse effect occurs where traffic flows at a junction will be beyond or very close to capacity with the Proposed Scheme and the increases in traffic due to the Proposed Scheme will be such as to substantially increase queues and delays on a routine basis at peak times. A moderate adverse effect will occur when traffic flows at a junction will be

- 12.4.16 Utility works (including diversions) have been considered in detail where works are expected to be major 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 the area. More minor utilities works and associated traffic management measures will have only localised impacts and are expected to be short-term in duration. Utilities works in this area are not expected to result in significant additional adverse effects.
- 12.4.17 There are no significant effects anticipated in terms of loss of car parking and loading on roads in the area.
- 12.4.18 The effect on accident and safety risks is not expected to be significant.
- 12.4.19 It is not expected that the construction of the Proposed Scheme will require any bus route diversions or resulting delays to buses, as no road closures are proposed. There will therefore be no significant effect on bus passenger delays.
- 12.4.20 Construction of the Proposed Scheme will not result in the loss of pedestrian access or interchange links to public transport. However, it is likely that the access to the Mandeville Road vent shaft main compound will need to be widened with consequent short-term temporary relocation of the southbound bus stop on the eastern side of Mandeville Road. Following widening, the bus stop will be reinstated locally. The effect is not considered to be significant.
- 12.4.21 No cycle diversions are proposed and only minor pedestrian diversions will be required. These will not have a significant effect.
- 12.4.22 There are no significant effects expected on either the Grand Union Canal or River Brent.

### *Cumulative effects*

- 12.4.23 The assessment includes the cumulative effects of planned development during construction by taking this into account within the background traffic growth.
- 12.4.24 The assessment also includes in-combination effects by taking into account traffic and transport impacts of works being undertaken in neighbouring areas. Specifically, the assessment includes general traffic diversion effects of road closures associated with the Kilburn (Brent) to Old Oak Common area (CFA<sub>4</sub>). In total these flows represent an increase of approximately 90 vehicles in the peak hour in the vicinity of Friary Road.

### *Permanent effects*

- 12.4.25 Any permanent construction effects have been considered in the operational assessments 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 operation need to be considered together.

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approaching or at capacity with the Proposed Scheme and modest increases in traffic will increase the frequency of queues and more substantial delays. A minor adverse effect occurs when traffic flows at a junction are not generally exceeding capacity with the Proposed Scheme but the increase in flows will result in occasional queues and delays or small increases in existing delays.

### **Other mitigation measures**

- 12.4.26 The implementation of the CoCP (see Volume 5: Appendix CT-003-000) in combination with the construction workforce travel plan will, to some degree, mitigate the transport related effects during construction of the Proposed Scheme. The reductions in effects arising from the travel plan measures have not been included in the assessment, which will mean the adverse effects may be overstated.
- 12.4.27 The operation of TfL adaptive traffic signals that adjust signals to deal with changes in traffic flow and reduce delays, where located on routes affected by the Proposed Scheme, will help mitigate any increased delays or congestion.
- 12.4.28 Based on the outcomes of this assessment, no further traffic and transport mitigation measures during construction of the Proposed Scheme are considered necessary.

### **Summary of likely significant residual effects**

- 12.4.29 Changes in traffic flows will lead to congestion, increasing delays for road users at the junction of Horn Lane/Friary Road.
- 12.4.30 Increased traffic flows will make it more difficult to cross the road at Friary Road.
- 12.4.31 The significant effects that result from construction of the Proposed Scheme are shown in Maps TR-03-006 to TR-03-008 (Volume 5, Traffic and Transport Map Book).

## **12.5 Effects arising from operation**

### **Avoidance and mitigation measures**

- 12.5.1 Traffic and transport related changes during operation of the Proposed Scheme are very limited as there will be no stations or depots that generate any additional traffic in this area and the route is entirely within tunnel. Consequently, no specific mitigation is proposed.

