highways england

Lower Thames Crossing

Preliminary Environmental Information Report

Volume 1

Statutory consultation 2018

Lower Thames Crossing

Preliminary Environmental Information Report

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Chapter 1.

Introduction

1 Introduction

1.1 Background to the Lower Thames Crossing and this report

1.1.1 This *Preliminary Environmental Information Report* (*PEIR*) has been prepared by Highways England as part of the Environmental Impact Assessment (EIA) of the proposed Lower Thames Crossing project (the Project). This document provides a preliminary review of the likely significant environmental effects of the Project and how they could be mitigated. This allows for an informed response to consultation to be given by the public and stakeholders, including local authorities and Statutory Environmental Bodies (SEBs). A summary document for non-technical readers has also been provided for the statutory consultation.

1.1.2 The Project is a proposed new crossing of the River Thames east of London that will connect Kent, Thurrock and Essex. For more than 50 years, the Dartford Crossing has provided the only road crossing of the Thames Estuary east of London.

1.1.3 This *PEIR* provides preliminary information about the proposals. The Project design will continue to be developed to reflect the outcomes of the consultation, and the process of gathering information and identifying how the environment might be affected by it is ongoing. The information in this document is, therefore, preliminary and may be subject to change as assessment work continues.

1.2 Purpose of the PEIR

1.2.1 Regulation 12(2) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (EIA Regulations) defines preliminary environmental information as "information referred to in regulation 14(2) which:

a. has been compiled by the applicant; and

b. is reasonably required for the consultation bodies to develop an informed view of the likely significant environmental effects of the development (and of any associated development)"

1.2.2 Planning Inspectorate Advice Note Seven states:

"The Preliminary Environmental Information (PEI) is not expected to replicate or be a draft of the Environmental Statement (ES). However, if the applicant considers this to be appropriate (and more cost-effective) it can be presented in this way. A good PEI document is one that enables consultees (both specialist and non-specialist) to understand the likely environmental effects of the proposed development and helps to inform their consultation responses on the proposed development."

1.2.3 The purpose of this *PEIR*, therefore, is firstly to meet the requirements of the EIA Regulations, but also to inform stakeholders, landowners and SEBs of the ongoing EIA work. It also provides an opportunity for consultation with them. Reporting on the progress of the EIA, particularly with regards to ongoing

survey works, will ensure a comprehensive ES will be produced for the Development Consent Order (DCO) application.

1.2.4 Under the Act, there are two separate formal stages of pre-application consultation:

a. Section 42 with prescribed consultees (eg, Natural England, Environment Agency, Historic England), local authorities, landowners and others with interests in land

b. Section 47 consultation with the local community in accordance with the Statement of Community Consultation

1.2.5 For the purposes of this Project, both consultation stages will run in parallel.

1.2.6 The *PEIR* will be made available to the prescribed consultees, local authorities and landowners, as well as to members of the public and the wider community, so that an informed response can be given as part of the consultation.

1.2.7 Consultees are encouraged to respond to the information contained in this *PEIR* and other consultation documents. The responses will be considered in preparing the finalised design of the Project.

1.2.8 The ES will be published as part of the DCO application to the Planning Inspectorate for the Project.

1.3 Structure of the PEIR

1.3.1 This *PEIR* comprises:

a. Volume 1: Main text

b. Volume 2: Appendices

c. Volume 3: Figures

1.3.2 In line with the EIA Scoping Report and the Planning Inspectorate's Scoping Opinion of December 2017 (see section 5.2), the following environmental topics are included in this *PEIR*:

a. Chapter 6: Air Quality

b. Chapter 7: Cultural Heritage

c. Chapter 8: Landscape

d. Chapter 9: Terrestrial Biodiversity

e. Chapter 10: Marine Biodiversity

f. Chapter 11: Geology and Soils

g. Chapter 12: Materials

h. Chapter 13: Noise and Vibration

i. Chapter 14: People and Communities

j. Chapter 15: Road Drainage and Water Environment

k. Chapter 16: Climate

1.3.3 The approach taken in preparing this *PEIR* is provided in Chapter 5: Environmental Assessment Methodology.

1.4 Consultation

1.4.1 We are currently in statutory consultation where we present our proposals for the Project and listen to your feedback. The next stage is applying for a DCO.

1.4.2 This report forms part of a suite of documents that we have published as part of the statutory consultation we are carrying out to support the DCO application process.

1.5 Consenting process

1.5.1 The Project meets the criteria of a Nationally Significant Infrastructure Project (NSIP) under the Planning Act 2008, as amended (the Act).

1.5.2 The Project is a 'highways' NSIP under section 22(2) of the Act (as amended) because it will involve construction of a new highway of an area greater than 15 hectares, which is wholly in England and where the Secretary of State (SoS) will be the Highway Authority for the highway once it has been constructed.

1.5.3 As the Project is an NSIP, Highways England is required to make an application for a DCO to the Planning Inspectorate, and this must be accompanied by an ES. If granted, the DCO will provide the necessary authorisation to allow the Project to be constructed and operated.

1.5.4 A DCO is similar to planning permission but is designed for NSIPs to make the process clearer, faster and fairer. It does this by allowing many of the consents and permissions needed for the Project to be considered at the same time.

1.6 Highways England

1.6.1 Highways England is responsible for the delivery of the Lower Thames Crossing.

1.6.2 We are a government-owned company who work with the Department for Transport (DfT). We operate, maintain and improve England's motorways and major A-roads, also known as the strategic road network. Our aim is to ensure that road users have safer and more reliable journeys and that businesses have the effective road links they need to prosper.

1.7 Glossary

1.7.1 You can find explanations of terms and abbreviations used here in the glossary at the back of this document.

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Chapter 2.

Project Description

2 Project Description

2.1 Introduction

2.1.1 This chapter provides preliminary information about the key elements of the Project including the route, tunnel construction and supporting (ancillary) works such as service and utility diversions, traffic forecasting and user charging. Details are also provided about how environmental considerations inform the evolution of the design.

2.1.2 The area that is likely to be needed for the development is shown in Figure 2.1 in Volume 3 of this *Preliminary Environmental Information Report (PEIR)*. This also presents the route of the proposed Project. Permanent and temporary land take, land for utility diversions and environmental mitigation is shown in detail in *Map Book 2 Land Use Plans*. The Project is expected to be open during 2027, subject to the necessary funding and planning approvals.

2.1.3 This chapter is intended to define the current Project proposals in sufficient detail to allow stakeholders to understand the scope and extent of the Project, and to develop an informed view of the likely significant environmental effects.

2.1.4 The design will be further developed to reflect the findings of ongoing environmental studies, comments raised during the statutory consultation and ongoing engagement with stakeholders. As the design develops, the embedded mitigation measures discussed throughout this *PEIR* will also be refined as part of an iterative process.

The Project context

2.1.5 The Project is located in a very populated area of the country in the vicinity of urban areas including, but not limited to, Gravesend, Grays and Tilbury. There are a large number of footpaths, bridleways, National Cycle Network routes, local cycle routes and trails within the area to provide non-motorised users (NMUs) (pedestrians, cyclists and horse riders) with access and connectivity to surrounding areas.

2.1.6 Areas of the physical environment around the Project are designated for their important ecological, cultural heritage and landscape features. South of the River Thames, and in close proximity to the A2, there are a number of areas of nationally important ancient woodland, Sites of Special Scientific Interest (SSSI) and sites of local biodiversity importance. On the south bank of the River Thames to the east of Gravesend and the north of Chalk lies the Thames Estuary and Marshes Ramsar Site and SSSI with the land further east also being designated as a Special Protection Area. To the north of the River Thames lies Goshems Farm Local Wildlife Site (LWS). There are a number of other LWSs between the river and the M25, as well as other areas of ancient woodland.

2.1.7 The land between the villages of Thong and Shorne and to the south of the A2 forms part of the Kent Downs Area of Outstanding Natural Beauty (AONB). Also, south of the A2, lies the Cobham Hall Registered Park and Garden. The villages of Shorne and Cobham are also designated as Conservation Areas. North of the River Thames the settlements of East and West Tilbury are

designated as Conservation Areas. Both south and north of the Thames there are a number of Listed Buildings of all grades, particularly Grade II and II*. Other heritage features of note are Scheduled Monuments that include New Tavern Fort and Cliffe Fort on the southern bank of the River Thames and Coalhouse Fort Battery and Artillery Defences and Tilbury Fort on the northern bank of the River Thames as well as a cropmark complex at Orsett adjacent to the A13.

2.1.8 There are extensive areas of floodplain across the area associated with the River Thames and the Mardyke. The Mardyke lies to the north of the River Thames in Thurrock and flows into the River Thames at Purfleet. Parts of the area benefit from the River Thames tidal flood defences. Numerous smaller watercourses and drainage ditches traverse the area particularly to the north of the River Thames.

2.1.9 There are a number of Air Quality Management Areas (AQMAs) designated by Gravesham, Thurrock and Havering Councils, which demonstrate the existing air quality issues in these areas. There is also an AQMA designated at the existing Dartford Crossing. A number of Noise Important Areas (NIAs) are also designated south of Gravesend along parts of the A2, along the A13 and the M25. Further details about the local environment are provided in Chapters 6 to 16 of this *PEIR*.

Environmental considerations

2.1.10 The Highways England Licence (2015) sets out the Secretary of State's statutory directions and guidance to Highways England. It sets out what is expected of Highways England and how it must behave when discharging its duties delivering the vision and plans for the network, set out in the *Road Investment Strategy 2015/16 – 2019/20* (Department for Transport, 2015).

2.1.11 Section 4.2g of the licence states that Highways England when exercising its functions and complying with its legal duties must act in a manner which it considers best calculated to: "*Minimise the environmental impacts of operating, maintaining and improving its network and seek to protect and enhance the quality of the surrounding environment*". This requirement is further outlined in Section 5.23 of the licence.

2.1.12 Effective design is an iterative process informed by the Environmental Impact Assessment (EIA) process and working to avoid significant effects on environmental receptors where possible.

2.1.13 The *Design Manual for Roads and Bridges* (*DMRB*) suggests design measures, which can be incorporated within highways design where appropriate, to mitigate impacts arising from highways development that cannot be avoided. Dependent on the nature of the impact, the environmental design measures will address effects on different environmental receptors. Examples of these possible measures are detailed further through the relevant sections in Chapters 6 to 16 of this *PEIR*.

The Rochdale Envelope

2.1.14 Planning Inspectorate Advice Note 9: *Using the 'Rochdale Envelope* provides guidance regarding the degree of flexibility that may be considered appropriate within an application for development consent under the Planning Act 2008. The

advice note acknowledges that there may be parameters of a project's design that are not yet fixed and, therefore, it may be necessary for the Environmental Statement (ES) to assess likely worst-case variations to ensure that the likely significant environmental effects of the Project have been assessed. This approach reflects the need for the Project design to evolve over time following the established principle set out in the case of *R v Rochdale Metropolitan Borough Council ex p Milne (2000)* and *R v Rochdale Metropolitan Borough Council ex p Tew (1999).*

2.1.15 This chapter of the *PEIR* presents information about the Project that is currently available at this stage of the development of the design. The preliminary consideration of potential effects is based on this information.

2.1.16 The Project is to be developed further through the reference design and this will form the basis for the Development Consent Order (DCO) application. Therefore, when presenting the Project design in the ES and the accompanying technical documents, the requirements of Advice Note 9 will be reflected. This will ensure that the likely significant effects of the Project are fully assessed. Furthermore, the reference design will be informed by the EIA with the design reflecting iterative working between the designers and the environmental specialists.

2.2 Project route and junctions

2.2.1 The route will connect the A2 in Kent, east of Gravesend, crossing under the River Thames by means of two bored tunnels, before joining the M25 south of junction 29. The Project will also include changes to the M2/A2, A13 and M25, described below.

2.2.2 The total length of the route, including M2/A2 and M25 improvements, will be approximately 31km, with approximately 4km in a tunnel.

2.2.3 Currently, the main road of the Project between the A2 and the M25 is being designed as an all lane running motorway, with three lanes in each direction. An all lane running motorway is a high-standard free-flowing route, with grade separated junctions, and safety levels matching the highest standards of the network. The road will not have hard shoulders for most of its length but will have hard strips, emergency areas and technology providing lane control and variable speed limits. The same vehicle restrictions as on other motorways will apply. There will also be a rest and service area (RaSA) along the route of the Project (see section 2.20).

2.2.4 The horizontal and vertical alignments of the Project route are discussed below and will be designed to the *Design Manual for Roads and Bridges* (*DMRB*) TD 9/93 Table 3 for highway link design. The design speed will be 120kph, with a 70mph speed limit.

2.2.5 Junctions are proposed at the following locations:

a. A new junction with the A2 to the east of Gravesend

b. A new junction east of Tilbury

c. A modified junction with the A13/A1089 in Thurrock

d. A new junction with north-facing slip roads on the M25 between junctions 29 and 30

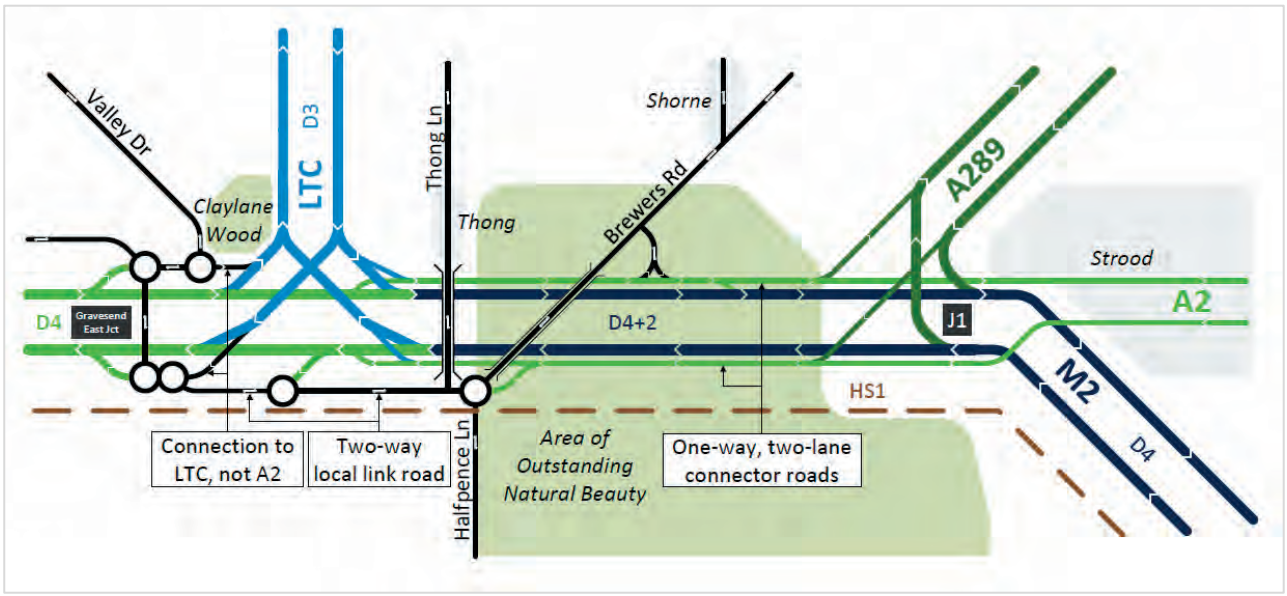
2.2.6 The route of the Project and the proposed junctions are described in more detail below.

A2/M2 and Project/A2 junction

2.2.7 The A2 within the AONB will be kept as four lanes each way but will be widened to provide hard shoulders along this length. Two new one-way parallel connecting roads will also be provided north and south of the A2 connecting to the existing A289 and old A2 at the east end. The eastbound connecting road will have a hard shoulder. These two roads will no longer connect to the A2 at M2 junction 1 with the connections being made at the site of the new Project junction instead. The M2 will be widened from three lanes each way to four lanes each way through junction 1. To minimise the land take requirement outside of the existing highway boundary, which includes ancient woodland, an area of vegetation in the central reserve of the existing A2 will be removed.

2.2.8 The new junction with the A2 east of Gravesend is shown in Plate 2.1.

Plate 2.1 A2/M2 section and Project/A2 junction



2.2.9 The following connections will be provided as part of these junction arrangements:

a. Project route southbound to A2/M2 eastbound dividing to connect to both the M2 and the eastbound parallel connecting road to A2/A289.

b. Project route southbound to A2 westbound dividing to also connect to the Gravesend east junction where the existing east facing slip road will no longer connect to the A2.

c. A2 eastbound to Project route northbound which will be joined by a slip road from the Gravesend east junction which will also no longer connect to the A2.

d. M2/A2 westbound to Project route northbound which will be joined by a connection from the westbound parallel connecting road.

e. A2 eastbound to eastbound parallel connecting road.

f. Eastbound parallel connecting road to M2 eastbound (at M2 junction 1).

2.2.10 In addition, to maintain connections for local traffic, a two-way local connecting road will be provided to the south of the A2 from a new roundabout at Henhurst Road to Brewers Road with an intermediate roundabout connected to a slip road off the A2 westbound.

2.2.11 To maintain connections for local traffic, slip roads will be maintained on and off the eastbound parallel connecting road at Brewers Road. On the westbound parallel connecting road, the slip road off the A2 eastbound will be maintained but the westbound on-slip will be used to connect to the local connecting road described above.

2.2.12 The A2 will be kept at its existing level and the parallel connecting roads will be at about the same level. At the site of the new junction cuttings up to about 10m deep will be needed on both sides of the A2 to accommodate the new link and connector roads. The slip roads and connector roads will pass over or under as follows:

a. A2/M2 westbound and westbound connecting road to Project route northbound will be in a cutting passing under the A2 main carriageway, Project route southbound to A2 westbound and A2 eastbound to Project route northbound.

b. A2 eastbound to Project route northbound will be elevated on an embankment and a structure passing over M2/A2 westbound to Project route northbound twice so that it can merge on the left.

c. Project route southbound to M2/A2 eastbound will start in a cutting to pass under Project route southbound to A2 westbound before becoming elevated on an embankment with the connection to M2/A2 eastbound passing over the A2 eastbound to the eastbound parallel connecting road connection.

d. Project route southbound to A2 westbound will be elevated on an embankment and structure passing over Project route southbound to the M2/A2 eastbound, and the M2/A2 westbound to Project route northbound and the A2 main carriageway.

2.2.13 Parts of the local two-way connecting road south of the A2, including the intermediate roundabout will be elevated slightly on embankment and the slip road from the A2 westbound will pass over the connection from the westbound parallel connecting road to A2 westbound which will be in a shallow cutting.

2.2.14 The existing Thong Lane and Brewers Road bridges over the A2 will be demolished and replaced by new longer bridges over the new arrangement. The existing Park Pale Bridge is currently expected to be retained but the

service road and haulage company access on the north side of the A2 will be realigned.

Gravesend link

2.2.15 From the A2, the new route will pass under Thong Lane between Gravesend and Thong and will cross the site of the Southern Valley Golf Course towards the A226.

South portal and approach

2.2.16 The approach to the tunnel entrance from the south will be at a gradient of 4% through a deep chalk cutting leading to a depth of approximately 30m at the entrance.

2.2.17 The proposed southern tunnel entrance is located about 2km south of the river bank to the south-east of the village of Chalk, south of the A226.

2.2.18 Emergency access and vehicle turnaround facilities will be provided at the southern tunnel entrance. This will comprise a single lane road linking the two main roads by climbing as a loop above the tunnel entrance, as shown in Sheet 6 of *Map Book 1 General Arrangement Plans*. There will be a connection from this loop to the A226 for use by maintenance and emergency service vehicles. There will also be emergency vehicle rendezvous points on each carriageway close to the tunnel entrance and turn-throughs in the central reserve for use in an emergency.

Tunnel

2.2.19 The tunnel crossing is located to the south-east of the village of Chalk on the south of the River Thames and to the west of East Tilbury on the north side. The tunnel will pass under the A226, Lower Higham Road, Thames and Medway Canal, North Kent Railway Line, the Thames Estuary and Marshes Ramsar site, South Thames Estuary and Marshes SSSI and the Metropolitan Police Service Specialist Training Centre.

2.2.20 The 4% approach gradient will continue into the tunnel as far as its crossing under Lower Higham Road at which point it will reduce to 1.6%. This gradient will continue to about the centre of the river where the road level will be around 30m below the riverbed and around 50m below the mean highwater spring level.

2.2.21 To the north of the centre of the river the road will climb at a gradient of 3% as far as the northern entrance where it will emerge into a cutting about 10m below ground level.

2.2.22 Further information about the tunnel design is provided in section 2.14.

North portal and approach

2.2.23 On the north side of the river, the proposed northern tunnel entrance will be about 650m north of the river bank and 1.5km south of the Tilbury Loop Railway Line. The route will reach existing ground level about 450m north of the entrance.

2.2.24 The facility to turn vehicles round in an emergency will be provided by using the Tilbury junction (see section 2.3). As at the southern entrance, emergency

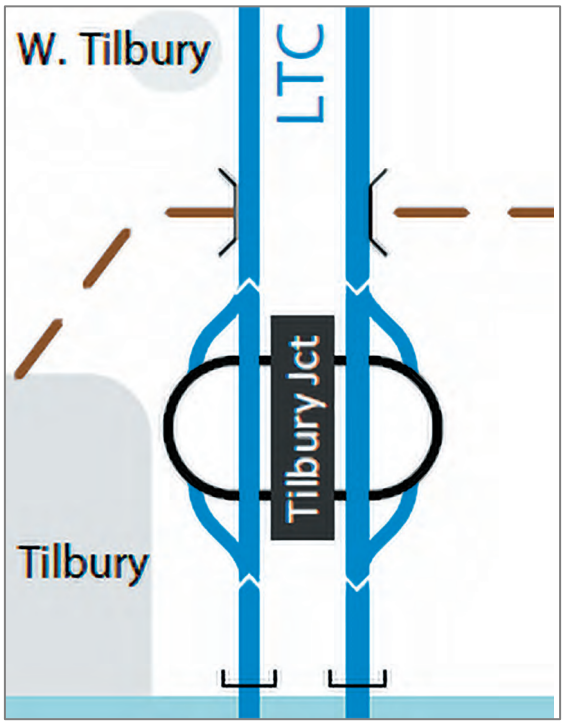
access and emergency vehicle rendezvous points on both carriageways and turn-throughs in the central reserve for use in an emergency will be provided.

Tilbury junction

2.2.25 After reaching ground level the route will continue to climb initially on embankment and then on a viaduct passing over Station Road and the Tilbury Loop railway. The maximum height of the viaduct above ground level will be about 12.5m just north of the railway. After the viaduct the road will continue on embankment as its level reduces to reach ground level about 500m north of the railway. This section needs to be above ground level as it is within a flood zone.

2.2.26 The new Tilbury junction is shown in Plate 2.2 and will be located to the west of East Tilbury about 1km north of the northern tunnel portal and 0.4km south of the Tilbury Loop railway. The junction will comprise a roundabout close to existing ground level with four single lane (with hard shoulder) slip roads to and from the Project route.

Plate 2.2 Tilbury junction



2.2.27 There will be two connections to the east side of the roundabout. One will give access to the proposed RaSA (see section 2.20). The second will be for the tunnel maintenance and access road. There will be no connection on the west side of the roundabout.

2.2.28 The tunnel maintenance and access road will run south from the junction for about 1.5km to provide access to a tunnel maintenance building. This will be located above the tunnel about 500m south of the north portal and 150m north of the river bank. There will be an access to the proposed maintenance depot from the tunnel maintenance and access road about 100m south of the roundabout. There will be a second access to the proposed maintenance depot from the severed section of Station Road, East Tilbury west of its junction with the realigned section of Station Road (see section 2.3).

2.2.29 Station Road, East Tilbury, will be stopped up south of the railway and diverted before passing under the Project's route and the north facing slip roads (see section 2.3) for a more detailed description of the permanent diversion.

Chadwell St Mary link

2.2.30 The route will run to the west of East Tilbury and between Chadwell St Mary and Linford.

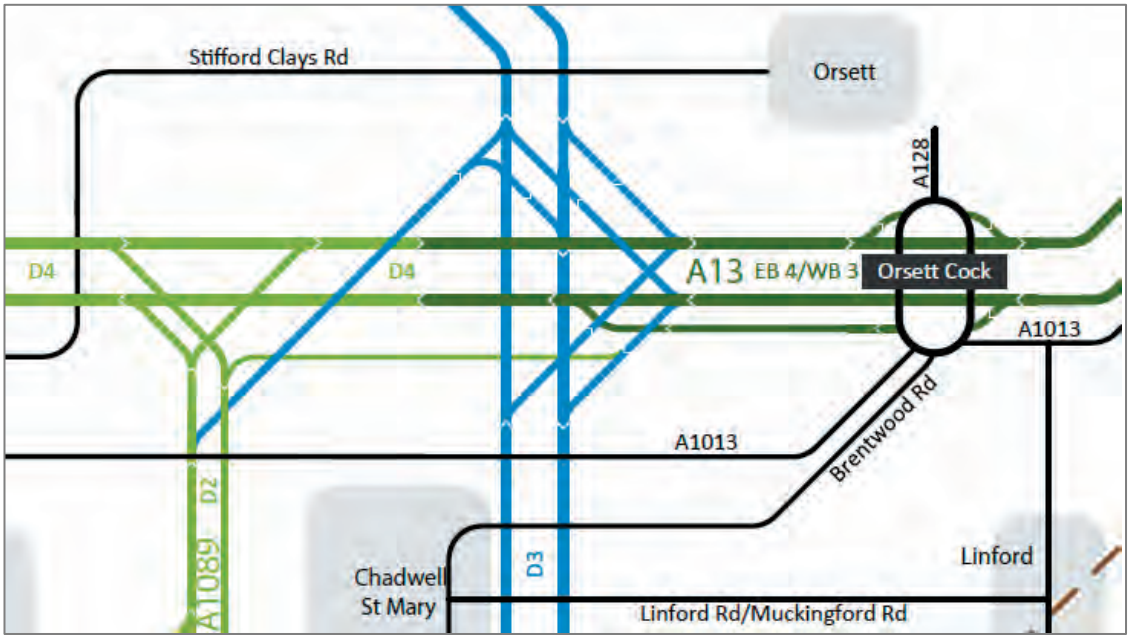
2.2.31 Much of the rest of the route between Tilbury Loop railway and the A13/A1089 junction will be close to ground level. There will be a length of embankment up to 6m high approximately 750m north of Muckingford Road and a short length of cutting up to approximately 7m deep just to the south of Hoford Road.

Project route/A13 junction

2.2.32 The route will cross the A13 to the west of Orsett at the location of the existing A13/A1089 junction with a new junction layout. The main Project route through the A13/A1089 junction will be in cutting approximately 8m deep.

2.2.33 The new junction between the Project route and the A13 and A1089 is shown in Plate 2.3 and will be located at the site of the existing junction between these roads to the west of Orsett.

Plate 2.3 Project route/A13 junction



2.2.34 The Project's route will pass under the A13 to the east of the existing A1089 bridge in a new structure.

2.2.35 The following connections will be provided at the new junction:

a. Project route northbound to A13 eastbound.

b. Project route southbound to A13 eastbound which will join the connection from Project route northbound and have a lane drop off.

c. A13 westbound to Project route northbound and southbound. The connection to Project route southbound will be combined with a connection to A1089 southbound (this connection will need modification of the existing A13 westbound to A1089 southbound slip road). There will be a lane gain on the Project route at the merge from A13 westbound. The connection from A13 westbound to Project route northbound will be joined by a connection from A1089 northbound.

d. A1089 northbound to Project route northbound and southbound. The connection to Project route southbound will diverge from the A1089 northbound and A13 westbound to Project route northbound connection.

2.2.36 No connections will be provided from the Project route to A13 westbound or to the A1089.

2.2.37 No connection will be provided from A13 eastbound to the Project route.

2.2.38 The existing connections between the A13 and A1089 will all be retained with some modifications.

2.2.39 The westbound on-slip road to A13 from the Orsett Cock junction will be realigned and raised onto an embankment to pass over the A13 westbound to the Project route and A1089 southbound connection and merge with the A13 after the A13 westbound to Project route connection has diverged. The A13 will be reduced to two lanes westbound between the diverge to the Project route and the merge of the realigned slip road from Orsett Cock.

2.2.40 The A13 will be widened to four lanes eastbound between the merge from the Project route and the Orsett Cock junction.

2.2.41 The Project route will have two lanes southbound between the diverge to A13 eastbound and the merge from A13 westbound. Northbound there will be two lanes between the diverge to A13 eastbound and the merge from A13 westbound and A1089 northbound. These two-lane sections of the Project route will be provided with hard shoulders.

2.2.42 As part of the works, Long Lane will be realigned to join the A1013 west of its bridge over the A1089 to Project route northbound connection at a left-in and left-out only T-junction. As part of the works Heath Road will be diverted to join the A1013 west of its bridge over the Project route and east of its existing bridge over the A1089.

2.2.43 The new junction will be at the same levels as the existing A1089 which is at ground level in this location, and the A13 which is on embankment, with other sections of the new connections being in cutting below existing ground level. The relative levels and crossings of the connections at the junction will be as follows:

a. Project route northbound to A13 eastbound will start in cutting before rising to cross the Project route and merge with the connection from Project route southbound on embankment before joining the A13.

b. Project route southbound to A13 eastbound will start in cutting passing under the realigned Stifford Clays Road before rising onto embankment, merging with the connection from Project route northbound, passing over Baker Street and joining the A13.

c. A13 westbound to Project route southbound will be in cutting passing under the realigned on-slip from Orsett Cock and A13 westbound to Project route northbound connection.

d. A13 westbound to Project route northbound will diverge from A13 westbound to Project route southbound in cutting before rising onto embankment and crossing over A13 westbound to Project route southbound, the realigned Baker Street, the Project route and A1089. It will then merge with A1089 northbound to Project route northbound and drop into cutting and pass under the A13 main road, existing A13 eastbound to A1089 southbound slip road and the realigned Stifford Clays Road.

Ockendon link

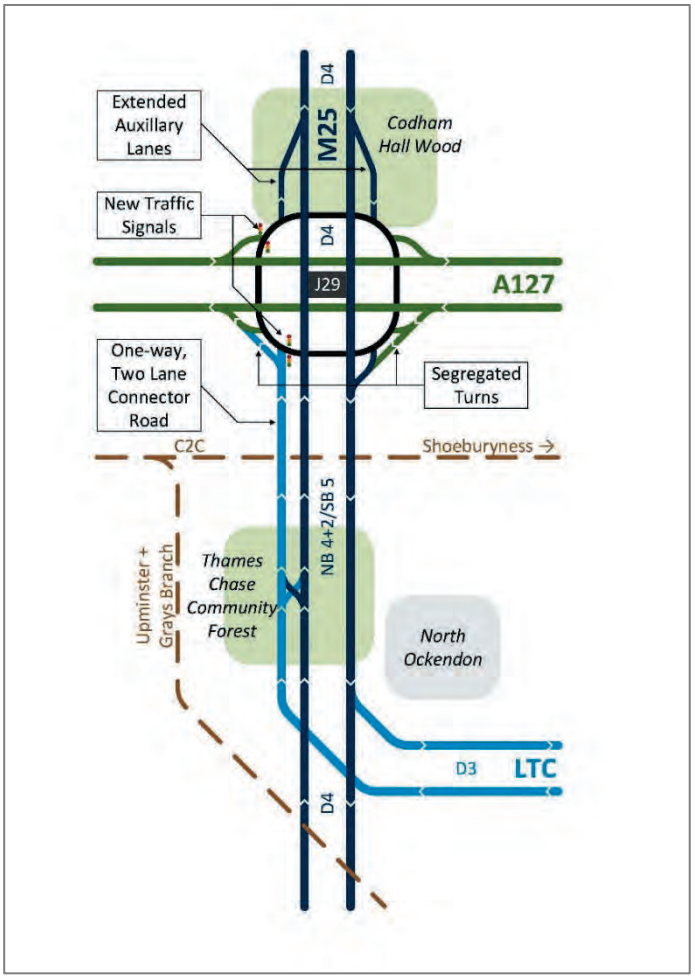
2.2.44 To the north of the A13 the route will pass to the west of Orsett and then turn to the west passing north of South Ockendon.

2.2.45 North of the A13 junction it will be at about ground level for about 1km before climbing to cross the flood plain of the Mardyke. The route crosses the Mardyke flood plain for 2km with about 1.5km of embankment up to 7.5m high and a 450m long viaduct across the Mardyke river and nearby Golden Bridge Sewer. West of the Mardyke, where the route runs to the north of the Ockendon landfill site, it will continue on shallow embankment for about 1km before a cutting up to 5m deep for a further kilometre. After the cutting, the route will run close to ground level for about 750m before the main roads divide and the northbound carriageway goes under the M25 junction.

Project route/M25 junction

2.2.46 The Project will connect with the M25 between junctions 29 and 30 via a new junction, shown in Plate 2.4, which will be located about 3km south of junction 29 near Ockendon Road. It will only have north facing slip roads for northbound Project route traffic to join the M25 and southbound M25 traffic to join the Project route.

Plate 2.4 Project route/M25 junction and junction 29



2.2.47 Modification works will also be carried out on the M25 between the new junction and junction 29, at junction 29 and to the north of junction 29. Between the Project route junction and junction 29 northbound, a one-way two-lane parallel connecting road with hard shoulder connecting to the junction 29 northbound off-slip is proposed, which will no longer connect to the M25. In the southbound direction the M25 will be widened from four lanes with a hard shoulder to five lanes and a hard shoulder between the junction 29 southbound on-slip and Project route southbound off-slip.

2.2.48 Approaching the M25 from the east the Project route will be in cutting and to the west of North Road the carriageways will divide. The northbound carriageway will descend into a deeper cutting passing under the M25 just to the north of its crossing of the Upminster and Grays branch railway. East of the railway it will remain in cutting to pass under Ockendon Road. Ockendon Road will be realigned to the south of its existing route with a new bridge over the Project route northbound slip road and a replacement bridge over the M25.

2.2.49 About 500m north of Ockendon Road the northbound slip road will divide, with two lanes continuing to connect to the M25 northbound and the third lane connecting to the northbound parallel connecting road.

2.2.50 On the northbound M25 main carriageway a two-lane slip road will leave close to the Ockendon Road crossing. This will pass over the Project route

northbound to M25 northbound connection before merging with the connection from Project route northbound to the northbound parallel connecting road.

2.2.51 The M25 will be reduced to three lanes locally between the diverge of the connection to the junction 29 connecting road and the merge from Project route northbound. North of the connection from the Project route the M25 northbound main road will revert to its existing four lanes with hard shoulder as far as the disconnected junction 29 northbound off-slip.

2.2.52 Through junction 29 the M25 main carriageway will be widened from three lanes each way with hard shoulder to four lanes each way with hard shoulder in both directions. This will involve the widening of the existing viaduct structure over the existing roundabout and A127.

2.2.53 North of junction 29 the connections of the north facing slip roads will be modified because of the widening of the main road through the junction. The northbound on-slip will be modified from a lane gain arrangement to an extended auxiliary lane for about 950m north of the junction. In the southbound direction a two-lane auxiliary lane parallel diverge will be provided in place of the existing lane drop. These auxiliary lanes will be about 1.5km long.

2.2.54 Modifications will also be carried out at the existing junction 29 roundabout. Full signalisation will be provided in place of the current partial signalisation and free-flow left turn lanes will be provided from the A127 westbound off-slip to M25 southbound on-slip and from the northbound parallel connecting road to the A127 westbound on-slip.

2.3 Side roads

2.3.1 Where existing side roads are affected by the route, provision has been made to reconnect the roads. In most locations, the affected side roads will go over the new route and will generally need alterations to the horizontal alignment of the local roads to enable the new side roads to be constructed off-line of the existing roads. This will ensure that traffic will be able to continue to use the roads during construction. Further details of provisions for NMUs are included in section 2.12.

2.3.2 The following specific provision for existing side roads will be included in the Project:

a. Brewers Road crossing of A2 replaced with new bridge on existing route with either a temporary diversion to the west during construction or temporary stopping up.

b. Thong Lane crossing of A2 replaced with new bridge over widened corridor to the west of the existing bridge.

c. Thong Lane crossing of Project route with new bridge on the line of the existing road with a temporary diversion during construction.

d. Station Road, East Tilbury will be stopped up and an alternative route will be provided to avoid the site of the proposed RaSA. A 200m section of Station Road will be stopped up between Bowaters Farm and properties

north west. The realigned Station Road will have a new junction 50m to the west of Love Lane and run around the eastern perimeter of the RaSA and under the Project route to rejoin existing Station Road south of Tilbury Loop railway. A connection east of the Project Route will be provided from new Station road to existing Station Road to maintain access to the properties and European Metal Recycling.

e. Muckingford Road realigned to the south of the existing route for about 900m and raised by up to 8m to cross over the Project route.

f. Holford Road realigned to the south of the existing route for about 450m and raised by up to 7m to cross over the Project route.

g. Brentwood Road (A128) realigned horizontally for about 600m to straighten existing alignment and raised by up to 11m to cross over the Project route.

h. High House Lane will be stopped up where it crosses the Project route. The section south of the Project route will be diverted to the west for about 300m to join Brentwood Road. The section north of the Project route will be realigned to the north of its existing alignment for about 200m and raised to join the realigned Brentwood Road as it climbs to cross the Project route.

i. Hornsby Lane realigned to the east of the existing route for about 750m and raised by up to 9m to cross over the Project route.

j. A1013 Stanford Road: three new bridges provided on the route of the existing road. One over the Project route, one over the connection from A1089 northbound to Project route northbound as part of A13 junction works and one over the A13 westbound to Project route southbound connection (refer to section 2.3 above). The existing bridge over the A1089 is replaced.

k. Section of A1013 Stanford Road either side of its junction with Rectory Road realigned to the south for about 800m and raised slightly to accommodate realigned Orsett Cock westbound on-slip and replacement Rectory Road bridge over A13.

l. Baker Street realigned for about 400m to run on the east side of the Project route north from a new junction with A1013 Stanford Road east of its bridge over the Project route. This will pass under the A13 to Project route northbound connection and the existing A13 westbound to A1089 southbound slip road before rejoining the existing road south of the existing bridge under the A13 main road which will be unaltered. This will be carried out as part of A13 junction works (refer to section 2.3 above).

m. Rectory Road stopped up for about 400m north of its junction with A1013 Stanford Road to the allotment access south of School Lane. Alternative

route about 800m long provided from a junction with the A1013 about 200m east of the existing junction and the School Lane roundabout. This will cross the realigned westbound on-slip to the A13 from the Orsett Cock junction and the A13 on a new bridge before running north and then west around the Orsett Show Ground.

n. Stifford Clays Road realigned to the south of the existing route for about 600m and raised by about 5m above existing ground to cross over the Project route and connections from A13 westbound and A1089 northbound to Project route northbound and Project route southbound to A13 eastbound which are in cutting at this point.

o. Green Lane realigned to the north of the existing route for about 600m and raised by up to 7.5m to cross over the Project route.

p. B186 North Road realigned to the east of the existing route for about 450m and raised by up to 6m to cross over the Project route.

q. Ockendon Road realigned to the south of the existing route for about 700m close to existing ground level to cross over the M25 and Project route to M25 northbound on new bridges as part of M25 junction works (refer to section 2.3 above).

2.3.3 The side roads crossing over the Project route will generally have lengths of embankment either side of a bridge structure over the new road.

2.4 Highways cross-section

2.4.1 Main road lane widths will be in accordance with the appropriate design standards. The main 3 lane roads will be 11m wide with 1m wide hard strips on each side. The widths of the central reserve and verge will vary with widening being provided either for sight lines or to accommodate items such as signs and drainage. The minimum central reserve width will be 4.5m (including hard strips) and the minimum verge width will be 2.5m (including hard strips).

2.4.2 Emergency areas will be provided on both main roads outside the tunnel at intervals of about 1.5km. These will be 4.6m wide lay-bys which will be 100m long (including tapers). The emergency areas will be combined with maintenance hard standings comprising reinforced concrete grass paving and will generally be the locations of features and equipment such as variable message signs (VMSs), CCTV cameras and communications cabinets.

2.4.3 Slip road cross-sections will vary. Two-lane slip roads will generally have 7.3m wide carriageways with metre hard strips and one-lane slip roads will have a 3.7m wide running lane and a 3.3m wide hard shoulder. The two-lane parallel connecting roads at the A2 will be 7.3m wide with metre hard strips and the northbound two-lane parallel connecting road at the M25 will be 7.3m wide with a 3.3m wide hard shoulder.

2.5 Road pavement and road surfacing

2.5.1 The design of road pavements will be carried out in accordance with the appropriate design standards and good practice. For the purpose of the assessment in this *PEIR*, a hot rolled asphalt surface has been assumed throughout, which represents a worst case from the perspective of noise generation. However, the design will be developed considering operational, maintenance and acoustic requirements.

2.5.2 The use of surfaces with low-noise properties, such as a thin wearing course, will be considered, as discussed in Chapter 13: Noise and Vibration.

2.5.3 High friction surfacing (HFS) will also be considered where high braking forces will be expected, such as on approaches to junctions. Risk assessments will be carried out and the locations where HFS material will be used will be defined during the detailed design stage for each junction approach.

2.6 Safety and security

2.6.1 The safety performance of the Project has been given due consideration at each stage of the Project development. This will continue as the definition of the Project develops from preliminary design through detailed design and during the Project life cycle.

2.6.2 The route will be designed to the latest safety standards using technology to effectively manage traffic and provide better information to drivers. The latest and safest construction methods will be used.

2.7 Earthworks design

2.7.1 The earthworks comprise cuttings and embankments. Preliminary slope recommendations within these areas are based on the anticipated stratigraphy, based on the information provided in studies to date.