### **Assessment of impacts and effects**

- 12.5.2 The following section considers the impacts on traffic and transport and the consequential effects resulting from the operational phase of the Proposed Scheme (as described in Section 2.4 of this report).
- 12.5.3 Prior to operation, the highways and pedestrian/cycle routes in the vicinity of the main construction compounds will have been reinstated to their pre-construction condition with no permanent effects.
- 12.5.4 Occasional traffic may access the vent shaft areas of the Proposed Scheme for maintenance purposes. However, these infrequent vehicle movements are expected to be very low and will therefore have no significant effect.
- 12.5.5 In 2041 there is expected to be an increase in congestion resulting in delays to vehicle users in B4492 Acton Lane/Mordaunt Road due to additional traffic generated by the operation of Old Oak Common station (in CFA4). This is expected to constitute a minor adverse effect.
- 12.5.6 In 2041, increases in daily traffic flow (i.e. more than 10% for HGV or all vehicles) as a result of diversionary impacts from additional traffic and modifications at junctions on Old Oak Common Lane (in CFA4) will be expected to cause an increase in traffic-

related severance in Friary Road between Horn Lane and the A40 Western Avenue constituting a major adverse effect.

### *Cumulative effects*

- 12.5.7 The forecasting methodology adopted and the assessment have allowed for the cumulative effects of planned development during operations, by taking this into account within the background traffic growth.
- 12.5.8 The assessment considers in-combination effects by taking into account impacts as a result of the Proposed Scheme neighbouring areas. The effects in this area will result from operation of Old Oak Common station (CFA4). The impact in this area will be approximately 40 additional vehicles in the vicinity of Friary Road in the peak hour in 2041.

### **Other mitigation measures**

- 12.5.9 No further mitigation measures for the operation of the Proposed Scheme are considered necessary based on the outcomes of this assessment.

### **Summary of likely significant residual effects**

- 12.5.10 There will be an increase in congestion resulting in delays to vehicle users in B4492 Acton Lane/Mordaunt Road.
- 12.5.11 Increases traffic flows will make it more difficult to cross Friary Road.
- 12.5.12 The significant effects that result from the operation of the Proposed Scheme is shown in Map Series TR-04-006 – TR-04-008 (Volume 5, Traffic and Transport Map Book).



# 13 Water resources and flood risk assessment

## 13.1 Introduction

13.1.1 This section provides a description of the current baseline for water resources including surface water, groundwater and the baseline conditions for flood risk. It then reports 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:

- Grand Union Canal (Paddington Branch);
- River Brent (a main river);
- the Chalk Principal aquifer;
- the Lambeth Group and Thanet Sand Formation Secondary A aquifers; and
- eight licensed groundwater abstractions to the west of North Acton and south of Northolt.

13.1.3 Key environmental issues relating to water resources and flood risk include:

- potential impacts on groundwater flow to local private abstractions;
- potential temporary impacts on groundwater quality as a result of construction activities associated with tunnelling; and
- potential impacts on the risk of surface water flooding at the Westgate, Greenpark Way and Mandeville Road vent shafts.

13.1.4 Volume 5: Appendix WR-001-000 contains a report on the route-wide effects including:

- generic assessments on a route-wide basis;
- stakeholder engagement;
- in-combination effects;
- a draft operation and maintenance plan for water resources and flood risk;
- a Water Framework Directive<sup>80</sup> (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:

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<sup>80</sup> *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.

- Volume 5: Appendix WR-002-005: Water Resources Assessment report; and
- Volume 5: Appendix WR-003-005: Flood Risk Assessment.

13.1.6 Map Series WR-01 to WR-03 showing details, environmental baseline and design features referred to in this report and those in Volume 5 are all contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

13.1.7 Discussions have been held with the Environment Agency, the Canal and River Trust (formerly British Waterways), the LBB, the LBE, the LBHa, Ealing Golf Club and Thames Water Utilities Limited.

## 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 Section 8 of Volume 1 and in the SMR and its addendum presented in Volume 5 (Volume 5: Appendix CT-001-000/1 and Appendix CT-001-000/2). This report follows the standard assessment methodology.

13.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this is defined as the study area.

13.2.3 WFD classification data has been made available by the Environment Agency. For water bodies that do not have a WFD status class shown in the relevant River Basin Management Plan (RBMP), the status class for those watercourses has been taken as the status class for the first downstream water body for which a status class is reported. Where groundwater does not have a WFD status class shown in the relevant River Basin Management Plan (RBMP), these are referred to as 'not assessed' by the Environment Agency in the summary of geology and hydrogeology tables in Table 13 of this report and Volume 5: Appendix WR-002-005.

13.2.4 There are limited borehole records available along the route of the Proposed Scheme in the study area to understand the local geological and hydrogeological conditions likely to be encountered for areas of below ground construction. It is assumed that the data available provide an accurate indication of the regional groundwater levels and flow. Where appropriate, maximum groundwater levels have been used to provide an indication of the potential impact from the Proposed Scheme.

13.2.5 There are limited borehole records available along the route of the Proposed Scheme in the study area, to understand the local geological and hydrogeological conditions likely to be encountered for areas below ground construction. It is assumed that the data available provide an accurate indication of regional groundwater levels and flow. Where appropriate, maximum groundwater levels have been used to provide an indication of the potential impact from the Proposed Scheme.

- 13.2.6 Environment Agency flood risk mapping 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-003-005.

### 13.3 Environmental baseline

#### Existing baseline – Surface water resources

##### *Surface water features*

- 13.3.1 Water bodies within the study area include the River Brent and the Grand Union Canal (Paddington Branch) as well as a number of un-named drains and ponds. The catchments fall within the Thames River Basin District (RBD) and are covered by the associated RBMP<sup>81</sup>.
- 13.3.2 In this area the route is entirely in tunnel and will pass beneath the River Brent, water crossing SWC-CFA5-01 as shown on Map WR-01-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book), and the Grand Union Canal, water crossing SWC-CFA5-04 as shown on Map WR-01-006 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 13.3.3 The Grand Union Canal is currently used for navigation by both commercial and leisure users.
- 13.3.4 Surface run-off currently drains into the Thames Water sewer network. The water quality of this run-off will reflect the urban nature of the study area and therefore may be contaminated with sediment, oil and other pollutants associated with urban catchments.
- 13.3.5 The current surface water baseline is shown in Maps WR-01-005 and WR-01-006 (Volume 5, Water Resources and Flood Risk Assessment Map Book) and all surface water features within the study area are assessed within Volume 5: Appendix WR-002-005. Table 11 includes features potentially affected by the Proposed Scheme.

Table 12: Surface water features potentially affected by the Proposed Scheme

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book, map reference)	Watercourse classification <sup>82</sup>	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value <sup>83</sup>
River Brent	The route will pass beneath the River Brent near Manhattan Business Park, Alperton  (SWC-CFA5-01)	Main river	River Brent (below Silk Stream and down to the River Thames)  (GB106039023590),	Good potential	High

<sup>81</sup> Environment Agency (2009), *River Basin Management Plan, Thames River Basin District*.

<sup>82</sup> 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.

<sup>83</sup> For examples of receptor value see Table 43 in the addendum to the SMR (Volume 5, Appendix CT-001-000/2).

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book, map reference)	Watercourse classification <sup>82</sup>	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value <sup>83</sup>
			Poor		
Grand Union Canal (Paddington Branch)	The route will pass beneath the Grand Union Canal (Paddington Branch) near the Kelvin Industrial Estate, Northolt  (SWC-CFA5-04)	Artificial	Grand Union Canal, (Uxbridge to Hanwell Locks, Slough Arm, Paddington Arm)  (GB70610078).  Moderate	Good potential	High
Grand Union Canal dock	A dock connected to and south of the Grand Union Canal at Ockham Drive, north of the route.  (Map WR-01-006, H5)	Artificial	No status shown in RBMP – assumed status  Moderate	No status shown in RBMP – assumed status  Good potential	High
Two drains	Drains located near Rothesay Avenue and Carr Road draining towards the Grand Union Canal, north of the route.  (Map WR-01-006, H5)	Ordinary watercourse	No status shown in RBMP – assumed status  Moderate	No status shown in RBMP – assumed status  Good potential	Moderate
Several ponds at Park Royal, Lord Halsbury Memorial Playing Fields, Ealing Golf Course and Horsenden Hill	Various locations (see Volume 5: Appendix WR-002-005 for details)	Not applicable	Not applicable	Not applicable	Low
A number of drains and unnamed watercourses, some of which are culverted	Various locations (see Volume 5: Appendix WR-002-005 for details)	Ordinary watercourse	No status shown in RBMP – assumed status  Moderate	No status shown in RBMP – assumed status  Good potential	Moderate