2.7.2 The geology underlying the Project is described in full in Chapter 11: Geology and Soils, but the anticipated stratigraphy along the route is summarised below:

a. A2/M2, Project route/A2 junction & Gravesend link (including south portal approach ramp): this section of the route is mostly directly underlain by the Harwich Formation, Lambeth Group, Thanet Formation or White Chalk Subgroup, and occasionally overlain by patches of Head Deposits or Made Ground.

b. Tilbury junction and Chadwell St Mary link (including north portal approach ramp): this section of the route is underlain by Made Ground or Alluvium overlying River Terrace Deposits and bedrock comprising Thanet Formation and the White Chalk Subgroup to the south of the section, and by Head Deposits or River Terrace Deposits overlying Thanet Formation to the north of the section.

c. A13 junction: this section of the route is underlain by Made Ground or Head Deposits or River Terrace Deposits, overlying bedrock consisting of the London Clay Formation, Lambeth Group and Thanet Formation.

d. Ockendon link: part of this section of the route is underlain by Alluvium overlying London Clay Formation, while the rest of the site comprises Head Deposits and River Terrace Deposits overlying London Clay Formation.

e. Project route/M25 junction and M25/junction 29: this section of the route is underlain by Head Deposits, Alluvium (northern part of this section) or River Terrace Deposits, overlying London Clay Formation.

2.7.3 The southern portal structures will be constructed predominantly in Chalk geology, partially above the groundwater table. The north entrance and approach ramps will be constructed in the flood plain where ground conditions comprise Made Ground, including potentially contaminated soil overlying Alluvium (silts, clays and peat), River Terrace Deposits and Chalk with the below ground structures constructed below the groundwater table.

2.8 Highway structures

2.8.1 All the structure details given in this section are indicative of potential solutions and may be subject to change as the design develops. The range of new structures needed is summarised in Table 2.1.

2.8.2 The Project is seeking to incorporate existing bridges where possible; there are several of these existing bridges on the M25, A13 and A2 that will be incorporated into the Project as the Project layout is developed.

Table 2.1 Summary of proposed highway structures[1]

Type of structure	Number of structures
Replacement road overbridge	5
New road overbridge	24
New road underbridge	5
Widened road underbridge	2
New viaduct	6
Widened viaduct	1
New tunnel	1
New footbridge	5
New underpass	1
New main river bridge	3
Widened main river bridge	1
New rail underbridge	1
Widened rail underbridge	1
New accommodation overbridge	2

2.8.3 The highway structures currently included in the Project are set out in Table 2.2.

[1] Indicative numbers only, subject to change as design develops

Table 2.2 Proposed highway structures

Location	Type of structure
A2/M2	
Brewers Road crossing A2/M2	Replacement overbridge
Thong Lane crossing A2/M2	Replacement overbridge
Project route/A2 junction	
A2 eastbound to Project route northbound first crossing of A2/M2 westbound to Project route northbound	New overbridge
A2 eastbound to Project route northbound second crossing of A2/M2 westbound to Project route northbound	New overbridge
Project route southbound to A2 westbound crossing A2 westbound to Project route northbound and M2 main road	Three overbridges
Project route southbound to A2 westbound crossing Project route southbound to A2/M2 eastbound	New overbridge
Project route southbound to A2/M2 eastbound crossing A2 main road	New overbridge
A2 westbound slip road to local connecting road roundabout crossing westbound parallel connecting road to A2 westbound	New overbridge
Project route southbound to A2/M2 eastbound crossing A2 eastbound to eastbound parallel connecting road	New overbridge
Footpath 167 crossing A2 westbound to Project route northbound	New footbridge
Footpath 167 crossing A2/M2 eastbound to Project route northbound	New underpass
Footpath 167 crossing Project route southbound to A2/M2 eastbound and Project route southbound to A2 westbound	New footbridge
Gravesend link	
Thong Lane crossing Project route	New overbridge
Footpath NG7 crossing Project route	New footbridge
Tilbury junction	
Project route crossing Tilbury junction roundabout, Station Road and Tilbury Loop railway	New viaduct
Tilbury junction northbound on-slip crossing Station Road	New viaduct
Tilbury junction southbound off-slip crossing Station Road	New viaduct
Chadwell St Mary link	
Muckingford Road crossing Project route	New overbridge

Location	Type of structure
Hoford Road crossing Project route	New overbridge
A128 Brentwood Road crossing Project route	New overbridge
Farm track and footpath FP79 crossing Project route	New accommodation overbridge
A13/A1089 junction	
Hornsby Lane crossing Project route	New overbridge
A13 westbound to Project route northbound crossing A13 westbound to Project route southbound	New overbridge
A1013 crossing A13 westbound to Project route southbound	New overbridge
A1013 crossing Project route main road	New overbridge
A1013 crossing A1089 northbound to Project route northbound	New overbridge
A13 westbound to Project route northbound crossing Baker Street, Project route main road, A13 westbound to A1089 southbound, and A1089 main road	New viaduct
Realigned Orsett Cock westbound on-slip crossing A13 westbound to Project route	New overbridge
Rectory Road crossing realigned Orsett Cock A13 westbound on-slip and A13 main road	Replacement overbridge
A13 main road crossing Project route main road	New overbridge
A13 main road crossing of A1089 main road	Unaltered overbridge
A1089 northbound and A13 westbound to Project route crossing of A13 main road	New underbridge
A1089 northbound and A13 westbound to Project route crossing of A13 main road to A1089 southbound	New underbridge
A13 main road crossing Baker Street	Unaltered overbridge
Project route to A13 eastbound crossing Baker Street	New underbridge
Stifford Clays Road crossing A1089 northbound and A13 westbound to Project route northbound	New overbridge
Stifford Clays Road crossing Project route main road and Project route southbound to A13 eastbound	New overbridge
A13 westbound to A1089 southbound crossing Baker Street	New overbridge
A13 westbound to A1089 southbound crossing Project route main road	New overbridge
A13 eastbound to A1089 southbound crossing A13 westbound and A1089 northbound to Project route	New overbridge
Project route northbound to A13 eastbound crossing Project route main road	New overbridge

Location	Type of structure
A1089 northbound to Project route southbound crossing Project route main road	New overbridge
Ockendon link	
Green Lane bridleway crossing Project route	New accommodation overbridge
Project route crossing Orsett Fen Sewer (main river)	New main river bridge
Project route crossing Golden Bridge Sewer (main river), Mardyke (main river) and bridleway BR219	New viaduct
Footpath FP 136 crossing Project route	New footbridge
B186 North Road crossing Project route	New overbridge
Project route/M25 junction	
Diverted footpath FP251 crossing M25 southbound to Project route southbound, Project route northbound to M25 northbound and Upminster and Grays branch railway	New footbridge
Project route northbound crossing of M25	New underbridge
Ockendon Road crossing M25	Replacement overbridge
Ockendon Road crossing of Project route northbound to M25 northbound	New overbridge
M25 northbound to parallel connecting road to junction 29 crossing Project route northbound to M25 main road	New overbridge
M25 and junction 29	
M25 crossing of main river	Widened main river bridge
Northbound parallel connecting road to junction 29 crossing of main river	New main river bridge
M25 crossing of St Marys Lane	Widened underbridge
Northbound parallel connecting road to junction 29 crossing of St Marys Lane	New underbridge
M25 crossing of Upminster to Shoeburyness railway	Widened rail underbridge
Northbound parallel connecting road to junction 29 crossing of Upminster to Shoeburyness railway	New rail underbridge
M25 crossing of junction 29 roundabout and A127	Widened viaduct
Folkes Lane crossing of M25	Replacement overbridge

2.8.4 In addition to the highway structures set out in Table 2.2, there will be minor structures such as culverts over ditches and several retaining walls along the route.

2.9 Highways drainage

2.9.1 The Project has two distinct sections, each requiring a different approach to drainage:

a. South of the River Thames, ground profiles are generally very steep, and the sub-soils are predominantly of permeable chalk with a deep groundwater table. Because of the permeable nature of the geology there are no watercourses south of the tunnel entrance. There is a network of ditches/watercourses north of the entrance, located within the Ramsar site close to the River Thames.

b. North of the River Thames, ground conditions are more variable and less permeable. This area is characterised by the presence of natural watercourses that regularly cross the proposed route with the primary watercourses being Mardyke and Tilbury Main, which are both designated as 'Statutory Main Rivers' by the Environment Agency.

2.9.2 South of the River Thames, drainage systems will outfall to soakaways and the River Thames. There are several existing soakaways along the A2 in the form of infiltration basins and where appropriate, these will be retained and enhanced. Several existing basins will be decommissioned, and new infiltration basins will be provided to suit the revised road routes. New or enhanced infiltration basins will include pollution control facilities to provide water quality treatment and will also include facilities to staunch and contain any accidental spillages.

2.9.3 North of the River Thames, drainage systems will generally be positive pipe systems outfalling into the watercourses along the route, such as the Mardyke. Nevertheless, there are some locations, primarily around the A13 junction which lend themselves to infiltration drainage and, where appropriate, swales or infiltration basins will be proposed in these locations. Other features supporting the drainage systems will comprise retention ponds and along the section of the widened M25 existing balancing ponds. These balancing ponds, originally constructed as dry features for the 2010 M25 widening scheme, will be resized to accommodate the additional runoff from the new impermeable areas.

2.9.4 Outfalls to watercourses will include attenuation basins to reduce outflows to green-field runoff rates. Attenuation basins may include constructed wetlands to provide water quality treatment.

2.9.5 All outfalls will include facilities to staunch and contain any accidental spillages, either in lined channels or swales or in oversized pipes.

2.9.6 As well as the ground conditions and the permeability of sub-soils at any particular location, the drainage solution adopted will also be designed to suit several constraints including the extent of flood plains, the location of landfills and ground water levels.

2.9.7 At the A13 junction the road will be in deep cutting. For this area, a positive drainage network in the form of filter drains will be provided, draining via a balancing pond to a watercourse.

2.9.8 The existing drainage along the proposed section of M25 widening comprises several positive piped networks discharging into dry type balancing ponds which outfall into the Mardyke at various locations. As part of the widening works the intention will be to reuse these ponds resized to accommodate the additional surface water runoff and manage the discharge rates to the watercourses to

current legislation. To provide a betterment over the current dry type ponds and improve the water quality treatment process, the proposed enlarged ponds may be constructed as hybrid wetland type features.

2.10 Highways lighting

2.10.1 The lighting design is at an early stage of development; therefore, the extent of new lighting is yet to be confirmed. However, for the purposes of the preliminary environmental information assessment it is assumed that lighting will be needed at junctions and interchanges on the route, parts of the local access roads and certain sections of the Project.

2.10.2 The design has been carried out in accordance with BS 5489-1:2013, BS5489-2:2016, Highways England's TD34/07 and the guidance contained in the Institution of Lighting Professionals (ILP) document Guidance Notes for the Reduction of Obtrusive Light GN01:2011.

2.10.3 Using the ILP's GN01:2011 document, the Project is considered to fall within environmental lighting zones as shown in Table 2.3 below.

Table 2.3 Ambient luminance zones for the Project

Area	Environmental zone	Notes
A2/M2 and A2 junction	E1/E2	Combination of AONB, ancient woodland, community woodland, but close to Gravesend and existing A2/M2 lit
Gravesend link, south portal approach and south portal	E1/E2	Farmland, but close to Gravesend
North portal, north portal approach, Tilbury junction and RaSA	E1/E2	Farmland, but close to river and Tilbury
Chadwell St Mary link	E2/E3	Combination of farmland but close to Tilbury; existing A13 lit
A13 junction and Ockendon link	E1	Mardyke river and farmland; existing A13 lit
Project route/M25 junction and M25 junction 29	E1/E2	Rural dwellings, farmland, but existing M25 is lit

2.10.4 All highway lighting, including within the tunnel, will be in accordance with the appropriate design standards and guidance and use energy efficient light sources and controls throughout.

2.10.5 Lighting could also be used to improve perceived personal security and to illuminate cycle ways, footways and other underpasses under the Project.

2.10.6 All the luminaires used will emit no light above the horizontal (ie, into the sky) and reduce light spill into adjacent areas to a minimum level while providing a compliant highway lighting scheme, in accordance with current Institute of Lighting Professionals guidance and national standards.

2.10.7 The tunnel lighting system will be designed in accordance with BS5489-2:2016, with the interior of the tunnel divided into several zones, each with different light

requirements. The lighting levels for each zone are set relative to the level just outside of the entrance/exit portals both during the day and night, with a minimum level set by the traffic flow, and speed limit. The tunnel lighting will include controls to allow the tunnel light level to be adjusted automatically to account for changes in the lighting outside of the tunnel, and to traffic flow to reduce the energy consumed and extend maintenance intervals.

2.11 Technology

2.11.1 The design of technology assets, including types and locations, is still being developed, but it is currently envisaged that the Project will include technology assets such as:

a. VMSs mounted on gantries

b. CCTV cameras

c. above ground traffic detectors

d. charging infrastructure as appropriate

2.11.2 Emergency areas and VMSs will be provided along the route based on Highways England guidance. These signs will be used by the Highways England regional control centre to display travel information, hazard warnings and both advisory and mandatory signage to drivers. The signs will be a standard Highways England design and mounted gantries located in the verge. Where practical, the signs will be co-located with gantry-mounted direction signage to minimise the number of gantries on the road.

2.11.3 On each approach to the tunnel, LED matrix lane control signals will be mounted on cantilever gantries above each lane. These will allow Highways England to condition traffic before entering the tunnel, applying any lane closures or speed restrictions in advance, to allow traffic to flow freely through the tunnel. Where practical, the signals will be located on gantries provided for other purposes.

2.11.4 CCTV masts will typically also be sited at emergency areas, with additional masts installed if necessary to avoid blind-spots and provide surveillance coverage of the whole road. Images from the CCTV cameras are used by Highways England for a wide variety of purposes including managing and investigating incidents, monitoring of activities on site including the health and safety of workers and the public, asset protection, monitoring specific operations and network usage and the prevention and detection of crime. Standard CCTV mast height is between 10m and 15m above ground level.

2.11.5 Traffic detectors will be mounted on poles in the verge at approximately 500m spacing, co-located with emergency areas or other accessible locations wherever possible. The detectors are needed to control automatic traffic management systems (eg, variable speed limits) and to collect data on traffic flows. The poles are typically slender and up to 8m high.

2.11.6 Wherever practicable, equipment cabinets will be co-located with emergency areas or clustered at locations that offer safe maintenance access, eg, from adjacent land.

2.11.7 The need for any additional VMSs on the roads approaching the Project route (the M25, A2 and A13) will be considered as part of the Project development. It is feasible that little additional variable message signage could be needed as the approach roads are already equipped with highway communications equipment. However, it may be necessary to move or add signage to enable drivers to be advised of alternative routes when either the Project or Dartford Crossings are congested or closed. It is expected that VMSs for strategic diversions will be mounted on cantilever structures, providing a display matrix.

2.11.8 In conjunction with the requirements for technology, highways signs will be included in the design. This could include both gantry and roadside mounted signs. Where large advance directional signs are needed, their height will be kept to a minimum using reduced letter heights where standards permit.

2.12 Non-motorised users (pedestrians, cyclists and horse riders) provision

2.12.1 For safety reasons, NMUs which include pedestrians, cyclists, horse riders and slow-moving vehicles will be prohibited from using the Project route.

2.12.2 An initial assessment of non-motorised use for the Project as a whole has been carried out under HD42/17 of the *Design Manual for Roads and Bridges*. The assessment considers existing routes directly affected by the Project and routes within a 5km radius that could benefit from additional design input. Existing NMU provisions for pedestrians, cyclists and horse riders that will be affected by the Project are shown in Map Book 1 General Arrangement Plans.

2.12.3 Where the Project will directly affect the existing Public Rights of Way eg, footpaths, bridleways and existing cycle routes, provision will be made to ensure that the route remains open. This may be through provision of underbridges or overbridges, or, where a direct connection is not feasible, alternative routes using suitable diversion will be provided.

2.12.4 Additional design input for the wider impacts on the NMU network will be determined through engagement with user groups, local authorities and local communities.

2.12.5 During construction, routes could be temporarily stopped up, in which case suitable alternative routes will be identified and signed.

2.13 Flood risk management

2.13.1 In accordance with the requirements of the National Planning Policy Framework (NPPF) and the National Policy Statement for National Networks (NPSNN), a Flood Risk Assessment (FRA) will be prepared for submission with the DCO application. This will demonstrate how flood risk to the development will be managed now, and when taking future climate change into account. The FRA will also consider the flood risk generated because of the Project.

2.13.2 Although the majority of the development lies in Flood Zone 1, parts of the development will lie in Flood Zone 3. The parts of the development which lie in Flood Zone 3 are as follows:

a. immediately to the north of the River Thames (Tilbury Marshes)

b. Orsett Fen (combined flood plains of the Mardyke, Golden Bridge Sewer and Orsett Fen Sewer)

c. M25 crossing (West Mardyke)

2.13.3 The parts of the development in Tilbury Marshes and Orsett Fen benefit from flood defences (the primary flood mechanism in these areas is tidal flooding; the defences comprise sea walls and sluice gates).

2.13.4 Development behind flood defences can increase the residual risk of flooding if the flood defences are breached or overtopped. Development in the low-lying area behind the flood defences will reduce the time taken for overtopping/breach flows to inundate the area, due to displacement of floodplain storage. Where sections of the Project fall within Flood Zone 3, compensatory flood storage areas will be provided.

2.13.5 Flood compensatory storage areas will be located as close to the development as is possible and practicable. It will be necessary to use areas that currently lie in Flood Zone 1 for compensatory storage; in such cases, the storage areas will be linked to existing Flood Zone 3 areas by means of a common boundary.

2.13.6 Flood compensation will also be needed for the temporary works. It is envisaged that any flood compensation used for the temporary works will also be used for the permanent works.

2.13.7 Indicative areas of flood compensation land are shown in Map Book 1 General Arrangement Plans.

2.13.8 In addition to assessing flood risk, the FRA will also be used to inform certain elements of the detailed design, including:

a. flood defence of the north tunnel portal

b. bridge deck levels and spans

c. road levels

d. development of a main drainage strategy including dealing with exceedance flows

e. pollution control and water quality

f. runoff assessment

g. location of surface water balancing facilities

2.14 Tunnel design

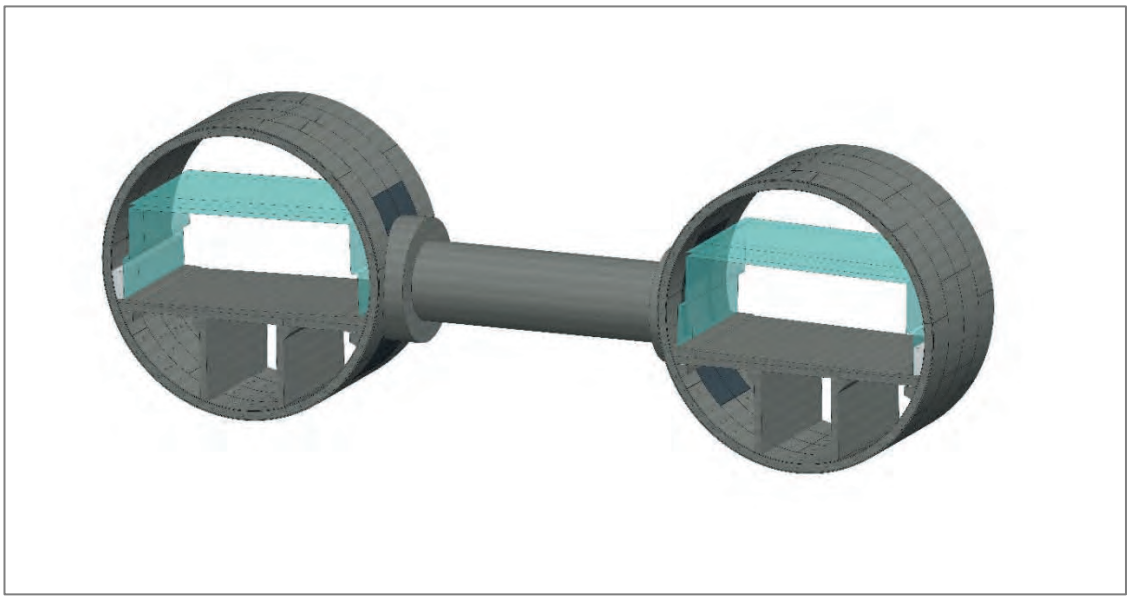
2.14.1 The Project will comprise a twin bored tunnel approximately 4km in length. The size of the twin tunnels will be able to accommodate three lanes each way, and the external diameter of each tunnel bore will be approximately 16m with a maximum road gradient of 4% within the tunnel.

2.14.2 Cross-passages connecting each tunnel will be provided for emergency evacuation as well as maintenance works. Connecting cross-passages provided

between the tunnel bores will be at an appropriate spacing, subject to standards and further analysis.

2.14.3 An indicative cross-section of the tunnels is shown in Plate 2.5.

Plate 2.5 Indicative tunnel cross-section



2.14.4 The vertical tunnel alignment has approximately 1 diameter cover at mid-river, subject to further studies on bathymetric, future navigation channel depth and scour of seabed.

2.14.5 The tunnel will be designed in accordance with the *DMRB*, *BD78-Design of Road Tunnels* and will achieve the minimum safety requirements for tunnels on the trans-European road network. A system of height detection will be used to prevent oversized vehicles accessing the tunnel. A detour road may be needed to allow oversized vehicles to leave the highway before entering the tunnel.

2.14.6 The tunnels will be provided with drainage capacity to deal with wash-down water, infiltration, firefighting water and surface water runoff from the approaches before entering the tunnel. Captured water will discharge to a deep pump sump located at the lowest point of both tunnels and a main pump sump at the deepest parts of the ramps at the tunnel entrance points. A pumping station will also be needed at each tunnel portal to manage surface water runoff from the tunnel approaches.

Tunnel lighting

2.14.7 Tunnel lighting during operation (termed “normal lighting”) will be provided to ensure appropriate visibility during day and night for drivers in the threshold, transition and exit zones of the tunnel.

2.14.8 Safety lighting will be provided to allow a minimum visibility for tunnel users to evacuate the tunnel in their vehicles in the event of a breakdown of the power supply.

2.14.9 Evacuation lighting, such as evacuation marker lights will be provided to guide tunnel users to evacuate the tunnel on foot, in the event of emergency.

Tunnel ventilation

2.14.10 The assumed ventilation system for the tunnel is a longitudinal ventilation system. The system will use clusters of jet fans located along the entire length of each of the tunnel bores.

2.14.11 Ventilation during normal operation will generally be via the natural piston effect of the unidirectional traffic. However, a mechanical ventilation system may also be needed to supplement the natural ventilation to minimise the concentration of emissions in the tunnel from the vehicles. The tunnel's command and control system will control the operation of the fans during normal operation, based on in-tunnel air quality measurements. The fans will operate sequentially to maintain the air quality in the tunnel.

2.14.12 The tunnel ventilation system will be subject to further design in conjunction with the air quality assessment to ensure that emissions are minimised as far as possible.

2.14.13 In the event of a fire, the ventilation system in the bore will maintain safe conditions upstream of the event by pushing smoke to the tunnel exit portal. Counter-ventilation in the adjacent bore will prevent inflow of smoke at the tunnel portal. Ventilation Design Fire Load will be agreed in consultation with the Tunnel Design Safety Consultation Group (TDSCG). TDSCG includes members of the Project team, Highways England tunnel specialists, Highways England operations directorate, the emergency services, adjacent local highway authorities and environmental bodies. It is possible that, subject to risk assessments, a Fixed Fire Fighting System will be implemented.

Emergency arrangements (operation)

2.14.14 In coordination with the TDSCG, it will be agreed how the special access to the tunnel portal will be used in an emergency, to allow for quick first response from the local emergency services. Rendezvous points will also be provided at either end of the tunnel.

2.14.15 Emergency services would arrive following agreed procedures on emergency service crew safety and welfare. Vehicular crossing of the central reserve will be made possible outside each portal. This measure will allow emergency services to gain immediate access to either tunnel.

Service building

2.14.16 At each of the tunnel portal locations, a service building will be constructed to provide mechanical and electrical, drainage, and maintenance operations. The service building will include an office, pump rooms, water basin for firefighting, power supply and a local control room.

2.14.17 A tunnel control facility will be installed to serve local tunnel control. There will be a connection with the regional tunnel control centre, and the local control facility will be used as a backup protocol in case the regional control centre has any issues. For maintenance purposes the control building will have parking and a connection with a maintenance access road.

2.15 Environmental design

2.15.1 Environmental considerations inform the evolution of the design. As a result, environmental design measures are being incorporated within highways design, to mitigate impacts arising from highways development and address effects on different environmental receptors. Examples of these measures are detailed further below and are shown in Figure 2.4 Outline Environmental Masterplan.

2.15.2 The landscape design has been developed to integrate the Project with the local character of the surrounding landscape and soften the visual impact. The proposed landscaping aims to maintain local vegetation patterns and landform while ensuring that any biodiversity benefits have also been maximised.

2.15.3 Environmental barriers in the form of earth mounding or green walls are being considered to provide screening from increased noise levels during the Project's operational phase. As part of the proposed landscaping, where appropriate, earthworks are also being planted up to minimise visual impacts on the landscape.

2.15.4 Project design has also considered biodiversity and opportunities are being explored to identify the most suitable areas for potential habitat creation where significant effects on designated areas and protected species have been identified. This has informed the design process so that linkages between habitats and new wildlife corridors are incorporated within Project design. For example, the proposed green structures on the A2 corridor and Project route aim to connect new and existing habitats north-south and east-west.

2.15.5 To mitigate potential impacts on the water environment associated with the construction and operational phases of the Project, the proposed design includes measures to control water pollution and methods to drain surface water from the site effectively. This includes surface water outfalls, soakaways and the creation of balancing ponds.

2.16 Demolition and land take

2.16.1 The Project will need land on a permanent and temporary basis. The permanent land take will be for the road and tunnel along with other operational infrastructure, land for utility diversions and land for environmental mitigation and flood compensation. On a temporary basis, land will be needed for construction compounds and stockpiling areas. In line with the requirements of the DCO, land take will be kept to the minimum required. Compensation will be payable in accordance with the Statutory Compensation Code. Consultation with landowners, occupiers and agents will continue as the Project develops to manage and reduce impact on property owners as far as practicably possible.

2.16.2 South of the River Thames there are nine residential properties and five commercial properties within the Development Boundary. Most of the properties are located at the proposed junction with the A2.

2.16.3 North of the River Thames 153 residential properties at the northern end of the Project have been included in the Development Boundary due to the need for works on overhead lines. These properties will not be directly affected by the Project. Excluding the properties affected only by pylon works, there are 68 residential properties and 10 commercial properties within the Development

Boundary. A large proportion of these properties are within the area identified for the construction of the A13 junction.

2.16.4 Not all properties within the Development Boundary will require demolition. Opportunities for reducing the amount of properties to be demolished will continue to be a key focus as the design develops.

2.16.5 Along the route there is a large amount of agricultural land that will be affected and north of the River Thames the route will directly affect an area of Open Access Land at Orsett Fen.

2.17 Services and utility diversions

2.17.1 The route will require the diversion or alteration of overhead high voltage electricity transmission and distribution lines. In addition, there are large high-pressure gas feeder mains that will need diversion.

2.17.2 At the three main junctions, the A2, A13 and the M25, the route will require complex diversions including: high, medium and low-pressure gas distribution mains, high pressure water mains and sewers, underground electricity distribution cables and a range of telecommunications cables including fibre optic cables. In addition, there could be low voltage electricity cables, small water mains and other utilities that may need diversion or protection works.

2.17.3 An envisaged plan of utility diversions is shown in Figure 2.3 in Volume 3 of this *PEIR*. Disruption of existing services will be minimised through careful planning and liaison with the utility providers and construction works programme. This will enable the efficient diversion of utilities and minimise disruption to the many customers of these utility companies.

2.17.4 It is assumed that some of the major diversions will be done as part of early enabling works.

2.17.5 The full extent of diversions and mitigation measures will be determined following discussions with the relevant utility companies and fully assessed in the Environmental Statement (ES).

2.18 Construction works

2.18.1 The estimated overall construction duration is approximately seven years. The following construction activities will be needed to deliver the Project as described:

a. enabling works

b. new junctions on the M25 and other major roads

c. new carriageway in cuttings, on embankments and viaducts

d. multiple crossings of roads, rail lines and watercourses

e. long tunnel approach structures

f. bored tunnel crossing

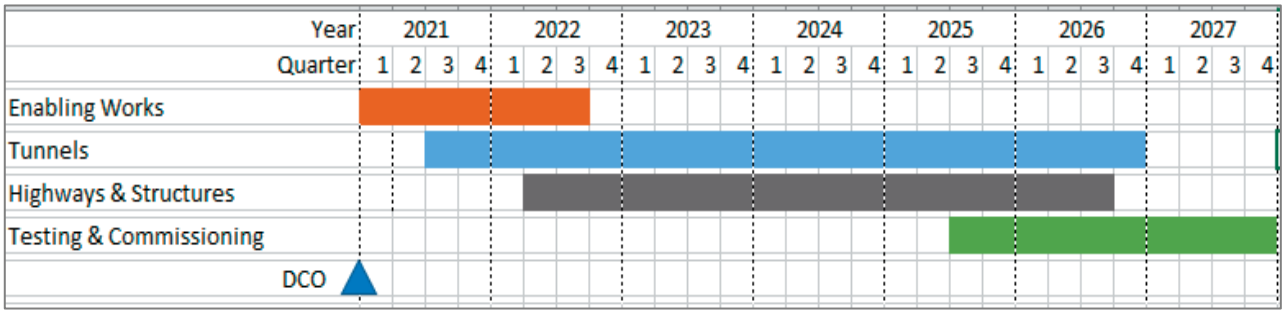
Construction phases

2.18.2 It is envisaged that the construction works will be carried out in phases as presented in Table 2.4. It should be noted that some phases may have significant overlaps with others as presented in the Gantt Chart in Plate 2.6.

Table 2.4 Indicative construction phases

Construction phase	Works
Enabling works (Project wide)	• Critical utility diversions • Archaeological investigation • Flood compensation • Ecological surveys and mitigation • Main compound enabling works eg, access roads, hardstanding • Specific accesses/ haul routes • Temporary utilities including substation
Tunnel works	• Site setup, precast facilities • North portal construction • South portal construction • Tunnel boring machine (TBM) drives, Cross Passages and Technical Galleries
Highways and structures	• Site setup • A2, A13, M25 works • Project route works • Structures works
Testing and commissioning (Project wide)	• Clean up • Landscaping • Testing and commissioning

Plate 2.6 Gantt Chart summarising the construction phases



Haulage routes and construction traffic management

2.18.3 Access for construction vehicles to and from the main construction compounds and construction sites will be from the Strategic Road Network on designated routes which will be clearly signposted. Haulage routes to the Thurrock construction sites will be from the A13, M25 and A1089. Haulage routes to the Kent sites will be from the A2 and A226.

2.18.4 Linear features, such as major roads, railway lines and watercourses form physical barriers preventing unrestricted access to the full route until suitable structures and accesses have been established. It will, therefore, be necessary to use the local road network initially to access and establish construction compounds and where there is no direct access from the strategic road network.

2.18.5 Haul routes within the Project area will be dictated by the balance of cut and fill within the site areas. This will be dictated by the design of the new roads and the suitability of the materials arising for reuse.

2.18.6 The main areas where the construction sites will interface with road users will be at locations where connections to the existing network will be created. In these locations, traffic management will be needed to segregate the construction sites from road vehicles.

2.18.7 A specific temporary haul route will need to be formed to provide access to the northern tunnel entrance to enable early site establishment, the delivery of materials and TBM components. This is likely to take the form of a dedicated temporary access route from the A1089 to the northern tunnel portal construction site. An option to construct an early temporary access route for initial site establishment from Fort Road through the RWE site is also being investigated.

2.18.8 A separate temporary haul route will need to be formed to provide access to the southern tunnel portal to enable site establishment and the delivery of materials. This is likely to take the form of a dedicated temporary access route from the A226 to the southern tunnel portal construction site. This will further enable construction of the Project route linking to the A2.

2.18.9 Several local roads will be closed for prolonged periods to facilitate construction activities and access to the Project route. The duration of road closures and any traffic management measures will be agreed with the local highway authorities and relevant stakeholders.

2.18.10 All bridge structures, road junctions, and road furniture will be assessed in consideration of abnormal loads for delivery to all sections of the route eg, TBM components.

Construction compound locations

2.18.11 Four main compounds are currently being considered, one north of the Project, one south of the Project and one at each tunnel portal either side of the river where the central management functions will be carried out and TBM related construction activities will take place.

2.18.12 Smaller satellite compounds will be placed along the route to support the main compounds. These will provide welfare and accommodation, local to key parts of the works.

2.18.13 Indicative compound locations and layouts are shown on Figures 2.2a, 2.2b and 2.2c in Volume 3 of this *PEIR*.

2.18.14 There are many factors which have contributed to the selection of locations for both the main and, to a lesser extent, the satellite compounds:

a. access to the trunk road network to enable ready access for site personnel and deliveries without unduly impacting on the local road network

b. impact on the local population by locating compounds away from densely populated areas where practicable

c. efficient and convenient location(s) for vehicle recovery centres, for motorists stranded by accident or vehicle breakdown

d. efficient and convenient location(s) for traffic management control

Key components of the construction compounds

2.18.15 Components of the construction compounds could include (although not every compound will contain all of these components):

a. administration and management offices

b. welfare and staff accommodation facilities

c. trunk road CCTV 24hr control facility

d. rapid vehicle recovery 24hr facility (excluding tunnel compound)

e. staff and vehicle parking

f. plant and equipment storage

g. materials handling and production facilities

h. concrete batching plant (if required)

i. waste recovery and management centre

j. topsoil storage, potentially in bunds around compound sites

Construction hours of work

2.18.16 The majority of the construction compounds and sites will be operational only during standard (core) working hours – 08.00 to 18.00 on weekdays and 08.00 to 16.00 on Saturdays. To maximise productivity within the core hours, a period of up to one hour before, and up to one hour after standard working hours for start-up and close down of activities is envisaged. This will include but not be limited to deliveries, movement to place of work, unloading, maintenance and general preparation works. This will not include operation of plant or machinery likely to cause a disturbance to local residents or businesses. These periods will not be considered an extension of core working hours.

2.18.17 Certain enabling works activities may need either extended standard working hours, night-time working, lane closures working and/or out of hours/possession working. Utility diversions carried out as part of the enabling works may need

planned interruption of the services which will need to be agreed with the network operators to minimise impact to their networks and customers.

2.18.18 Due to the nature of producing precast concrete, the envisaged tunnel segment production facility will need to operate on a continuous basis, seven days a week.

2.18.19 Most surface activities around and in the portals will be completed within the standard working hours. Certain activities will be unable to be completed within the standard working hours and will need 'extended standard hours'. These activities include major concrete pours and piling/diaphragm wall works. Underground excavation of the portal structure and the required hoisting operations may need continuous working for a certain period of time.

2.18.20 The tunnel construction will be carried out on a continuous working hour basis, 24 hours a day and seven days a week, to ensure the safety and integrity of the works. This will also reduce the construction time and therefore period of disruption to the local community. The process of TBM reception will necessitate some continuous 24hr working. Several construction sites will need to operate in connection with tunnel drive sites where the tunnelling works will be carried out on a 'continuous basis'.

2.18.21 Most of the construction of highways and structures will be completed within the standard working hours. Certain activities will be unable to be completed within the standard working hours and will need 'extended standard hours'. These activities include major concrete pours and piling/diaphragm wall works.

2.18.22 The online sections of the new route of the Project will need night-time working to facilitate traffic management and installation of signs and technology, and surface tie-ins. For example, most of the online road surface may have to be laid during night-time working hours. These working hours will be dictated by network occupancy criteria.

2.18.23 Demolition of some existing structures and buildings may be needed. To ensure the safety of the all road users and construction workers, certain activities may need to be carried out during closures of the road network.

Tunnel construction

2.18.24 It is presently assumed that the tunnel bores will be constructed with two TBMs, one TBM for each bore. They could be driven from the north or from the south, but based on current information, it is assumed that both bores will be driven from the north.

2.18.25 Before tunnel construction essential site facilities will be established adjacent to the northern tunnel entrance. Such facilities will include site compounds with office and welfare facilities, water treatment plant for processing waste water, a precast facility for tunnel lining production and storage, separation plant for processing excavated material, hyperbaric facilities and other plant to support the tunnelling operation.

2.18.26 It will be necessary to construct a temporary substation to power the TBMs used for constructing the tunnels and all the necessary support functions described above. In the permanent case independent substations will be needed at each tunnel portal, thereby assuring power backup. Should the supply on one side fail, the other side will take over.

2.18.27 Launch shafts will be constructed as part of the cut and cover tunnel section at the northern tunnel portal from which the TBMs will be launched and serviced for their respective tunnel drives.

2.18.28 Each tunnel will be excavated by a single TBM and lined with precast concrete segments erected behind the TBM. Segment design will be based on ground loads, construction loads and fire load.

2.18.29 Based on current information, it is assumed that slurry TBMs may be needed. With a slurry TBM, the excavation chamber is completely filled with slurry providing face-support during tunnelling. The excavated material from the TBM face is pumped through pipes to a slurry treatment plant on the surface where the excavated material is separated from the slurry.

2.18.30 Potential reuse and soil conditioning will be explored further, as well as potential options for excavated material disposal and reuse. Methods of transport of the excavated material are still under consideration but may be by road or river. River transport will be by barges which could need new infrastructure in the River Thames such as a jetty, or there might be potential to reuse an existing jetty. Transportation by rail has been considered but has been deemed unsuitable for this Project due to limitations on track capacity.

Scour protection

2.18.31 Scour protection may be needed to maintain the stability of the riverbed, within the Project's tunnel protection zone, over the 120-year design life of the Project. Should scour protection of the tunnel route be needed, then it is likely to take the form of either rock dumping or using mattress type solutions to cover the tunnel section. It is envisaged that the use of scour protection will follow a monitoring approach and scour protection only placed after a trigger level is reached either by natural changes in the riverbed or requirements to dredge the channel deeper for marine traffic.

2.18.32 The need for scour protection and impact of other river-based construction activities will be assessed at completion of dedicated studies and in consultation with relevant statutory bodies.

Dewatering

2.18.33 During construction, control of groundwater at excavations for ramps and cut and cover tunnel sections will be by temporary drainage (active pumping).

2.18.34 The temporary groundwater control measures, including robust monitoring regimes, will be designed to minimise environmental impact. These will draw on the following: a hydrogeological assessment of the portals and surrounding area; designing construction to limit volumes of groundwater to be pumped and, where necessary, recharging clean groundwater back into the aquifer to limit drawdown of the water table outside of the Development Boundary.

2.18.35 The TBMs used for construction will be capable of countering and controlling the ground and groundwater pressure without external groundwater lowering. Permeation grouting, and/or similar ground improvement measures could be implemented at the tunnel launch/reception locations, 'safe havens' for cutter-head inspection and maintenance, and for the construction of the cross

passages and sumps to control water ingress. However, this will be dependent on the ground conditions at each point.

Third party asset protection

2.18.36 During tunnel construction, some settlement of the ground above the tunnel is likely due to ground movement around the tunnel excavation. Although the chosen route minimises the number of assets that could be affected, there are several located within the settlement area of influence. There are, however, well-established and appropriate methods to assess and control this ground movement.

2.18.37 To understand the risk of damage to these assets, established methods of assessment will be used to identify the need for any specific mitigation works.

2.18.38 Depending on the findings of the assessment process, specific mitigation measures could include additional measures to minimise ground movement at the tunnel face or ground treatment to improve the engineering response of the ground. Alternatively, structural measures may be employed to improve the asset's ability to resist or accommodate any settlement.

Contaminated land

2.18.39 North of the River Thames, the route will pass through a known area of historic landfill, which could contain a range of contaminants at the location of the northern section of the tunnel and north portal.

2.18.40 Measures that will be explored for the Project in areas of contaminated land will include the selection of appropriate foundation, retaining walls and excavation techniques, as well as management of excavated materials, following the waste hierarchy to minimise the impact of contamination.

2.18.41 The specific engineering solutions that may be adopted for remediation, where it is identified to be needed, will be dependent on the nature and distribution of contaminants identified from the investigation and monitoring. This may include encapsulation and/or treatment of contamination in situ or the isolation of works from sources or receptors to contamination. In all cases, the remediation will be designed to meet an appropriate standard in accordance with the relevant legislation.

Waste management

2.18.42 The Project's aim will be to minimise the volume of waste generated by applying the waste hierarchy (reduce - reuse – recycle - responsible disposal).

2.18.43 The Project will identify all wastes that are likely to be produced, the quantities likely to be generated and set out the approach for the control and sustainable management of excavated materials and waste from the construction, operation and maintenance of the Project.

2.18.44 Any waste disposal and storage will be carried out in accordance with regulatory requirements set out in Chapter 12: Materials.

Excavated materials from the tunnel

2.18.45 Construction of the tunnel will produce a significant quantity of material arisings. Management of that material on site will include onsite treatment to facilitate

transportation and potential reuse. Opportunities for reuse are being investigated in consultation with the Environment Agency to minimise the amount that needs disposal.

2.18.46 The opportunity to transport material by river to reduce the number of construction movements by road will be considered. If transport by river was found to be practicable then this may need either the construction of a new jetty, or the potential reuse of an existing jetty located on the River Thames.