### *Water Framework Directive status*

- 13.3.6 The WFD water body Grand Union Canal (Uxbridge to Hanwell Locks, Slough Arm, Paddington Arm) is designated an artificial water body and is assessed by the Environment Agency as having Moderate overall status.

- 13.3.7 The River Brent (below Silk Stream down to the River Thames) is designated as a heavily modified water body and is assessed by the Environment Agency as having Poor overall status.

### *Abstractions and permitted discharges*

- 13.3.8 There are no licensed surface water abstractions within 500m of the Proposed Scheme<sup>84</sup>. There is the potential for unlicensed abstractions to exist that have not been identified, as a licence is not required for abstraction volumes below 20m<sup>3</sup> per day.
- 13.3.9 The Environment Agency reports that there are six current consented surface water discharges within 500m of the route as shown on Maps WR-01-005 and WR-01-006 (Volume 5, Water Resources and Flood Risk Assessment Map Book). The consents are for Thames Water pumping stations, trade effluent and non water company-treated effluent (details in Volume 5: Appendix WR-002-005).

## **Existing baseline – groundwater resources**

### *Geology and hydrogeology*

- 13.3.10 The location of abstractions, geological formations and indicative groundwater levels are shown on Map WR-02-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book). A schematic cross-section along the line of the route in the study area with regard to geological strata, groundwater elevations (where known) and the Proposed Scheme is presented in Volume 5: Appendix WR-002-005.
- 13.3.11 A summary of the superficial and bedrock geology and hydrogeology is presented in Table 13. Unless otherwise stated, the geological groups listed are all crossed by the route.

Table 13: Summary of geology and hydrogeology in the Northolt Corridor area

Geology	Distribution	Formation description	Aquifer classification	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value
<b>Superficial deposits</b>						
Alluvium	Along the base of the valley of the River Brent	Clay, silt, sand and gravel	Secondary Type A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Taplow Gravel Formation	Along the base of the valley of the River Brent	Sand and gravel	Secondary Type A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Kempton Park Gravel Formation	Along the base of the valley of the River Brent	Sand and gravel	Secondary Type A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate

<sup>84</sup> Surface water abstractions for public water 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
Thames Valley Formation (not crossed by route)	An isolated outcrop south of Hanger Hill Park	Sand and gravel	Secondary Type A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
<b>Bedrock</b>						
Thames Group (London Clay Formation)	Across entire area	Sandy silty clay	Unproductive strata	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Low
Thames Group (London Clay Formation; Claygate Member)	Small outcrop adjacent to the south of the route, close to the Hanger Lane gyratory, marginally crossed by route	The Claygate Member is the uppermost unit of the London Clay Formation and comprises interbedded fine-grained sand, silt and clay	Secondary Type A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Lambeth Group (Harwich, Reading and Woolwich Formations)	Assumed to underlie London Clay Formation throughout the area	Lenses and interbedded layers of clay, silty sand and shelly silty clay at the top, sand and gravel towards the base	Unproductive (top)/ Secondary Type A (base)	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Low/ moderate
Thanet Sand Formation	Thanet Sand Formation is presented as discrete lenses beneath the Lambeth Group	Greenish and brownish grey, silty, fine-grained sand	Secondary Type A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
White Chalk Subgroup	Underlies Lambeth Group/Thanet Sand Formation throughout the area (not penetrated by the route)	Firm white chalk with marl seams and flint bands	Principal aquifer	Mid-Chilterns Chalk groundwater body (GB40601G601200)  Poor status	Good status	High

### *Superficial deposits*

- 13.3.12 A layer of made ground may be present due to the presence of an existing railway corridor (comprising track-bed materials and existing embankments) as well as previous cycles of development along the edge of the railway.
- 13.3.13 With the exception of the Thames Valley Formation, shallow groundwater within the superficial deposits is likely to be in continuity with surface water in the River Brent.