Excavated materials from the construction of highways

2.18.47 Construction of the highway will involve significant excavation of materials where the road will be below the existing ground level. Large amounts of construction materials will also be needed to create embankments, as well as to create noise bunds and similar structures. It may be possible to use some of the excavated materials to construct these elements, and the design process will aim to optimise the balance between the amount of material excavated and the material required, to minimise the total demand for material exports and imports. However, it is likely that some excavated materials will also need to be disposed of. These excavated materials will be managed using the same framework as described above for the tunnel arisings.

Environmental management during construction

2.18.48 The construction of the Project will be subject to measures and procedures defined within a Construction Environmental Management Plan (CEMP). This will include the implementation of industry standard practice and control measures for environmental impacts arising during construction, such as the control of dust and the approach to waste management on site.

2.18.49 A Code of Construction Practice (CoCP) will be prepared as part of the DCO application, which will outline the measures to be implemented through the CEMP to minimise adverse effects during the construction phase, including measures for control of pollution. This will reflect mitigation identified through the technical assessments within the EIA. This *PEIR* discusses proposed mitigation to be included in the CoCP or CEMP as appropriate in relation to the preliminary assessments.

2.19 Operations and maintenance

2.19.1 The operation of the Project is expected to give rise to regular maintenance activities including:

a. inspections of Project elements – such as tunnel linings, bridges, underpasses and drainage systems

b. maintenance – such as periodic washing of tunnel lining, verges, cross passages and niches; highways cleaning; vegetation management; maintenance of equipment

c. programmed repairs and renewals – such as repairing tunnel side-walls; repair or renewal of road surfaces, equipment and furniture

2.19.2 It is foreseen that in order to carry out inspection and certain specified maintenance activities in the tunnel, a full closure of the relevant bore will be needed periodically. These will be planned to minimise disruption.

2.19.3 Additional maintenance activities may be needed at short notice in response to emergency situations, such as repair of damage for safety reasons.

2.20 Rest and service area

2.20.1 A RaSA is currently proposed to be located to the north-east of the Tilbury junction. The site will also accommodate a maintenance depot for the roads and tunnels and the potential for a Driver and Vehicle Standards Agency facility.

2.20.2 RaSAs perform an important road safety function by allowing road users to stop and take a break in the course of their journey. This reduces the effects of fatigue and subsequent impacts on the safety of all road users. Government advice in DfT Circular 02/2013 is that motorists should stop and take breaks every 2 hours. We will follow the guidance in this circular in assessing the need for the RaSA and the numbers of parking bays needed.

2.20.3 The RaSA will include:

a. up to 400 car parking spaces

b. up to 80 lorry parking spaces

c. up to 10 coach parking spaces

d. toilet and handwashing facilities

e. shower facilities

f. fuel station

g. hot food and drink facilities

h. charging points for electric vehicles provided at designated parking bays

i. landscaping areas

2.20.4 The RaSA will be operational 7 days a week, 24 hours a day.

2.21 Decommissioning

2.21.1 The Project has been designed to maximise the scope for materials reuse in the event of decommissioning of its components, as well as considering the design life and maintenance requirements of the Project. The Project design-life is 120 years, and it is not intended that the permanent structures and the tunnel will be decommissioned in the foreseeable future.

2.21.2 Some temporary structures however will need decommissioning upon the completion of the construction works. For example, it is envisaged that the temporary jetty, if required, will be decommissioned once the tunnel is operational.

2.22 Major incidents

2.22.1 Accepted best practice dictates that an Emergency Preparedness Plan will be developed through detailed workshops in conjunction with the major parties participating in the Project. This will be a risk-based process and will cover all potential major incidents and establish lines of communication, controls and process protocols.

2.23 User charging

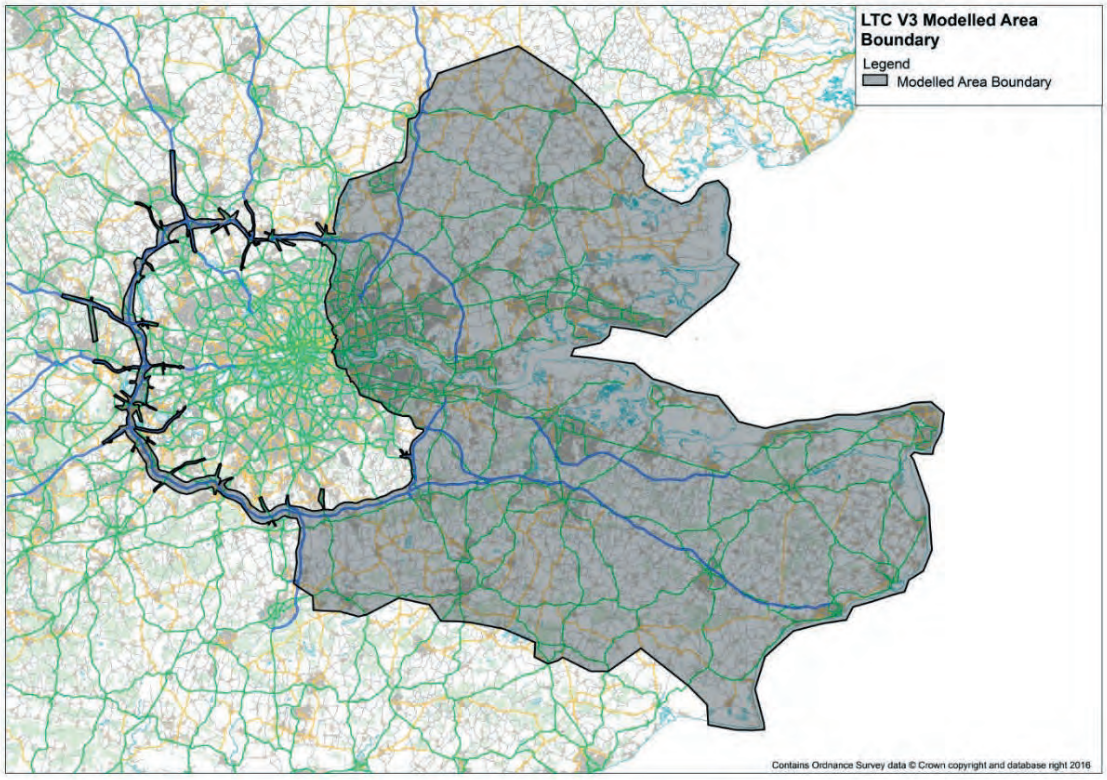
2.23.1 The assessed charging case, of equal charging across the Project and the Dartford Crossing, has informed Project development, traffic modelling, environmental assessment and the outline business case for the Project. It has formed the basis for the assessments presented to support statutory consultation. The assessed charging case adopts scheme details from the current Dart Charge scheme, with a charge applying from 06:00–22:00 hours, with crossings made outside those hours being free. The charge applies every day, including weekends and bank holidays. There is a fixed charge for all charged hours, which is varied by vehicle class. This means there is no peak charging. In the Lower Thames Area Model (LTAM) the average Dart Charge collected per chargeable crossing has been applied, meaning that there is an inherent assumption that account discounts and exemptions will apply.

2.23.2 Please note that for the DCO application we intend to seek flexibility over the design of the charging scheme to help meet our objectives, including traffic management. This means that the charging scheme implemented for the Lower Thames Crossing may be different from the one at the Dartford Crossing. For more information on charging, see our statutory consultation report Approach to Design, Construction and Operation.

2.24 Traffic forecasting

2.24.1 LTAM has been used to assess the strategic demand and assignment impacts of the Project. The model covers the whole of the UK, but the extent of the detailed network modelled area is shown in Plate 2.7.

Plate 2.7 Detailed highway network modelled area in the Lower Thames Area Model



2.24.2 The LTAM base year is 2016. For the purposes of modelling, the following forecast years have been used:

a. opening year of 2026 (which covers a range between 2025 and 2027)

b. intermediate year of 2031

c. design life year of 2041

d. horizon year of 2051

2.24.3 Future year traffic flows have been extracted from the model for the purposes of the different environmental assessment topics, eg, air quality, noise and vibration.

2.24.4 While the scenarios to be modelled and then assessed in the ES will be discussed and agreed with consultees, it is currently anticipated that the traffic forecasting will be carried out for the following scenarios:

a. 2016 base model year (reflecting the existing situation)

b. 2026 (opening year) without Project (but including any committed schemes that will open between 2016 and 2026)

c. 2026 (opening year) with Project (and committed schemes that will open between 2016 and 2026)

d. 2031 (intermediate year) without Project (but including any committed schemes that will open between 2016 and 2031)

e. 2031 (intermediate year) with Project (and committed schemes that will open between 2016 and 2031)

f. 2041 (design life year) without Project (but including any committed schemes that will open between 2016 and 2041)

g. 2041 (design life year) with Project (and committed schemes that will open between 2016 and 2041)

h. 2051 (horizon year) without Project (but including any committed schemes that will open between 2016 and 2051)

i. 2051 (horizon year) with Project (and committed schemes that will open between 2016 and 2051)

2.24.5 Population and employment forecasts included within LTAM reflect the latest National Trip End Forecasts (obtained from the DfT software TEMPro v7.2). We have also explicitly included trips from major local planned developments (with growth capped to the overall level set by TEMPro). These developments have been categorised in an Uncertainty Log as either near certain, more than likely, reasonably foreseeable or hypothetical. The developments falling into the category of near certain and more than likely provide the basis for the central (Core) forecasting work. Sensitivity tests have been conducted which reflect low growth and high growth scenarios, incorporating different growth assumptions.

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Chapter 3.

Alternatives

3 Alternatives

3.1 Introduction

3.1.1 A structured process has been followed by the Department for Transport (DfT) and Highways England to identify and assess potential options for the Project.

3.1.2 A full description of the historic options considered during the option selection phase can be found in *Approach to Design, Construction and Operation* (Lower Thames Crossing, 2018). Section 3.3 and Table 3.2 in this chapter provide a summary of the key dates and decisions for the Project development leading up to the Preferred Route Announcement (PRA) in April 2017.

3.1.3 Alternatives studied to date as part of the design evolution, along with the main environmental considerations for selecting the chosen option, are presented in section 3.4 of this chapter. In line with the requirements of the Environmental Impact Assessment (EIA) Directive, a full description of the reasonable alternatives considered, including their specific characteristics and a comparison of the environmental effects, will be included within the Environmental Statement (ES).

3.2 National Policy Statement for National Networks

3.2.1 The requirements of the National Policy Statement for National Networks (NPSNN) for the reporting of the reasonable alternatives considered by the Project are presented in Table 3.1.

Table 3.1 NPSNN requirements and Project response

Requirement	Project response
4.26 “Applicants should comply with all legal requirements and any policy requirements set out in the NPS on the assessment alternatives. In particular: • The EIA Directive requires projects with significant environmental effects to include an outline of the main alternatives studied by the applicant and an indication of the main reasons for the applicant’s choice, taking into account the environmental effects. • There may also be other specific legal requirements for the consideration of alternatives, for example, under the Habitats and Water Framework Directives. • There may also be policy requirements in this NPS, for example the flood risk sequential test and the assessment of	The EIA will be completed in compliance with the EIA Directive. The ES will include: “a description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed Project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.” Specific legal and policy requirements related to the environmental topics will be addressed as part of the ES or relevant documentation included within the Development Consent Order application.

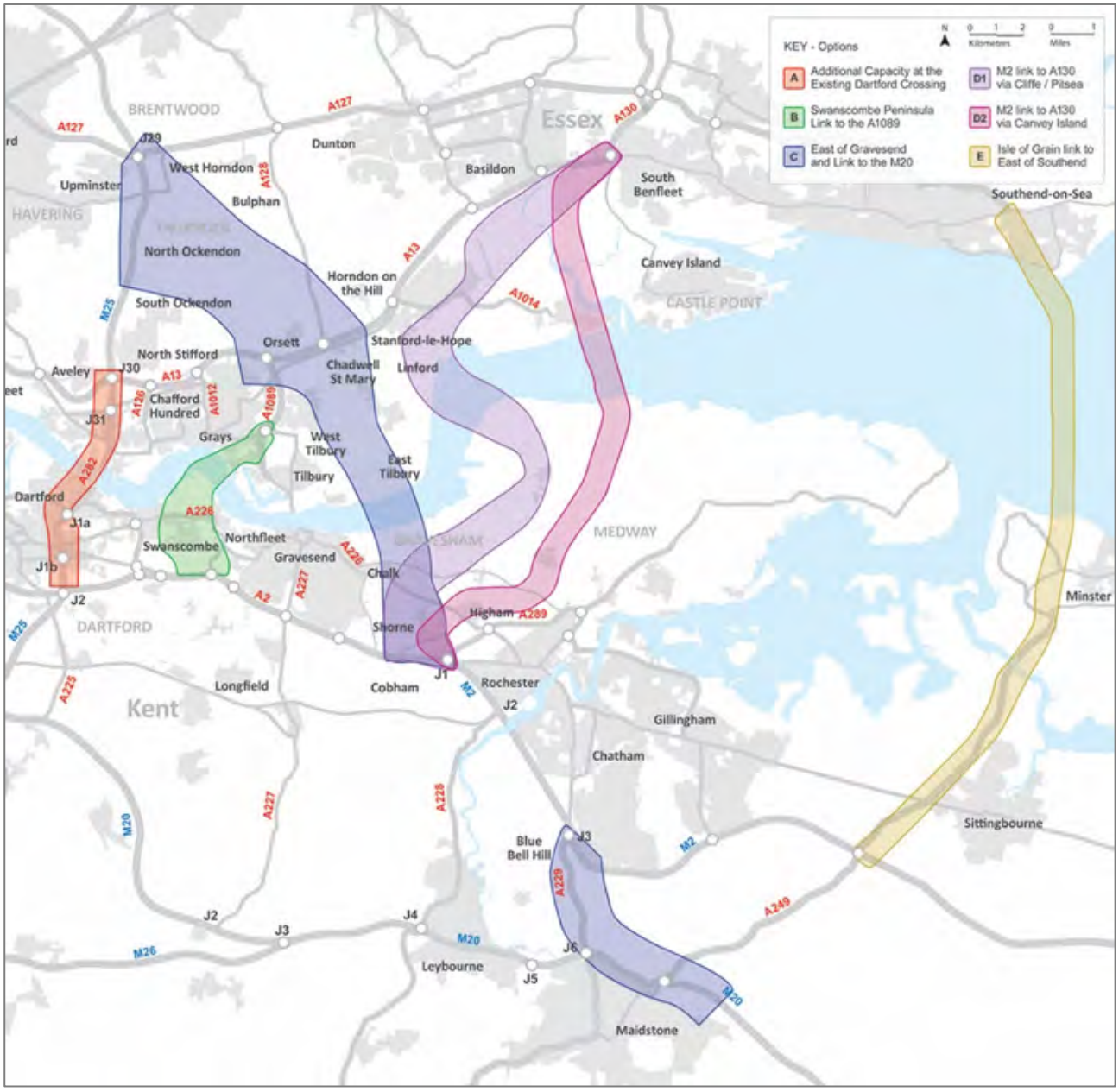
Requirement	Project response
alternatives for developments in National Parks, the Broads and Areas of Outstanding Natural Beauty (AONB)."	
4.27 "All projects should be subject to an options appraisal. The appraisal should consider viable modal alternatives and may also consider other options. For national road and rail schemes, proportionate option consideration of alternatives will have been undertaken as part of the investment decision making process. It is not necessary for the Examining Authority and the decision maker to reconsider this process, but they should be satisfied that this assessment has been undertaken."	Optioneering in terms of corridor location, route and crossing type has been completed through several project stages leading to the announcement of the preferred route in April 2017. This also included an assessment into alternative modal options. Alternatives have been reported within the following documents: • *Department for Transport Dartford River Crossing Study*, 2009 • *Highways England Pre-Consultation Scheme Assessment Report*, 2016 • *Highways England Post Consultation Scheme Assessment Report*, 2017 These are summarised within this chapter.

3.3 Summary of the options appraisal

3.3.1 DfT carried out a study in 2009 that reviewed six potential crossing locations, identified as A, B, C, D1, D2 and E (see Plate 3.1). The locations included a link between the M2 and M20 at Bluebell Hill which was considered as a variation of location C with the potential to enhance benefits from the Project and was therefore known as C variant.

3.3.2 The DfT study also assessed modal options, considering both a heavy rail crossing of the Thames and a combined heavy rail and road crossing, serving passengers and rail freight. The report concluded that there was little justification for the inclusion of rail passenger services as part of any future Lower Thames crossing facility. It further concluded that the provision of rail freight facilities over any new crossing in the Lower Thames area will be unlikely to assist in addressing any shortage of freight paths on key rail routes. As a result of this study, provision of rail capacity at the Lower Thames Crossing was not considered further.

Plate 3.1 The five route corridors investigated in the 2009 DfT study



Key	
A	Additional capacity at the existing Dartford Crossing
B	Swanscombe Peninsula Link to the A1089
C	East of Gravesend and Link to the M20
D1	M2 Link to A130 via Cliffe/Pitsea
D2	M2 to A130 via Canvey Island
E	Isle of Grain Link to East of Southend

3.3.3 Assessment of location D indicated that the options would not meet the traffic objective to relieve congestion at the existing Dartford Crossing and provide free flowing north-south capacity. They would have poor to low value for money, limited safety benefits, and have significant environmental impacts including on

Holehaven Creek Site of Special Scientific Interest (SSSI) for option D2, Mucking Flats and Marshes SSSI for option D1, South Thames Estuary and Marshes SSSI and on the Thames Estuary and Marshes Special Protection Area (SPA) and Ramsar site for both options. Both these options would also need substantial areas of flood compensation.

3.3.4 Assessment of location E indicated that the option would provide very limited relief to the existing Dartford Crossing and would have poor to low value for money. There would be potential direct and indirect effects on a number of international and nationally important nature conservation sites including: Medway Estuary and Marshes Ramsar site and SSSI, Swale Ramsar site and SSSI, Foulness (Mid-Essex Coast Phase 5) Ramsar site and SPA and the Foulness SSSI and the Essex Estuary Special Area of Conservation (SAC).

3.3.5 As a result of these assessments, the two location D and location E options were not selected for further assessment by DfT following the first stage of location identification and appraisal.

3.3.6 Further work was carried out by DfT in 2013 to consider three of the potential crossing locations in more detail, A, B and C. These crossing locations were presented at a public consultation in 2013. Following the public consultation, location B was discounted due to the conflicts between the potential solutions and the local development plans, particularly with the Ebbsfleet Garden City and the Swanscombe Peninsula. Two crossing locations, A and C, were taken forward for further consideration.

3.3.7 Highways England summarised the assessments in the *Pre-Consultation Scheme Assessment Report* (Highways England, 2016). In 2014 Highways England started a further option identification and route selection process at crossing locations A and C. This study identified a longlist of nine options at location A, six options at location C and four options for the C variant. The options assessed a variety of bridge, immersed tube and bored tunnel solutions.

3.3.8 Assessment of the C variant options determined that they did not help to transfer traffic from the existing Dartford Crossing on to the new route at location C and had substantial impacts on the Kent Downs AONB. As a result, the C variant options were not considered further.

3.3.9 Location A could not be developed into a solution that met the scheme objectives. The identified solutions failed to relieve the congestion on the approaches to the Dartford Crossing as they did not provide a suitable alternative route for traffic travelling along the A2 and A13. Solutions that relied on the connections at junction 2 and junction 30 of the M25 failed to relieve congestion at or on the approaches to these key junctions, while solutions that did not include these connections failed to provide the necessary relief to the Dartford Crossing itself. An optimised alternative at location A was identified as route 1 for detailed appraisal. The appraisal found that the alternative did not meet the scheme objectives, and consequently was not identified as a proposed route in the 2016 public consultation.

3.3.10 Alternatives considered at location C included a bridge, a bored tunnel and an immersed tube tunnel. The assessment determined that there would be a risk of significant effects to the Thames Estuary and Marshes, a statutory designated site protected under the Ramsar convention, with both bridge and immersed

tube solutions. The bored tunnel was therefore the only viable crossing alternative at location C as it was the least environmentally damaging alternative. The options at location C were refined, considering the performance against the scheme objectives and the environmental impacts, and were presented at a non-statutory public consultation in 2016. The routes presented at public consultation were identified as routes 2, 3 and 4 north of the River Thames, and western southern/eastern southern links south of the River Thames (Plate 3.2).

Plate 3.2 Shortlisted routes presented at non-statutory consultation in 2016

3.3.11 A further appraisal was undertaken, and the preferred route was announced in April 2017 by the Secretary of State for Transport based on the information obtained before, during and after the non-statutory public consultation. The preferred route was route 3 north of the River Thames, with a bored tunnel crossing under the River Thames east of Gravesend and Tilbury and a new road south of the river which will join the A2 east of Gravesend (the Western Southern Link), see Plate 3.3.

3.3.12 The preferred route met the scheme objectives, while having the lowest impact on several environmentally sensitive areas, particularly on the Thames Estuary and Marshes SPA and Ramsar site, ancient woodlands in the area, and the Kent Downs AONB, as well as on the communities close to the route. The assessment that resulted in the identification of the preferred route is presented in the *Post-Consultation Scheme Assessment Report* (Highways England, 2017).

Plate 3.3 The preferred route announced in April 2017

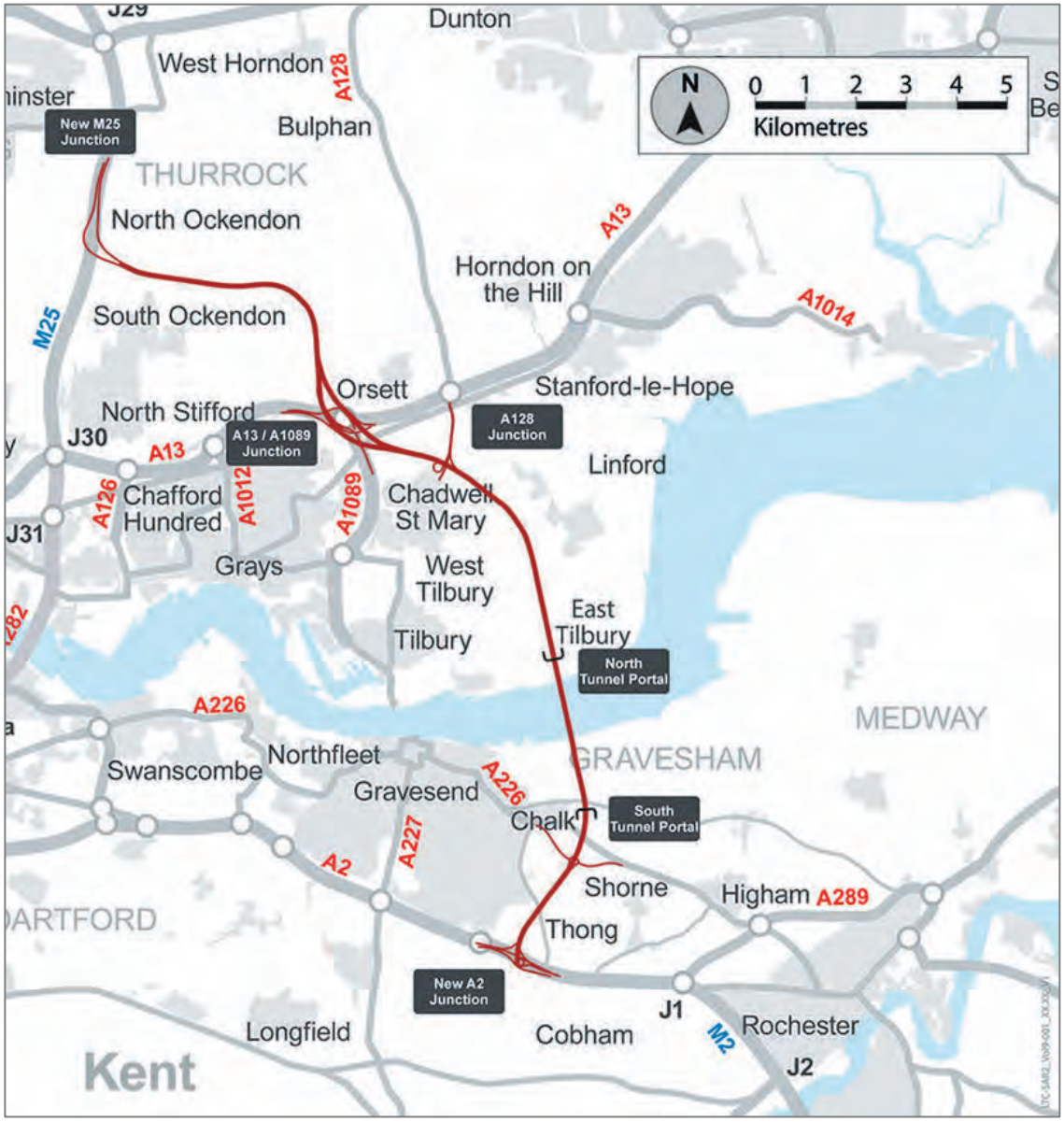


Table 3.2 Summary of key dates and decisions in the lead up to the preferred route

Location	Key dates	Assessment
A – Additional capacity at the existing Dartford Crossing	2009 – Identified in the study carried out on behalf of DfT *Dartford River Crossing Study Final Repor*t, 2009, DfT 2013 – Appraised and presented for public consultation by DfT *Options for a New Lower Thames Crossing*, 2013, DfT 2016 – Appraised in further detail and considered not to meet scheme objectives *Pre-Consultation Scheme Assessment Report,* 2016, Highways England Lower Thames Crossing Route Consultation 2016 2017 – Re-appraised and not selected as the preferred route *Post Consultation Scheme Assessment Report*, 2017, Highways England	Location A was identified as a potential option in public consultation undertaken in 2013. It was then considered in further detail but was considered not to meet the scheme objectives. Public consultation in 2016 invited feedback on the proposed location of the crossing. Further appraisal of location A took place following conclusion of that consultation. Location A could not be developed into a solution that met the scheme objectives. The identified solutions were not viable because they failed to relieve the congestion on the approaches to the Dartford Crossing as they did not provide a suitable alternative route for traffic travelling along the A2 and A13. Solutions that relied on the connections at junction 2 and junction 30 of the M25 failed to relieve congestion at or on the approaches to these key junctions. Solutions that did not include these connections failed to provide the necessary relief to the Dartford Crossing itself.
B – Swanscombe Peninsula Link to the A1089	2009 – Identified in the study carried out on behalf of DfT *Dartford River Crossing Study Final Report, 2009, DfT* 2013 – Appraised and taken to Public Consultation by DfT *Options for a New Lower Thames Crossing, 2013, DfT* 2013 – The decision was made not to carry out further work on this location *Options for a New Lower Thames Crossing – Consultation Response Summary, 2013, DfT*	Location B was presented to public consultation in 2013. Following the consultation, this location was not taken forward for further assessment, due to the conflicts between the identified solutions and the local development plans, particularly including Ebbsfleet Garden City and the Swanscombe Peninsula. As a result, no viable solutions could be developed at this location.
C – East of Gravesend and Link to the M20	2009 – Identified in the study carried out on behalf of DfT *Dartford River Crossing Study Final Report, 2009, DfT* 2013 – Appraised and taken to Public Consultation by DfT	Following the early studies and the Public Consultation in 2013, location C was developed into a series of potential solutions which were appraised in detail in the 2016 assessment. Three routes to the north of the River Thames, identified

Location	Key dates	Assessment
	Options for a New Lower Thames Crossing, 2013, DfT 2016 – Multiple options were developed, and three different options were taken forward to public consultation *Pre-Consultation Scheme Assessment Report, 2016,* Highways England *Lower Thames Crossing Route Consultation 2016* 2017 – Re-appraised following consultation and the preferred route was identified at location C *Post-Consultation Scheme Assessment Report*, 2017, Highways England	as routes 2, 3 and 4, and two routes to the south identified as Eastern Southern Link and Western Southern Link, were identified as able to meet the scheme objectives. Each of these potential routes would be connected across the River Thames by a bored tunnel to minimise impacts on the local environmentally sensitive areas. These routes were presented at public consultation in 2016. Information gathered during and following the consultation was then used to re-appraise each of the routes. Following this appraisal, it was identified that route 3, with the Western Southern Link, would have the lowest impact on several environmentally sensitive areas, particularly on the Thames Estuary and Marshes SPA and Ramsar site, the ancient woodland and the Kent Downs AONB, as well as on the communities close to the route. On 12 April 2017 the Secretary of State for Transport confirmed the preferred route as follows: • a bored tunnel crossing under the River Thames east of Gravesend and Tilbury (location C) • a new road north of the river which will join the M25 between junctions 29 and 30 (Route 3) • a new road south of the river which will join the A2 east of Gravesend (the Western Southern Link)
D1 – M2 Link to A130 via Cliffe/Pitsea D2 – M2 to A130 via Canvey Island	2009 – Identified in the study carried out on behalf of DfT. The decision was made not to carry out further work on these locations *Dartford River Crossing Study Final Report, 2009, DfT*	The two alternative location D options were not taken forward following the first stage of location identification and appraisal. The location D options were found to be located too far to the east and modelling showed that they failed to provide the necessary relief to the congested Dartford Crossing as they did not support the key traffic movements across the River

Location	Key dates	Assessment
		Thames. As a result, no solutions could be developed at this location that would meet the scheme objectives.
E – Isle of Grain Link to East of Southend	2009 – Identified in the study carried out on behalf of DfT. The decision was made not to carry out further work on these locations *Dartford River Crossing Study Final Report,* 2009, DfT	As with the two alternative location D options, location E was not taken forward following the first stage of location identification and appraisal. Similarly to the D options, location E was located too far to the east and did not provide the necessary relief to the congested Dartford Crossing as it did not provide for many of the key traffic movements across the River Thames. As a result, no solutions could be developed at this location that would meet the scheme objectives.

3.4 Options appraisal review (2018)

3.4.1 An assessment of the previous options appraisal process has been carried out taking account of the changes made to the proposals for the Project following the PRA in April 2017. This exercise started with the six options first presented by DfT in 2009 and concluded with the announcement of the preferred route.

3.4.2 This exercise has confirmed the selection of the preferred route, taking account of the changes made to the proposals for the Project following the PRA in April 2017. It concluded the key assumptions and conclusions remained valid. More detail on these reviews is provided in section 9.4 of the Approach to Design, Construction and Operation.

3.5 Design development and main alternatives considered

3.5.1 Following the announcement of the preferred route in April 2017, new information gathered has allowed the Project to continue to develop. New information feeding into the design following the PRA includes:

a. a new traffic model, the Lower Thames Area Model, based on updated traffic data and newly published DfT national traffic forecasts

b. environmental and geotechnical surveys carried out to date along the preferred route

c. stakeholder and community engagement

d. emerging local plans published by local authorities

3.5.2 The information gathered has improved understanding of the existing environment and has therefore been used to further develop the design, making changes to junctions, link roads and carriageway routes.

3.5.3 For each of the proposed changes, reasonable alternatives were considered and studied, taking into account the scheme objectives, including any environmental considerations.

3.5.4 A summary of the main alternatives considered, along with the environmental aspects associated with the selected option, is included in Table 3.3.

3.5.5 Full details of all the alternatives considered at each key area are described in Chapter 12 of the *Approach to Design, Construction and Operation* and will be reported as part of the Project description in the ES.

3.6 Highway structures

3.6.1 A number of new and replacement structures will be needed along the Project's route.

3.6.2 At each structure, a number of alternative structural forms and designs have been developed and assessed against the environmental topics and a selected baseline option. This includes assessing the impact of the structure against air quality, cultural heritage, landscape, biodiversity, geology and soils, materials, noise and vibration, people and communities, road drainage and the water environment and health and socio-economic effects. The findings of the environmental appraisals of each proposed structure feeds into the overall proposed design. The structure proposed to cross the Mardyke Valley has been presented within Table 3.3 as an example of an alternative structure considered by the Project.

Table 3.3 Summary of the key alternatives considered since the PRA

Design element	Position at PRA	Summary of alternatives considered	Conclusions
Project wide alternatives			
Rest and service area	An assessment of the need for, and the requirements of, a rest and service area had not been completed at the PRA.	Four options were considered for the location of a rest and service area: Option 1: West of Tilbury junction (Shed Marshes area). Option 2: North east of Tilbury junction. Option 3: South east of Tilbury junction. Option 4: North of Ockendon link.	While it was acknowledged that Option 2 is located in Greenbelt, it was selected as a preferred option as the location: • avoids Flood Zone 3 and reduces the overall risk of flooding • avoids disturbance of contaminated land reducing potential geotechnical risks
Overhead line utility diversions (example presented for M25 junction 29)	The PRA impacted a number of existing utility assets including overhead lines.	A number of options have been identified for overhead line diversions across the Project. An example is the diversion needed at the M25 junction 29, where four options were considered: Option 1: Relocate tower to the east of its existing position. A temporary diversion and tower located to the north. Option 2: Divert overhead line alignment to the west of the M25 with new towers located in the area. Temporary diversion near existing alignment. Option 3: Divert the overhead line to the west of the M25. Temporary overhead line will be diversion located to the west of M25.	While it was acknowledged that Option 3 may have a potential impact to the setting of Cranham Conservation Area and Franks Farmhouse Grade II listed building, it was selected as a preferred option as it: • avoids disruption of Hobbs Hole ancient woodland • avoids closure of the M25, minimising disruption of road users of the M25. This has resultant benefits with respect to noise and vibration and air quality

Design element	Position at PRA	Summary of alternatives considered	Conclusions
		Option 4: Do nothing and maintain the existing route (if the Project modifies the route).	
Tunnel design			
South tunnel portal	At the PRA the south tunnel portal was located to the south of Lower Higham Road, outside of the Thames Estuary and Marshes Ramsar site, SAC, SPA and SSSI. The total length of enclosed tunnel was approximately 3.3km.	Four options were considered for the south tunnel portal location: Option 1: Move the portal south of the A226 with an additional tunnel length of 600m and a total of 3.9km. Option 2: An additional tunnel length of 800m and a total of 4.1km. Option 3: Move the tunnel portal 1.2km from the PRA position with a total length of 4.5km. Option 4: Do nothing and maintain the south tunnel portal location presented at PRA.	Option A was the alternative selected. There were a number of environmental benefits highlighted including: • reducing the risks of impacting the adjacent Thames Estuary and Marshes Ramsar site • reducing the impacts on groundwater and drainage • addressing the concerns of severance between the village of Chalk and St Mary the Virgin church, Chalk • reduced impacts to air quality and noise • reduced CO2 emissions associated with road users due to a reduction in the road gradient
North portal location	At the PRA the north portal was located approximately 750m north of the north bank of the River Thames and approximately 1.5km south of the Tilbury Loop Railway Line. The design included a 320m long section of cut and cover tunnel in the area.	The following alternatives were considered for the north tunnel portal location: Option 1: Extend the tunnel portal a further 1km north. Option 2: Do nothing and maintain the north tunnel portal location presented at PRA.	Option 2 was selected as the preferred option. The PRA portal location was selected as the critical risks associated with the alternative outweighed the potential advantages. However, key environmental impacts were acknowledged including the impact on landscape and visual amenity due to the proposed embankment and viaduct

Design element	Position at PRA	Summary of alternatives considered	Conclusions
			structures, impacts to the setting of heritage assets such as Coal House Fort, a higher road gradient resulting in higher emissions concentrations and the challenging geology and ground gas regime. The selected option would result in some environmental benefits including: • less land take reducing impacts to local businesses • reducing the construction stage impacts on the surrounding environmental receptors • reducing the impact on Network Rail assets and operations
North of Thames			
Horizontal alignment – electricity pylons between Tilbury and the A13	The preferred route passes under five overhead cable routes, requiring the diversion of 1.5km of cable. The route passes approximately 820m from the nearest residential property in West Tilbury, 470m from the nearest residential properties in East Tilbury, 500m from the nearest residential properties in Linford and 140m from the nearest residential properties in Chadwell St Mary.	Two alternative options were considered for the route: Option 1: Did not have any impact on the overhead transmission lines or pylons. It moved the route closer to West Tilbury and Linford and slightly further from Chadwell St Mary. It impacted two properties. Option 2: This option reduced but did not eliminate impacts to overhead transmission lines. The route moved slightly closer to West Tilbury, and Linford, while it moved further away from East Tilbury and Chadwell St Mary.	The option selected was a compromise of the two alternatives presented. This was found to require the removal of two pylons, the modification of a further four pylons and the diversion of 600m of cables. The route is approximately the same distance from West and East Tilbury as the preferred route but closer to Linford. A number of key environmental factors were considered during the selection of the alternative route. It: • maintains a distance of at least 200m from residential properties, which reduces impacts of air quality

Design element	Position at PRA	Summary of alternatives considered	Conclusions
			• minimises severance of agricultural land • does not require the demolition of existing residential properties • will reduce the visual impact of moving overhead lines and pylons closer to residential properties
Mardyke crossing	At PRA the mainline between the A13 and M25 crossed the Mardyke Valley on a low embankment about 4m high. It also crossed the Mardyke river and the two nearby main rivers (Orsett Fen Sewer and Golden Bridge Sewer) on short individual single span structures which were slightly wider than the rivers.	A total of three options were considered for the crossing of the Mardyke valley: Option 1: A single span structure at each of the three river crossings. Option 2: A 1500m viaduct carrying the mainline across the majority of the floodplain. Option 3: A hybrid option with 450m of viaduct and 50m single span structure over the Orsett Fen Sewer.	Option 3 was selected as the alternative for the Mardyke crossing. A number of environmental benefits were identified: • The viaduct option gives a more open aspect reducing the visual impact. • Reducing the length of embankment would need less flood compensation, with resultant benefits on traffic movements, land take and greenhouse gas emissions.
M25 junction crossing	At PRA the proposals used high embankments requiring two railway crossings and a viaduct over the M25.	Three options for crossing the M25 were considered: Option 1: Crossing over the M25 with a permanent viaduct. Option 2: Crossing under the M25 'Top Down' construction with a temporary diversion of the M25. Option 3: Crossing under the M25 'Pushed Box' structure during construction.	Passing underneath the M25 was selected as the preferred option, although Option 3 was considered the most favourable approach by the Project. Key environmental considerations for the selection of Option 3 as the preferred option included it: • reduces impact on the landscape and visual amenity compared to crossing above the M25 • avoids the need for diversions on the M25, reducing impacts on

Design element	Position at PRA	Summary of alternatives considered	Conclusions
			noise and vibration, air quality and road user disruption • will avoid two railway crossings preventing potential disruption to network rail assets and operations as well as rail operators and users

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Chapter 4.

Consultation

4 Consultation

4.1.1 This chapter outlines the consultation that has been carried out to date with key environmental stakeholders only in relation to the Project's development during the identification of options and appraisal of the preferred route. Consultation will continue as part of the ongoing development of the Project design and preparation of the Environmental Statement.

4.2 Approach to consultation

4.2.1 Section 47 of the Planning Act 2008 requires consultation on the proposals for the Project before submitting the Development Consent Order (DCO) application. A Statement of Community Consultation was issued to local authorities for comment. This sets out how communities will be consulted on the Project, including details as to where information can be viewed and how people can comment on it.

4.2.2 During the consultation, Highways England are seeking comments on:

a. The Project (including its route, connections to other roads, user charging policy and other aspects)

b. Information on the likely significant environmental effects of the Project, as understood at this time and detailed in this *Preliminary Environmental Information Report* (*PEIR*)

4.3 Responding to consultation

4.3.1 Comments made throughout the consultation will be recorded and carefully considered in developing the Project. Should other potentially viable options be raised during consultation, their relative merits will be considered and reported on in the consultation report.

4.3.2 An explanation of how comments have shaped and influenced the proposals (including feedback received at the previous stage of consultation) will be reported to the Planning Inspectorate (PINS) in a consultation report prepared by Highways England. This will accompany the DCO application, as required by Section 37(3) (c) of the Planning Act 2008.

4.3.3 Once the consultation report has been produced, the feedback considered will be explained face-to-face and in writing by direct communications, local meetings, through the media and via Project updates.

4.4 Pre-application consultation programme

4.4.1 Pre-application consultation is an important legal requirement for DCO applications. It allows for potential issues to be raised, considered and, where possible, addressed before the DCO application is submitted for examination by PINS. As part of the application process, the PINS, acting on behalf of the appropriate Secretary of State (Department for Transport) will consider whether our pre-application public consultation has been satisfactory.

4.5 Options consultation

4.5.1 Department for Transport held a non-statutory public consultation in 2013, which looked at the need for a new crossing and invited views on locations A (at the existing crossing), B (connecting the A2 and Swanscombe Peninsula with the A1089), C (east of Gravesend) and C variant (widening of the A229 between the M2 and M20).

4.5.2 The Government published its response to the 2013 consultation in July 2014, confirming that there is a need for an additional crossing between Essex and Kent, but that there was no consensus about the location of the crossing. The Government then commissioned Highways England to carry out a more detailed assessment of locations A and C, with or without the C variant. The Government made the decision not to proceed with location B due to limited public support, the potential impact on local development plans and the limited transport benefits of this option.

4.5.3 As part of this assessment, Highways England carried out a programme of engagement from September 2014 until September 2016 to determine constraints and priorities which would affect the identification and development of feasible options for a new Lower Thames Crossing. A planned and focused approach to engagement was adopted to ensure high quality and meaningful engagement. This provided opportunities for sharing complex and technical information and facilitated relationship building with opportunities for further engagement. Key stakeholders were local authorities, statutory and environmental bodies, statutory undertakers (utilities), local groups, organisations and businesses which might be affected. The Project also sought to engage council leaders and MPs in directly affected and neighbouring areas.

4.5.4 Highways England held a non-statutory public consultation from 26 January to 24 March 2016. The proposed Project, and those shortlisted routes that performed satisfactorily against the scheme objectives and were considered viable, were presented for comment at the consultation. Proposals at location C were presented which included three routes north of the river in Essex and two south of the river in Kent. The consultation also included information on those routes that were not considered viable and the reasons for this, together with the opportunity to comment on the issues raised and to propose other solutions.