The superficial deposits along the River Brent between Westgate and Alperton Lane are potentially contaminated (see Section 8 of this report for further information).

### *Bedrock aquifers*

- 13.3.14 East of Bideford Avenue, the tunnel will pass through the London Clay Formation. The London Clay Formation is designated as unproductive strata.
- 13.3.15 To the south-west of Park Royal (close to the Hanger Lane gyratory), geological mapping shows the Claygate Member to be present. The Claygate Member is the uppermost unit of the London Clay Formation and comprises inter-bedded fine-grained sand, silt and clay.
- 13.3.16 West of Bideford Avenue, the tunnel will pass into the Lambeth Group, which is likely to be in hydraulic continuity with the underlying Thanet Sand Formation (where present) and the White Chalk Subgroup, part of the Chalk Principal aquifer.
- 13.3.17 The geological formations within this study area are described in Section 8, Land Quality and further details are included in the Volume 5: Appendix WR-002-005.

### *Water Framework Directive status*

- 13.3.18 No WFD classification has been given by the Environment Agency to the superficial deposits, the London Clay Formation, Lambeth Group and Thanet Sand Formation in this area. The White Chalk Subgroup forms part of the Mid-Chilterns Chalk groundwater body. The WFD status of the White Chalk Subgroup is summarised in Table 13.

### *Abstractions and permitted discharges*

- 13.3.19 The Environment Agency reports that there are eight licensed groundwater abstractions within the study area. There is the potential for unlicensed abstractions to exist that have not been identified, as a licence is not required for abstraction volumes below 20m<sup>3</sup> per day. There are no PWS or associated SPZ in this study area. Details regarding the abstractions are provided in Volume 5: Appendix WR-002-005.
- 13.3.20 There are four groundwater discharge consents in the study area. Further details are included in Volume 5: Appendix WR-002-005 and Map WR-02-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

### *Surface water/groundwater interaction*

- 13.3.21 Shallow groundwater in the superficial deposits in the valley of the River Brent is expected to be in hydraulic continuity with the River Brent. Shallow groundwater flow is assumed to be towards the river, following topography.

### *Water dependent habitats*

- 13.3.22 There are no areas with statutory ecological designations in relation to surface water or groundwater in the study area.

## **Existing baseline – flood risk**

### *River flooding*

- 13.3.23 The agreed data set for river flooding is the Environment Agency Flood Zone Mapping.

- 13.3.24 The River Brent has a catchment size of 128km<sup>2</sup> at the route crossing location. The route will be below approximately 20m of Flood Zone 3 in tunnel. The floodplain is constrained by high ground on the left and right bank for approximately 360m upstream of the route to Hanger Lane.
- 13.3.25 The route will pass in tunnel approximately 16m below the bed of the River Brent, which, according to the Environment Agency historic flood outlines shown on Maps WR-01-005 and WR-01-006 (Volume 5, Water Resources and Flood Risk Assessment Map Book), has previously flooded both upstream of the study area (close to the crossing of the A4005 Hanger Lane) and downstream of the study area (within Perivale Park Golf Course).
- 13.3.26 The Westgate vent shaft is located in the lowest risk Flood Zone 1 (the area with less than a 1 in 1,000 or 0.1% annual probability of river flooding) approximately 250m to the east of the River Brent.

### *Surface water flooding*

- 13.3.27 The locally agreed surface water flooding dataset is from the modelling activities undertaken as part of the Drain London project for the production of the preliminary flood risk assessment (PFRA) reports<sup>85, 86</sup>. The Environment Agency Flood Map for Surface Water (FMfSW) has also been reviewed to inform the assessment of surface water flood risk, and is shown on Maps WR-01-005 and WR-01-006 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 13.3.28 There are parts of the study area that are shown to have a high risk of surface water flooding for flood events up to and including the 1 in 200 annual (0.5%) probability event. As the route is within tunnel for the whole of the study area, surface water flood risk has only been considered where there will be above ground construction. The LBE SFRA identifies a number of historical surface water and sewer flooding events, however, the majority of these incidents are in Acton south of the Proposed Scheme.
- 13.3.29 Close to the Westgate vent shaft there are areas at risk of surface water flooding between the vent shaft construction compound and Hanger Lane junction, and also to the south of the London Underground Central line embankment.
- 13.3.30 There are isolated areas at risk of surface water flooding within the Westway Cross Shopping Park close to the Greenpark Way vent shaft.
- 13.3.31 The Central line cutting at Northolt station, to the south of the Mandeville Road vent shaft, is also at risk of surface water flooding.
- 13.3.32 The ground level at the vent shafts is significantly above the ground level of the railway cuttings that are at risk of surface water flooding. No surface water flooding overland flow routes have been identified at the vent shaft sites.

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<sup>85</sup> Hyder/AECOM (2011), *London Borough of Brent Preliminary Flood Risk Assessment*

<sup>86</sup> Hyder/AECOM (2011), *London Borough of Harrow Preliminary Flood Risk Assessment*

### *Sewer flooding*

- 13.3.33 The agreed datasets for sewer flooding are Thames Water records in the Lead Local Flood Authority (LLFA) PFRAs and the local authority Strategic Flood Risk Assessment (SFRA) reports. These are provided in Volume 5: Appendix WR-003-005.
- 13.3.34 Thames Water historic sewer flooding records show that there have been a number of sewer flooding incidents within or close to the study area. The majority of these incidents occurred in Acton, south of the route. Of the properties affected, approximately 235 lie within the study area (see Volume 5: Appendix WR-003-005).

### *Artificial water bodies*

- 13.3.35 Flooding from artificial water bodies, such as canals and reservoirs, may occur as a result of failure of a retaining structure that impounds water. The agreed dataset for flooding due to reservoir failure is the Environment Agency Reservoir Inundation Map<sup>87</sup>.
- 13.3.36 The route will pass in tunnel approximately 25m below the bed of the Grand Union Canal (Paddington Branch) to the west of Greenford. At this location, the canal is at or below surrounding ground levels and therefore does not pose a risk of flooding due to failure of the canal structure.
- 13.3.37 The route will cross an area shown to have a residual risk of flooding associated with a failure of the Brent Reservoir (Welsh Harp). The modelled flow paths from the Brent Reservoir (at no point is the reservoir closer than 4.4km from the route) follow the course of the River Brent and associated floodplain. There will be no above ground infrastructure in the vicinity of the River Brent that could affect the risk of reservoir flooding at this location. Therefore flooding as a result of a failure of the Brent Reservoir is not considered further.

### *Groundwater flooding*

- 13.3.38 The agreed dataset for groundwater flooding is the local authority PFRA report.
- 13.3.39 The LBE PFRA<sup>88</sup> indicates that there have been four past incidents of groundwater flooding recorded within the study area. Two are to the south-east of the Hanger Lane junction, one within the valley of the River Brent to the north of the route, and one to the north-east of Northolt station on the London Underground Central line.

### **Future baseline**

- 13.3.40 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 committed developments in relation to water resources and flood risk have been considered as part of this assessment of the construction and operation of the Proposed Scheme.

<sup>87</sup> Environment Agency (2009), *Model Reservoir Inundation Mapping Specification*.

<sup>88</sup> Capita Symonds (2011), *London Borough of Ealing Preliminary Flood Risk Assessment*.

- 13.3.41 All new developments are required to comply with the National Planning Policy Framework (NPPF)<sup>89</sup>, development plans and other legislation and guidance. As such committed developments should have a neutral effect on the water resources and flood risk baseline.
- 13.3.42 WFD future status objectives are set out in Table 11 and Table 12. These changes are not considered to result in the reported effects from the Proposed Scheme changing in significance.