4.5.5 The consultation aimed to inform as many people as possible about the Project and obtain feedback on the proposals, and to identify any new and relevant information that should be considered in the decision-making process. Highways England then conducted further assessment of the route options, taking account of consultation responses, to inform the preferred route recommendation that was made to the Secretary of State for Transport (location C, route 3 with Western Southern Link).

4.5.6 The 2016 consultation was a non-statutory consultation. In planning and carrying out the consultation Highways England was guided by Government guidance on consultation, best practice and lessons learned from other major consultations.

4.5.7 The consultation was widely publicised, and a variety of material was made available, digitally and in hard copy form, to ensure the public had access to the information needed to consider the options presented and respond to the

consultation accordingly. Highways England also held a total of 24 public information events in 20 locations in the Lower Thames area during the consultation period.

4.5.8 The consultation generated 47,034 responses, the largest ever for a UK road project. Responses were received from across the UK, with the largest proportion from south Essex, north Kent and the London boroughs. Most responses were received from members of the public; 523 responses were received on behalf of organisations and groups; 13,284 responses were received from 14 separate campaigns and three petitions were submitted. More than 33,000 people provided responses to the questionnaire.

4.5.9 Highways England appointed Ipsos MORI, an independent research and analysis organisation, to undertake analysis of responses and to prepare an independent report of its findings. As part of its independent assurance, the consultation questionnaire was reviewed by Ipsos MORI to ensure questions were impartial and not misleading.

4.5.10 The consultation responses were considered in making a recommendation to Government about the choice of a preferred route to be taken forward to the next stage of development. Many of the comments continue to help inform detailed design refinements as the Project is developed in more detail.

4.5.11 The *Post Consultation Scheme Assessment Report* summarises responses to the consultation, the appraisal of route options and a recommendation on Highway England's preferred route: https://highwaysengland.citizenspace.com/cip/lower-thames-crossing-consultation/.

4.6 Preferred route stakeholder engagement

4.6.1 Following the announcement of the preferred route in April 2017, engagement with key environmental stakeholders has focused on obtaining feedback and technical information on updates to the design, approach to environmental surveys and assessments, modelling, mitigation and enhancement measures, consents and future engagement.

4.6.2 The purpose of this engagement has been to share Project information, build strong relationships, and ensure a comprehensive view of environmental constraints has been considered during design development.

4.6.3 Engagement with key environmental stakeholders has so far included bilateral meetings, data requests, joint workshops and forums such as the Statutory Environment Body (SEB) and Stakeholder Advisory Panel meetings, site visits, emails and telephone meetings.

Statutory environmental bodies

4.6.4 The SEBs are advisory bodies and key stakeholders. They include the Environment Agency, Historic England (including Greater London Archaeology Advisory Service), Marine Management Organisation, Natural England and the Forestry Commission (including Forestry Enterprise).

4.6.5 We have also included the Port of London Authority in some of the discussions, specifically engaging with them in relation to marine consents.

4.6.6 The Project has engaged with the SEBs on the following matters:

Table 4.1 SEB engagement

SEB	Areas of engagement
Environment Agency	Biodiversity, flood risk, road drainage and the water environment, groundwater, contaminated land, geology and soils and cumulative effects.
Historic England	Cultural heritage and building conservation, landscape, geology and soils, noise and vibration, road drainage and the water environment and cumulative effects.
Marine Management Organisation	Licensing, planning of marine activities and marine biodiversity.
Natural England	Marine and terrestrial biodiversity, designated sites, air quality, noise and vibration, landscape, road drainage and the water environment, and cumulative effects.
Forestry Commission (including Forestry Enterprise)	Biodiversity, people and communities, and landscape.

Environmental organisations

4.6.7 Engagement to date has been undertaken on key topic areas such as biodiversity, air quality, noise and landscape with the following environmental organisations:

a. Buglife

b. Essex and Kent Wildlife Trust

c. Kent Downs Area of Outstanding Natural Beauty

d. RSPB

e. The Woodland Trust

4.6.8 Further engagement is planned with other environmental organisations and groups as the design is developed and this will be reported in the *Environmental Statement*.

Local authorities

4.6.9 The host local authorities engaged with to date are:

a. Brentwood Borough Council

b. Dartford Borough Council

c. Essex County Council

d. London Borough of Havering

e. Gravesham Borough Council

f. Kent County Council

g. Medway Council

h. Thurrock Council

4.6.10 Local authorities have been engaged with on key environmental topics including:

a. air quality

b. noise and vibration

c. biodiversity

d. landscape

e. road drainage and the water environment

f. cultural heritage

g. people and communities

h. geology and soils

i. materials

j. cumulative effects

k. health

4.6.11 Engagement to date has involved technical officers and specialists including Environmental Health Officers and planning officers, as well as councillors and environmental consultants.

Third party asset owners and operators

4.6.12 Regular engagement with key asset owners and operators has taken place throughout the development phase to discuss the need to protect and/or divert current asset infrastructure affected by the Project. The Project team has worked very closely with utility stakeholders, such as National Grid and Southern Gas Network to assess diversion options, environmental constraints against proposed options and potential diversion construction methods.

4.6.13 Wider engagement with industrial landowners such as Port of Tilbury is also being carried out to understand existing environmental conditions and data sets available. It also provides opportunities to share data with other DCO projects that are running in parallel, such as the redevelopment of the Tilbury Power Station and the development of Tilbury2. This involves proposals to develop a new port terminal on part of the disused Tilbury Power Station site.

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Chapter 5.

EIA Methodology

5 Environmental Assessment Methodology

5.1 Environmental Impact Assessment process

5.1.1 An Environmental Impact Assessment (EIA) is the process of compiling, evaluating and presenting environmental information in support of an assessment of all likely significant effects of a proposed development. The assessment is designed to inform the development of the Project. The process allows mitigation measures to be identified to avoid, reduce or offset significant environmental effects. These are incorporated into the design of the Project and commitments can be made to environmentally sensitive construction methods and practices. The collation of environmental information and analysis of this information against the Project proposals continues throughout the Project's development.

5.1.2 The findings of the process are recorded in the Environmental Statement (ES), which is prepared to provide decision makers and statutory consultees with the environmental information they need during the determination of an application for consent. The ES will be submitted as part of the application for the Development Consent Order (DCO).

5.1.3 The following sections provide background to the EIA work that has been completed to date for this Project. They explain how this *Preliminary Environmental Information Report* (*PEIR*) has been prepared, and the next steps towards preparing the ES.

5.2 EIA work completed to date

Screening and scoping

5.2.1 Under Regulation 8(1) of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (EIA Regulations 2017) the applicant for a proposed Nationally Significant Infrastructure Project (NSIP) is required to either submit a screening request to the Secretary of State or notify the Secretary of State, in writing, of the intention to provide an ES in respect of the proposed NSIP. A Regulation 8 notification was therefore submitted to the Planning Inspectorate (PINS) on 2 November 2017, informing them of the intention to submit an ES for the proposed Lower Thames Crossing project (the Project).

5.2.2 Regulation 8 also sets out the EIA scoping process, which determines which topics should be included in the ES, and the level of detail to which they should be assessed. Following these requirements, on 2 November 2017, Highways England wrote to PINS to request, in accordance with Regulation 8(1), that PINS provides its opinion on the scope of the information to be included in the ES for the Project.

5.2.3 To inform the PINS Scoping Opinion, a Scoping Report was submitted by Highways England, clearly outlining the intended scope of each environmental topic. The Scoping Report is available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010032/TR010032-000006-LTC%20EIA%20Scoping%20Report.pdf

5.2.4 PINS provided their Scoping Opinion on 13 December 2017. This is available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010032/TR010032-000033-LTC%20-%20Scoping%20Opinion.pdf

5.2.5 It is a requirement for the EIA to reflect the PINS Scoping Opinion. Highways England is therefore updating the EIA approach to reflect these requirements where appropriate. Further discussions with relevant stakeholders will be carried out, where required, to discuss and agree the scope of the assessments. In addition to this, Highways England is considering the other stakeholder responses to the scoping consultation (those not included in the PINS Scoping Opinion) in developing the EIA process.

Data collection

5.2.6 An important stage in carrying out EIA is to establish the baseline conditions within which the Project is being developed. The process of identifying the baseline conditions and sensitive receptors (see section 5.2.9) is currently underway and this *PEIR* reports an interim stage in that process. The collation of data for the environmental assessment to date has included:

a. review of desk-based studies/data sources

b. site visits and surveys to understand the characteristics of the study area

c. consultation with key organisations including meetings, telephone conversations and data requests

5.2.7 Information collected so far has informed the development of the design and the assessments in this *PEIR*, and details of the information collected are provided in the specialist topic chapters of this *PEIR*.

Preparation of this PEIR

5.2.8 The purpose and structure of this *PEIR* is set out in Chapter 1: Introduction.

5.2.9 Based on the data collected to date, this *PEIR* identifies elements of the environment which could be affected by the Project, known as receptors. The value of a receptor is an important factor in identifying the sensitivity of it to a potential change because of a project. Throughout the preparation of this *PEIR* the level of value of a receptor, using widely accepted guidance, has been considered with the categories from high through to negligible as follows.

Table 5.1 Typical receptor examples

Value	Receptor examples
Very high	Very high importance and rarity, international scale and very limited potential for substitution eg, Special Area of Conservation, Special Protection Area, Ramsar site.
High	High importance and rarity, national scale, and limited potential for substitution eg, Site of Special Scientific Interest, Listed Buildings grade II* and above.

Value	Receptor examples
Medium	High or medium importance and rarity, regional scale, limited potential for substitution eg, local geological sites.
Low	Low or medium importance and rarity, local scale – Public Right of Way, locally designated sites.
Negligible	Very low importance and rarity, local scale – eg, hedgerows, local ditches.

5.2.10 Given the preliminary nature of the assessments in this *PEIR*, detailed assessments using significance criteria have not been undertaken at this stage. Rather, the environmental topic assessments provide an indication of those likely significant effects that may occur because of the Project, based on current knowledge of the environment and the Project components. The environment topic assessments seek, where information is available, to provide a preliminary view on the:

a. extent of the impact (geographical area and size of the affected population)

b. magnitude and complexity of the impact

c. probability of the impact

d. duration, frequency and reversibility of the impact

5.2.11 For each potential environmental effect, potential mitigation has been considered to avoid, reduce or offset the effect. Minimising adverse environmental effects has been an integral part of the Project design process to date, with several measures already implemented to reduce the Project's adverse environmental effects. Measures are discussed in Chapter 2: Project description, Chapter 3: Alternatives, and the individual specialist topic chapters as appropriate.

5.2.12 This *PEIR* also considers the relevant aspects of the National Policy Statement for National Networks (NPSNN), which sets out the Government's policy in relation to the delivery of NSIPs on the national road and rail networks in England. Decisions on NSIP road projects are made by the Secretary of State in line with the policy set out in the NPSNN.

Uncertainty and limitations

5.2.13 There have been no specific limitations during the preparation of this *PEIR,* although there are several surveys currently ongoing (ground investigation, ecological, archaeological, air quality and noise) that will improve our understanding of the baseline environment and inform our future assessment of the Project and the design of mitigation.

5.2.14 The Project design will continue to be developed to reflect the outcomes of the consultation, and the process of gathering information and identifying how the environment might be affected by it is still taking place. The information in this document is, therefore, preliminary and may be subject to change as assessment work continues.

5.3 Next steps

5.3.1 Following consultation, the design will be developed further to consider consultation responses and findings of ongoing baseline surveys.

5.3.2 The ES will draw on consultation responses, and ongoing survey and design work, and will be prepared to accompany the DCO application. Each technical chapter of this *PEIR* provides a clear section outlining the further work that will be carried out between statutory consultation and DCO submission.

5.3.3 In the ES the significance of environmental effects will be assessed using criteria that reflect current best practice, as set out in the *EIA Scoping Report*, and taking into consideration the Scoping Opinion provided by PINS.

5.3.4 The ES will also include an assessment of the cumulative effects of the Project, as set out in the *EIA Scoping Report*, and following the guidance in PINS' Advice Note 17: Cumulative Effects Assessment. The Cumulative Effects Assessment will identify where two or more sources of effects interact to give rise to impacts on environmental resources or receptors.

Chapter 6.

Air Quality

6 Air Quality

6.1 Introduction

6.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on air quality related to the construction and operation of the Project.

6.1.2 The information presented in this *Preliminary Environmental Information Report* (*PEIR*) is a preliminary view based on information available at the time of its preparation. This will be further developed through ongoing stakeholder engagement, and further data collection, design and assessment. Updated information will be presented in the Environmental Statement (ES).

6.1.3 Clean air is an essential ingredient for a good quality of life. The Government is committed to meeting health-based air quality criteria for human health and for the protection of vegetation and ecosystems. Road transport sources account for a large proportion of the emissions of several air pollutants. The pollutants of most concern near roads are nitrogen dioxide (NO_2) and particles (PM_{10}) in relation to human health and oxides of nitrogen (NO_x) in relation to vegetation and ecosystems.

6.1.4 The aims of this chapter are to, in relation to air quality:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to air quality

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on air quality (and how these have been assessed for the purpose of this *PEIR*)

f. describe potential mitigation measures

6.1.5 There are expected to be interrelationships between the potential effects on air quality and other disciplines reported on in the *PEIR*. Please see:

a. Chapter 9: Terrestrial Biodiversity

b. Chapter 14: People and Communities

6.1.6 Effects on climate change from greenhouse gas emissions are covered in Chapter 15: Climate.

6.2 Planning policy and legislative requirements

European legislation

6.2.1 The EU Directive on ambient air quality (2008/50/EC) sets out a range of mandatory Limit Values for different pollutants including NO_2 and particulate matter less than 10 microns in diameter (PM_{10}), which are the traffic pollutants of most concern with respect to compliance with the Directive. The Directive consolidated previous air quality directives (apart from the Fourth Daughter Directive), setting Limit Values or Target Values for the concentrations of specific air pollutants and providing a new regulatory framework for particulate matter smaller than 2.5 microns in diameter ($PM_{2.5}$). It also allows Member States to apply to postpone attainment deadlines. The EU Limit Values for NO_2 and PM_{10} are presented in Table 6.1. The Air Quality (Standards) Regulations 2010 (SI 2010/64) transpose into English law the requirements of Directives 2008/50/EC on ambient air quality.

6.2.2 The Department for the Environment, Food and Rural Affairs (Defra) annually assesses and reports compliance against EU Limit Values to the European Commission. The UK is divided into 43 zones for the purposes of the assessment and reporting, and the compliance status of each zone (in relation to a Limit Value) is determined by the maximum measured or modelled concentration in that zone.

6.2.3 EU Limit Values apply throughout the zones and agglomerations; the zones/agglomerations achieve compliance when everywhere within the zone/agglomeration is below the EU Limit Value (although there are exceptions to where the EU Limit Value applies in Annex III of the Air Quality Directive, which are locations where members of the public can't access or there is no fixed habitation).

6.2.4 EU Limit Values for NO_2 are currently exceeded in several UK zones and agglomerations, and in 2017, Defra published an Air Quality Action Plan (Defra, 2017) for bringing NO_2 within statutory limits in the shortest time possible.

National legislation

6.2.5 Part IV of the Environment Act (1995) requires the UK Government to produce a national Air Quality Strategy (AQS) which contains standards, objectives and measures for improving ambient air quality. The AQS sets out objectives that are maximum ambient concentrations that are not to be exceeded either without exception or with a permitted number of exceedances over a specified timescale.

6.2.6 The ambient air quality standards and objectives are given statutory backing in England through the Air Quality (England) Regulations 2000 (SI 2000/928), and the Air Quality (England) (Amendment) Regulations 2002 (SI 2002/3043). The AQS objectives for the protection of human health and applicable to this assessment are presented in Table 6.1.

Table 6.1 Air quality objectives and EU Limit Values for NO_2 and PM_{10}

Air quality objectives and European directives for the protection of human health					
Air quality objectives				**EU Limit Values**	
Pollutant	**Concentration**	**Averaging period**	**Compliance date**	**Concentration**	**Compliance date**
NO_2	200 µg.m^{-3}	1-hour mean (not to be exceeded more than 18 times per year)	31 December 2005	200 µg.m^{-3} (1-hour mean, not to be exceeded more than 18 times per year)	1 January 2010
	40 µg.m^{-3}	Annual mean	31 December 2005	40 µg.m^{-3}	1 January 2010
PM_{10}	50 µg.m^{-3}	24-hour mean (not to be exceeded more than 35 times per year)	31 December 2010	50 µg.m^{-3} (24-hour mean, not to be exceeded more than 35 times per year)	1 January 2005
	40 µg.m^{-3}	Annual mean	31 December 2004	40 µg.m^{-3}	1 January 2005
$PM_{2.5}$	-	Annual mean	-	25 µg.m^{-3}	1 January 2015

6.2.7 The AQS objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (ie, where people will be exposed to pollutants). The annual mean AQS objective applies to all locations where members of the public might be regularly exposed; these include building façades of residential properties, schools, hospitals and care homes. The 24-hour mean AQS objective applies to all locations where the annual mean objective would apply, together with hotels and gardens of residential properties. The 1-hour mean AQS objective also applies at these locations as well as any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed.

6.2.8 The AQS objectives and EU Limit Values for the protection of vegetation and ecosystems applicable to this assessment are presented in Table 6.2.

Table 6.2 Air quality objectives and EU Limit Value for the protection of vegetation

Air quality objectives and European directives for the protection of vegetation and ecosystems					
Air quality objectives				EU Limit Values	
Pollutant	Concentration	Averaging period	Compliance date	Concentration	Compliance date
NO_x	30 µg.m^{-3}	Annual mean	31 December 2000	30 µg.m^{-3}	19 July 2001

6.2.9 Local authorities have no legal requirement to comply with AQS objectives; they are however required to demonstrate best efforts to work towards achieving them.

6.2.10 Under the Local Air Quality Management (LAQM) regime local authorities have a duty to make periodic reviews of local air quality against the AQS objectives. Where a local authority's review and assessment of local air quality indicates that AQS objectives are not expected to be achieved, local authorities are required to designate Air Quality Management Areas (AQMA). An Air Quality Action Plan (AQAP) must then be formulated, outlining a plan of action to meet AQS objectives in the AQMA.

Air quality strategy objectives/EU Limit Values

6.2.11 While AQS objectives and EU Limit Values are identical in relation to the concentrations that are applied, there are differences in how they should be interpreted and assessed. Local authorities are required to demonstrate best efforts to achieve the AQS objectives whereas the UK government is mandatorily required to achieve EU Limit Values.

6.2.12 Compliance against EU Limit Values is determined by Defra and reported at a zonal/agglomeration level. Zones/agglomerations only comply when everywhere in the zone meets the EU Limit Value. The maximum concentration within the zone is used to determine the date by which the zone will comply with the Limit Value. AQS objectives are assessed at a much more local level, where an AQMA can be designated as a result of an exceedance of the AQS objective at individual properties.

6.2.13 The air quality assessment will consider the impact of the Project on both AQS objectives (does the Project lead to a significant impact on air quality at individual properties) and EU Limit Values (will the Project impact on Defra's plans to achieve compliance with the Limit Values).

Environmental Protection Act 1990

6.2.14 Generally, dust is only a cause of annoyance but when of sufficient scale and frequency it may become a statutory nuisance. The relevant legislation dealing with statutory nuisance is given in Part III of the Environmental Protection Act 1990. A statutory nuisance in relation to dust and deposits is defined under Section 79 of the Act as follows:

a. Any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance.

b. Any accumulation or deposit which is prejudicial to heath or a nuisance.

6.2.15 Under the provisions of the Act where a local authority is satisfied that a Statutory Nuisance exists, it is under a mandatory duty to serve an Abatement Notice requiring abatement or cessation of one or more activities deemed to be causing the nuisance. In the absence of any kind of standard, identification of a nuisance is dependent on the professional judgement of the local authority as to whether Best Practical Means (BPM) are being employed to control emissions. Where BPM is evident or can be clearly demonstrated then a particular activity cannot be deemed to be causing a Statutory Nuisance.

National policy and NPSNN requirements

National Planning Policy Framework

6.2.16 The National Planning Policy Framework (NPPF) published in 2018 sets out the Government's planning policies for England and how these are expected to be applied.

6.2.17 Paragraph 181 of the NPPF considers impacts of developments on air quality: "Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

6.2.18 The NPPF therefore requires consideration of:

a. the scheme air quality impacts on the UK's ability to comply with the Air Quality Directive

b. scheme air quality impacts on national objectives for pollutants

National Policy Statement for National Networks

6.2.19 The NPSNN sets out the Government's policies to deliver the development of Nationally Significant Infrastructure Projects (NSIPs) on the national road and rail networks in England. Paragraph 5.11 of the NPSNN states that air quality considerations are likely to be particularly relevant where schemes are proposed:

a. within or adjacent to AQMA; roads identified as being above Limit Values or nature conservation sites (including Natura 2000 sites and Sites of Special Scientific Interest (SSSIs), including those outside England)

b. where changes are sufficient to bring about the need for a new AQMA or change the size of an existing AQMA; or bring about changes to

exceedances of the Limit Values, or where they may have the potential to impact on nature conservation sites

6.2.20 Paragraph 5.12 of the NPSNN provides context of where the decision maker should consider substantive weight judgements, and paragraphs 5.12 and 5.13 set out whether they should recommend refusal.

6.2.21 Table 6.3 outlines the requirements of the NPSNN and indicates how the Project will respond to these requirements through the air quality assessment.

Table 6.3 NPSNN requirements and Project response

Requirement	Project response
Paragraph 5.6: "Where the impacts of the project (both on and off-scheme) are likely to have significant air quality effects in relation to meeting EIA requirements and/or affect the UKs ability to comply with the Air Quality Directive, the applicant should undertake an assessment of the impacts of the proposed project as part of the environmental statement".	A preliminary air quality assessment has been undertaken for the *PEIR* which includes an indicative review of the risk of the Project leading to significant air quality effects, and non-compliance with the EU Air Quality Directive. It should be noted that the traffic forecasts and air quality monitoring data used to undertake the preliminary air quality assessment for the *PEIR* will be updated at the ES stage of the Project. The air quality results presented in the *PEIR* are therefore provisional and subject to change. A full assessment of the significance of air quality effects and compliance risk with the EU Directive will be undertaken for the ES.
Paragraph 5.7: "The Environmental Statement should describe: • existing air quality levels; • forecasts of air quality at the time of opening, assuming that the Project is not built (the future baseline) and taking account of the impact of the Project; and • any significant air quality effects, their mitigation and any residual effects, distinguishing between the construction and operation stages and taking account of the impact of road traffic generated by the Project."	The existing air quality conditions have been described in section 6.4. Preliminary air quality modelling has also been undertaken to determine existing air quality conditions (for a Base scenario) and future air quality at the time of opening both without (Do-Minimum scenario) and with the Project (Do-Something scenario), as presented in section 6.6. Information on existing and future air quality will also be presented in the ES. Detailed consideration of the air quality effects of the construction phase have not been considered in the *PEIR* and will be addressed in the ES. Mitigation measures for construction dust have however been suggested and are outlined in section 6.6. This *PEIR* presents the initial modelled operational air quality effects at worst-case receptors. A definitive judgement on significance has not been made at this stage as this requires the assessment of all receptors which are likely to exceed AQS objectives (where pollutant concentrations

Requirement	Project response
	are higher than pollutant specific thresholds set out in legislation), and not just worst-case receptors. It should also be noted that the traffic forecasts and air quality monitoring data on which the air quality modelling results are based are also subject to change. Any requirements for operational mitigation will be identified based on the outcome of the significance assessment completed for the ES.
Paragraph 5.8: "Defra publishes future national projections of air quality based on evidence of future emissions, traffic and vehicle fleet. Projections are updated as the evidence base changes. Applicant's assessment should be consistent with this but may include more detailed modelling to demonstrate local impacts."	The latest Defra air quality tools, including background air quality maps and emission projections have been used to inform the preliminary air quality assessment presented in the *PEIR*, as described in section 6.3. The latest Defra tools available at the time will be used for the ES.
Paragraph 5.9: "In addition to information on the likely significant effects of a project in relation to EIA, the Secretary of State must be provided with a judgement on the risk as to whether the project would affect the UK's ability to comply with the Air Quality Directive."	See Project Response to NPSNN Paragraph 5.6.
Paragraph 5.10: "The Secretary of State should consider air quality impacts over the wider area likely to be affected, as well as in the near vicinity of the Scheme. In all cases the Secretary of State must take account of relevant statutory air quality thresholds set out in domestic and European legislation. Where a project is likely to lead to a breach of the air quality thresholds, the applicant should work with the relevant authorities to secure appropriate mitigation measures with a view to ensuring so far as possible that those thresholds are not breached."	The *PEIR* has considered air quality effects near the Project and on the wider road network, where the greatest changes in traffic are predicted as a result of the Project. Air quality effects will be considered across the full Affected Road Network (ARN)for the ES. Air quality effects have been considered in relation to relevant statutory thresholds in order to consider the significance of effects and risk of non-compliance with the Air Quality Directive. Any mitigation measures required will be determined at the ES stage of the Project.
Paragraph 5.12: "The Secretary of State must give air quality considerations substantial weight where, after taking into account mitigation, a project would lead to a significant air quality impact in relation to EIA and/or where they lead to a deterioration in air quality in a zone/agglomeration."	See Project Response to NPSNN Paragraph 5.6. The preliminary results presented in the *PEIR* suggest there is a low risk of significant adverse air quality effects arising because of the Project. However, it should be reiterated that the traffic forecasts and air quality monitoring data used to inform this risk assessment are subject to change at the ES stage of the Project. A revised air quality assessment will be undertaken for the ES, and a definitive judgement of the significance of air quality effects will be made in accordance with Highways England IAN 174/13.

Requirement	Project response
Paragraph 5.13: "The Secretary of State should refuse consent where, after taking into account mitigation, the air quality impacts of the scheme will: • Result in a zone/agglomeration which is currently reported as being compliant with the Air Quality Directive becoming non-compliant; or • Affect the ability of a non-compliant area to achieve compliance within the most recent timescales reported to the European Commission at the time of the decision"	See Project Response to NPSNN Paragraph 5.6. The preliminary results presented in the *PEIR* suggest there is a low risk of the Project leading to non-compliance with the Air Quality Directive (2008/50/EU). It should be reiterated that the traffic forecasts and air quality monitoring data used to inform this risk assessment are subject to change at the ES stage of the Project. A revised air quality assessment will be undertaken for the ES, and the effect of the operation of the Project on compliance with the Air Quality Directive will be determined through the application of a compliance risk assessment (Highways England IAN 175/13).

Local policy

6.2.22 Local policies relevant to air quality are outlined in Table 6.4.

Table 6.4 Local policies for air quality

Strategy/Plan	Policy
Thurrock Council – *Core Strategy and Policies for Management of Development* (Adopted 2015)	PMD1: Minimising Pollution and Impacts on Amenity "5. The Council will seek compliance with, and contribution to, EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality in local areas arising from individual sites. PMD9: Road Network Hierarchy The Council will only permit the development of new accesses or increased use of existing accesses where: vi. Measures are taken to mitigate all adverse air quality impacts in or adjacent to Air Quality Management Areas. vii. The development will minimise adverse impacts on the quality of life of local residents, such as noise, air pollution, and the general street environment."
Havering Council – *Core Strategy and Development Control Policies Development Plan Document* (Adopted 2008)	CP15 Environmental Management "To reduce their environmental impact and to address the causes and adapt to and mitigate the effects of climate change in their location, construction and use new development should: • ensure that it does not singularly or cumulatively breach air quality targets;" DC52 Air Quality "Planning permission will only be granted where new development, both singularly or cumulatively, does not cause significant harm to air quality, and does not cause a breach of the targets set in Havering's Air Quality Management Area Action Plan (HAQMAAP).

Strategy/Plan	Policy
	A formal assessment will be required where it is suspected that a development is likely to cause a breach of emission levels for prescribed pollutants. Where the assessment confirms a breach, planning permission will only be granted if suitable mitigation measures are put in place through conditions or legal agreement."
Medway Council – *Core Strategy and Policies for management of Development* (Adopted 2003)	BNE24: Air Quality "Development likely to result in airborne emissions should provide a full and detailed assessment of the likely impact of these emissions. Development will not be permitted when it is considered that unacceptable effects will be imposed on the health, amenity or natural environment of the surrounding area, taking into account the cumulative effects of other proposed or existing sources of air pollution in the vicinity."
Dartford Borough Council – *Core Strategy Plan* (2011)	Policy DP5: Environmental and Amenity Protection "Development will only be permitted where it does not result in unacceptable material impacts, individually or cumulatively, on neighbouring uses, the Borough's environment or public health. Particular consideration must be given to areas and subjects of potential sensitivity in the built and natural environment (including as highlighted on the Policies Map) and other policies, and other potential amenity/ safety factors such as: a. air and water quality, including groundwater source protection zones;"
Brentwood Council – Replacement Local Plan (Adopted 2005)	CP1 - General Development Criteria "Any development will need to satisfy all of the following: vii) the proposal would not have an unacceptable detrimental impact on health, the environment or amenity due to the release of pollutants to land, water or air (including noise, fumes, vibration, smells, smoke, ash, dust and grit)."

6.3 Methodology

6.3.1 The air quality assessment for the *PEIR* has considered the operational effects of the Project based on the latest information available at this stage of the Project. The construction phase also has the potential to affect air quality because of emissions of construction dust, and emissions from plant and construction vehicle movements including those by road, river and rail. These construction effects have not been considered in the *PEIR*, but mitigation measures for construction dust have been identified and outlined in section 6.6. It should be noted that the traffic data used to derive emissions and air quality predictions, and the air quality monitoring data used to derive model adjustment factors, will be revised at the ES stage of the Project. The modelling results presented here are therefore provisional and subject to change. A full assessment of the air quality effects of the construction and operational phase will be reported in the ES.

6.3.2 The air quality assessment of the operational phase has been completed in accordance with guidance HA207/07 Volume 11, Section 3, Part 1 of the

Design Manual for Roads and Bridges (*DMRB*) (Highway Agency (now Highways England), 2007) and the associated Interim Advice Notes (IAN).

6.3.3 The relevant guidance documents are listed below:

a. HA207/07 DMRB Volume 11, Section 3, Part 1, May 2007

b. Local Air Quality Management Technical Guidance (LAQM.TG)(16) issued by the Department for the Environment, Food and Rural Affairs (Defra, 2016)

c. IAN 170/12v3 Updated air quality advice on the assessment of future NO_x and NO_2 projections for users of *DMRB* Volume 11, Section 3, Part 1 'Air Quality, November 2013, the document is accompanied by an Excel-based tool (available on request from Highways England)

d. IAN 174/13 Updated advice for evaluating significant local air quality effects for users of *DMRB* Volume 11, Section 3, Part 1 Air Quality (HA207/07), June 2013

e. IAN 175/13 Updated advice on risk assessment related to compliance with the EU Directive on ambient air quality and on the production of Scheme Air Quality Action Plans for users of *DMRB* Volume 11, Section 3, Part 1 Air Quality (HA207/07), June 2013

f. IAN 185/15, Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into ‘speed-bands’ for users of *DMRB* Volume 11, Section 3, Part 1 ‘Air Quality and Volume 11

6.3.4 The guidance (specifically the *DMRB*) requires several different assessments to be undertaken including:

a. local air quality assessment (predicting concentrations of pollutants for comparison against the AQS objectives at sensitive receptors eg, residential, schools and ecological sites, with and without the Project)

b. regional assessment (change in emissions because of the Project including carbon)

c. Transport Analysis Guidance (WebTAG) assessment (overall change in pollution exposure as a result of the Project)

d. assessment of the risk of the Project impacting on the UK's ability to comply with the EU Air Quality Directive

6.3.5 The *PEIR* has focused on the local air quality assessment and the risk of the Project impacting on the UK’s ability to comply with the EU Air Quality Directive. These assessments are used to determine compliance with the NPSNN as described in Table 6.3. The Regional and WebTAG assessment will be presented in the ES.

Baseline conditions

6.3.6 A review of the existing baseline was undertaken to establish an understanding of the baseline air quality environment and to identify areas likely to be sensitive to changes in emissions because of the Project. The baseline conditions have been established within 200m of modelled roads shown in Figure 6.1 in Volume 3, which represents the assessment study area. The assessment study area has been defined where the greatest changes in traffic flows occur due to the Project, as described in the section below.

6.3.7 Baseline information on air quality has been collected from the following sources:

a. Defra UK Air website (http://uk-air.defra.gov.uk/)

b. local authorities' websites (LAQM and Annual Status Report documents)

c. local authorities' officers responsible for air quality

d. Kent Air website (http://www.kentair.org.uk)

e. Essex Air website (http://www.essexair.org.uk/)

f. Highways England air quality monitoring database

g. Project-specific air quality monitoring

Local authorities

6.3.8 Monitoring data has been collected from the 22 local authorities within the assessment study area. Data has been collected from NO_2 diffusion tubes and automatic monitoring sites.

Highways England

6.3.9 Highways England has historically undertaken NO_2 diffusion tube monitoring for the following road schemes in the study area:

a. A2 Bean

b. M20 junctions 3 to 5

c. M25 junction 30

d. A2 Ebbsfleet

e. A12 M25 to Chelmsford

f. M25 junction 28 improvement

g. M2 junction 5 improvement

h. M25 junctions 23 to 27

i. Dartford (mainly covering M25 junctions 1A to junction 3)

6.3.10 The monitoring by Highways England for these schemes was undertaken over different periods between August 2013 and December 2017. All the Project monitoring data had previously been bias-adjusted using the national bias adjustment spreadsheet available from Defra. The data was annualised to 2016 following the methodology outlined in Box 7.9 of LAQM.TG16 (Defra, 2016) which involves calculating an annualisation factor from background automatic monitoring stations. The data was annualised using data from 5 Defra Automatic Urban and Rural Network (AURN) background stations, and annualisation factors of 0.98 to 1.07 were obtained and applied, depending on the periods covered by each Project survey.

Project-specific monitoring data

6.3.11 A 12-month monitoring survey is being undertaken to address gaps in air quality monitoring data within the vicinity of roads likely to be affected by the Project. A total of 89 NO_2 diffusion tubes (using 20% triethanolamine in water method of preparation) were installed in the study area in August 2017, and monitoring will be undertaken over a period of 12 months. A total of 12 additional sites have also been added throughout the survey in response to consultation with stakeholders. The locations of these monitoring sites are shown in Figure 6.1 in Volume 3.

6.3.12 Due to the inherent bias associated with passive NO_2 diffusion tubes, it is necessary to calculate a bias adjustment factor, which is applied to the raw monitoring results. Throughout the monitoring period, triplicate diffusion tubes were co-located at two automatic monitors; Thurrock 8 (Purfleet, Thurrock) and Dartford 3 (A2 Bean interchange), in accordance with LAQM.TG(16).

6.3.13 At this stage of the Project, seven months of data were available from the Project survey and this data has been bias-adjusted using a factor of 0.92 as obtained using the AEA_DifTPAB_v04 spreadsheet available from the Defra LAQM webpage (https://laqm.defra.gov.uk/bias-adjustment-factors/local-bias.html). The data was also annualised to be representative of 2016, following the methodology outlined in Box 7.9 of LAQM.TG(16) (Defra, 2016) which involves calculating an annualisation factor from background automatic monitoring stations. The data was annualised using five AURN background stations, and an annualisation factor of 0.89 was obtained and applied to the data.

Local air quality assessment

6.3.14 Concentrations of NO_2 and PM_{10} have been predicted for the local air quality assessment using the Atmospheric Dispersion Modelling System (ADMS)-Roads detailed dispersion model (Version 4.1) for the following scenarios:

a. Base Year (2016) – the base year scenario is modelled to characterise the baseline air quality environment and for the purposes of model verification (ie, the comparison of 2016 monitored and modelled concentrations). The verification approach is detailed in B.1 in Appendix B in Volume 2

b. Do-Minimum (2026) – predicted future air quality environment in Project Opening Year without the Project

c. Do-Something (2026) – predicted future air quality environment in Project Opening Year with the Project

6.3.15 To undertake the modelling, traffic data was obtained for the Base Year, Do-Minimum and Do-Something scenarios. The year 2026 has been used to represent the earliest anticipated opening year of the Project. Background pollutant concentrations and emissions from newer vehicles (alternative fuelled and Euro 6/VI) are expected to improve air quality over time as older more polluting vehicles are replaced in the vehicle fleet. Therefore, it is expected that 2026 will represent the worst-case in terms of air quality impacts.

6.3.16 The study area for the local air quality assessment is defined using the traffic change-based criteria defined in the *DMRB*. The Do-Minimum (2026) traffic scenario has been compared to the Do-Something (2026) traffic scenario. Roads that meet the criteria are defined as 'affected roads', all of which together comprise the ARN.

6.3.17 The traffic change criteria set out in HA207/07 Design Manual for Roads and Bridges (*DMRB*) Volume 11 Section 3 Part 1, is used to define the ARN for the local air quality assessment. The *DMRB* traffic change criteria are as follows:

a. Road alignment will change by 5m or more, or

b. Daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) or more, or

c. Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more, or

d. Daily average speed will change by 10 km/hr or more, or

e. Peak hour speed will change by 20 km/hr or more.

6.3.18 The *PEIR* has not included all roads that trigger the *DMRB* ARN criteria. The assessment has focused on the areas with the greatest change in traffic flows arising from the Project. Concentrations of NO_2 and PM_{10} have been predicted at sensitive receptors located within 200m of these roads, and this comprises the operational air quality study area. The study area for the operational assessment is presented in Figure 6-1. The ES will provide the modelled results for the full ARN and be fully compliant with *DMRB*.

6.3.19 It should be noted that $PM_{2.5}$ has not been specifically modelled for the Project, as annual mean concentrations are expected to be well below the EU limit value of 25 $\mu g.m^{-3}$ at all receptors. Annual mean PM_{10} concentrations modelled at receptors have however been compared to the $PM_{2.5}$ limit value to demonstrate that $PM_{2.5}$ concentrations will be below this threshold. It should be noted that PM_{10} concentrations include $PM_{2.5}$ size particles, as well as larger particles, and so this approach will overestimate $PM_{2.5}$ concentrations.

Determining significance

6.3.20 The NPSNN requires that the significance of air quality effects is determined in line with the requirements of the Environmental Impact Assessment (EIA) Directive. The assessment should also determine whether the Project would affect compliance with the EU Directive 2008/50/EC on ambient air quality. This

will establish whether the Project effects require mitigation beyond that which is embedded in the design and will also guide the decision maker in relation to whether the Project should be granted development consent; the key test is described in paragraph 5.12 and 5.13 of the NPSNN:

6.3.21 Paragraph 5.12 ″The Secretary of State must give air quality considerations substantial weight where, after taking into account mitigation, a project would lead to a significant air quality impact in relation to EIA and/or where they lead to a deterioration in air quality in a zone/agglomeration.″

6.3.22 Paragraph 5.13 "The Secretary of State should refuse consent where, after taking into account mitigation, the air quality impacts of the Scheme will*:*

a. result in a zone/agglomeration which is currently reported as being compliant with the Air Quality Directive becoming non-compliant; or

b. affect the ability of a non-compliant area to achieve compliance within the most recent timescales reported to the European Commission at the time of the decision."

6.3.23 Highways England, IAN 174/13 provides advice to determine the significance of project impacts. The IAN was developed to determine whether a significant impact is triggered for Paragraph 5.12 of the NPSNN. To determine whether Paragraph 5.13 of the NPSNN is triggered, a compliance risk assessment must be completed and is discussed later in this chapter.

6.3.24 Sensitive receptors that have a reasonable risk of exceeding AQS objectives have been assessed in both the Do-Minimum and Do-Something scenarios. The difference in pollutant concentration between the two scenarios is used to describe the 'magnitude' of change in accordance with Table 6.5. It should be noted that while the modelled results are reasonable there is still some element of residual uncertainty, which is referred to in IAN 174/14 as the Measure of Uncertainty (MoU). This is due to inherent uncertainty in air quality monitoring, modelling and the traffic data used in the assessment. However, the larger the magnitude of change, the more certainty there is that there would be an impact because of the Project. Where the Project impact on concentrations is less than 1% of the air quality threshold, then the change at these receptors is considered to be imperceptible, and these receptors are scoped out of the judgement on significance.

6.3.25 It must be reiterated that a definitive judgement on significance cannot be made without modelling all receptors which exceed the AQS objective in the study area (based on the Project changes in traffic within the ARN). The air quality assessment that has been presented in this report is based on the results from selected worst-case receptors and therefore provides an overview of the Project's impacts on local air quality. A definitive judgement on the significance of impacts on local air quality will be made in the ES when all receptors which exceed the AQS objectives in the Project Opening Year have been modelled. The findings of the ES will need to fully satisfy the requirements detailed in paragraphs 5.12 and 5.13 of the NPSNN.

Table 6.5 Air quality – magnitude of change criteria (Highways England IAN 174/13)

Magnitude of change in concentration (μg.m^{-3})	Value of change in annual average NO_2 and PM_{10}
Large (>4)	Greater than full MoU value of 10% of the air quality objective(4 μg.m^{-3}).
Medium (>2)	Greater than half of the MoU (2 μg.m^{-3}), but less than the full MoU(4 μg.m^{-3}) of 10% of the air quality objective.
Small (>0.4)	More than 1% of objective (0.4 μg.m^{-3}) and less than half of the MoU ie, 5% (2 μg.m^{-3}). The full MoU is 10% of the air quality objective(4 μg.m^{-3}).
Imperceptible (≤ 0.4)	Less than or equal to 1% of objective (0.4 μg.m^{-3}).

6.3.26 The total number of receptors in each magnitude band (which exceed AQS objectives) are aggregated and compared to the guideline number of receptors constituting a significant impact as shown in Table 6.6. The guideline bands have been developed for each magnitude category and set the upper level of likely non-significance and the lower level of likely significance. Between these two levels are the ranges where likely significance is more uncertain, and therefore professional judgement would be required. Where the differences in concentrations are less than 1% of the air quality threshold (eg, less than or equal to 0.4μg/m^3 for annual mean NO_2), the changes at these receptors are considered to be imperceptible as defined in the IAN and are scoped out of the evaluation on significance.

Table 6.6 Air quality – guideline to number of properties constituting a significant effect (Highways England IAN 174/13)

Magnitude of change in annual average NO_2 or PM_{10} (μg.m^{-3})	Number of receptors with:	
	Worsening of air quality objective already above objective or creation of a new exceedance	Improvement of an air quality objective already above objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2)	10 to 30	10 to 30
Small (>0.4)	30 to 60	30 to 60

6.3.27 Where the number of receptors fall below the lower guideline bands to inform significance, a project is deemed unlikely to have a significant impact eg, 20 receptors with a small worsening would unlikely to be classed as significant. If the number of receptors affected is greater than the upper guideline bands (60 Small, 30 Medium and 10 Large) then a project is more likely to have a significant impact on air quality. Projects which affect receptors within the guideline bands require justification to determine whether the effect is significant.

6.3.28 Table 6.6 will be populated once modelling of all receptors which exceed AQS objectives has been undertaken. The significance assessment will be undertaken as part of the ES.

Compliance with the EU Directive on ambient air quality

6.3.29 IAN 175/13 provides the guidance that should be followed to determine whether the conditions in paragraph 5.13 of the NPSNN are met.

6.3.30 It is important to note that Defra assesses and reports to the European Commission on the status of air quality in the UK, by reference to the Limit Values for each pollutant, in accordance with EU Directive (2008/50/EC). For the purposes of Defra assessment and reporting, the UK is divided into 43 zones and agglomerations (hereafter referred to as zones). The main pollutant of concern with respect to compliance is NO_2.

6.3.31 The assessment of compliance with the Directive is undertaken using both monitoring (AURN) and modelling from Defra's Pollution Climate Mapping (PCM) model. To determine the study area for the compliance risk assessment, the ARN for the local air quality assessment is compared with the PCM model network as modelled by Defra. Where the two networks overlap, this is known as the Compliance Risk Road Network and forms the basis of the assessment of compliance risk. The Defra PCM modelling is undertaken at a much larger scale than the modelling that has been undertaken for this Project, as it covers the national road network. The Project modelling is much more locally focused and, as such, is verified at a local level rather than on a national scale. Consequently, there are differences in the results between both models. However, as the Defra PCM modelling is used to inform compliance, it has to be used to determine whether the Project is a risk to compliance with the EU Directive on ambient air quality.

6.3.32 For the *PEIR* the most recent Defra PCM data, as issued in July 2017 (Defra, 2017) has been used, and any updated information that is published following the consultation will be included in the compliance risk assessment within the ES. The PCM projections are available for 2015 and for each year between 2017 and 2030. The forecasted NO_2 concentrations decline into the future, mainly in response to cleaner vehicles and technologies, and actions in Defra's 2017 Air Quality Action Plan (Defra, 2017).

6.3.33 The impact of the Project on compliance is undertaken in accordance with IAN 175/13, whereby the concentrations in the Defra PCM model for the Opening Year of the Project are used to determine which roads exceed the EU Limit Value.

6.3.34 A zone can only become compliant when all locations throughout that zone meet the relevant EU Limit Value. IAN 175/13 considers the impact of a project on the individual links in the PCM model within the zone. Mitigation is required where a project results in an overall worsening on links that exceed the EU Limit Value (ie, a greater number of links which are projected to be above the EU Limit Value and experience a deterioration in air quality because of the Project). In those circumstances, mitigation is required in the form of a Scheme Air Quality Action Plan (SAQAP). Therefore, an SAQAP may be required even if a project does not affect the worst link in the zone (ie, the link with the highest concentration in excess of the limit value).

6.3.35 IAN 175/13 provides guidance to determine whether a project has a high or low risk of non-compliance with the EU Directive. A low risk of non-compliance would be defined where there are either no exceedances of EU Limit Values or where there is an overall air quality benefit on links that exceed EU Limit Values (assuming the worst link in the zone is not adversely affected). A high risk of non-compliance would be defined where the Project increases the number of links that exceed EU Limit Values, or the Project leads to an increase in pollution on the worst link in a zone (where impacts are greater than imperceptible ie, >0.4µg/m³).

6.3.36 If a project is assessed as having a high risk of non-compliance, the IAN provides guidance on the production of an SAQAP containing actions designed to further mitigate impacts and so reduce the risk of the Project impacting on compliance.

Air quality dispersion modelling

6.3.37 The ADMS-Roads model (version 4.1) has been used to predict NO_2 and PM_{10} concentrations in the Base Year and Opening Year Do-Minimum and Do-Something scenarios.

6.3.38 The dispersion model was built by digitising traffic model links to the OS MasterMap Integrated Transport Network and assigning road widths based on OS MasterMap Highways Network data. The highway design associated with the Do-Something scenario was digitised based on drawings of the Project. Road widths and alignments were adjusted to represent the Project.

6.3.39 The following inputs and tools are required to undertake the air quality dispersion modelling:

a. Traffic data

b. Emission factors

c. NO_x to NO_2 conversion

d. Meteorological data

e. Receptors

f. Background pollutant concentrations

g. Future assumptions on concentrations based on monitored trends

Traffic data

6.3.40 Traffic data used in the assessment was obtained from the Lower Thames Area Model (LTAM), developed by Highways England. Traffic flow forecasts were derived from the Simulation and Assignment of Traffic in Urban Road Networks (SATURN) model and were converted into the format required for the air quality assessment. The flows were based on the C8E scenario.

6.3.41 Traffic data comprising total vehicle flows, percent of HDVs and speeds was used for the following periods:

a. AM peak period (06:00 to 09:00)

b. Inter-peak (IP) period (09:00 to 15:00)

c. PM peak period (15:00 to 18:00)

d. Off-peak period (18:00 to 06:00)

6.3.42 The data was based on AADT conditions (ie, weekdays and weekends). Modelled traffic speeds have been pivoted against observed speeds from TrafficMaster data and categorised into speed bands in accordance with IAN 185/15.

Emission factors

6.3.43 Road traffic emission factors for NO_x and PM_{10} were derived from an update to the speed band emission factors published in IAN 185/15. The speed band emission factors have been updated by Highways England following the release of EFT v8.0 (released Oct 2017). Emissions were defined according to the speed band category of the road, and the road type/location.

6.3.44 Although IAN 185/15 provides predictions of future emissions, there remains some uncertainty over these forecasts, particularly regarding emissions from Euro 6/VI vehicles in urban driving conditions. This uncertainty has been addressed through applying Long Term Trend (LTT) gap analysis factors to uplift Opening Year concentrations, as described below.

6.3.45 The emissions were represented in the dispersion model using time varying emission factors.

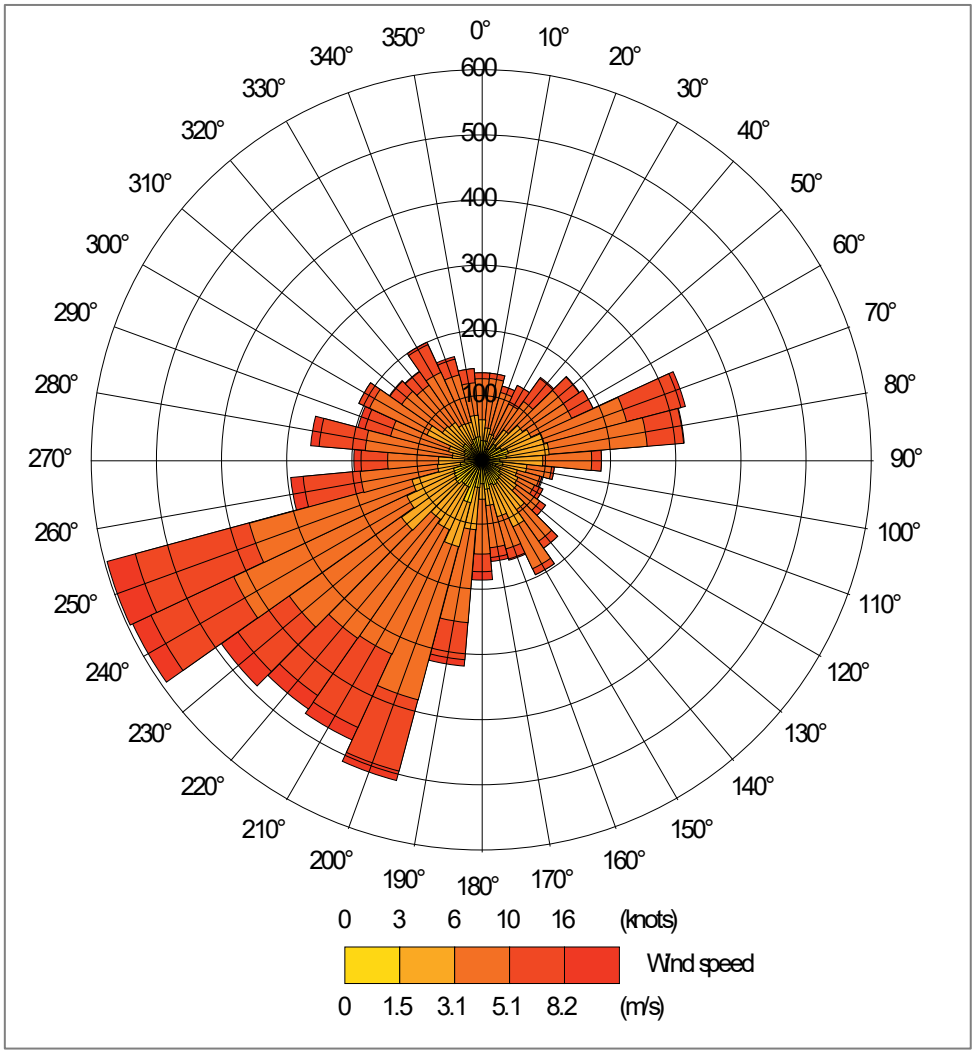
NO_x to NO_2 conversion

6.3.46 In accordance with LAQM.TG(16) (Defra, 2016) all modelled road-based concentrations of NO_x have been converted to annual mean NO_2 using the 'NO_x to NO_2' calculator (Version 6.1, released October 2017). The traffic mix and local authority used for the conversion from NO_x to NO_2 were selected depending on the modelled receptor and diffusion tube location.

Meteorological data

6.3.47 Meteorological data from Gravesend-Broadness station has been used in the assessment. This station is located within 5km of the Project development boundary and is the nearest suitable data source for 2016. The year 2016 corresponds with the base year of the traffic model and allows for verification of modelled outputs with 2016 monitoring data. The wind rose for Gravesend-Broadness is presented in Plate 6.1. The predominant wind direction is from the south west, which is also associated with the greatest wind speeds.

Plate 6.1 Wind rose for Gravesend-Broadness 2016



Human health receptors

6.3.48 Pollutant concentrations have been predicted at sensitive receptors, defined according to Defra (2016) as:

'Locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the relevant air quality objective'.

6.3.49 A total of 548 human receptors were selected for the assessment at worst-case locations across the model study area as shown in Table D.2 in Appendix D in Volume 2 and Figure 6.2 in Volume 3. Worst-case locations were selected where total pollutant concentrations were expected to be greatest (typically closest receptors to roads), or where the largest change in air quality was anticipated based on the traffic impacts. The receptors considered included residential uses, schools, hospitals, care homes and hotels (note that annual objective doesn't apply here). It should be noted that the air quality objectives do not apply to offices or other places of work where members of the public do not have regular access (Defra, 2016).

6.3.50 Future receptors were included in the model based on the future developments identified within 5km of the development boundary, as presented in Chapter 16

of the *EIA Scoping Report*. It should be noted that future receptors will be considered for the full study area, ie, beyond an extent of 5km, for the assessment undertaken for the ES.

6.3.51 It should also be noted that broad air quality impacts on human health and wellbeing are also considered in Chapter 14: People and Communities.

Ecological receptors

6.3.52 Elevated NO_x concentrations can adversely affect ecosystems. *DMRB* guidance recommends that the following designated nature conservation sites are considered: Special Areas of Conservation (SACs); Special Protected Areas (SPAs); SSSIs and Ramsar sites.

6.3.53 NO_x concentrations have been predicted at designated nature conservation sites within 200m of the modelled road network. These sites have been considered as a series of receptors (spaced at 10m intervals) extending into the site from the closest point between the designated site and the nearest affected road (out to 200m from the road). The ecological receptor transects included in the assessment are shown in Table C.2 in Appendix C. in Volume 2 and Figure 6.2 in Volume 3. The changes in air quality in ecological sites are also considered in Chapter 9: Terrestrial Biodiversity.

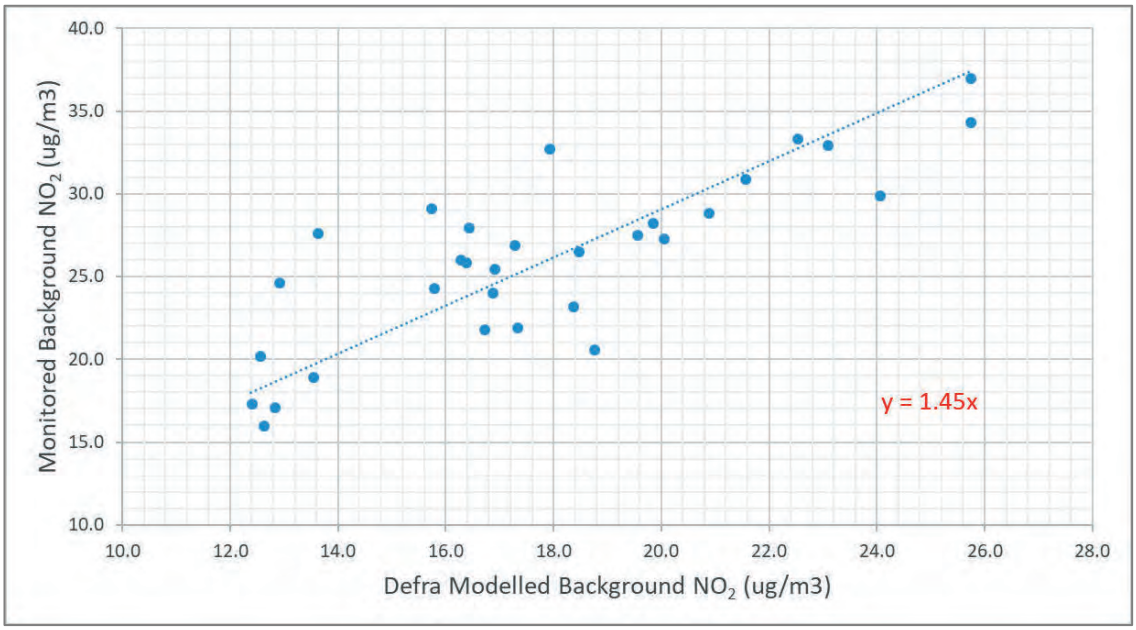
Background pollutant concentrations

6.3.54 Total air pollutant concentrations comprise a background and local component; both of which have to be independently considered for the air quality assessment. The background component is determined by regional, national and international emissions, and often represents a significant proportion of the total pollutant concentration. The local component is affected by emissions from sources such as roads and chimney stacks, which are less well mixed locally, and add to the background concentration.

6.3.55 Background pollutant concentrations are spatially and temporally variable throughout the UK and have been obtained from the Defra UK-AIR website for NO_x, NO_2 and PM_{10}. Defra provide predictions based on a grid at a resolution of 1 km^2 across the whole of the UK and forecast from a base year of 2015.

6.3.56 A comparison between Defra background NO_2 and monitored NO_2 has been undertaken at 31 background monitoring sites across the study area for the year 2016, as shown in Plate 6.2. Based on this comparison, Defra background NO_x and NO_2 concentrations were uplifted by a factor of 1.45 for all modelled scenarios. Background PM_{10} concentrations were not uplifted due to the limited background monitoring sites available to undertake this comparison.

Plate 6.2 Comparison of 2016 monitored and Defra modelled background NO2



6.3.57 The background NO_x and PM_{10} maps provide data for individual pollutant sectors. The road traffic component has been removed for roads included in the dispersion model to avoid double-counting the road traffic contribution to the background concentration. This included removing the in-grid and out-grid contribution of motorways, trunk A roads and primary A roads in the model. A tool is available on the Defra website to adjust the NO_2 backgrounds, allowing sector removal of NO_x from the total NO_x background. This tool (v6.0) was used to adjust the base year and Opening Year background NO_2 concentrations used in the assessment. The background NO_2 and PM_{10} concentrations used for human receptors are shown in Table C.1 in Appendix C in Volume 2. Background NO_x concentrations used for ecological receptors are shown in Table C.2 in Appendix C in Volume 2.

Assumptions on future trends in emissions

6.3.58 Vehicle emission factors assume that air quality improves in future years, as older vehicles are replaced with modern cleaner vehicles. However, generally, UK monitored roadside NO_2 concentrations have not declined as would be expected in recent years. This trend is thought to be related to the increased use of modern diesel vehicles, which emit more NO_x than expected under urban driving conditions and have higher primary NO_2 emissions than petrol vehicles.

6.3.59 IAN 170/12 v3 provides advice on taking account of future NO_2 projections and this advice has been followed for the assessment. The IAN was produced in response to Defra's advice on LTTs, which acknowledged there is a gap between current projected vehicle emission improvements and projections on the annual rate of improvements in ambient air quality. The advice ensures that the modelling is not overly optimistic regarding air quality improvements in the future.

6.3.60 The IAN involves undertaking LTT NO_2/NO_x gap analysis, based on adjustment of modelled NO_2/NO_x for both the Do-Minimum (2026) and the Do-Something (2026) scenarios using Base Year (2016) NO_2/NO_x and an alternative projection factor (based on a projected Base Year, which is the Base Year traffic data with Opening Year 2026 emissions and background air quality). Highways England has provided a gap analysis tool (LTTv1.1) to assist with the calculation.

6.3.61 In November 2017, Defra released an updated version of the Emission Factor Toolkit (EFTv8), which includes emissions from the Computer Program to Calculate Emissions from Road Transport Version 5 (on which the EFT is based). EFTv8 incorporates uplifted emissions from certain classes of Euro 5 and Euro 6 vehicles compared to previous versions of the tool. Although IAN170/12v3 was released prior to these updates, it has still been utilised in the air quality assessment as it provides more pessimistic modelled concentrations than relying solely on the Defra modelling tools.

Assessment of short-term NO_2 and PM_{10} concentrations

6.3.62 Defra's Technical Air Quality guidance (Defra, 2016) advises that exceedances of the 1-hour mean AQS objective for NO_2 are only likely to occur where annual mean concentrations are 60µg.m^{-3} or above. Therefore, exceedances of 60µg.m^{-3} as an annual mean are used as an indicator of potential exceedances of the 1-hour mean NO_2 AQS objective.

6.3.63 The prediction of daily mean concentrations of PM_{10} is available as an output option within the ADMS roads dispersion model for comparison against the short-term air quality objective. However, as the model output for annual mean concentrations is considered more accurate than the modelling of the daily mean, an empirical relationship has been used to determine daily mean PM_{10} concentrations. In accordance with Defra (2016), the following formula has been used:

No. of 24-hour mean exceedances = -18.5 + 0.00145 x annual mean^3 + (206/annual mean)

6.3.64 Based on this formula, an exceedance of the 24-mean PM_{10} AQS objective is unlikely to occur where the annual mean PM_{10} concentration is less than 32 µg.m^{-3}.

6.4 Existing environmental conditions

AQMAs

6.4.1 There are 33 AQMAs (ie, areas which exceed AQS objectives) that have been declared across the study area and these are presented in Figure 6.1 in Volume 3. A description of the AQMAs in the study area, including the area they cover and the pollutants for which they are declared is also presented in Table 6.7. It should be noted that Havering AQMA and Gravesham A2 AQMA fall within the development boundary.

Table 6.7 Local authority AQMAs in the study area

Local authority	AQMA name	Pollutant and declaration	Area description
Bexley, London Borough of	Bexley AQMA	Annual mean NO2 Annual mean PM10	The whole borough of Bexley.
Brentwood Borough Council	Brentwood AQMA No.2	Annual mean NO2	The AQMA comprises parts of Brook Street, Brentwood and the A12.
	Brentwood AQMA No.4	Annual mean NO2	The AQMA comprises parts of Warescot Road, Hurstwood Avenue and Ongar Road, Brentwood and the A12.
Broxbourne Borough Council	Broxbourne AQMA No. 1	Annual mean NO2 24-hour mean PM10	Several residential properties close to the M25, including Arlington Crescent, Parkside and nos. 13-21 High Street, Waltham Cross.
	Extension to AQMA 1	Annual mean NO_2	Arlington Crescent to Abbey Road
	Broxbourne AQMA No. 2	Annual mean NO_2	Properties nos. 33 to 55 Teresa Gardens, Waltham Cross.
	Broxbourne AQMA No. 3	Annual mean NO_2	An area incorporating Tile Kiln Cottage on Burntfarm Ride, just north of the M25.
Dartford Borough Council	Dartford AQMA No.1	Annual mean NO_2 24-hour mean PM_{10}	A corridor approximately 250m wide along the A282 Dartford Tunnel Approach Road from junction 1a to 300m south of junction 1b.
	Dartford AQMA No.2	Annual mean NO_2	An area encompassing London Road, Dartford.
	Dartford AQMA No.3	Annual mean NO_2	An area encompassing Dartford Town and a number of approach roads.
	Dartford AQMA No.4	Annual mean NO_2	An area encompassing the Bean Interchange between the A2 and A296.
Enfield, London Borough of	Enfield AQMA	Annual mean NO_2 24-hour mean PM_{10}	The whole borough.

Local authority	AQMA name	Pollutant and declaration	Area description
Epping Forest District Council	AQMA (Epping Forest District Council) no2	Annual mean NO_2 1-hour mean NO_2	Bell Vue Cottage, High Road, Epping; Up's and Downs, High Road, Epping
Gravesham Borough Council	Gravesham A2 AQMA	Annual mean NO_2	The A2 Trunk Road AQMA. An area extending either side of the length of the A2 within the borough.
Havering, London Borough of	Havering AQMA	Annual mean NO_2 24-hour mean PM_{10}	An area encompassing the entire London Borough of Havering.
Hertsmere Borough Council	Hertsmere AQMA No. 1	Annual mean NO_2	An area comprising the domestic properties 23-27 Dove Lane and caravan site off A1000 Barnet Road.
	Hertsmere AQMA No. 2	Annual mean NO_2	An area comprising the domestic property known as Charleston Paddocks, St Albans Road, South Mimms, Potters Bar.
	Hertsmere AQMA No. 3	Annual mean NO_2	An area comprising the domestic properties 31-39 Blanche Lane, South Mimms.
Maidstone Borough Council	Maidstone Town AQMA	Annual mean NO_2 24-hour mean PM_{10}	An area encompassing the entire Maidstone conurbation including the location previously designated as the separate M20 AQMA.
Medway Council	Central Medway AQMA	Annual mean NO_2	A large central AQMA which includes the previous AQMAs of Frindsbury Road, Cuxton Road, Strood Centre, Rochester Centre and Chatham Centre which have been slightly extended, but also includes the new areas of Luton Road, Chatham, High Street, Chatham and Rainham Road, Chatham.
Rochford District Council	Rayleigh AQMA	Annual mean NO_2	Rayleigh town centre. Exceedance of nitrogen dioxide annual mean due to road vehicle exhaust emissions

Local authority	AQMA name	Pollutant and declaration	Area description
Sevenoaks District Council	AQMA No.1 (M20)	Annual mean NO_2	An area following the M20 throughout the borough extending 80m either side of the motorway centreline.
	AQMA No.2 (M25)	Annual mean NO_2	An area following the M25 throughout the borough extending 200m either side of the motorway centreline between J5 and 6, 80m between J3 and 5 and 140m between J2 and 3.
	AQMA No.3 (M26)	Annual mean NO_2	An area following the M26 throughout the borough extending 40m either side of the motorway centreline.
	AQMA No.6 (M25-PM10)	24-hour mean $PM1_0$	An area encompassing part of the M25 motorway, west of junction 5.
	AQMA No. 13 (A25)	Annual mean NO_2	The entire length of the A25 from the border with Tonbridge and Malling in the East to the border with Tandridge on the West.
Southend Borough Council	Air Quality Management Area Southend on Sea Borough Council No 1 Order 2016	Annual mean NO_2	The AQMA is designated in relation to a likely breach of the Nitrogen Dioxide Annual Mean Objective as specified in the Air Quality Regulations 2000. The designated area is shown edged green on the plan in Schedule 1.
St Albans District Council	St Albans AQMA No. 7	Annual mean NO_2	An area encompassing a number of domestic properties in Frogmore and Colney Street in the vicinity of the M25.
Thurrock Council	Thurrock AQMA	Annual mean NO_2 24-hour mean PM_{10}	Consists of 15 separate areas, comprising several ribbons, clusters and isolated properties which are close to the busiest roads in Thurrock. All 15 areas are declared with respect to nitrogen dioxide, four of these are also declared with respect to PM10.

Local authority	AQMA name	Pollutant and declaration	Area description
	AQMA 26	Annual mean NO_2	AQMA 26 declared for annual mean objective. Located along Purfleet Bypass, Purfleet.
Tonbridge and Malling Borough Council	Tonbridge and Malling - M20 AQMA	Annual mean NO_2 24-hour mean PM_{10}	An area extending 39m from the centreline along the M20 between the points where it passes below New Hythe Lane, Larkfield to the west and where it crosses Hall Road, Aylesford to the east.
	Tonbridge and Malling - Larkfield AQMA	Annual mean NO_2	An area encompassing the A20 London Road in East Malling, Larkfield and Ditton, including the junction with New Hythe Lane.
	Tonbridge and Malling - Aylesford AQMA	Annual mean NO_2	An area encompassing the A20 London Road in Aylesford, including the junction with Hall Road and Mills Road.

Ecological sites

6.4.2 Elevated NO_x concentrations and nitrogen (N) deposition can adversely affect ecosystems. *DMRB* guidance recommends that the following designated nature conservation sites are considered: SACs; SPAs; SSSIs and Ramsar sites. Critical loads for the deposition of nitrogen, which represent the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem (according to current knowledge), have been established for specific habitats. Table 6.8 shows ecological sites within the assessment study area together with their critical loads for nitrogen deposition. Average rates of nitrogen deposition exceed the critical loads in most of the ecological sites.

Table 6.8 Ecological designated sites and nitrogen (N) critical loads and deposition

Ecological site	Site designation	Most nitrogen sensitive feature	N critical load (kg N ha^{-1} yr^{-1})	Average N deposition (kg N ha^{-1} yr^{-1}) 2013-2015
Cobham Woods	SSSI	Broad-leaved, mixed and yew woodland	15 – 20	26.3
Grays Thurrock Chalk Pit	SSSI	Invertebrate assemblages	**	10.4

Ecological site	Site designation	Most nitrogen sensitive feature	N critical load (kg N ha^{-1} yr^{-1})	Average N deposition (kg N ha^{-1} yr^{-1}) 2013-2015
Wouldham to Detling Escarpment	SSSI	Broad-leaved, mixed and yew woodland	5 to 15	27.8
Shorne and Ashenbank Woods	SSSI	Broad-leaved, mixed and yew woodland	15 – 20	24.6
Halling to Trottiscliffe Escarpment	SSSI	Broad-leaved, mixed and yew woodland	5 to 15	25.4
Titsey Wood	SSSI	Broad-leaved, mixed and yew woodland	15 – 20	27.3
Hangman's Wood and Deneholes	SSSI	Mixed species	**	10.9
Darenth Wood	SSSI	Broad-leaved, mixed and yew woodland	15 – 20	27.2
West Thurrock Lagoon and Marshes	SSSI	Littoral sediment	10 to 20	13.9
Holborough to Burham Marhses	SSSI	Fen, marsh and swamp	15 - 30	16.5
Queendown Warren	SSSI, SAC	Broad-leaved, mixed and yew woodland	15 - 20	26.7
North Downs Woodlands	SAC	Taxus baccata woods	5 to 15	25.9
South Thames Estuary and Marshes	SSSI	Dwarf shrub heath	10 to 20	12.2
Epping Forest	SSSI, SAC	Acid grassland	8 to 15	16.6
Inner Thames Marshes	SSSI	Littoral sediment	20 - 30	17
Great Crabbles Wood	SSSI	Broad-leaved, mixed and yew woodland	15 - 30	25.5

Ecological site	Site designation	Most nitrogen sensitive feature	N critical load (kg N ha^{-1} yr^{-1})	Average N deposition (kg N ha^{-1} yr^{-1}) 2013-2015
Woldingham and Oxted Downs	SSSI	Broad-leaved, mixed and yew woodland	10 to 20	28.3
Basildon Meadows	SSSI	Neutral grassland	20 - 30	23.1
Westerham Wood	SSSI	Broad-leaved, mixed and yew woodland	15 - 20	28.7
Lullingstone Park	SSSI	Broad-leaved, mixed and yew woodland	10 to 20	28.1
Vange and Fobbing Marshes	SSSI	Vascular plant assemblage	**	10
Curtsmill Green	SSSI	Neutral grassland	20 - 30	16.2
Thorndon Park	SSSI	Broad-leaved, mixed and yew woodland	15 - 20	28.3
Garrold's Meadow	SSSI	Neutral grassland	20 - 30	14.6
Thundersey Great Common	SSSI	Acid grassland	8 to 15	16

** *No comparable habitat with established critical load estimate available*

Local authority monitoring data

NO_2 diffusion tubes

6.4.3 There are more than 200 local authority diffusion tube sites within the assessment study area, and the site details and data from these sites are presented in Table A.1 in Appendix A in Volume 2. The location of these sites is shown in Figure 6.1 in Volume 3.

6.4.4 In summary, the diffusion tube data shows that there were 42 sites where the annual mean NO_2 AQS objective was exceeded in 2016, extending across 11 local authority boundaries. Most of these sites are located across the AQMAs shown in Table 6.7. There are two sites located within 200m of the route, one of these (GR110) is in Gravesham AQMA (west of the A2/Project junction), and one (WES) is located adjacent to the A13 (west of the A13/Project junction). In 2016, GR110 and WES measured an annual mean NO_2 concentration of 34.5 and 31.8 $\mu g.m^{-3}$, respectively, which is below the annual mean NO_2 AQS objective. Gravesham Borough Council also monitor background NO_2 from a diffusion tube (GR69) located ~0.5km west of the Project, and this tube

monitored an annual mean concentration of 20.3 µg.m^{-3} in 2016, which is well below the NO_2 AQS objective and likely to be representative of background air quality near the Project.

Automatic monitoring

6.4.5 Annual mean NO_2 concentrations and the number of exceedances of the 1-hour mean threshold of 200 µg.m^{-3} (not to be exceeded more than 18 times per year), recorded by the roadside continuous monitoring stations within the assessment study area, are shown in Table 6.9. This table also shows monitoring data from all urban background stations within 1km of the study area. The location of these stations is shown in Figure 6.1 in Volume 3.

6.4.6 Table 6.9 shows that four sites recorded exceedances of the annual mean NO_2 AQS objective between 2014 and 2016. Exceedances were recorded at Thurrock 8 (London Road, Purfleet), Dartford 1 (St Clements Way, Greenhithe), Dartford 3 (A2 Bean interchange), and CM1 (A229, Maidstone). The highest annual mean NO_2 concentration monitored in 2016 across these stations was 57 µg.m^{-3}, which was monitored at the Dartford 3 automatic station. This station together with Dartford 1 also monitored an exceedance of the hourly AQS objective in 2016, monitoring a total of 26 hours above the 200 µg.m^{-3} threshold.

6.4.7 Annual mean PM_{10} concentrations and the number of exceedances of the 24-hour threshold of 50 µg.m^{-3} (not to be exceeded more than 35 times per year), recorded at the continuous automatic monitoring sites across the study area are shown in Note: values in bold exceed the AQS objectives, values in italics have less than a 75% data capture

6.4.8 Table 6.10. This table shows that PM_{10} concentrations were well below the annual mean AQS objective at all the stations between 2014 and 2016. The highest PM_{10} concentration monitored in 2016 was 27 µg.m^{-3}, which was monitored at the Dartford 3 station (A2 Bean interchange). The PM_{10} 24-hour mean objective was also not exceeded at any of the stations between 2014 and 2016. Thurrock 8 had the most occurrences of 24-hour mean concentrations exceeding the 50 µg.m^{-3} threshold in 2016, when 11 occurrences were recorded.

6.4.9 Annual mean $PM_{2.5}$ concentrations recorded at the continuous automatic monitoring sites across the study area are shown in Table 6.11. Annual mean concentrations of $PM_{2.5}$ were well below 25 µg.m^{-3} at all the stations between 2014 and 2016. The maximum annual mean $PM_{2.5}$ concentration monitored in 2016 was 13.4 µg.m^{-3}, which was recorded at the Stanford-le-Hope station.

Table 6.9 NO_2 concentrations ($\mu g.m^{-3}$) recorded by automatic stations between 2014 and 2016

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014			2015			2016		
				Annual mean NO_2 ($\mu g/m^3$)	Number of hours above 200$\mu g/m^3$	Data capture (%)	Annual mean NO_2 ($\mu g/m^3$)	Number of hours above 200 $\mu g/m^3$	Data capture (%)	Annual mean NO_2 ($\mu g/m^3$)	Number of hours above 200$\mu g/m^3$	Data capture (%)
Brentwood Borough Council	Brentwood Town Hall	559860	193617	22.5	0	100	24.0	0	*27*	24.5	0	96
Dartford Borough Council	(Dartford 3) Bean interchange (Roadside)	558622	172752	51.0	0	*39.3*	**61.0**	**24**	93	**57.0**	**26**	97
	(Dartford 1) St Clements Way, Greenhithe (Roadside)	558525	174709	60.5	51	*60.1*	**50.0**	8	98	**47.0**	**19**	93
Gravesham Borough Council	(ZG2) Gravesham A2 Roadside, Painters Ash (Roadside)	562589	172076	30.9	0	96	30.0	0	96	29.6	0	99

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014			2015			2016		
				Annual mean NO_2 (µg/m³)	Number of hours above 200µg/m³	Data capture (%)	Annual mean NO_2 (µg/m³)	Number of hours above 200 µg/m³	Data capture (%)	Annual mean NO_2 (µg/m³)	Number of hours above 200µg/m³	Data capture (%)
	(ZG3) Gravesham Industrial Background, Northfleet (Industrial)	562155	174360	24.4	0	99	23.4	0	99	24.1	0	90
Maidstone Borough Council	(CM1) A229 (Roadside)	575740	155615	**46.9**	2	96	**40.1**	0	99.4	38.0	0	99
	(CM2) Scragged Oak Lane, Detling (Rural Background)	580075	159700	12.2	0	99	12.6	0	84	12.0	0	98
Medway Council	Rochester Stoke (Rural Background)	583164	176313	14.4	0	98	13.0	0	99	13.3	0	92
Thurrock Borough Council	(Thurrock 1) London Road (Grays) (Urban Background)	560900	177700	26.5	0	98	25.4	0	99	27.9	0	99

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014			2015			2016		
				Annual mean NO_2 (µg/m³)	Number of hours above 200µg/m³	Data capture (%)	Annual mean NO_2 (µg/m³)	Number of hours above 200 µg/m³	Data capture (%)	Annual mean NO_2 (µg/m³)	Number of hours above 200µg/m³	Data capture (%)
	London Road Purfleet (Thurrock 8 formerly TK2) (Roadside)	556698	177937	**61.5**	5	99	**55.5**	0	90	**55.0**	1	90

Note: values in bold exceed the AQS objectives, values in italics have less than a 75% data capture

Table 6.10 PM_{10} concentrations (µg.m^{-3}) recorded by automatic stations between 2014 and 2016

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014			2015			2016		
				Annual mean PM_{10} (µg/m³)	Number of days above 50µg/m³	Data capture (%)	Annual mean PM_{10} (µg/m³)	Number of days above 50µg/m³	Data capture (%)	Annual mean PM_{10} (µg/m³)	Number of days above 50µg/m³	Data capture (%)
Dartford Borough Council	(Dartford 3) Bean Interchange	558622	172752	32.4	11	63	26.0	7	95	27.0	10	95
	(Dartford 1) St Clements Way, Greenhithe	558525	174709	30.6	11	65	20.0	3	95	24.0	5	95

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014			2015			2016		
				Annual mean PM_{10} (µg/m³)	Number of days above 50µg/m³	Data capture (%)	Annual mean PM_{10} (µg/m³)	Number of days above 50µg/m³	Data capture (%)	Annual mean PM_{10} (µg/m³)	Number of days above 50µg/m³	Data capture (%)
Gravesham Borough Council	(ZG2) Gravesham A2 Roadside, Painters Ash (Roadside)	562589	172076	17.5	6	99	18.0	2	-	19.0	1	97
	(ZG3) Gravesham Industrial Background, Northfleet (Industrial)	562155	174360	19.3	11	99	19.7	7	-	18.0	2	79
Maidstone Borough Council	(CM1) A229 (Roadside)	575740	155615	22.6	10	81	22	3	88	24	5	*45*
	(CM2) Scragged Oak Lane, Detling (Rural Background)	580075	159700	25.3	18	-	19.4	3	95	20	4	84
Medway Council	Chatham (Roadside)	577434	166993	21.4	15	97	18.5	4	93	19.1	3	90
	Rochester Stoke (Rural)	583164	176313	17.6	8	94	14.6	2	82	15.8	4	85

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014			2015			2016		
				Annual mean PM_{10} ($\mu g/m^3$)	Number of days above 50$\mu g/m^3$	Data capture (%)	Annual mean PM_{10} ($\mu g/m^3$)	Number of days above 50$\mu g/m^3$	Data capture (%)	Annual mean PM_{10} ($\mu g/m^3$)	Number of days above 50$\mu g/m^3$	Data capture (%)
Thurrock Council	(Thurrock 8) London Road Purfleet (Roadside)	556700	177928	26.8	22	99	24.9	22	99	24.8	11	99
	(Thurrock 1) Grays (Urban Background)	560900	177700	19.3	11	96	17.1	2	98	17.3	4	96

Note: Values in italics have less than a 75% data capture - in a cell means no data available

Table 6.11 $PM_{2.5}$ concentrations ($\mu g.m^{-3}$) recorded by automatic stations between 2014 and 2016

Local authority	Monitoring station	X OS grid ref	Y OS grid ref	2014		2015		2016	
				Annual mean $PM_{2.5}$ ($\mu g/m^3$)	Data capture (%)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)	Data capture (%)	Annual mean $PM_{2.5}$ ($\mu g/m^3$)	Data capture (%)
London Borough of Havering	Rainham (Roadside)	553110	182516	12.0	94	11	97	12.1	98
Medway Council	Chatham (Roadside)	577434	166993	14.0	96	11.8	93	12.0	75
	Rochester, Stoke (Rural)	583164	176313	15.0	80	8.9	82	11.3	86
Thurrock Council	Stanford-le-Hope (Roadside)	569306	182737	14.1	92	10.1	95	13.4	91

Highways England monitoring

6.4.10 There are 149 monitoring stations located in the assessment study area, and these are shown in Figure 6.1 in Volume 3. Details of the monitoring sites and the annualised concentrations recorded are presented in Table A.2 in Appendix A in Volume 2.

6.4.11 Based on the 2016 annualised data, 43 of the sites exceeded the annual mean AQS objective, and the majority of these are in the AQMAs described in Table 6.7. The highest concentration recorded was from the roadside site M25J25Im_023_0116, which is located on Great Cambridge Road and measured an annualised NO_2 concentration of 70.7 $\mu g.m^{-3}$.

Project-specific monitoring data

6.4.12 The annualised monitoring data for the Project is presented in Table A.3 in Appendix A in Volume 2. Annual mean NO_2 concentrations are less than the annual mean AQS objective at all sites within 200m of the route alignment. The maximum concentration monitored within 200m of the route alignment was 37.4 $\mu g.m^{-3}$, monitored from site LTC72 on Baker Street, which is located 55m north of A13. The annual mean AQS objective is exceeded at 12 monitoring sites, two of these sites are the triplicate co-location sites, and two are sites associated with ecological receptors. The highest concentration monitored was from site LTC_ECO_7, which is located on A228 and monitored a concentration of 53.9 $\mu g.m^{-3}$.

Future baseline

6.4.13 Background pollutant concentrations and emissions from newer vehicles (alternative fuelled and Euro 6/VI) are expected to improve air quality over time as older more polluting vehicles are replaced in the vehicle fleet. Air quality is therefore predicted to improve in the future. These air quality improvements are reflected by the NO_2 and PM_{10} concentrations predicted at human receptors in the Base Year (2016) and Opening Year (2026) scenario (Table D.1 in Appendix D in Volume 2).

6.5 Further baseline information and surveys required

6.5.1 Most local authorities monitor air quality on a rolling annual basis and, where available, the baseline conditions will be updated in the ES to reflect latest published data. Complete Project-specific monitoring results will be available and published in the ES.

6.6 Potential effects and mitigation measures

6.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon available data relating to both the construction and operation phases of the Project. The potential effects and, if required, potential mitigation measures to manage them are outlined below. Note that this assessment is ongoing and is subject to change through ongoing development of the Project proposals.