### *Climate change*

- 13.3.43 Current projections to the 2080's indicate that climate change may affect the future baseline against which the impacts of the Proposed Scheme on surface water and groundwater resources have been assessed. There may be changes in the flow and water quality characteristics of surface water and groundwater bodies as a result of changes in climate. However, except for flood flows described below, these changes are not considered to result in the reported effects from the Proposed Scheme changing in significance.
- 13.3.44 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.
- 13.3.45 When considering the influence that climate change may have on the future baseline, against which the impacts from the Proposed Scheme on flood risk have been evaluated, the assessment has used the recommended precautionary sensitivity ranges of key parameters, as given in Table 5 in the technical guidance to the NPPF. The sensitivity testing undertaken allows for variations in climate change factors included in other national guidance.
- 13.3.46 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 Avoidance and mitigation measures that will reduce potentially adverse effects on water resources and flood risk are summarised below. Further details are given in Volume 5: Appendix WR-002-005 and Volume 5: Appendix WR-003-005.
- 13.4.3 During the development of the design since January 2012, a key design change was made to place the route entirely in tunnel in this area. This has avoided many of the potential impacts to water resources and flood risk.

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<sup>89</sup> Department for Communities and Local Government (2012), *National Planning and Policy Framework*.

- 13.4.4 The route will be in bored tunnel approximately 16m below the riverbed at the crossing of the River Brent and there will be no above ground infrastructure in the vicinity of the river that could affect the risk of river flooding at this location.
- 13.4.5 The tunnelling method will be selected to avoid significant groundwater ingress into the tunnels and there is no anticipated requirement to remove significant quantities of water (i.e. there will not be significant dewatering works). Drainage from within the tunnel will be directed towards shafts and discharged at a controlled rate to Thames Water Utilities Limited sewers.
- 13.4.6 The Northolt tunnel will be constructed within the London Clay Formation and the Lambeth Group. This substantially reduces the potential impact of tunnelling on water quality in the underlying Chalk aquifer, due in part to the low permeability of the London Clay Formation. As the construction occurs above the top of the Chalk aquifer, there will not be any disruption to groundwater flow in the Chalk and the risks to groundwater quality from turbidity in the Chalk aquifer will be low, due to the presence of the overlying lower permeability strata.
- 13.4.7 Mitigation measures to reduce an increase in flood risk will include sustainable drainage systems (SuDS) to reduce the rate and volume of run-off from the area of the new vent shafts and adjacent hardstanding at Westgate, Greenpark Way and Mandeville Road.
- 13.4.8 Due to the urban nature of the area, the alignment of the Proposed Scheme in tunnel, the nature of the geology and presence of potentially contaminated made ground, there is limited potential for the incorporation of SuDS features within the surface water drainage. Attenuation will therefore be provided through use of lined tanks or other forms of storage as necessary. The SuDS features will be designed where practicable to discharge at existing run-off rates and will accommodate for events up to and including the 1 in 100 annual probability (1%) including an allowance for climate change. Approval to discharge to storm drains or combined sewers will be obtained prior to construction from Thames Water Utilities Limited to ensure that there is sufficient capacity in the receiving infrastructure. This will avoid an increase in the risk of surface water or sewer flooding and any risks to surface or groundwater quality. 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.
- 13.4.9 The following examples illustrate how the implementation of mitigation measures set out in the CoCP will reduce potentially significant effects on water resources and flood risk to levels that will not be significant.
- 13.4.10 Monitoring of water quality, flows and groundwater levels will be carried out where required in consultation with the Environment Agency to determine the potential effect of construction on the surface water or groundwater feature including aquifers and local abstractions. In order to ensure that conditions within the surface water and groundwater feature potentially affected by the construction phase stabilise appropriately, monitoring may need to extend into the operational phase. This monitoring will include one private abstraction used for domestic purposes (GW53),

and to confirm the effectiveness of agreed temporary and permanent mitigation measures.