6.6.2 A full detailed assessment will be undertaken before DCO application, which will identify the likely significant effects, and mitigation measures if required. The

results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the ES.

Construction

6.6.3 The construction phase of the Project has the potential to affect air quality because of emissions of dust, and because of emissions from Non-Road Mobile Machinery (NRMM) and construction vehicle movements by road, river and rail. These effects have not been considered in the *PEIR* and will be considered as part of the ES submitted with the DCO application.

6.6.4 A Code of Construction Practice (CoCP) will be prepared as part of the ES, which will set out mitigation measures to be implemented during the construction phase. This section summarises the types of mitigation measures that will be considered to mitigate against the effects of construction dust where required. They represent BPM which should be adopted during the construction phase, and further detailed mitigation will be developed as part of the construction assessment for the ES.

Construction site planning

a. No burning of waste materials on site

b. Plan site layout – avoid machinery being located close to sensitive receptors

c. Trained and responsible manager on site during work times to maintain logbook and carry out site inspections

d. Visual inspections should be made daily to determine whether there are any significant dust episodes as a result of the construction activities

e. Hard surface site haul routes

f. Ensure adequate water supply on site, using non-potable water where possible and appropriate

Construction traffic and NRMM

a. All vehicles to switch off engines when not in use – no idling vehicles

b. Effective vehicle cleaning and specific wheel-washing on leaving site and damping down of haul routes, where there is potential for carrying dust or mud off the site

c. Routinely clean public roads and access routes using wet sweeping methods

d. All loads entering and leaving the site to be covered

e. No site run-off of water or mud

f. Ensure all on-road vehicles comply with the requirements of the London Low Emission Zone and the London NRMM standards, where applicable (ie, in the London Borough of Havering). Ensure vehicles working on site have exhausts positioned such that the risk of re-suspension of ground dust is minimised (exhaust should preferably point upwards), where reasonably practicable.

g. Impose and signpost maximum speed limits on unsurfaced haul routes and work areas and surfaced haul routes and work areas

h. Hard surfacing and effective cleaning of haul routes around site (no dry sweeping of large areas). Regularly dampen down with fixed or mobile sprinkler systems and regularly cleaned.

i. Inspect haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable, record all inspections in the log book

Application site activities

a. Minimise dust-generating activities

b. Ensure disposal of run-off water from dust suppression activities, in accordance with the appropriate legal requirements

c. Maintain all dust control equipment in good condition and record maintenance activities

d. Avoid double handling of material wherever reasonably practicable

e. Sheet or otherwise to enclose loaded bins and skips

f. Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate

g. Use water as dust suppressant where applicable

h. Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction

i. Ensure mixing of cement, bentonite, grout and other similar materials takes place in enclosed areas remote from site boundaries and potential receptors

j. Ensure slopes on stockpiles are no steeper than the natural angle of repose of the material and maintain a smooth profile

k. Ensure equipment is readily available on site to clean any spillages as soon as reasonably practicable after the event using wet cleaning methods

l. Cover seed or fence stockpiles to prevent wind-whipping where appropriate

m. Stockpiles should be located away from sensitive receptors as far as practicable

n. Revegetate earthworks and exposed areas

o. If applicable, ensure concrete crusher or concrete batcher has a permit to operate

p. Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos, with suitable emission control systems, to prevent escape of material and overfilling during delivery

6.6.5 With the adoption of BPM measures, the impact of construction activities would be reduced and should ensure that the impacts are minimised, if not eliminated. Additionally, opportunities to transport construction materials and excavated materials to and from the site using the River Thames will be considered, thereby reducing the number of construction vehicles required on site and on the surrounding road network.

6.6.6 The impact of emissions from construction vehicles and traffic management will be considered in the ES to determine the impact of the construction phase on air quality. This will involve identifying the worst-case year during the construction phase (which will be determined based on the largest number of construction vehicle movements).

6.6.7 The identified mitigation measures will be set out in the CoCP reflecting the requirements of BPM.

Operational impact

Human health

6.6.8 A total of 548 sensitive receptors were considered for the local air quality assessment. These were identified at worst-case locations alongside the modelled road network. The location of the human receptors considered in the assessment is shown in Table C.1 in Appendix C in Volume 2 and Figure 6.2 in Volume 3.

6.6.9 Total NO_2 and PM_{10} concentrations were predicted for the Base year (2016), Opening year (2026) Do-Minimum and Opening year (2026) Do-Something scenarios. The verified modelled concentrations at all receptors are presented in Table D.1 in Appendix D in Volume 2. The approach used to verify the model is presented in Appendix B.1 in Volume 2.

6.6.10 The changes in NO_2 and PM_{10} predicted at modelled receptors are attributable to Project-related changes in traffic and the addition of new road infrastructure. It is therefore important to understand how the Project affects traffic flows on the road network to understand the Project air quality effects. The description of traffic flows provided in this section focuses on changes in AADT flow in specific

locations. It should be noted that the AADT changes reported have been rounded to the nearest 1,000. The flows will also be subject to change at the ES stage of the Project. Further information on the traffic flows associated with the Project are provided in the Highways England (2018) *Traffic Forecasting Report.*

6.6.11 The Project's road is predicted to have an AADT flow of approximately 75,000 vehicles per day (vpd) between the A2 and A13 junction, and an AADT flow of around 52,000 between the A13 and M25 junction. In the Opening Year, the Project is predicted to lead to a reduction in AADT flow on the Dartford Crossing of around 34,000. The increased capacity across both the Dartford Crossing and the Project would lead to an overall increase in vehicle kilometres travelled on the road network and a redistribution of traffic.

6.6.12 South of the River Thames the key changes in traffic would be:

a. an increase in AADT flow of between 1,000 and 3,000 on the M25 between junction 3 and junction 7

b. a reduction in AADT flow on the M20 between junction 1 and junction 6 of 5,000 to 12,000.

c. a reduction in AADT flow of 6,000 on the M25 between junction 2 and junction 3 (approach to the Dartford Crossing)

d. a reduction in AADT flow, by as much as 24,000 on the A2 between M25 junction 2 and the Project

e. an increase in AADT flow of 2,000 to 23,000 between M2 junction 1 and M2 junction 7

f. an increase in AADT flow on the A228 (between M2 junction 2 and M20 junction 4) and A229 (between M2 junction 3 and M20 junction 6) by as much as 5,000 and 4,000, respectively

6.6.13 North of the River Thames the key changes in traffic would be:

a. a reduction in AADT flow by as much as 18,000 on the A13 between M25 junction 30 and the Project

b. an increase in AADT flow of 9,000 to 21,000 on the A13 east of the Project between the A128 junction and A130 junction

c. an increase in AADT flow of between 1,000 and 9,000 between M25 junction 29 and junction 23

d. a maximum increase in AADT flow of 1,000 between M11 junction 6 and junction 8a

e. an increase in AADT flows by a maximum of 7,000 on the A127 west of M25 junction 29 (specifically between M25 junction 29 and Front Lane), but

a decrease in flows by up to 7,000 on the A127 east of M25 junction 29 (specifically between M25 junction 29 and A128 junction).

6.6.14 The study area has been split up into discussion areas to allow for ease of understanding of the air quality impacts. The areas are:

a. **Discussion Area 1** – Northern Zone: includes M25 (junction 21 to J29), M11 (junction 6 to junction 8a), A12, A127, A128 and A130

b. **Discussion Area 2** – Central Northern Zone: includes M25 (junction 29 to junction 1a), A13, Grays and surrounding area

c. **Discussion Area 3** – Lower Thames Crossing Zone: includes Project Development Boundary

d. **Discussion Area 4** – Central Southern Zone: includes M25 (junction 1a to junction 3), Dartford, Gravesend, A2 and M2 (junction 1 to junction 8)

e. **Discussion Area 5** – Southern Zone: includes M25 (junction 3 to junction 7), M20 (junction 1 to junction 7), M26, A228 and A229

6.6.15 The modelled receptors, with predicted notable changes in air quality and maximum modelled concentrations, have been identified for each discussion area. These key modelled receptors are highlighted in Figure 6.2 in Volume 2. A discussion on the impacts and reasons for changes in concentrations has also been provided. The concentrations predicted in each scenario, and the concentration change associated with the Project, are influenced by a variety of factors. These include traffic flows and speeds on adjacent roads, the distance between road and receptors, and the wind direction relative to the location of roads and receptors. For example, for a south to north orientated road, during westerly winds, concentrations would be higher on the eastern side of the road compared to the west.

6.6.16 Background pollutant concentrations and emissions from newer vehicles (alternative fuelled and Euro 6/VI) are expected to improve air quality over time as older more polluting vehicles are replaced in the vehicle fleet. Air quality is therefore predicted to improve between the Base Year (2016) and Opening Year (2026), which is reflected by the receptor results described below.

Nitrogen dioxide

Discussion Area 1 – northern zone

6.6.17 There are 105 modelled receptors in Discussion Area 1 and the results for key receptors discussed in this section are shown in Table 6.12. In the Project Opening Year, annual mean NO_2 concentrations are predicted to be below the AQS objective at most of these receptors. There are two receptors where the annual mean NO_2 AQS objective is predicted to be exceeded in the Opening Year. Annual mean NO_2 concentrations are predicted to exceed the AQS objective at receptor PEIR0390 (Broxbourne (Air Quality Management Area) AQMA, M25 junction 25 to junction 26) and PEIR0484 (A127, Prince Avenue) in both the Do-Minimum (DM) and Do-Something (DS) scenarios. The Project

leads to an increase in NO_2 of 0.3 $\mu g.m^{-3}$ at these receptors (imperceptible magnitude of change) due to an increase in traffic of around 2,000 vpd on adjacent roads.

6.6.18 On the M25 between junction 21 and junction 29, the largest change in NO_2 is predicted at PEIR0337 (M25 J28), where concentrations increase by 0.5 $\mu g.m^{-3}$ because of an increase in traffic of around 9,000 vpd on the adjacent section of the M25 (the receptor is located approximately 70m from the M25). Along the M11 (junctions 6-8a), there is an increase in traffic of approximately 1,000 vpd, and changes in NO_2 are imperceptible (less than 0.4 $\mu g.m^{-3}$) at all modelled receptors. Across the A12, A127 and A130, the largest increase in NO_2 occurs at PEIR0212, where there is an increase of 0.6 $\mu g.m^{-3}$, because of an increase in flow of 5000 vpd on the adjacent section of A127 (west of the M25). The largest decrease in NO_2 in this area occurs at PEIR0063, where there is a reduction in concentration of 1.3 $\mu g.m^{-3}$ because of a decrease in flow of around 7,000 vpd on the adjacent section of the A127 (east of the M25). Annual mean NO_2 concentrations are predicted to decrease on the A128 Tilbury Road, because of a reduction in traffic flow, with the largest decrease (3.4 $\mu g.m^{-3}$) occurring at receptor PEIR0052. PEIR0052 is located 5m east of A128, where there is a decrease in traffic flow of around 3,000 vpd, and a reduction in congestion from heavy to light in the AM traffic period.

Table 6.12 Discussion Area 1 – modelled annual mean NO_2 at human receptors

Receptor	Approximate location	Change in AADT	Annual mean NO_2 ($\mu g.m^{-3}$)			
			Base year	Do-Minimum	Do-Something	Change
PEIR0390	M25 J25-26	2,000 vpd	**56.4**	**46.0**	**46.3**	0.3
PEIR0484	A127 Prince Av	2,000 vpd	**61.1**	**47.7**	**48.0**	0.3
PEIR0337	M25 J27-28	9,000 vpd	30.9	24.4	24.9	0.5
PEIR0212	A127 (West M25)	5,000 vpd	30.0	23.2	23.8	0.6
PEIR0063	A127 (East M25)	-7,000 vpd	34.4	27.1	25.8	-1.3
PEIR0052	A128 Tilbury Road	-3,000 vpd	37.8	31.5	28.1	-3.4

Exceedance of Annual Mean AQS Objective in Bold

Change in AADT is the approximate change in traffic flow (because of the Project) at the main road source adjacent to receptor. Note, however, that the change in NO2 is also affected by other parameters such as level of traffic congestion and distance between road and receptor.

Discussion Area 2 – central northern zone

6.6.19 There are 151 modelled receptors in Discussion Area 2 and the results for key receptors discussed in this section are shown in Table 6.13. In the Project Opening Year, annual mean NO_2 concentrations are predicted to be below the AQS objective at most of these receptors.

6.6.20 There are five modelled receptors where the annual NO_2 AQS objective is predicted to be exceeded in the Opening Year, and these are in Grays and Purfleet. An exceedance of the annual mean NO_2 AQS objective is predicted in the DM scenario at PEIR0188, which is located adjacent to Treacle Mine Roundabout (Grays). In the Do-Minimum scenario there is a traffic flow of around 20,000 vpd on the roundabout. With the Project (Do-Something scenario) there is a predicted reduction in traffic flow of 3,000 vpd and a resultant reduction in NO_2 by 3.4 $\mu g.m^{-3}$ at this receptor. This is considered a medium magnitude of change, resulting in NO_2 being below the AQS objective with the Project.

6.6.21 Receptors PEIR0190 and PEIR0122 are in Thurrock AQMA (Purfleet) and are predicted to exceed the NO_2 AQS objective in both the DM and DS scenarios. Concentrations at PEIR0190 and PEIR0122 are predicted to decrease by 0.6 and 0.5 $\mu g.m^{-3}$ respectively (small magnitude of change), which is largely due to the decrease in traffic of around 35,000 vpd on the adjacent section of M25 (which is located 200-350m east of the receptors (this is the reason for the small reduction in concentrations with the large change in flows)). Receptors PEIR0519 and PEIR0520 are located on London Road, Purfleet and are also predicted to exceed the annual AQS objective in the DM and DS scenarios. The concentration at both receptors changes by less than 0.4 $\mu g.m^{-3}$ (imperceptible magnitude of change), due to a change in traffic of less than 100 vpd on London Road, as a result of the Project (note although London Road is not an affected road, these receptors are within 150m of the A1090 which is affected).

6.6.22 Throughout the Grays area, annual mean NO_2 concentrations are predicted to decrease at most receptors located within the Thurrock AQMA. Concentrations are predicted to decrease on the A1306 by up to 1.8 $\mu g.m^{-3}$ (PEIR0089), because of a decrease in traffic of around 5,000 vpd along the adjacent section of road. There is also a predicted decrease in NO_2 of up to 1.6 $\mu g.m^{-3}$ (PEIR0038) on the A126 due to a decrease in traffic of around 2,000 vpd on the adjacent section of road. Elsewhere across Grays, the maximum predicted increase in NO_2 is 2.5 $\mu g.m^{-3}$, which is predicted at receptor PEIR0054 on A1013 Stanford Road, due to an increase in traffic flow of 2,000 vpd on the adjacent A1013 and 21,000 vpd on the A13 (55m from receptor).

6.6.23 Along the A13 between M25 (junction 30) and the Project, traffic flows are predicted to decrease, leading to a maximum decrease in NO_2 of 1.4 $\mu g.m^{-3}$ as predicted at receptor PEIR0211 (decrease of around 13,000 vpd on adjacent section of A13). An increase in NO_2 is predicted on the A13 east of the Project, and the maximum predicted increase is 2.0 $\mu g.m^{-3}$, as modelled at receptor PEIR0239 (23m north of A13), due to an increase in traffic of approximately 21,000 vpd on the adjacent section of A13.

6.6.24 On the M25 between junction 29 and junction 1a, the largest change in NO_2 is predicted at receptor PEIR0226 (between junction 31 and junction 1a) where a

reduction of 3.5 µg.m^{-3} occurs because of a decrease in AADT traffic of around 36,000 vpd on the adjacent section of M25.

Table 6.13 Discussion Area 2 – modelled annual mean NO_2 at human receptors

Receptor	Approximate location	Change in AADT	Annual mean NO_2 (µg.m^{-3})			
			Base year	Do-Minimum	Do-Something	Change
PEIR0188	Treacle Mine Roundabout	-3,000	**51.1**	**40.2**	36.8	-3.4
PEIR0190	Stonehouse Lane	-35,000**	**64.8**	**53.7**	**53.1**	-0.6
PEIR0122	Stonehouse Lane	-35,000**	**56.4**	**45.0**	**44.5**	-0.5
PEIR0519	London Road	<100	**48.3**	**42.2**	**42.3**	0.1
PEIR0520	London Road	<100	**53.1**	**47.6**	**47.8**	0.2
PEIR0089	A1306	-5,000	**45.7**	35.7	33.9	-1.8
PEIR0038	A126	-2,000	**47.1**	37.1	35.5	-1.6
PEIR0054	A1013	2,000	28.0	22.8	25.3	2.5
PEIR0211	A13 (west of Project)	-13,000	**40.6**	34.1	32.7	-1.4
PEIR0239	A13 (east of Project)	21,000	33.3	27.8	29.8	2.0
PEIR0226	M25 J31-1a	-36,000	38.9	34.0	30.5	-3.5

*Exceedance of Annual Mean AQS Objective in **Bold***

*** Change in flow is for M25 junction 31 to junction 1a located ~200-350m east of receptors PEIR0190 and PEIR0122)*

Change in AADT is the approximate change in traffic flow (as a result of the Project) at the main road source adjacent to receptor. Note however, that the change in NO_2 is also affected by other parameters such as level of traffic congestion and distance between road and receptor.

Discussion Area 3 – Lower Thames Crossing zone

6.6.25 There are 36 modelled receptors in Discussion Area 3 and the results for key receptors discussed in this section are shown in Table 6.14. In the Project Opening Year, annual mean NO_2 concentrations are predicted to be below the AQS objective for all these receptors. The highest concentration is predicted in the DM scenario at receptor PEIR0255 (adjacent to the A2, immediately west of the Project junction) where a concentration of 38.6 µg.m^{-3} occurs. In the DS scenario, this receptor is predicted to experience the largest decrease in annual mean NO_2, of 6.9 µg.m^{-3} because of a decrease in traffic of approximately 30,000 vpd on the adjacent section of the A2. The largest increase in NO_2 predicted due to the Project occurs at receptor PEIR0244 (M2 junction 1), where there is an increase in NO_2 of 5.3 µg.m^{-3} due to an increase in traffic flow of around 23,000 vpd on the adjacent section of the M2.

6.6.26 There are no receptors located within 1km of the north portal. The two nearest (worst-case) receptors to the south portal are located more than 280m away, on Rochester Road (PEIR0526) and Church Avenue (PEIR0527). The greatest Opening Year concentration, modelled at these receptors is predicted at receptor PEIR0526 in the DS scenario and is 20.9 µg.m^{-3} which is well below the annual mean AQS objective. The maximum change in NO_2 predicted is at receptor PEIR0527, where an increase in NO_2 of 3.8 µg.m^{-3} occurs, mainly due to emissions from the south portal.

Table 6.14 Discussion Area 3 – modelled annual mean NO_2 at human receptors

Receptor	Approximate location	Change in AADT	Annual Mean NO_2 (µg.m^{-3})			
			Base Year	Do-Minimum	Do-Something	Change
PEIR0255	A2 (west of Project)	-30,000	**48.3**	38.6	31.7	-6.9
PEIR0244	M2 J1-2	23,000	35.5	28.1	33.4	5.3
PEIR0526	A226 (south tunnel portal)	75,000**	23.1	18.1	20.9	2.8
PEIR0527	A226 (south tunnel portal)	75,000**	18.2	14.0	17.8	3.8

*Exceedance of Annual Mean AQS Objective in **Bold***

*** Traffic flow on Project route, which is located >280m away from receptors PEIR0526 and PEIR0527.*

Change in AADT is the approximate change in traffic flow (as a result of the Project) at the main road source adjacent to receptor. Note however, that the change in NO_2 is also affected by other parameters such as level of traffic congestion and distance between road and receptor.

Discussion Area 4 – central southern zone

6.6.27 There are 130 receptors in Discussion Area 4 and the results for key receptors discussed in this section are shown in Table 6.15. In the Project Opening Year, 15 of these receptors are expected to exceed the annual mean NO_2 AQS objective in the DM scenario. The exceedances are predominantly predicted in Dartford AQMA along the M25 (A282) between junction 1a and junction 2. There are also exceedances of the objective predicted at receptors PEIR0293 (Dartford, A2 Bean AQMA) and PEIR0208 (near A2 Bean AQMA), and at PEIR0516 (located within 10m of A2, west of M25 junction 2) and PEIR0256 (located within 20m of A2 east of M25 junction 2). The highest concentration is predicted at receptor PEIR0023 in the DM scenario, where a concentration of 68 µg.m^{-3} is predicted. This indicates that the 1-hour NO_2 AQS objective could also be exceeded at this receptor. PEIR0023 is located on the A226, East Hill in Dartford, where traffic emissions are particularly elevated because of a gradient. Most of the receptors with an exceedance of the annual mean NO_2 AQS objective in the DM scenario are predicted to experience a reduction in NO_2 because of the Project. The only receptor with an exceedance of the annual AQS objective and an increase in NO_2 associated with the Project is PEIR0516, where an increase of 0.4 µg.m^{-3} is predicted (imperceptible change) due to an

increase in traffic flow of around 3,000 vpd on the A2. The changes in NO_2 predicted at receptors in the discussion area are described in more detail below.

6.6.28 In the Dartford area, including along the M25 (A282) between junction 1a and junction 2, the largest reduction in NO_2 associated with the Project occurs at PEIR0135 (A282 near junction 1b). At PEIR0135, NO_2 concentrations decrease by 5.5 $\mu g.m^{-3}$ from 45.4 to 39.9 $\mu g.m^{-3}$ because of a reduction in traffic of approximately 30,000 vpd on the adjacent section of M25. The largest Opening Year concentration predicted at receptors on this section of the M25 is 52.5 $\mu g.m^{-3}$, which is predicted in the DM scenario at receptor PEIR0131 (located 9m east of the M25, between junction 1a and junction 1b). NO_2 is predicted to decrease at this receptor by 4.7 $\mu g.m^{-3}$ because of the Project due to the reduction in traffic on the adjacent section of M25.

6.6.29 Between the M25 junction 2 and junction 3, the largest concentration is predicted at PEIR0281 in the DM scenario (31.9 $\mu g.m^{-3}$), which is located on Hawley Road adjacent to the NB carriageway. The largest change in NO_2 (-0.8 $\mu g.m^{-3}$) is predicted to occur at receptor PEIR0275 due to a reduction in flow of around 6,000 vpd on the adjacent section of M25.

6.6.30 On the A2 between A2018 and the M2 junction 1, the largest reduction in NO_2 occurs around the A2 Bean junction. A reduction in annual mean NO_2 of 3.3 $\mu g.m^{-3}$ is predicted at PEIR0208 adjacent to this junction, because of a decrease in traffic of approximately 20,000 vpd on the adjacent section of the A2. An increase in traffic of around 3,000 vpd predicted between the M25 and A2018, leading to a maximum increase in NO_2 of 0.4 $\mu g.m^{-3}$, is predicted at receptor PEIR0516 (described above).

6.6.31 An increase in traffic is predicted on the M2 (junction 1 to junction 8) as a result of the Project. The largest increase in annual mean NO_2 is predicted at PEIR0193 (near M2 J3) where concentrations increase by 3.7 $\mu g.m^{-3}$ due to an increase in traffic of 14,000 vpd on the adjacent section of the M2, but annual mean concentration does not exceed the AQS objective at this receptor with the Project (34.6 $\mu g.m^{-3}$).

Table 6.15 Discussion Area 4 – modelled annual mean NO_2 at human receptors

Receptor	Approximate location	Change in AADT	Annual mean NO_2 ($\mu g.m^{-3}$)			
			Base year	Do-Minimum	Do-Something	Change
PEIR0293	A2, Bean interchange	-22,000	**43.9**	**45.7**	**44.2**	-1.5
PEIR0208	A2, Bean interchange	-22,000	**51.2**	**43.4**	**40.1**	-3.3
PEIR0516	A2 (west of M25)	3,000	**53.1**	**42.8**	**43.2**	0.4
PEIR0256	A2 (east of M25)	-24,000	**48.6**	**40.1**	37.0	-3.1
PEIR0023	A226	<100	**83.8**	**68.0**	**66.7**	-1.3

Receptor	Approximate location	Change in AADT	Annual mean NO_2 ($\mu g.m^{-3}$)			
			Base year	Do-Minimum	Do-Something	Change
PEIR0135	M25 J1a-1b	-30,000	**51.9**	**45.4**	39.9	-5.5
PEIR0131	M25 J1a-1b	-30,000	**63.7**	**52.5**	**47.8**	-4.7
PEIR0281	M25 J2-3	-6,000	38.2	31.9	31.2	-0.7
PEIR0275	M25 J2-3	-6,000	36.6	30.7	29.9	-0.8
PEIR0193	M2 J2-3	14,000	39.5	30.9	34.6	3.7

*Exceedance of Annual Mean AQS objective in **Bold***

Change in AADT is the approximate change in traffic flow (as a result of the Project) at the main road source adjacent to receptor. Note however, that the change in NO_2 is also affected by other parameters such as level of traffic congestion and distance between road and receptor.

Discussion Area 5 – southern zone

6.6.32 There are 125 modelled receptors in Discussion Zone 5 and the results for key receptors discussed in this section are shown in Table 6.16. In the Project Opening Year, annual mean NO_2 concentrations are predicted to be below the annual mean AQS objective at all these receptors, other than receptor PEIR0105. Receptor PEIR0105 is located adjacent to the M20, between junction 4 and junction 5, in Tonbridge and Malling M20 AQMA. A reduction in annual mean NO_2 of 1.2 $\mu g.m^{-3}$ is predicted to occur at this receptor due to the Project (decreasing from 46.5 to 45.3 $\mu g.m^{-3}$ between the DM and DS scenario) which reduces traffic flows of around 8,000 vpd on the adjacent section of M20.

6.6.33 The largest change in NO_2 predicted on the M20 is expected to occur at receptor PEIR0105, which is described above. On the M26, the largest change in NO_2 associated with the Project is predicted at receptors PEIR0231 and PEIR0268, where a reduction of 0.3 $\mu g.m^{-3}$ is predicted, because of a decrease in traffic on the M26 of around approximately 1,000 vpd. On the M25, between junction 3 and junction 7, there is an increase in traffic flow of between 4,000 and 2,000 vpd, leading to a maximum change in NO_2 of 0.2 $\mu g.m^{-3}$, as predicted at receptor PEIR0302 (near M25 junction 5).

6.6.34 On the A228, the largest impact is predicted at receptor PEIR0036, which is located on the A228, North Halling. The annual mean NO_2 concentration is predicted to increase by 4.7 $\mu g.m^{-3}$, increasing from 34.8 to 39.5 $\mu g.m^{-3}$ between the DM and DS scenarios, because of an increase in flow of around 5,000 vpd on the adjacent section of the A228. There is an increase in traffic of up to 4,000 vpd on the A229, which leads to an increase in NO_2 at receptor PEIR0358 of 1.7 $\mu g.m^{-3}$.

Table 6.16 Discussion Area 5 – modelled annual mean NO_2 at human receptors

Receptor	Approximate location	Change in AADT	Annual mean NO_2 ($\mu g.m^{-3}$)			
			Base year	Do-Minimum	Do-Something	Change
PEIR0105	M20 J4-5	-8,000	**57.4**	**46.5**	**45.3**	-1.2
PEIR0231	M26 J2a-3	-1,000	35.7	28.9	28.6	-0.3
PEIR0268	M26 J1-2a	-1,000	31.4	25.2	24.9	-0.3
PEIR0302	M25 J4-5	3,000	27.3	21.8	22.0	0.2
PEIR0036	A228	5,000	**41.8**	34.8	39.5	4.7
PEIR0358	A229	4,000	29.8	24.1	25.8	1.7

Exceedance of annual mean AQS objective in bold

Change in AADT is the approximate change in traffic flow (as a result of the Project) at the main road source adjacent to receptor. Note however, that the change in NO2 is also affected by other parameters such as level of traffic congestion and distance between road and receptor.

$PM_{10}/PM_{2.5}$

6.6.35 The maximum PM_{10} concentration predicted in the Opening Year at any receptor is 24.9 $\mu g.m^{-3.}$ This is predicted at receptor PEIR0023 in the DM scenario. There are no receptors which exceed the annual mean PM_{10} AQS objective, and as annual mean concentrations are below 32 $\mu g.m^{-3}$ at all receptors, there are expected to be no exceedances of the 24-hour mean objective for PM_{10}.

6.6.36 The largest modelled increase in PM_{10} due to the Project is 2.0 $\mu g.m^{-3}$, predicted at receptor PEIR0036 located adjacent to the A228. At this location traffic flows increase by around 5,000 vpd (+2,000 HDVs per day) because of the Project.

6.6.37 The largest modelled decrease in PM_{10} due to the Project is 2.4 $\mu g.m^{-3}$ and is predicted at receptor PEIR0255, located adjacent to the A2 (west of the Lower Thames Crossing junction) where traffic flows decrease by approximately 30,000 vpd.

6.6.38 $PM_{2.5}$ has not been modelled as a separate pollutant but is considered through the results of the PM_{10} modelling, as $PM_{2.5}$ is a component of $PM_{10.}$ The modelling has predicted that PM_{10} concentrations in the Opening Year would be less than the $PM_{2.5}$ threshold of 25 $\mu g.m^{-3}$ at all receptors, so it can be concluded that there would be no exceedances of the $PM_{2.5}$ EU Limit Value, even if it was assumed that all of the modelled PM_{10} existed in the $PM_{2.5}$ size fraction.

Ecological sites

6.6.39 As described in section 6.3, annual mean NO_x concentrations were modelled in statutory ecological sites using roadside transects spaced at 10m intervals. The full set of results are shown in Table D.1 in Appendix D in Volume 2 and Figure 6.2 in Volume 3 and the key results are reported in this section.

6.6.40 Statutory designated ecological receptors with NO_x concentrations exceeding the 30 µg.m^{-3} annual mean AQS objective, and with a Project associated change in concentration above 0.4 µg.m^{-3} (ie, perceptible change) are presented in Table 6.17.

Table 6.17 Modelled annual mean NO_x ($\mu g.m^{-3}$) at selected ecological receptors

Ecological receptor	Site name and designation	Closest point to road source (m)	Base	DM	DS	Change
CobhamWoods1	Cobham Woods SSSI	16	65.6	45.4	51.2	5.9
CBW2		20	43.6	29.7	32.4	2.7
WouldhamDetling1b	Wouldham to Detling Escarpment SSSI	26	59.7	40.8	41.7	0.9
WD2b		36	51.4	34.9	35.7	0.7
WD3b		46	46.3	31.4	32.0	0.6
WouldhamDetling1a		23	57.0	38.7	39.6	0.9
WD2a		33	46.1	31.2	31.8	0.6
ShorneAshenbank1b	Shorne and Ashenbank Wood SSSI	2	32.9	22.4	32.0	9.6
ShorneAshenbank1a		8	72.8	51.2	70.3	19.1
SA2a		18	59.6	41.6	51.4	9.8
SA3a		28	51.7	35.9	42.3	6.5
SA4a		38	46.7	32.3	37.1	4.9
SA5a		48	42.9	29.5	33.3	3.8
SA6a		58	40.0	27.4	30.5	3.1
HailingTrott1	Hailing to Trottiscliffe Escarpment SSI	5	100.5	76.7	90.6	13.9
HT2		15	57.0	41.6	46.9	5.3
HT3		25	46.2	33.0	36.4	3.3
HT4		35	40.4	28.5	30.8	2.3
TitseyWood1a	Titsey Wood SSSI	8	159.4	119.5	120.6	1.1

Ecological receptor	Site name and designation	Closest point to road source (m)	Base	DM	DS	Change
HangmansWood1	Hangman's Wood and Deneholes SSSI	8	55.4	39.4	40.7	1.3
HW2		18	44.0	30.4	31.0	0.7
DarenthWood1	Darenth Wood SSSI	33	71.4	51.5	47.8	-3.7
DW2		43	56.0	39.8	37.5	-2.4
DW3		53	48.5	34.2	32.4	-1.7
DW4		64	43.9	30.7	29.4	-1.4
DarenthWood1a		12	179.4	133.7	119.0	-14.7
DW2a		22	99.3	72.4	66.0	-6.4
DW3a		32	77.8	56.1	51.8	-4.3
DW4a		42	66.3	47.4	44.2	-3.2
DW5a		52	59.1	42.0	39.5	-2.5
DW6a		62	54.6	38.6	36.5	-2.1
DW7a		72	51.1	36.0	34.1	-1.8
DW8a		82	48.6	34.1	32.5	-1.6
DW9a		92	46.6	32.6	31.2	-1.4
DW10a		102	45.0	31.4	30.1	-1.3
DW11a		112	43.6	30.4	29.2	-1.2

DM = 2026 Do-Minimum Scenario

DS = 2026 Do-Something Scenario

Change = Project associated change in NOx concentration (DS minus DM)

6.6.41 There are seven statutory ecological designated sites that are in the study area and are predicted to be exposed to annual mean NO_x in excess of the AQS objective (in Project Opening Year), and perceptible changes in NO_x due to Project associated changes in traffic. Annual mean NO_x concentrations are predicted to increase by more than 0.4 $\mu g.m^{-3}$ in six of the seven ecological sites which exceed the annual mean NO_x objective. The largest increase occurs in Shorne and Ashenbank Woods SSSI (19.1 $\mu g.m^{-3}$) due to a predicted increase in traffic flow of around 29,000 vpd along the adjacent section of A2. The largest reduction in NO_x is predicted to occur in Darenth Wood SSSI (14.7 $\mu g.m^{-3}$) due to a predicted reduction in traffic flow of around 24,000 vpd on the adjacent section of the A2.

6.6.42 Under the advice of IAN 174/13, the ecological sites shown in Table 6.17 will require a nitrogen deposition assessment to support in the evaluation of significance. A full nitrogen deposition assessment will be undertaken for the ES and will be used together with the NO_x predictions to determine the significance of effects. The Terrestrial Biodiversity ES Chapter will also consider the effects of air quality on ecological species.

Compliance risk assessment

6.6.43 As discussed in section 6.5, IAN 175/13 provides guidance on the assessment of Project impacts and compliance with the EU Directive on Ambient Air Quality. A full compliance risk assessment, taking account of all receptors, will be undertaken for the ES. An indicative compliance risk assessment has been completed in this assessment based on the receptors considered as part of the *PEIR*.

6.6.44 The air quality study area currently intersects 895 PCM links. The maximum concentration predicted for any of these PCM links in the Opening Year is 32.7 $\mu g.m^{-3}$ corresponding to the A127 (Census ID 75041). The largest increase in NO_2 predicted at any receptor within 200m of a PCM link is 3.8 $\mu g.m^{-3}$ (PEIR0527). Even if this receptor was located on the PCM Link with the highest modelled concentration, there would be no exceedance of the annual mean EU Limit Value. Based on current information, the Project is therefore considered to have a low risk of leading to non-compliance with the EU Directive on Ambient Air Quality.

Summary of operational effects

6.6.45 The air quality modelling results show that the operation of the Project will result in both improvements and deteriorations in local air quality because of associated changes in traffic flows.

6.6.46 A reduction in NO_2 is predicted at receptors between the Base Year (2016) and Opening Year (2026) scenarios, as there are expected to be improvements in vehicle emissions over this period (eg, due to uptake in vehicles with lower emissions, such as Euro 6/VI, alternative fuels etc). Beyond the Opening Year, further improvements in vehicle emissions are expected, therefore the results discussed here are expected to represent a worst case, with the predicted impacts reducing over time beyond the opening of the Project.

6.6.47 Based on the modelling completed as this stage, 23 of the 548 human receptors considered were predicted to exceed the AQS objective for annual mean NO_2

in the Do-Minimum Opening Year of 2026. With the Project, annual mean NO_2 concentrations were predicted to decrease by more than 0.4 $\mu g.m^{-3}$ (ie, a perceptible change) at 18 of these receptors, with 5 receptors experiencing an imperceptible change in NO_2. Most of these improvements are in Dartford AQMA, around the approach to the Dartford Crossing, and occur due to the reduction in traffic and congestion in this area. While deteriorations are predicted in some areas, there are no receptors which are predicted to exceed the annual mean NO_2 AQS objective in the DM or DS scenarios and experience a perceptible increase in NO_2 because of the Project. This is because most of these changes occur in areas where the existing baseline concentrations of NO_2 are low in relation to the objectives.

6.6.48 There are no exceedances of PM_{10} AQS objectives predicted with or without the Project. The results therefore suggest that the Project would have a low risk of leading to significant adverse air quality effects in relation to IAN 174/13, as there are no receptors which exceed AQS objectives and experience a perceptible increase in NO_2 or PM_{10} because of the Project.

6.6.49 An indicative compliance risk assessment has been undertaken, and the Project is expected to have a low risk of non-compliance in relation to the EU Directive on Ambient Air Quality.

6.6.50 Note that the traffic data used to derive emissions and air quality predictions, and the air quality monitoring data used to derive model adjustment factors, will be revised at the ES stage of the Project. The modelling results presented here are therefore provisional and subject to change. It should also be noted that a definitive evaluation of the significance of effects of the Project on local air quality cannot be made until all receptors within 200m of affected roads are modelled. This information will be presented in the ES submitted with the DCO.

6.6.51 The preliminary air quality assessment undertaken here suggests that the Project is unlikely to require air quality-specific mitigation for the operational phase, as the results indicate that the Project is unlikely to lead to a significant impact on air quality in accordance with IAN 174/13 and is likely to be low risk in relation to impacting on the UKs reported ability to comply with the EU Directive on Ambient Air Quality, in accordance with IAN 175/13. However, a full detailed assessment will be undertaken before DCO application. If the full detailed assessment predicts a significant impact, mitigation will be required as part of a Scheme Air Quality Action Plan. These mitigation measures, if required, would need to be effective, viable and quantifiable and would be likely to focus on management of traffic flows in the affected areas.

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Chapter 7.

Cultural Heritage

7 Cultural Heritage

7.1 Introduction

7.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on cultural heritage related to the construction and operation of the Project.

7.1.2 Cultural heritage comprises all aspects of the environment resulting from the interaction between people and places through time. For the purposes of this assessment cultural heritage is considered in terms of archaeological remains, built heritage and historic landscapes. These aspects are referred to as heritage assets: buildings, monuments, sites, places, areas or landscapes identified as having a degree of significance due to their heritage interest that merit consideration in planning decisions. Cultural heritage influences how people relate to places and cultures and can provide a sense of place and stability to a community.

7.1.3 The UK Government has ratified several international conventions that commit the government and its agencies to measures that balance the need for development against the requirement to protect and enhance our cultural heritage. In line with this, some heritage assets are designated and have statutory protection (scheduled monuments, listed buildings and conservation areas), while others are designated but not protected by statute (including registered parks and gardens). Other heritage assets with lower levels of heritage interest are referred to as non-designated, but in most cases they still need assessment to determine the scale and nature of any impact from development.

7.1.4 The aims of this chapter are to, in relation to cultural heritage:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to cultural heritage

b. explain how information on the existing and future environment has been collected (for example, through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on cultural heritage (and how these have been assessed for the purpose of this *PEIR*)

f. describes potential mitigation measures

7.1.5 There are expected to be interrelationships between the potential effects on cultural heritage and other disciplines reported on in the *PEIR*. Please refer to:

a. Chapter 8: Landscape

b. Chapter 11: Geology and Soils

c. Chapter 13: Noise and Vibration

d. Chapter 15: Road Drainage and the Water Environment

7.2 Planning policy and legislative requirements

Legislative requirements

7.2.1 The relevant legislation applicable to the cultural heritage assessment of the Project is presented below:

Table 7.1 Legislative requirements applicable to cultural heritage

Legislation	Summary of requirements
Infrastructure Planning (Environmental Impact Assessment) Regulations 2017	Regulation 5(2)(d) of the 2017 Regulations states that the Environmental Impact Assessment (EIA) must identify, describe and assess the direct and indirect significant effects of the proposed development on material assets, cultural heritage and the landscape. Paragraph 2 of Schedule 3 of the 2017 Regulations confirms that particular regard must be had to the environmental sensitivity of geographical areas likely to be affected by the development and must be considered with particular regard to landscapes and sites of historic, cultural or archaeological significance. Paragraph 4 of Schedule 4 to the 2017 Regulations also lists cultural heritage, including architectural and archaeological aspects, as one of the elements that must be described in environmental statements.
Planning Act 2008	The requirement for consents and notifications under the Planning (Listed Buildings and Conservation Areas) Act 1990 and the Ancient Monuments and Archaeological Areas Act 1979 are disapplied by the 2008 Act and therefore do not apply to works for which development consent is required. The requirements of these Acts would be addressed by the development consent order examination process. However, any works to be carried out during the pre-application assessment and design process will be subject to these Acts, to the extent that the works engage the requirements of these Acts (on which, please see below).
Ancient Monuments and Archaeological Areas Act 1979	Provides statutory protection to any structure, building, works or areas considered to be of particular historic or archaeological interest or importance and regulates any activities which may affect such structures, buildings, works or areas. Under the 1979 Act, consent must be obtained for any work that is carried out on a scheduled monument or which would result in the demolition, destruction or damage of a scheduled monument. Under the 1979 Act, notice must also be served on relevant local authorities prior to undertaking works on land of archaeological importance.

Legislation	Summary of requirements
Planning (Listed Buildings and Conservation Areas) Act 1990	Provides special protection to buildings and areas of special architectural or historic interest. It makes provision for the listing of buildings of special architectural or historic interest, designation of conservation areas, and the exercise of planning functions in relation to them. It requires local planning authorities to have special regard to the desirability of preserving a listed building or its setting or any features of special architectural or historic interest which it possesses (sections 16 & 66) and to pay special attention to the desirability of preserving or enhancing the character or appearance of conservation areas (section 72). Listed building consent is required for any demolition or alteration to the structure of a listed building or its curtilage before any works begin.

National Policy Statement for National Networks

7.2.2 The relevant NPSNN requirements for the cultural heritage assessment of the Project are presented in Table 7.2.

Table 7.2 NPSNN requirements and Project response

Requirement	Project response
5.126 “Where the development is subject to EIA the applicant should undertake an assessment of any likely significant heritage impacts of the proposed project as part of the Environmental Impact Assessment and describe these in the environmental statement.”	This chapter identifies the key heritage assets that may be impacted and the nature of these impacts. A more detailed assessment, including the most up to date information, will be included in the Environmental Statement (ES).
5.127 “The applicant should describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the asset’s importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant Historic Environment Record (HER) should have been consulted and the heritage assets assessed using appropriate expertise. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, the applicant should include an appropriate desk-based assessment and, where necessary, a field evaluation.”	Information regarding the historic environment baseline information is included in section 7.3 of this chapter. Details of further information to be obtained are included in section 7.5. The significance of all heritage assets included in the assessment will be presented in the desk-based assessment (DBA), as an appendix to the ES. Methodologies for field evaluation will be agreed with heritage stakeholders and the results presented as appendices to the ES. The information regarding heritage assets generated by the evaluation will be assessed in the ES.
5.128 “In determining applications, the Secretary of State should seek to identify and assess the particular significance of any heritage asset that may be affected by the proposed development (including by development affecting the setting of a heritage asset), taking account of the	The Project will produce a DBA to be included as an appendix to the ES, assessing the significance of all heritage assets potentially affected by the development, including through changes to their setting. Information on heritage assets has been obtained from designation records and relevant HERs. The ES chapter will

Requirement	Project response
available evidence and any necessary expertise from: • Relevant information provided with the application and, where applicable, relevant information submitted during examination of the application; • Any designation records; • The relevant Historic Environment Record(s), and similar sources of information; • Representations made by interested parties during the examination; and • Expert advice, where appropriate, and when the need to understand the significance of the heritage asset demands it."	assess the potential effects of the development in relation to the significance of the heritage assets. The ES will also include the results of suitable field evaluation.
5.129 "In considering the impact of a proposed development on any heritage assets, the Secretary of State should take into account the particular nature of the significance of the heritage asset and the value that they hold for this and future generations. This understanding should be used to avoid or minimise conflict between their conservation and any aspect of the proposal."	The DBA and ES will provide an assessment of the value of the heritage assets, including descriptions of the nature of their significance.
5.130 "The Secretary of State should take into account the desirability of sustaining and, where appropriate, enhancing the significance of heritage assets, the contribution of their settings and the positive contribution that their conservation can make to sustainable communities – including their economic vitality. The Secretary of State should also take into account the desirability of new development making a positive contribution to the character and local distinctiveness of the historic environment. The consideration of design should include scale, height, massing, alignment, materials, use and landscaping (for example, screen planting)."	Ongoing assessment will be undertaken to investigate opportunities for the development to make a positive contribution to the character and local distinctiveness of the historic environment. This will also ensure that, as far as possible, the design and landscaping is sympathetic to and in keeping with the character and local distinctiveness of the historic environment.
5.131 "When considering the impact of a proposed development on the significance of a designated heritage asset, the Secretary of State should give great weight to the asset's conservation. The more important the asset, the greater the weight should be. Once lost, heritage assets cannot be replaced and their loss has a cultural, environmental, economic	The assessment in the ES will identify the level of impact on designated heritage assets and whether there is a risk of substantial harm or total loss of significance. The design has been developed to minimise impacts on designated heritage assets, as described in Chapter 2: Project Description, through an iterative design process.

Requirement	Project response
and social impact. Significance can be harmed or lost through alteration or destruction of the heritage asset or development within its setting. Given that heritage assets are irreplaceable, harm or loss affecting any designated heritage asset should require clear and convincing justification. Substantial harm to or loss of a grade II Listed Building or a grade II Registered Park or Garden should be exceptional. Substantial harm to or loss of designated assets of the highest significance, including World Heritage Sites, Scheduled Monuments, grade I and II* Listed Buildings, Registered Battlefields, and grade I and II* Registered Parks and Gardens should be wholly exceptional."	
5.132 "Any harmful impact on the significance of a designated heritage asset should be weighed against the public benefit of development, recognising that the greater the harm to the significance of the heritage asset, the greater the justification that will be needed for any loss."	The assessment in the ES will identify the level of impact on designated heritage assets and whether there is a risk of substantial harm or total loss of significance. The design has been developed to minimise impacts on designated heritage assets, as described in Chapter 2: Project Description, through an iterative design process. The business case for the Project explains the overwhelming need for the Project and the public benefits that the Project will provide.
5.133 "Where the proposed development would lead to substantial harm to or total loss of significance of a designated heritage asset the Secretary of State should refuse consent unless it can be demonstrated that the substantial harm or loss of significance is necessary in order to deliver substantial public benefits that outweigh the loss or harm, or alternatively that all of the following apply: • The nature of the heritage asset prevents all reasonable uses of the site; and • No viable use of the heritage asset itself can be found in the medium term through appropriate marketing that will enable its conservation; and • Conservation by grant-funding or some form of charitable or public ownership is demonstrably not possible; and • The harm or loss is outweighed by the benefit of bringing the site back into use."	The assessment in the ES will identify the level of impact on designated heritage assets and whether there is a risk of substantial harm or total loss of significance. The design has been developed to minimise impacts on designated heritage assets, as described in Chapter 2: Project Description, through an iterative design process. The business case for the Project explains the overwhelming need for the Project and the public benefits that the Project will provide.

Requirement	Project response
5.134 “Where the proposed development would lead to less than substantial harm to the significance of a designated heritage asset, this harm should be weighed against the public benefits of the proposal, including securing its optimum viable use.”	The assessment in the ES will identify the level of impact on designated heritage assets and whether this constitutes less than substantial harm. The design has been developed to minimise impacts on designated heritage assets, as described in Chapter 2: Project Description. The business case for the project explains the overwhelming need for it and the public benefits that it will provide.
5.135 “Not all elements of a World Heritage Site or Conservation Area will necessarily contribute to its significance. The Secretary of State should treat the loss of a building (or other element) that makes a positive contribution to the site’s significance either as substantial harm or less than substantial harm, as appropriate, taking into account the relative significance of the elements affected and their contribution to the significance of the Conservation Area or World Heritage Site as a whole.”	The DBA and ES will provide descriptions and assessment of significance for any conservation areas potentially affected by the Project.
5.137 “Applicants should look for opportunities for new development within conservation areas and World Heritage Sites, and within the setting of heritage assets, to enhance or better reveal their significance. Proposals that preserve those elements of the setting that make a positive contribution to or better reveal the significance of the asset should be treated favourably.”	The iterative design process and development of mitigation has considered opportunities for enhancement, where possible. A comprehensive assessment will be included in the ES.
5.138 “Where there is evidence of deliberate neglect of or damage to a heritage asset the Secretary of State should not take its deteriorated state into account in any decision.”	Noted.
5.140 “Where the loss of the whole or part of a heritage asset’s significance is justified, the Secretary of State should require the applicant to record and advance understanding of the asset and its significance before it is lost. This should be proportionate to the importance and impact. Copies of reports should be deposited with the relevant HER and the archive should be deposited with a suitable depository willing to receive it.”	Potential mitigation measures are outlined in this chapter and will be described in more detail in the ES. The Project will adhere to the requirements for archiving of any reports and physical material.
5.142 “Where there is a high probability that a development site may include as yet undiscovered heritage assets with archaeological interest, the Secretary of	The potential for undiscovered heritage assets with archaeological interest will be identified in the DBA and through field survey and will be assessed in the ES. Potential mitigation

Requirement	Project response
State should consider requirements to ensure that appropriate procedures are in place for the identification and treatment of such assets discovered during construction."	measures are outlined in this chapter and will be described in more detail in the ES.

Planning policy requirements

7.2.3 The Project is located within Gravesham, Thurrock and Havering and the study area for the cultural heritage assessment extends into Medway and Brentwood, so the relevant planning policies of these authorities are applicable to the cultural heritage assessment of the Project. Policy for Dartford is not considered as it is located outside the study area for cultural heritage. The relevant planning policies are presented below:

Table 7.3 Local planning policy

Policy name	Summary of requirements
Gravesham Local Plan Core Strategy (2011-2028)	Section 5.16 of the plan sets out the council's approach to heritage and the historic environment with policy detailed by CS20: Heritage and the Historic Environment. Policy CS20 particularly focuses on heritage that contributes to the distinct identity of the Borough including: Gravesend Town Centre and its development and setting as a riverside town; the urban and rural conservation areas; and surviving built and archaeological remains associated with maritime, military, industrial and transport heritage. The policy states: "When considering the impact of a proposed development on a designated heritage asset, the weight that will be given to the asset's conservation value will be commensurate with the importance and significance of the asset. For non-designated assets, decisions will have regard to the scale of any harm or loss and the significance of the heritage asset." (Paragraph 5.16.12)
Gravesham Local Plan First Review (1994)	Three saved policies from the Gravesham Local Plan First Review, adopted in 1994, relate to cultural heritage and are considered in determining planning applications: TC2 for listed buildings; TC3 for conservation areas; and TC7 concerning other archaeology sites. • TC2 states that proposals which involve the demolition of a listed building will not be granted consent unless the applicant demonstrates substantial and overriding reasons for consent. It also states that proposals for alterations to listed buildings or affecting their settings will need to be sympathetic to the listed building in terms of massing, scale, appearance and materials. • TC3 states that applications must contain sufficient details to enable the impact of the proposed development on the conservation area to be assessed. Demolition of unlisted buildings will only be permitted where the building is harmful to the conservation area and the alternative use will be beneficial. • TC7 states that development on important archaeological sites will not normally be permitted and that on sites where permanent preservation is not warranted the developer must ensure that appropriate investigation and recording is undertaken. This investigation must be approved by the borough council. The council may require additional information, in the

Policy name	Summary of requirements
	form of assessment and possibly evaluation of the importance of the site, to determine a planning application.
Thurrock Core Strategy and Policies for Management of Development (2015)	The policies for Thurrock concerning cultural heritage are Core Strategic Environment Policy CSTP24 Heritage Assets and the Historic Environment, and Policy for Management of Development PMD4 Historic Environment. • CSTP24 covers 3 areas. Firstly, it outlines how the council will preserve and enhance heritage assets, secondly the requirements placed on development proposals and thirdly priorities for heritage regeneration and enhancement. The policy emphasises the significance of Tilbury and Coalhouse Forts and states that the settings and fabric of these assets will be protected and enhanced. In relation to the Bata Village and Factory complex, designated as East Tilbury Conservation Area, the council will ensure that development in the area will be well designed and contribute positively to its setting. • PMD4 states that the fabric and setting of heritage assets will be protected and enhanced in accordance with their significance. New development is required to retain and incorporate non-statutorily protected heritage assets that contribute to the quality of Thurrock's broader historic environment wherever reasonably possible. Local heritage guidance must be complied with for applications to demonstrate that they contribute positively to the special qualities and local distinctiveness of Thurrock. The policy further states that the council will follow the approach set out in the National Planning Policy Framework (NPPF) in the determination of applications affecting Thurrock's built or archaeological heritage assets.
Havering Core Strategy and Development Control Policies (2008)	Cultural heritage is managed by core policy CP18 and development control policies DC67-71. • CP18 states "All new development affecting sites, buildings, townscapes and landscapes of special architectural, historic or archaeological importance must preserve or enhance their character or appearance. Contributions may be sought towards the preservation or enhancement of historic assets where appropriate." • DC67 considers buildings of heritage interest and states that planning permission will only be granted where it does not adversely affect a listed building or its setting. • DC68 considers conservation areas and sets out that their character or appearance will be preserved or enhanced. • DC69 considers other areas of special townscape or landscape character of specific parts of the Borough; of relevance to the Project is the requirement that development has regard to the special character of Havering Ridge. • DC70 considers archaeology and ancient monuments. It states that planning permission will not be granted for development that adversely affects scheduled monuments or their settings and that the archaeological significance of sites will be considered in planning decisions and be appropriately safeguarded. • DC71 considers other historic landscapes and states that the character of historic parks and common land will be protected or enhanced, with attention to the protection of views to and from these areas.

Policy name	Summary of requirements
Medway Local Plan (2003)	Relevant saved policies from the Local Plan are: • BNE18 Setting of Listed Buildings, which prevents development that would adversely affect the setting of a listed building. • BNE20 Scheduled Ancient Monuments, which states that development that would damage or destroy such a site or be detrimental to its setting will not be permitted. • BNE21 Archaeological Sites, which states that development affecting potentially important sites will not be permitted unless the developer undertakes an appropriate archaeological evaluation prior to decision making on the application, or the development would not damage or destroy important archaeological remains or an appropriate archaeological investigation is undertaken in advance of development and is approved by the council.
Brentwood Replacement Local Plan (2005)	Relevant saved policies from the Replacement Local Plan are: • C9 Ancient Landscapes and Historic Parks and Gardens states that the council will aim to conserve, enhance and manage these areas and development that would damage their character or appearance will not be permitted. • C14 Development Affecting Conservation Areas states that development within or near conservation areas needs to preserve or enhance their character or appearance and development proposals must comply with various conditions. • C15 Demolition, Alteration or Extensions states “demolition or partial demolition of a listed building will only be allowed in the most exceptional circumstances”. • C16 Development within the Vicinity of a Listed Building states that such proposals will not be permitted if they would be likely to detract from its character or setting. • C18 Ancient Monuments and Archaeological Sites states that there is a presumption in favour of preservation in situ of important archaeological sites and monuments. In such cases the developer will be required to undertake archaeological field assessment prior to determination of the application to enable an informed decision. If preservation is not possible the development will not be permitted until provision has been made for investigation and recording.

7.3 Methodology

7.3.1 This section details the methodology used for the collection of the baseline information needed to assess the Project’s potential effects on cultural heritage. This methodology is drawn from Volume 11, Section 3, Part 2 HA208/07 Cultural Heritage of the *Design Manual for Roads and Bridges* (*DMRB*).

Study area

7.3.2 Information on designated and non-designated heritage assets within the Development Boundary and a 1km study area surrounding it are considered in the assessment.

7.3.3 The study area has been determined based on two key factors. Heritage assets located within the Development Boundary could experience direct physical impacts because of the Project. Heritage assets located outside the Development Boundary could still be directly affected by the Project without experiencing a physical impact, as changes to an asset's setting can affect its significance.

7.3.4 The preliminary Zone of Theoretical Visibility (ZTV) for the Project was viewed in conjunction with recorded heritage assets and confirmed that in most areas a 1km study area would encompass those heritage assets located in areas from which the Project would be visible. There are a limited number of heritage assets located outside the 1km study area that are included in the assessment because there is potential for the Project to affect them. They were identified both through comparison with the ZTV to identify areas beyond 1km that may experience visual impacts and by a consideration of the nature of the heritage assets. For example, where there is a relationship between an asset outside the study area and an asset within the study area/that could experience an effect, it means that the first asset also has potential to be affected by the Project.

Baseline

7.3.5 The cultural heritage baseline conditions have been established through desk-based research. Field surveys are ongoing and will continue to inform the baseline for the ES. Section 7.6 of this chapter details the outstanding baseline information to be obtained.

7.3.6 Baseline information has been obtained from the following sources:

a. Historic England's National Heritage List for England for information on designated heritage assets (scheduled monuments, listed buildings, registered parks and gardens, registered battlefields, protected wrecks, World Heritage Sites and assets on the Heritage at Risk Register)

b. Local planning authorities for conservation area boundary data and appraisals

c. HERs (Kent, Essex and Greater London) for information on non-designated heritage assets, previous investigations of archaeology and historic buildings, historic landscape characterisation and area-specific aerial mapping studies

d. Historic England Archive for additional information regarding non-designated heritage assets, previous investigations, cropmarks (National Mapping Programme) and aerial photographs

7.3.7 Information on the designated and non-designated heritage assets is presented in section 7.4. The overall numbers of assets currently considered in the assessment are presented followed by information on the known assets presented by geographical area, starting from the south of the Project. This is divided into three broad areas: south of the River Thames (comprising the route between the A2 and the approach to the south tunnel portal); the tunnels (comprising the south portal, main tunnel and north portal); and north of the

River Thames (comprising the route between the north tunnel portal approach and the M25, including the junction with the A13).

7.4 Existing environmental conditions

7.4.1 This section outlines the cultural heritage baseline data collected to date. Table 7.4 lists the current cultural heritage datasets and sources received to date. These will be updated where relevant as the assessment progresses and as further information becomes available. Some of these sources have not yet been fully analysed and are therefore not included in this chapter. They will be described and assessed in the DBA and ES.

Table 7.4 Data held for cultural heritage

Dataset	Date received	Originator
The *Palaeolithic Resource in The Medway Gravels Report (Essex)* − March 2007	Apr-15	English Heritage/University of Southampton/Queen Mary University of London
The Palaeolithic Resource in The Medway Gravels Report (Kent) − March 2007	Apr-15	English Heritage/University of Southampton/Queen Mary University of London
A Strategy for Researching the Historic Environment of Greater London 2015	Feb-17	Museum of London
Historic England Archive aerial photograph cover search	July-17	Historic England
National Mapping Programme data	July-17 and Mar-18	Historic England
Thurrock Historic Environment Characterisation Report 2009	July-17	Essex County Council
Conservation areas	Aug–Oct-17	Gravesham Borough Council, Thurrock Unitary Authority, London Borough of Havering, Brentwood Borough Council
South East Farmsteads Character Statement 2014	Dec-17	Historic England
Listed buildings	Jun-18	Historic England
Scheduled monuments	Jun-18	Historic England
Registered parks and gardens	Jun-18	Historic England
Heritage at Risk 2017	Jun-18	Historic England
East of England Regional Historic Environment Research Framework	Jan-18	Association of Local Government Archaeological Officers East of England/Historic England
Greater Thames Estuary Historic Environment Research Framework 2010	Jan-18	Greater Thames Estuary Archaeological Steering Committee/Historic England

Dataset	Date received	Originator
South East Research Framework	Jan-18	East Sussex, Kent, Surrey, West Sussex, Historic England
The Lower Palaeolithic Occupation of Britain 1999	Jan-18	Wessex Archaeology/English Heritage (John Wymer)
Lost Landscapes of Palaeolithic Britain 2016	Jan-18	Oxford Archaeology/Historic England (Mark White ed.)
Thames Gateway Historic Environment Characterisation Report 2005	Jan-18	English Heritage/Kent County Council/Essex County Council (Chris Blandford Associates)
Historic England Archive monument and event data	Jan-18	Historic England
Essex HER: monument and event full reports, historic environment character zones, Historic Landscape Characterisation (HLC), PDF image of cropmarks identified from aerial photographs	Mar-18	Essex County Council
Kent HER: monument and event full reports, conservation areas, HLC, historic parks and gardens, protected military remains, Medway Valley Palaeolithic Project, Hoo Peninsula aerial mapping study and archaeological reports	Mar-18	Kent County Council
LiDAR data	Mar-18	Environment Agency, Kent County Council
Historic Ordnance Survey and other cartography, including enclosure, tithe and estate maps	Apr-18	British Library, relevant local record offices/archives
Local authority lists of 'locally listed' (registers of locally significant buildings) heritage assets, if available	Apr-18	Gravesham Borough Council, Thurrock Unitary Authority, London Borough of Havering, Brentwood Borough Council
Local and regional histories and relevant historic documents	Apr-18	Relevant local record offices/archives, local studies libraries, National Archives of England at Kew
Greater London HER: monument and event full reports, archaeological priority areas shapefile, HLC (for part of the Borough of Havering)	May-18	Greater London Archaeological Advisory Service

7.4.2 From the sources consulted, the total numbers of designated and non-designated heritage assets within the Development Boundary and 1km study

area are listed below. These include those specific assets located outside the 1km study area included in the assessment as there is potential for the Project to affect their setting.

7.4.3 Designated assets within the study area:

a. 18 scheduled monuments

b. 217 listed buildings

c. 11 conservation areas

d. 3 registered parks and gardens

7.4.4 Six of these designated assets are within the Development Boundary:

a. Scheduled cropmark complex at Orsett (SM1)

b. Grade II listed Thatched Cottage (LB58)

c. Grade II listed 1 and 2 Grays Corner Cottages (LB89)

d. Grade II listed Murrells Cottages (LB96)

e. Grade II listed Parish Boundary Stone (LB105)

f. Grade II* registered park and garden at Cobham Hall (RPG1)

7.4.5 There are no World Heritage Sites, protected wrecks or registered battlefields within the Development Boundary or study area. Listed buildings and registered parks and gardens are designated as either grade I, II* or II, with grade I indicating exceptional interest, grade II* indicating particular importance of more than special interest and grade II indicating special interest.

7.4.6 Non-designated assets within the study area comprise:

a. 1,673 non-designated heritage assets (both non-listed historic buildings and archaeological remains)

b. 698 HLC units, representing 53 different character types

7.4.7 The locations of designated and non-designated heritage assets are shown on Figures 7.1 and 7.2 in Volume 3. A full list of the designated and non-designated heritage assets considered in the assessment is provided in tables in Appendix E in Volume 2. For each asset this provides a Project ID number, which will be used for ease of reference in this document and in the DBA and ES, the originator's unique ID, the name of the asset, its location and the broad period from which it dates.

7.4.8 The Project ID numbers for designated assets are in the format LB – listed buildings, SM – scheduled monuments, RPG – registered parks and gardens and C – conservation areas followed by a number. For non-designated assets the Project ID number is not preceded by a letter. Assets shown on Figures 7.1 and 7.2 in Volume 3 are labelled with the Project ID number.

South of River Thames

7.4.9 In the south section of the Project and its surrounding study area, there are 2 scheduled monuments, 69 listed buildings, 1 registered park and garden and 4 conservation areas. One of the listed buildings, The Dairy at Cobham Hall (LB176), is on Historic England's Heritage at Risk Register due to its poor condition. The Heritage at Risk programme identifies those sites that are most at risk of being lost because of neglect, decay or inappropriate development. Historic England updates the Heritage at Risk Register every year and considers grade I and II* listed buildings, grade II listed places of worship, grade II listed buildings in London and all other designated heritage assets.

7.4.10 The registered park and garden is the grade II* Cobham Hall (RPG1). This is located south of the A2 and east of the village of Cobham. The northern edge of the park is within the Development Boundary. The designation includes approximately 22ha of formal gardens and pleasure grounds, surrounded by 316ha of parkland, 120ha of which are wooded. The 2 scheduled monuments are located within the western half of the park and are a Bronze Age bowl barrow in Ashenbank Wood (SM8) and, a Romano-British villa and 19th century reservoir (SM10). There are 8 listed buildings within the registered park and garden, including the grade I listed Cobham Hall (LB122), the Mausoleum (LB189) and the grade II* Dairy (LB176). The other listed buildings are grade II.

7.4.11 The 4 conservation areas are the villages of Cobham, Thong, Shorne and Chestnut Green. Only the northern edge of Cobham conservation area is located within the 1km study area and the 28 listed buildings within the village are on the edge of or just beyond the study area. Two of these buildings are grade I listed, 2 are grade II* listed and the remainder are grade II listed. Twelve listed buildings are in the village and conservation area of Shorne, on the eastern edge of the study area. Two of these are grade II* listed and the others are grade II.

7.4.12 Five grade II listed buildings are located within Chestnut Green conservation area, also in the eastern part of the study area, and 1 grade II listed building is within Thong conservation area, surrounded by the Development Boundary.

7.4.13 Cobham Hall registered park and garden (RPG1) and the grade II listed Parish Boundary Stone (LB105), located on the north edge of the park, are located within the Development Boundary. A small part of the eastern edge of Thong conservation area is also located within the Development Boundary. None of the other designated heritage assets are located within the Development Boundary in this area of the Project.

7.4.14 Within the Development Boundary and study area in this section of the Project there are several non-designated heritage assets recorded by the Kent HER and Historic England Archive. These include the sites of 5 Second World War RAF camps (1324, 1331), immediately north and south of the A2, and the site of Gravesend Airfield (the former RAF Gravesham) (1459) to the east of Gravesend and north of Thong. The airfield was originally a civilian airfield, established in 1932, and was taken over by the RAF and Essex Aero in 1937. The camps to the south were created for the personnel stationed at the airfield. Within the village of Thong, there are houses built after the First World War for veterans, referred to as the Homes for Heroes (1561).

7.4.15 The route of Roman Watling Street (1680) follows the modern route of the A2 through part of this section. In the area between Thong and Gravesend, within the Development Boundary, there are several locations where cropmarks have been recorded, thought to indicate Iron Age or late prehistoric field systems and enclosures (677, 1597, 1398). To the north of this, in the area between Thong Lane and the A226 within the Development Boundary, a large number of cropmarks have been recorded, indicating various probable prehistoric remains, such as pits and barrows (1577, 1362, 1595, 1602, 1620), Romano-British occupation (1541, 1601, 1606, 1607, 1534) and a number of probable post-medieval field boundaries (792, 803).

7.4.16 This area of landscape was greatly modified during and after the post-medieval period. In the western part of the study area, Gravesend has expanded significantly in the 20th century, changing the previous rural character of this area of the landscape. In the central part of the study area, within the Development Boundary and the area immediately bordering it, the landscape has retained its predominantly rural character, although the nature of this rural character has changed in the 20th century with removal of field boundaries to create large prairie type fields. The exception to this is part of the site of the former Gravesend Airfield which is now a golf course and leisure centre.

7.4.17 The eastern part of the study area retains its rural character with areas of pre-19th century and 19th century coppice woodland in Shorne Woods. The development of the park and garden at Cobham Hall (RPG1) led to the creation of further woodland in the 18th and 19th centuries in this area.

7.4.18 To the west of the village of Shorne there is a small area of rectilinear fields with curving boundaries. These may be remnants of late medieval, or early post-medieval field systems and may be the element of the landscape in this area that demonstrates the greatest time depth.

Tunnels

7.4.19 In the tunnels section of the Project, the area comprising the south portal, main tunnel and north portal, and the surrounding study area there are 16 listed buildings and 5 scheduled monuments. Two of the scheduled monuments are on the Heritage at Risk Register. Coalhouse Fort (SM14) is on the register because it has suffered severe water damage to the gun emplacements and the barrack blocks are in severe disrepair. Cliffe Fort (SM15) is on the Heritage at Risk Register because it is flooded and vulnerable to decay, vandalism and erosion. None of the designated heritage assets are located within the Development Boundary in this section of the Project.

7.4.20 In the study area surrounding the south portal there are 12 listed buildings. Ten of these are in Chalk, five along Lower Higham Road and Chalk Road, all of which are grade II listed. 1 Chalk Road (LB26) has a plaque over the front door commemorating a visit by Charles Dickens. There are five listed buildings located along Church Lane and at the corner of Lower Higham Road and Church Lane, to the east of the Development Boundary. These are predominantly grade II listed farmhouses and barns, except for the grade II* listed Church of St Mary (LB27). The grade II listed Green Farm House (LB103) and Green Farm Granary (LB19) are located near the eastern edge of the study area.

7.4.21 Three of the scheduled monuments are in the western part of the study area for this section. Tilbury Fort (SM13) is on the north bank of the river and Gravesend Blockhouse (SM16) and New Tavern Fort including Milton Chantry (SM17) are located on the opposite bank of the river in Gravesend. The scheduled monuments in Gravesend are located outside the 1km study area but have been included in the assessment because of their visual and historic relationships with Tilbury Fort. The Officers' Barracks in Tilbury Fort (LB181) is grade II* listed, designated separately and excluded from the scheduling of Tilbury Fort (SM13). To the west of Tilbury Fort is the grade II listed World's End Inn (LB133).

7.4.22 Also associated with the defence of the river approach to London are Coalhouse Fort (SM14), Cliffe Fort (SM15) and the non-designated Shornemead Fort. Coalhouse Fort is located on the north bank of the river to the east of the Development Boundary, and Cliffe and Shornemead Forts are located on the south bank. Coalhouse Fort is within the 1km study area but the other two are not. Their inclusion in the assessment is due to their clear historic relationship with Coalhouse Fort and their mutual visibility with it.

7.4.23 The northern extent of the site of Gravesend Airfield (1459) is partially located within the Development Boundary near to the south portal approach. To the east of this part of the Development Boundary is the site of a Romano-British settlement (1610) and to the west is the site of a Romano-British villa (1447).

7.4.24 The areas of floodplain near both the north and south portals have potential to contain waterlogged organic remains dating from the Mesolithic period onwards. Many of these floodplain areas are also evidence of post-medieval land reclamation, comprising the draining of the marshes and construction of sea defence walls. The gravel terraces on either side of the river have very high potential to contain evidence of human activity. Previous work in this area, such as extensive aggregate extraction at Mucking near East Tilbury and the construction of the HS1 rail line south of Gravesend, shows evidence of human activity from all periods. This included find spots of Palaeolithic artefacts indicating that some of this will potentially be Palaeolithic (approximately 800,000 – 11,000 years ago).

7.4.25 Around the main tunnel to the south of the Thames there is the site of a former golf course (768), the eastern part of which is located within the Development Boundary. To the north of this is the Milton Rifle Range (1422) on Eastcourt Marshes, dating from the 19th century.

7.4.26 Within the river, to the immediate east of the Development Boundary, is the site of the submerged mooring of a Second World War barrage balloon (1374). Many non-designated wrecks and hulks are recorded within the Thames and along the banks, but none are recorded within or immediately adjacent to the Development Boundary.

7.4.27 The sites of oyster beds (346) and a probable prehistoric settlement (412) are located to the north of the river within the Development Boundary for the main tunnel section of the Project. The probable prehistoric settlement is partially located within the intertidal area.

7.4.28 Within the north portal section of the Development Boundary are the recorded sites of two salterns (442, 502) and Second World War anti-glider ditches (348, 349).

North of River Thames

7.4.29 Within the study area of the section of the Project comprising the Tilbury junction, and the route to the east of Chadwell St Mary, there are 36 listed buildings, 3 scheduled monuments and 2 conservation areas. One of the conservation areas, East Tilbury, is on the Heritage at Risk Register. The factory in East Tilbury conservation area, which forms a key part of its character, is in very poor condition. A small part of the eastern area of West Tilbury conservation area is within the Development Boundary, but none of the other designated heritage assets are located within the Development Boundary in this section of the Project.

7.4.30 Inland from Coalhouse Fort (SM14), discussed above, there are 2 further scheduled monuments with a former military defence purpose. These are East Tilbury battery (SM11) and the Second World War anti-aircraft battery at Bowaters Farm (SM9).

7.4.31 The other scheduled monument in this section is earthworks near the church in West Tilbury (SM5). The churchyard is located on the edge of a terrace and there is a length of bank and ditch, thought to be a former rampart and an indication of the site of a camp where, in 1588, Elizabeth I reviewed the preparation of her troops for the arrival of the Spanish Armada. The site is also reported to be the location of the Anglo-Saxon Bishop Cedda's palace.

7.4.32 The density of military defensive sites along the Thames within the study area of the Project, including the site of the non-designated anti-glider ditches (348, 349), emphasises the historic strategic importance of this area of the Thames.

7.4.33 In this section, approximately two thirds of the listed buildings are in West and East Tilbury. There are 13 listed buildings in West Tilbury, 2 of which are grade II* and the remaining 11 are grade II. In East Tilbury, there are 11 grade II listed buildings. Both East and West Tilbury are also designated as conservation areas. In the old village of East Tilbury, located to the south of the conservation area, there is the grade I listed Church of St Katherine (LB169) and a grade II listed rectory (LB128). The other listed buildings in this section of the Project are grade II listed farmhouses and barns.

7.4.34 Several cropmarks have been recorded in this section and these are thought to mainly represent later prehistoric and Romano-British enclosures and field systems (104, 203, 204, 205, 206, 243, 259, 271, 335, 336, 344, 345, 435, 449). They indicate settlement over this period in this area.

7.4.35 In the A13 junction section of the Project, and the surrounding study area, there are 39 listed buildings, 5 scheduled monuments and 1 conservation area. One of the scheduled monuments, the cropmark complex at Orsett (SM1), is within the Development Boundary and the designated area straddles the A13 corridor. This asset is also on the Heritage at Risk Register. The cropmarks are complex and indicate a background of relict field and river systems with enclosures of possible Romano-British date. They also include 'ring ditches' that may

represent ploughed-out barrows. Several large pits are also identified. These pits may indicate the sites of early Saxon sunken-floored buildings.

7.4.36 Three of the scheduled monuments are within the study area outside the Development Boundary to the east of the Project; the Neolithic causewayed enclosure and Anglo-Saxon cemetery 500m ENE of Heath Place (SM6), the 'Springfield style' enclosure and Iron Age enclosures south of Hill House, Baker Street (SM7) and Bishop Bonner's Palace, Orsett (SM4). To the west of the Project are the Dene holes in Hangman's Wood (SM3). The Neolithic causewayed enclosure and Anglo-Saxon cemetery (SM6) and the 'Springfield style' enclosure and Iron Age enclosures south of Hill House (SM7) have been identified from cropmarks and comprise buried archaeological remains. Bishop Bonner's Palace (SM4) and the Dene holes in Hangman's Wood (SM3) consist of earthworks visible as banks and depressions in the ground.

7.4.37 There are 3 grade II listed buildings within the Development Boundary in this section: Thatched Cottage (LB58), 1 and 2 Grays Corner Cottages (LB89) and Murrells Cottages (LB96). Most of the listed buildings in this section of the Project are in and around Orsett. There are 16 listed buildings in Orsett conservation area, located in the centre of the village. There are a further 6 listed buildings around the edge of the village or in the area immediately surrounding it. The Church of St Giles and All Saints (LB135), located in the centre of the village, is grade I listed and Orsett House (LB47), located to the west of the village, is grade II* listed. The other 4 buildings in this area are grade II listed.

7.4.38 In Baker Street, to the west of Orsett and immediately east of the Development Boundary, there are 6 grade II listed buildings. The other listed buildings in this section are all grade II and located in more isolated locations. They comprise farmhouses, cottages and barns.

7.4.39 In addition to the scheduled cropmarks, there are other areas of non-designated cropmarks recorded in the Development Boundary in this section. They appear to represent later prehistoric features such as trackways, field systems, pits, enclosures and a ring ditch (20, 27, 28, 33, 109, 194, 215), indicating that activity during this period occurred across this area.

7.4.40 Within the study area associated with the Ockendon link section of the Project there are 10 grade II listed buildings, 1 grade I listed building and 2 scheduled monuments. None of these are located within the Development Boundary. Three of the listed buildings are in South Ockendon, including the grade I listed Church of St Nicolas (LB36). The other listed buildings include a former gateway at Groves Barns (LB64), located to the north of the Development Boundary, the moat bridge and gatehouse at South Ockendon Old Hall (LB65), located to the south west of the Development Boundary, farmhouse, barn and granary at Great Mollands (LB97, LB63, LB43) and 3 farmhouses located to the east of the Development Boundary (LB188, LB216, LB210).

7.4.41 The 2 scheduled monuments are to the south west of the Development Boundary These are a Roman barrow (SM12) and the moat and gatehouse of South Ockendon Old Hall (SM2). This scheduling covers a larger area than the listed bridge and gatehouse (LB65).

7.4.42 Non-designated cropmarks of a moated site (178) are located to the south of the Development Boundary in this section, to the west of the scheduled moated site at South Ockendon Old Hall. Within the Development Boundary in this section there is the site of a Romano-British cremation (682), evidence of ridge and furrow (61), an area of possible prehistoric enclosure, pit and ditch (265) and a ditch (380).

7.4.43 In the section of the Project where the Project route joins the M25 and the M25 junction 29 there are 46 listed buildings, 2 registered parks and gardens, 1 scheduled monument and 4 conservation areas. a small area of the north west part of North Ockendon conservation area is within the Development Boundary, but none of the other designated heritage assets are located within the Development Boundary in this section of the Project. The grade II listed Warley Place registered park and garden (RPG2) is located at the northern edge of the 1km study area and the asset is also designated as a conservation area.

7.4.44 Most of the listed buildings are located within the other conservation areas: North Ockendon, Cranham and Great Warley. There are 8 listed buildings in North Ockendon conservation area. These are grade II listed except for the Church of St Mary Magdalen which is grade I listed. The garden walls to the former North Ockendon Hall (LB82) are on the Heritage at Risk Register.

7.4.45 There are 4 grade II listed buildings in the centre of Cranham conservation area. The small central settlement is surrounded by a large area of farmland and woodland, which is included within the conservation area. The garden walls at Cranham Hall (LB68) are on the Heritage at Risk Register.

7.4.46 There are 9 listed buildings in Great Warley conservation area and a further 9 nearby, to the west and south of it. The listed buildings within the conservation area are grade II listed, except for Two Door Cottage (LB141) which is grade II* listed. The Church of St Mary the Virgin (LB142), located to the south of the conservation area, is grade I listed and the lych gate to the church (LB149) is grade II* listed. The other buildings in this area are grade II listed.

7.4.47 The other listed buildings in the study area of this section are predominantly located in rural areas and are farmhouses and agricultural buildings. The majority are grade II listed, but Great Tomkyns house (LB140) and its barn to the north-east (LB177) are grade II* listed. Two grade II listed buildings, a barn and stable block to the north of the former Broadfields Farmhouse (LB109) and Franks Farmhouse (LB115), are located close to the western edge of the Development Boundary adjacent to the M25.

7.4.48 To the west of the M25 junction 29 are the grade II* listed Upminster Hall (LB233), the scheduled medieval grange barn (SM18) to the north of the Hall, the grade II listed Upminster Court registered park and garden (RPG3) and the 3 grade II listed buildings within the park and garden (LB232, LB235, LB237).

7.4.49 Non-designated cropmarks representing a possible round barrow, ring ditch, mound, linear feature and pit (186, 361) are located within the Development Boundary at the southern end of this section. There is also the recorded site of a medieval – post-medieval settlement (191, 192) near the possible round barrow and evidence for possible early medieval agriculture (594) and an oval enclosure of unknown date (611) in this area.

Future baseline

7.4.50 The future baseline of heritage assets in the Development Boundary and study area would be expected to remain in the same condition as at present without the implementation of the Project. If there were no development or changes in land use, then the condition of any buried archaeological remains would remain as they are currently for an indefinite period within areas of pasture. Within arable fields, it is possible that they may suffer a slow deterioration, given the impacts of the periodic deep-ploughing regime. Equally, features of the historic landscape would remain in their current condition if there were no changes in land use or management regime. In the case of built heritage assets, they would be more susceptible to slow deterioration in their condition, without regular maintenance. However, if they were maintained then they too would be expected to remain in their current condition for an indefinite period.

7.4.51 Climate change or unusual weather events could change the condition of any heritage asset. For example, a change in water table could change the conditions of buried archaeological remains. If this were a change from wet to dry, then any preserved organic material would deteriorate very quickly. If the change were from dry to wet this could also cause a deterioration in condition.

7.5 Further baseline information and surveys required

7.5.1 Archaeological walkover, designated asset setting survey and building conservation surveys are in progress.

7.5.2 The archaeological walkover survey has covered approximately 60% of the Development Boundary and a 50m study area surrounding it. Volume 11, Section 3, Part 2, Chapter 5 of *DMRB* states that walkover should be undertaken of the site or route. A small study area has been applied to ensure coverage for small changes in the Development Boundary. The survey will continue to address any gaps as the design of the Project develops. This survey identifies any unrecorded heritage assets that can be identified from above-ground evidence, the condition and above-ground visibility of recorded heritage assets, identifies/confirms the presence of historic landscape features and the current ground conditions, including evidence for disturbance or made ground, through a visual inspection of the above-ground remains. This informs assessment of the potential for unknown archaeological assets to be present.

7.5.3 The setting survey has focused on designated heritage assets within the Development Boundary and a 1km study area surrounding it. It includes some assets outside this study area where there is potential for the Project to affect the asset's significance through impacts on its setting. These assets were identified through comparison with the ZTV, consultation and a consideration of the characteristics of the assets. The purpose of this survey is to determine the nature and extent of an asset's setting, to inform an assessment of the degree to which the setting contributes to its significance, if at all.

7.5.4 Condition information is being collected for all designated buildings within the Development Boundary and a 100m study area surrounding it. This survey is an initial condition assessment of the exteriors of structures that may experience direct or indirect physical impacts to their fabric because of their proximity to the Project. This information will be used to inform the decision on where and

whether more detailed building surveys are required, once more detailed design and construction information is available.

7.5.5 The results of these surveys will be presented in full in the DBA and assessed in the ES.

7.5.6 In addition to this, a range of specialist analysis and survey techniques will be used to inform the understanding of the nature and significance of heritage assets that could experience impacts from the Project. These are:

a. An aerial mapping study, consisting of rectification of historic aerial photographs and an analysis of LiDAR data. This study will complement the existing National Mapping Programme data (a 1980s and 1990s aerial mapping study carried out with more basic techniques). The new study will cover the Development Boundary and a surrounding study area and will identify buried archaeology in detail in areas where non-intrusive geophysical survey has proven unreliable. The study will also identify relict palaeochannels within floodplain environments. The LiDAR images will also define areas where alluvial soils may mask buried historic landscapes.

b. Geophysical survey, using a range of appropriate techniques for the geological conditions and overhead power lines in each area.

c. Geoarchaeological assessment, incorporating results of geotechnical ground investigation and heritage-specific investigations. This will cover both the terrestrial and marine environment.

d. Trial trenching, to be informed by the results of the aerial photographic rectification and LiDAR analysis and, in part, by geophysical survey. Potentially significant archaeological features will be targeted to test reliability of other assessment methodologies in the specific area and provide further details about the nature of any identified assets. Areas apparently 'sterile' in terms of archaeological features according to the desk-based and non-invasive surveys will be investigated using a trench-sample percentage approach. Access to carry out trial trenching is subject to agreement with landowners.

e. An HLC study, which will make use of previous Project-specific historic landscape studies. There is no single, fixed methodology for this process. The Project will use the guidance on historic landscape character presented in the *DMRB* Volume 11 (Environmental Assessment) Section 3, Part 2, HA 208/07, Annex 7: Cultural Heritage Sub-Topic Guidance, Historic Landscape. The methodologies employed for non-road schemes, such as the *Hoo Peninsula Historic Landscape Project* (Historic England, 2013) will be examined for further guidance, where appropriate. The study will aim to establish:

i. the 'time-depth' profile of the landscape ie, how long it has been subject to human activity

ii. past landscape change and land use

iii. the chronology and process of land enclosure

iv. the present and future land use (Project impact)

f. Palaeolithic period assessment, focusing on the potential for currently unknown assets of this date to be present.