- 13.4.11 With regard to surface water, detailed method statements will reduce potentially significant effects on surface water quality or flows associated with construction. This will include controlling run-off prior to discharge to the Thames Water Utilities Limited sewer network.
- 13.4.12 With regard to groundwater, any dewatering requirements, such as during construction of the Westgate, Greenpark Way and Mandeville Road vent shafts, will be minor in nature and of short-term duration and will be in compliance with the draft CoCP, Section 16.
- 13.4.13 Groundwater contamination from surface infiltration at construction compounds will be prevented through the requirements of the CoCP, Section 16.
- 13.4.14 All sites will be managed to avoid an increase in flood risk but site-specific flood risk management plans will be prepared for construction compounds located within surface water flood risk areas, such as at the Westgate and Mandeville Road vent shafts, prior to the start of construction, as stated in Section 16 of the draft CoCP.

### **Assessment of impacts and effects**

- 13.4.15 This section describes the significant effects following the implementation of avoidance and mitigation measures.
- 13.4.16 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-002-005 and Flood Risk Assessment in Volume 5: Appendix WR-003-005.
- 13.4.17 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).
- 13.4.18 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**

- 13.4.19 The assessment shows there will be no temporary significant adverse effects on water resources in this study area.

#### **Groundwater**

- 13.4.20 Although effects on wider water body receptors are considered to be neutral, if there are fast pathways connecting the working area of the Proposed Scheme directly to high value receptors such as private boreholes for domestic use, the impact of even minor levels of turbidity will be large due to the high quality required to be met for potable use, resulting in a moderate and significant effect. In this area, if fast pathways exist, there will be a significant effect on one private abstraction located down gradient of where the Northolt tunnel passes below the London Clay and into

the Lambeth Group. The private water abstraction is identified as TH/039/0038/002) on Map WR-02-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book) and is used for domestic purposes. Other private abstractions are located in this area although are not used for potable supply and as such the effect of turbidity on these sources will be negligible and the effect will not be significant. Further mitigation for the one private abstraction used for domestic purposes is discussed below in other mitigation measures.

### **Flood risk**

- 13.4.21 The assessment shows there will be no temporary significant adverse effects on flood risk in this study area.

### *Cumulative effects*

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

### *Permanent effects*

### **Surface water**

- 13.4.23 The assessment shows there will be no permanent significant adverse effects on water resources in this study area.

### **Groundwater**

- 13.4.24 The assessment shows there will be no permanent significant adverse effects on groundwater resources in this study area.

### **Flood risk**

- 13.4.25 The assessment shows there will be no permanent significant adverse effects on flood risk in this study area from all sources of flooding.

### **Cumulative effects**

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

### **Other mitigation measures**

Although unlikely, where there is the potential for significant adverse effects on the licensed private water abstraction during construction, monitoring of groundwater turbidity will be used to verify if effects are occurring and provide evidence to justify further intervention, should that be required. Should further mitigation be required, appropriate measures will be agreed with the owner in advance of construction commencing and may, for example, consist of the provision of a temporary alternative supply.

- 13.4.27 No further mitigation measures for surface water or flood risk are considered to be required.

### **Summary of likely significant residual effects**

- 13.4.28 Following mitigation no significant residual adverse effects to water resources and flood risk have been identified within the assessment.

## 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 watercourses and groundwater bodies during operation and management of the Proposed Scheme are described in Volume 1, Section 9.
- 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 watercourses and groundwater bodies are described in Volume 1, Section 9 and in the 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 will pass. Generic examples of management measures that may mitigate flood risk are described in Volume 1.
- 13.5.4 Any water that enters the Northolt tunnel during operation will be in very low volumes and will be directed towards the Westgate, Greenpark Way and Mandeville Road vent shafts. At the three shafts, the water will be pumped from the shaft and discharged into the Thames Water combined sewer network at a controlled rate.
- 13.5.5 Drainage from associated access roads and hardstanding (e.g. the access roads to the Westgate, Greenpark Way and Mandeville Road vent shafts,) will be attenuated and discharged into the Thames Water sewer network at a controlled rate.

### Assessment of impacts and effects

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

### Other mitigation measures

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

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