7.5.7 The Project will seek to agree the scope of all surveys and assessments through consultation with heritage stakeholders. The results of these assessments will be presented in the ES and included in the assessment.

7.5.8 There are also further sources of desk-based information that will be obtained to inform the assessment and will be presented in the DBA. These are listed in Table 7.5.

Table 7.5 Type and source of baseline information to be obtained

Baseline information	Source
Information regarding past archaeological investigations	London Archaeological Archive and Research Centre
British Geological Survey borehole and geological data	British Geological Survey
2011 Aggregates Levy Sustainability Fund resource study	London Borough of Havering and Museum of London Archaeology
Aerial photographs	Historic England Archive, Essex and Kent County Councils and Cambridge Air Photos, if available
Victoria County Histories	British history online
Local authority planning documents regarding non-statutory designations for historic landscape	Gravesham Borough Council, Thurrock Unitary Authority, London Borough of Havering, Brentwood Borough Council

7.6 Potential effects and mitigation measures

7.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. It should be noted that this assessment is ongoing and is subject to change through ongoing development of the Project proposals. The mitigation currently proposed is based on available validated data and professional judgement.

7.6.2 A full detailed assessment will be undertaken before Development Consent Order application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will be set out in the ES.

Construction - south of River Thames

Table 7.6 Effects and mitigation of key heritage assets south of the River Thames

Item	Description
Receptor	Non-designated heritage assets within the Development Boundary
Potential nature of effect	Construction works would cause direct physical impacts to buried archaeological remains likely to result in partial or complete removal of the asset, depending on its precise location and the nature of construction works. This would have a negative effect on the impacted assets, which in most cases is unlikely to be significant following mitigation.
Likely duration	Permanent
Potential mitigation	Written Scheme of Investigation to be prepared in advance of enabling and construction works which will set out the methods for archaeological investigation and recording. This would be carried out, where appropriate, to mitigate physical impacts through the principle of 'preservation by record'.
Receptor	Crutches Gate Cottage and Farmhouse (LB126), Knights Place Farmhouse (LB180), Chapel Farmhouse (LB3), Orchard House (LB4), The George Inn (LB29), Corner Cottage (LB101), Church of St Margaret, Ifield (LB106), listed buildings grade II
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance, through construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the assets. However, given the existing road infrastructure along the A2 and at the M2 junction 1, these impacts are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including consideration of screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Cobham Hall registered park and garden (RPG1), grade II*
Potential nature of effect	Asset located within Development Boundary, potential for direct physical impacts along the northern edge of asset. Potential for changes to aspects of the asset's setting that contribute to its significance through construction activity, increase in road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the asset. Due to the small proportion of the asset that would be affected by physical impacts and the comparatively small change from the current setting this is unlikely to be significant.

Item	Description
Likely duration	Physical impacts would be permanent. Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	Written Scheme of Investigation to be prepared in advance of enabling and construction works which will set out the methods for archaeological investigation and recording. This would be carried out, where appropriate, to mitigate physical impacts through the principle of 'preservation by record'. CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Parish Boundary Stone (LB105), listed building grade II
Potential nature of effect	Asset located within Development Boundary, potential for direct physical impacts to the asset. Potential for changes to aspects of the asset's setting that contribute to its significance, through construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the asset. The potential for both physical impacts and impacts arising from changes to the asset's setting mean that these impacts are potentially significant.
Likely duration	Physical impacts would be permanent. Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, in this instance including removal of the asset from its current location and replacement in a suitable nearby location following completion of construction works to avoid any physical impacts. The CoCP would also consider screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Cobham Hall (LB122) grade I, The Temple at Cobham Hall (LB123) grade II, The Engine House at Cobham Hall (LB79) grade II, The Aviary at Cobham Hall (LB175) grade II, The Dairy at Cobham Hall (LB176) grade II*, The Mausoleum at Cobham Hall (LB189) grade I, The Mount (LB31), grade II, Bowl Barrow in Ashenbank Wood south of Cobham Park reservoir (SM8), Romano-British Villa and 19th century reservoir in Cobham Park (SM10) scheduled monuments, Cobham conservation area and listed buildings within the conservation area, Chestnut Green conservation area and listed buildings within the conservation area, Shorne conservation area and listed buildings within the conservation area.

Item	Description
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance, through construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the assets. However, given the distance to the Project and intervening woodland these are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Thong conservation area and White Horse Cottage (LB22), listed building grade II
Potential nature of effect	Changes to aspects of the assets' setting that contribute to their significance through construction activity, introduction of new road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the assets, which have the potential to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.

Construction – tunnels

Table 7.7 Effects and mitigation of key heritage assets for tunnels

Item	Description
Receptor	Non-designated heritage assets within the Development Boundary
Potential nature of effect	Construction works would cause direct physical impacts to buried archaeological remains, which would likely result in partial or complete removal of the asset, depending on its precise location and the nature of construction works. Indirect impacts resulting from changes in ground water levels because of the Project could affect the preservation of buried archaeological remains, potentially resulting in the deterioration of their condition. In this section of the Project, buried remains will include buried gravel deposits which could contain prehistoric (Palaeolithic) archaeological material. If construction of a jetty is required, then there is potential for impacts to archaeological remains located in the intertidal and riverine area. These impacts would have a negative effect on the impacted assets, which in most cases are unlikely to be significant following mitigation.

Item	Description
	If scour protection is required within the river over the main tunnel section of the Project this could impact currently unknown archaeological and palaeoenvironmental remains. If scour protection is required the potential effects will be fully assessed in the ES.
Likely duration	Permanent
Potential mitigation	Written Scheme of Investigation to be prepared in advance of enabling and construction works which will set out the methods for archaeological investigation and recording. This would be carried out, where appropriate, to mitigate physical impacts through the principle of 'preservation by record'.
Receptor	Church of St Mary (LB27), listed building grade II*
Potential nature of effect	Potential for changes to aspects of the asset setting that contribute to its significance through construction activity, introduction of new road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the asset, which have the potential to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Filborough Farmhouse (LB25), East Court Farmhouse (LB28), Granary at Little Filborough Farm (LB30), Barn to North West of Filborough Farmhouse (LB99), listed buildings grade II
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance are through: construction activity, introduction of new road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the assets but, given the distance to the Project, these are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	54-58 Vicarage Lane (LB23), Readers (LB24), 1 Chalk Road (LB26), 44 Chalk Road (LB100), The Old Forge (LB102), listed buildings grade II
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance are through: construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the assets. However, given the distance to the Project and the intervening urban landscape these are unlikely to be significant.

Item	Description
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Tilbury Fort (SM13), Gravesend Blockhouse (SM16), New Tavern Fort, Gravesend, including Milton Chantry (SM17) scheduled monuments
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance are through: construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the assets. However, there would be no changes to the visible relationship between the assets, which is a key element of their settings which contributes to their significance. This, along with the distance to the Project and the intervening urban or industrial landscape, means that impacts are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Coalhouse Fort Battery and Artillery Defences (SM14) scheduled monument
Potential nature of effect	Potential for changes to aspects of the asset setting that contribute to its significance are through: construction activity, introduction of road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the asset, that may be significant during construction. However, there would be no changes to the visible relationship between this asset and other key assets that inform its setting and also contribute to its significance (Cliffe Fort and Shornemead Fort on the southern bank of the river). The intervisibility between this asset and Tilbury Fort would also be unaffected, as the Project in the intervening area consists of the tunnel and north portal which would not constitute large above-ground structures. This, along with the distance to the Project, means that impacts overall are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.

Item	Description
Receptor	Cliffe Fort (SM15) scheduled monument, Shornemead Fort non-designated asset
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance are through: construction activity, introduction of road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the assets. However, there would be no changes to the visible relationship between the assets or with Coalhouse Fort (SM14) on the north bank of the river, which is a key element of their settings which contribute to their significance. This, along with the large distance to the Project, means that impacts are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.

Construction – north of River Thames

Table 7.8 Effects and mitigation of key heritage assets north of the River Thames

Item	Description
Receptor	Non-designated heritage assets within the Development Boundary
Potential nature of effect	Construction works would cause direct physical impacts to buried archaeological remains likely to result in partial or complete removal of the asset, depending on its precise location and the nature of construction works. Indirect impacts resulting from changes in ground water levels because of the Project could affect the preservation of buried archaeological remains, potentially resulting in the deterioration of their condition. In this section of the Project buried remains will include buried gravel deposits which could contain prehistoric (Palaeolithic) archaeological material. These impacts would have a negative effect on the impacted assets, which in most cases is unlikely to be significant following mitigation.
Likely duration	Permanent
Potential mitigation	Written Scheme of Investigation to be prepared in advance of enabling and construction works which will set out the methods for archaeological investigation and recording. This would be carried out, where appropriate, to mitigate physical impacts through the principle of 'preservation by record'.
Receptor	Second World War Anti-Aircraft Battery at Bowaters Farm (SM9) scheduled monument

Item	Description
Potential nature of effect	Potential for changes to aspects of the asset setting that contribute to its significance, through construction activity, introduction of road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the asset. There would be no changes to the visible relationship between the asset and Coalhouse Fort (SM14) and East Tilbury Battery (SM11), which is a key element of its setting that contributes to its significance. However, the proximity of the Project means that the impact may be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	East Tilbury Battery (SM11) scheduled monument
Potential nature of effect	Potential for changes to aspects of the asset setting that contribute to its significance, through construction activity, introduction of road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the asset. However, there would be no changes to the visible relationship between this asset and Coalhouse Fort (SM14) or the Second World War Anti-Aircraft Battery at Bowaters Farm (SM9), which is a key element of its setting that contributes to its significance. This, along with the distance to the Project, means that impacts are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	East Tilbury conservation area and listed buildings within the conservation area, West Tilbury conservation area and listed buildings and scheduled monument within the conservation area, Causewayed enclosure and Anglo-Saxon cemetery 500m east-north-east of Heath Place (SM6) scheduled monument, Whitecrofts Farmhouse (LB37), Heath Cottage (LB40), Heath Place (LB41), Thatched Barn at Whitfields (LB52), Whitfields (LB60), The Wilderness (LB53), Mill House (LB56), Baker Street Windmill (LB57) listed buildings grade II, North Ockendon conservation area and listed buildings within the conservation area, Barn and stable block to the north of Broadfields Farmhouse (LB109), Franks Farmhouse (LB115) listed buildings grade II
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance through construction activity, introduction of new road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the assets, which have the potential to be significant given the proximity of the Project.

Item	Description
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Dene holes in Hangman's Wood (SM3) scheduled monument, Street Farmhouse (LB32), Royal Oak Inn (LB95) listed buildings grade II, Church of St Nicholas (LB36) listed building grade I, Upminster Court registered park and garden (RPG3), Medieval grange barn south east of Upminster Court (SM18) scheduled monument, Upminster Hall (LB233) listed building grade II*, Upminster Court (LB235), Entrance piers and gates to Upminster Court (LB232), Stable block at Upminster Court (LB237) listed buildings grade II
Potential nature of effect	It is unlikely that there would be any change to the assets' setting because of the construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage for the Project. This is because of the large distance to the Project and the intervening urban landscape.
Likely duration	No effect anticipated.
Potential mitigation	Not applicable.
Receptor	Thatched Cottage (LB58), listed building grade II, 1 and 2 Grays Corner Cottages (LB89), listed building grade II, Murrells Cottages (LB96), listed building grade II
Potential nature of effect	Assets located within Development Boundary, direct physical impact to historic building fabric would result in complete removal of the assets. This would have a negative effect on the asset, which would be significant.
Likely duration	Permanent
Potential mitigation	Written Scheme of Investigation to be prepared which will set out the methods for comprehensive historic building recording. This would be done to mitigate physical impacts through the principle of 'preservation by record'.
Receptor	Orsett Crop Mark Complex (SM1), scheduled monument
Potential nature of effect	Asset located within Development Boundary, direct physical impact to buried archaeological remains likely to result in removal of a significant proportion of the asset. This would have a negative effect on the asset, which would be significant.
Likely duration	Permanent
Potential mitigation	Written Scheme of Investigation to be prepared which will set out the methods for archaeological investigation and recording. This would be carried out to mitigate physical impacts through the principle of 'preservation by record'.

Item	Description
Receptor	Greygoose Farmhouse (LB38), Little Wellhouse (LB67), Kemps (LB51), Kemps Cottage (LB86), Tylers Hall Farmhouse (LB116), Timber framed range of weatherboarded outbuildings to Tylers Hall Farmhouse (LB139) listed buildings grade II
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance through construction activity, introduction of new road infrastructure, noise and visibility of associated lighting and signage. These impacts would have a negative effect on the assets. However, given the existing road infrastructure at the A13/A1089 junction and the M25 these impacts are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.
Receptor	Old Rectory (LB128), Waltons Hall (LB203), Sutton's Farmhouse (LB204), Turners Farm (LB212), Weatherboarded barn at Waltons Hall (LB217) listed buildings grade II, Church of St Katherine (LB169) listed building grade I, Orsett conservation area and listed buildings within the conservation area, Springfield style enclosure and Iron Age enclosures south of Hill House, Baker Street (SM7), Bishop Bonner's Palace, Orsett (SM4), Gatehouse and moat of South Ockendon Old Hall (SM2), Roman barrow 260m north-east of South Ockendon Hall (SM12) scheduled monuments, Moat Bridge and Gatehouse at South Ockendon Hall (LB65), Former gateway at Groves Barns (LB64) listed buildings grade II, Cranham conservation area and listed buildings within the conservation area, Great Warley conservation area, listed buildings within the conservation area, Warley Park registered park and garden (RPG2)
Potential nature of effect	Potential for changes to aspects of the assets' setting that contribute to their significance, through construction activity, introduction of additional road infrastructure, noise and visibility of associated lighting and signage. These impacts may have a negative effect on the assets. However, given the distance to the Project these are unlikely to be significant.
Likely duration	Changes to setting would be temporary during construction but would continue into operation as permanent effects, at which point they would change in nature and potentially reduce in magnitude.
Potential mitigation	CoCP to set out methods to minimise impacts from construction activity, including considering screening where appropriate. Landscape design to provide visual screening of the completed Project from these receptors where possible.

Operation

7.6.3 There will be no additional impacts to any heritage assets during the operation phase of the Project. The impacts during this phase will comprise impacts to the setting of heritage assets, which are discussed above and will continue beyond construction. The nature of the impacts may change from construction to

operation. For example, disturbance from construction compounds and machinery will come to an end, but there could be ongoing disturbance from traffic and lighting. Any potential impacts in the operational phase are likely to reduce in magnitude following the removal of large construction machinery and construction compounds, and the greater distance from assets to the route alignment, rather than the edge of temporary land take within the Development Boundary.

7.6.4 In developing the environmental design for the Project, consideration is being given to the location of any existing heritage assets in relation to the Project and where possible screening vegetation and earthworks are proposed to mitigate any potential environmental effects. For example, the principles of the landscape design of the A2 junction are being developed to minimise any impacts on the setting of Thong Conservation Area. Further information on the proposed approach is provided in Chapter 8 Landscape and Figure 2.4 in Volume 3. The environmental design will be developed further as a result of ongoing design work and consultation, and to reflect ongoing environmental assessment work, and could include further elements such as noise attenuation where required.

7.6.5 Due to the nature of buried archaeological deposits and built heritage, physical impacts experienced during the construction phase will not reoccur, as the asset will no longer exist following excavation or demolition. No further impacts will, therefore, be possible during the operation phase.

Chapter 8.

Landscape

8 Landscape

8.1 Introduction

8.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects relating to landscape and visual amenity for the Project.

8.1.2 Under its licence, Highways England is required to act in a manner which minimises the environmental impacts of the network and seek to protect and enhance the quality of the surrounding environment. Highways England is required to ensure that protection and enhancement of the environment is embedded in its business decision-making processes. It should also have due regard to the principles and guidance on good design to ensure that development takes account of geographical, environmental and socio-economic context.

8.1.3 Highways England have consulted with the Design Review Panel and recognise the range of potential effects that a new piece of infrastructure will have on residents and places but also that it presents opportunities to positively contribute to local people and the landscape.

8.1.4 The importance and value of our landscape is recognised by the European Landscape Convention (ELC) which came in to effect in March 2007. This treaty recognises the importance of landscape not just in terms of its scenery or backdrop, but because it links culture with nature, and past with present. The treaty provides the following definition:

"Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors."

8.1.5 The ELC identifies the following reasons why landscape is of vital importance:

a. "Landscape is everywhere: Landscape provides a setting to people's lives, both physically and through memories and associations.

b. Landscape is the product of human history. It is the meeting ground between natural and cultural influences. It is constantly changing in response to a myriad of different decisions.

c. Landscape defines identity and sense of place: it is central to defining, national, regional, local and personal identity. Differences in landscape character play on all our senses – sight, hearing, smell and taste – day and night and through the seasons.

d. Landscape is imbued with personal values: it inspires and can take on spiritual values. These values change and evolve.

e. Landscape provides a sense of continuity: despite change it provides continuity in people's lives, linking the past with the present and the future.

f. Landscape provides a wide range of benefits: it provides goods and services essential for human survival and well-being."

8.1.6 The aims of this chapter are to, in relation to landscape:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative/policy requirements, and describe how the Project will respond to them with regard to landscape

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on landscape character (and how these have been assessed for this *PEIR*

f. outline the potential effects of the Project on visual amenity, and how these have been assessed for this *PEIR*

g. describe potential mitigation measures

8.1.7 Additionally, there may be interrelationships between the potential effects on landscape and other disciplines, such as heritage, ecology and tranquility. See:

a. Chapter 7: Cultural Heritage

b. Chapter 9: Terrestrial Biodiversity

c. Chapter 13: Noise and Vibration

d. Chapter 14: People and Communities

8.2 Planning policy and legislative requirements

Legislative requirements

8.2.1 The legislation applicable to the landscape assessment of the Project is presented in Table 8.1.

Table 8.1 Summary of legislative requirements

Legislation name	Summary of requirements
National Parks and Access to the Countryside Act 1949	Sets out the legislative framework for the designation and protection of our nationally designated landscapes and

	includes the Kent Downs Area of Outstanding Natural Beauty (AONB).
Wildlife and Countryside Act 1981	Sets out the legislative framework for the designation and protection of our nationally designated landscapes and includes the Kent Downs AONB.

National Policy Statement for National Networks

8.2.2 The relevant policies contained in the NPSNN for the landscape assessment of the Project are presented in Table 8.2 below:

Table 8.2 NPSNN requirements and Project response

Requirement	Project response
Paragraph 5.144: "The need to consider the likely significant effects on the landscape and townscape resource, and visual amenity."	The landscape chapter of the Environmental Statement (ES) will set out the likely significant effects of the Project on landscape, townscape and visual amenity.
Paragraph 5.144: Documents referred to include: • *Guidelines for Landscape and Visual Impact Assessment*, 3rd Edition, April 2013; • Natural England profiles for National Character Areas; • Reference to any landscape character assessment and associated studies; • Relevant local development plans and policies.	The ES assessment will consider the following documents: • *Design Manual for Roads and Bridges (DMRB)* Volume 11, Section 3, Part 1 and associated Interim Advice Notes (IAN) are the guidance documents used when assessing the impacts of road schemes • *Guidelines for Landscape and Visual Impact Assessment*, 3rd Edition, April 2013 • Natural England profiles for National Character Areas • Relevant local development plans and policies for Kent County Council, Gravesham Borough Council, Medway District Council, Essex County Council, Thurrock Borough Council, London Borough of Havering & Brentwood Borough Council.
Paragraph 5.145: The assessment should consider: • Significant effects during construction and operation on landscape components and landscape character (including historic landscape characterisation); • Visibility and conspicuousness of the project during construction and operation and potential impacts on views and visual amenity; and	The assessment of effects on the historic landscape will form part of the ES heritage assessment. However, the ES landscape assessment, when determining the value of the landscape resource, will consider the presence of cultural heritage assets as part of this process. The assessment of light pollution effects will be based on the Institution of Lighting Engineers (2005) *Guidance Notes on the Reduction of Obtrusive Light* guidelines which identify Environmental Zones that define the broad

Requirement	Project response
• Any noise, light pollution effects, including on local amenity, tranquility and nature conservation.	night-time characteristics of areas in terms of relative brightness or darkness. In addition, impacts on tranquility would consider the combined effects of traffic noise and visual intrusion for rural recreational receptors within and in the setting of the Kent Downs AONB and those adjacent to the Thames Estuary
Paragraph 5.146 states: • The assessment should include the visibility and conspicuousness of the project during construction and of the presence and operation of the project and potential impacts on views and visual amenity. This should include any noise and light pollution effects, including on local amenity, tranquility and nature conservation	The Landscape chapter of the ES will consider the effects of the Project on views and visual amenity. The key views for the assessment are considered in this chapter.
Paragraph 5.147 states: The applicant's assessment must comply with the following: • The duties in Section 11A of the National Parks and Access to the Countryside Act 1949; and • Section 85 of the Countryside and Rights of Way Act 2000	The Project interacts with the Kent Downs AONB at its north-western extent. The potential landscape and visual effects in respect of the Kent Downs AONB will form part of the ES which will support the Development Consent Order (DCO) application. The DCO application will be submitted to the Secretary of State (SoS) for a decision. In doing so the SoS will have regard to the purposes of conserving and enhancing the natural beauty of the AONB.
Paragraph 5.148 states that the applicant must fulfil the following requirements: • Defra's *English national parks and the Broads: UK Government Vision and circular* document or successor documents.	The Project interacts with the Kent Downs AONB at its north-western extent. The potential landscape and visual effects in respect of the Kent Downs AONB will form part of the ES which will support the DCO application.
Paragraph 5.149 requires the assessment to consider the following: • The nature of the existing landscape likely to be affected; • The nature of the effect likely to occur; • Designed carefully, having regard to siting, operational and other relevant constraints; and • Avoid or minimise harm to the landscape, providing appropriate mitigation.	The landscape assessment will consider well designed, practical and achievable mitigation measures to minimise the impacts of the Project on the character, visual amenity and tranquility of the Kent Downs AONB, London's Green Belt within Gravesham, Thurrock and London Borough of Havering as well as other areas of landscape adjacent to the Thames Estuary and Essex. The landscape assessment will consider, well designed, practical and achievable mitigation measures to minimise the impacts of the Project on the landscape character and visual amenity along its route which are of a high environmental standard.

Requirement	Project response
Regarding development proposed within nationally designated areas Paragraphs 5.150 to 5.155 apply. Paragraph 5.150 states: "Great weight should be given to conserving landscape and scenic beauty in nationally designated areas. National Parks, the Broads and Areas of Outstanding Natural Beauty have the highest status of protection in relation to landscape and scenic beauty. Each of these designated areas has specific statutory purposes which help ensure their continued protection and which the Secretary of State has a statutory duty to have regard to in decisions."	The Project interacts with the Kent Downs AONB at its north-western extent. The potential landscape and visual effects in respect of the Kent Downs AONB will form part of the ES which will support the DCO application.
Paragraphs 5.151 to 5.155: "The Secretary of State (SoS) should refuse development consent within these areas except in exceptional circumstances and where it can be demonstrated it is in the public interest. Consideration should include an assessment of; • Cost of and scope of developing outside the area; and • Any detrimental effect on the environment, the landscape and recreational facilities and the extent to which they can be moderated. • Need for the development and the impact on the local economy; "There is a strong presumption against any significant road widening or the building of new roads in an Area of Outstanding Natural Beauty unless it can be shown there are compelling reasons for the new or enhanced capacity and with any benefits significantly outweighing the costs; "Where consent is given in these areas the SoS should be satisfied that the applicant has ensured that the project shall be carried out to high environmental standards and where possible includes measures to enhance other aspects of the environment; "The duty to have regard to the purposes of the nationally designated area also applies when considering applications for projects outside the boundaries these areas which may have impacts on them; and "The fact a proposed project will be visible from within a designated area should not in itself be a reason for refusing consent".	The Project interacts with the Kent Downs AONB at its north-western extent. The potential landscape and visual effects in respect of the Kent Downs AONB will form part of the ES which will support the DCO application.

Requirement	Project response
Paragraph 5.157 states that the SoS should consider whether the Project: • Is designed carefully, having regard to siting, operational and other relevant constraints; and • Avoids adverse effects on landscape or minimises harm to the landscape, including by reasonable mitigation.	The landscape chapter in the ES will consider well designed, practical and achievable mitigation measures to minimise the landscape impacts of the Project which could be affected along its route.
Paragraph 5.158 states: • The SoS will have to judge whether the visual effects on sensitive receptors, such as residents, and other receptors such as visitors to the local area outweigh the benefits of the development.	The landscape chapter in the ES will include an assessment of the interrelated visual effects of the Project. This will consider well designed, practical and achievable mitigation measures to minimise the visual impacts of the Project on people at home and enjoying the countryside which could be affected along its route.
Paragraph 5.160 states: • Adverse landscape and visual effects may be minimised through appropriate siting of infrastructure, design (including choice of materials), and landscaping schemes; and • It may be appropriate to undertake landscaping off site, although if such landscaping is proposed to be consented by the development consent order, it would have to be included within the order limits of the application.	The landscape chapter in the ES will consider appropriate siting of structures and infrastructure (both temporary and permanent) as well as associated works to overhead powerlines and gas main diversions to minimise the impacts of the Project on the landscape character and visual amenity. Where good design requires landscape works to be relatively remote form the Project eg, hedgerow improvement, these will be included within the Order Limits for the Project.
Paragraph 5.161 states • Depending on the topography of the surrounding terrain and areas of population it may be appropriate to undertake landscaping off site, although if such landscaping was proposed to be consented by the development consent order, it would have to be included within the order limits for that application. For example, filling in gaps in existing tree and hedge lines would mitigate the impact when viewed from a more distant vista.	Initial measures for the Project are considering opportunities for landscape measures further afield to help reduce the visual impacts. These measures will need to be discussed and agreed with landowners to ensure that the long-term objectives of the Project are achieved.
Paragraph 5.164 states; • Green Belts, defined in a development plan, are situated around certain cities and large built-up areas. The fundamental aim of Green Belt policy is to prevent urban sprawl by keeping land permanently open; the essential characteristics of Green Belts are their openness and their permanence. For	The Project outside the Kent Downs AONB falls entirely within London's Green Belt.

Requirement	Project response
further information on the purposes and protection of Green Belt, see the National Planning Policy Framework.	

Planning policy requirements

8.2.3 The Planning Policy applicable to the landscape assessment of the Project is presented in Table 8.3.

Table 8.3 Summary of policy planning requirements

Policy name	Summary of requirements
National Planning Policy Framework (2012)	
7. Requiring good design	Paragraph 56. The government attaches great importance to the design of the built environment. Good design is a key aspect of sustainable development, is indivisible from good planning, and should contribute positively to making places better for people Paragraph 64. Permission should be refused for development of poor design that fails to take the opportunities available for improving the character and quality of an area and the way it functions.
9. Protecting Green Belt land	Paragraph 79. The government attaches great importance to Green Belts. The fundamental aim of Green Belt policy is to prevent urban sprawl by keeping land permanently open; the essential characteristics of Green Belts are their openness and their permanence.
11. Conserving and enhancing the natural environment	Paragraph 115. Great weight should be given to conserving landscape and scenic beauty in National Parks, the Broads and Areas of Outstanding Natural Beauty, which have the highest status of protection in relation to landscape and scenic beauty. The conservation of wildlife and cultural heritage are important considerations in all these areas, and should be given great weight in National Parks and the Broads Paragraph 116. Planning permission should be refused for major developments in these designated areas except in exceptional circumstances and where it can be demonstrated they are in the public interest. Consideration of such applications should include an assessment of: • the need for the development, including in terms of any national considerations, and the impact of permitting it, or refusing it, upon the local economy • the cost of, and scope for, developing elsewhere outside the designated area, or meeting the need for it in some other way • any detrimental effect on the environment, the landscape and recreational opportunities, and the extent to which that could be moderated Paragraph 125. By encouraging good design, planning policies and decisions should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Policy name	Summary of requirements
Thurrock Council	
PMD4 Historic Environment	This policy will be dealt with in Chapter 7: Cultural Heritage but is useful in helping to understand the value and importance attached to the landscape.
PMD5 Open Spaces, Outdoor Sports and Recreational Facilities	This policy will not be specifically dealt with in this chapter, but it is useful in helping to understand the importance and value attached to the links which connect the landscape and the visual experience of people using them.
PMD6 Development in the Green Belt	Thurrock recognises the Green Belt as an area for opportunities to retain and enhance landscapes and visual amenity and to improve damaged and derelict land.
CSTP18 Green Infrastructure	This policy will not be specifically dealt with in this chapter, but it is useful in helping to understand the importance and value attached to the links which connect the landscape and the visual experience of people using them. This policy includes Hoford Road (Protected Lane) and the landscape in the north west which falls within Thames Chase community forest.
CSTP20 Open Space	This policy will not be specifically dealt with in this Chapter, but it is useful in helping to understand the importance and value attached to the open spaces located at the urban edge and which contribute to the landscape and the visual experience of people using them.
CSTP23 Thurrock Character and Distinctiveness	This policy needs development to respond to landscape character, landscape quality and sense of place and to retain, enhance and protect important landscape features as well as strategic and local views. Further information on landscape character is set out in: Thurrock Council landscape capacity study, March 2005 and Land of the Fanns Landscape Character Assessment August 2016.
CSPT24 Heritage Assets and the Historic Environment	This policy will be dealt with by Chapter 7: Cultural Heritage of the *PEIR* but is useful in helping to understand the value and importance the heritage assets contribute to the landscape.
London Borough Havering	
Policy 27 Landscaping	This policy requires the landscape proposals for development to take account of landscape character and setting and to retain, enhance and protect important landscape features. Further information on landscape character is provided in: Land of the Fanns Landscape Character Assessment August 2016.
Policy 29 Green Infrastructure	This policy will not be specifically dealt with in this chapter, but it is useful in helping to understand the importance and value attached to the open spaces located at the urban edge and which contribute to the landscape and the visual experience of people using them.
Brentwood Borough Council	
C5 Retention and Provision of Landscaping and Natural Features in Development	Brentwood Borough Council recognises the importance of retaining existing landscape features within development as it helps to soften the built form, provides maturity and is beneficial for wildlife.

Policy name	Summary of requirements
C6 Tree Preservation Orders and Works to Preserved Trees	Brentwood Borough Council recognises the value trees can contribute, either individually or collectively for the visual amenity of an area and their historic value.
C7 Development Affecting Preserved Trees, Ancient Woodlands and Trees in Conservation Areas	Brentwood Borough Council will oppose the removal of such trees unless the development benefits outweigh the amenity or nature conservation value of the tree.
C8 Special Landscape Areas	This policy refers to areas where the conservation or restoration of existing landscape character will be given high priority.
C11 Thames Chase community forest	Brentwood Borough Council attaches great importance to the Community Forest area. Development will be assessed against their impact and contribution towards the successful implementation of the Thames Chase Plan.
C12 Landscape Improvements	The landscape to the SE of M25 junction 29 is a landscape improvement area. The council expect development to contribute positively towards the restoration of the area's original character.
GB1 New Development in the Green Belt	Brentwood Borough Council attaches great importance to the function provided by the Metropolitan Green Belt.
GB28 Landscape Enhancement	This policy needs the landscape proposals for development to take account of landscape character and setting and to retain, enhance and protect important landscape features. Further information on landscape character is provided in: Land of the Fanns Landscape Character Assessment August 2016.
Gravesham Council	
Policy CS12 Green Infrastructure	Landscape character and valued landscapes will be conserved, restored and enhanced. Greatest weight shall be given to the conservation and enhancement of the landscape and natural beauty of the Kent Downs AONB.
Policy CS19 Development & Design Principles	This policy requires new development to be visually attractive, fit for purpose and locally distinctive.
Policy CS20 Heritage	This policy will be dealt with in Chapter 7: Cultural Heritage of the *PEIR* but is useful in helping to understand the value and importance the heritage assets contribute to the landscape.
Medway Council	
BNE6 Landscape Design	This policy requires major developments to provide designs which enhance the character of the locality and should consider: • a structured, robust, attractive and maintainable environment • planting appropriate to the location • retaining important landscape features • providing wildlife benefit
BNE25 Development in the Countryside	This policy requires development in the countryside to maintain and enhance the character and amenity and functioning of the countryside.

Policy name	Summary of requirements
BNE30 Metropolitan Green Belt	Medway Council attaches great importance to the function provided by the Metropolitan Green Belt that covers areas to the west of Medway. The designation has retained a strategic gap between Strood and Gravesend and prevented the coalescence of Strood and Higham.
BNE32 Areas of Outstanding Natural Beauty	The highest protection will be given to the Kent Downs AONB to conserve and enhance its natural beauty, including the consideration of potential impact on its setting. The local character, qualities and distinctiveness of the Kent Downs AONB will be conserved and enhanced in the design, scale, setting and materials of new development
BNE33 Special Landscape Areas	In Medway there are two Special Landscape Areas, the North Downs and the North Kent Marshes, with the former being contiguous with the Kent Downs AONB. The council will aim to protect the natural beauty of these areas. Development which undermines this aim will only be considered if significant social or economic benefits would result.
Kent Downs AONB Management Plan 2014-2019	
The special characteristics and qualities of the AONB	The plan sets out the following special characteristics and qualities of the AONB: • Dramatic landform and views • Biodiversity-rich habitats • Farmed landscape • Woodland and trees • A rich legacy of historic and cultural heritage • Geology and natural resources
Access, enjoyment and understanding	The plan attaches great importance to access for all, health and well-being, education, interpretation and information.
Draft Setting Position Statement	The Kent Downs AONB attaches great importance to the setting of the AONB and considers the setting to be: “the land outside the designated area which is visible from the AONB and from which the AONB can be seen, but may be wider when affected by intrusive features beyond that.” In regard to the Kent Downs, features such as dry valleys, woodlands pastoral scenery, parklands, villages and churches, are important aspects of its setting.

8.3 Methodology

8.3.1 This chapter outlines the findings of the work undertaken to date and provides initial thoughts on the potential impacts of the Project on the landscape as an entity and on visual amenity. The latter is the interrelated, but separate, assessment of the visual experience of people who live nearby or who visit the area, and for people who experience the countryside for recreational purposes.

8.3.2 This chapter also considers initial mitigation measures which are shown in the Outline Environmental Masterplan (EMP) (see Figure 2.4 in Volume 3).

8.3.3 The work to-date and the findings set out in this chapter have been carried out in accordance with the *Design Manual for Roads and Bridges* (*DMRB*) and Interim Advice Note (IAN) 135/10 Landscape.

8.3.4 To identify the study area for the Project effects, it is important to identify the extent to which it could be visible. This is done by preparing either a Zone of Visual Influence (ZVI) or a Zone of Theoretical Visibility (ZTV). The former is more detailed because it is based on available light detecting and ranging (LiDAR) data and takes account of vegetation and buildings as well as ground contours. The latter is based solely on digital terrain modelling ground contours only.

8.3.5 A detailed study area extending up to 2km on either side of the proposed Project route centre-line is considered appropriate, (based on the ZVI) indicated on Figure 8.1 in Volume 3 and from site surveys carried out in winter 2017/2018. It is anticipated that this will be the extent to which potential significant landscape and visual effects are likely to occur. To verify this, a ZTV has also been prepared for a wider 5km study area which is shown on Figure 8.2 in Volume 3.

8.3.6 This chapter sets out the importance and value attached to the landscape receptors through designation or local recognition. It also identifies the characteristics and features which define the landscape resource and the visual amenity experienced by people.

8.3.7 Baseline landscape and visual amenity information has been gathered from publicly available publications commissioned by Natural England, the Kent Downs AONB Unit, Kent County Council, Essex County Council, Gravesham Borough Council, Medway Council, Thurrock Council, London Borough of Havering and Brentwood Borough Council.

Key landscape receptors

8.3.8 Landscape receptors are homogeneous areas of land which are made up of similar components such as landform, vegetation and land use, together with more experiential elements such as scale, pattern, tranquility and wildness. Typically, the elements which make up the landscape would be of a similar condition (ie, quality) although it is recognised that there would be localised variation. In addition, the landscape is recognised in terms of importance or value which is guided by known facts, such as local or national designations, historic and cultural aspects, local opinion or importance to the local community.

8.3.9 The landscape to the south of the Thames Estuary falls within either the nationally designated area of the Kent Downs AONB or within its setting. To the north of the Thames Estuary the landscape is not designated but is locally valued as an amenity, and for recreational purposes, situated at Greater London's urban edge.

8.3.10 The seascape of the Thames Estuary is set against a hinterland of flat marshland and rising chalk landscapes, with the immediate setting recognised for its military and biodiversity value.

8.3.11 The night-time landscape is presented in Figure 8.4 in Volume 3. The night-time landscape is characterised by the influence of the adjacent urban lighting, by floodlighting from sports facilities and street lighting from infrastructure routes

forming linear features in the night-time landscape. However, there are scattered remote locations within the Kent Downs AONB, along the Thames Estuary and Orsett Fen where dark night skies can still be appreciated.

8.3.12 Note that Green Belt is considered in this chapter in terms of its role as a planning designation and importance at the national level. The study area which falls outside the designated area of the Kent Downs AONB, and the built-up areas of Greater London's urban edge, falls within the Green Belt.

Key visual amenity receptors

8.3.13 Visual amenity receptors cover a range of types. These include occupiers of residential properties, users of Public Rights of Way (PRoW), visitors to recreational areas such as country parks, community parks, areas of Open Access Land, common land and heritage assets, people travelling, visitors to hotels and office workers. The identification of various categories of visual receptor (the viewer), and the assumed visual sensitivity of each, forms part of the visual baseline.

8.3.14 A selection of 54 key visual receptors have been identified as part of the desk based and field survey work with the 2km ZVI. Their locations are shown on Figure 8.5 in Volume 3, with the respective winter photographs shown in Figure 8.6 in Volume 3 and a description of each provided in Table 8.7 and Table 8.8 in this chapter.

8.3.15 Eleven of the key receptors were visited at night-time to give an indication of the ambient night-time lighting levels. The night-time photographs are provided in Figure 8.8 in Volume 3 and have been used to help inform the night-time lighting mapping shown on Figure 8.4 in Volume 3. The eleven receptors selected are:

a. Receptor S-01 (Viewpoint 2b) National Cycle Route 117, Park Pale overbridge (AONB)

b. Receptor S-08 (Viewpoint 6b) Jeskyns Community Woodland

c. Receptor S-09 (Viewpoint 7) PRoW, Thong conservation area

d. Receptor S-14 (Viewpoint 12) PRoW network between Gravesend & Shorne

e. Receptor S-18 (Viewpoint 17) Saxon Shore Way

f. Receptor N-05 (Viewpoint 21) Tilbury urban edge

g. Receptor N-09 (Viewpoint 25) East Tilbury

h. Receptor N-11 (Viewpoint 26) West Tilbury

i. Receptor N-16 (Viewpoint 31) Orsett Heath/Chadwell St Mary

j. Receptor N-21 (Viewpoint 36) Green Lane (PRoW)/Stifford Clays Road

k. Receptor N-34 (Viewpoint 44) B1421/B186, North Ockendon

8.3.16 Twelve of the views from the key visual receptors have been developed further with the Project overlaid on the photograph to give an impression of how the Project would sit in the view. The visualisations are also helpful to aid judgements on the potential changes the Project would have on the view with distance. These visualisations are provided in Figure 8.7 in Volume 3. The 12 receptors selected are:

a. Receptor S-01 (Viewpoint 2) National Cycle Route 117, Park Pale overbridge (AONB)

b. Receptor S-04 (Viewpoint 5) Timeball & Telegraph Trail LDP, Thong Lane overbridge (AONB)

c. Receptor S-08 (Viewpoint 6b) Jeskyns Community Woodland

d. Receptor S-09 (Viewpoint 7) PRoW, Thong Conservation Area

e. Receptor S-14 (Viewpoint 12) PRoW network between Gravesend & Shorne

f. Receptor S-18 (Viewpoint 17) Saxon Shore Way

g. Receptor N-05 (Viewpoint 21) Tilbury Urban Edge

h. Receptor N-09 (Viewpoint 25) East Tilbury

i. Receptor N-11 (Viewpoint 26) West Tilbury

j. Receptor N-16 (Viewpoint 31) Orsett Heath/Chadwell St Mary

k. Receptor N-21 (Viewpoint 36) Green Lane (PRoW)/Stifford Clays Road

l. Receptor N-294 (Viewpoint 44) B1421/B186, North Ockendon

8.4 Existing environmental conditions

8.4.1 Natural England has published National Character Area (NCA) profiles for 159 distinct natural areas across England. The NCAs describe the distinctive characteristics of each area and identify opportunities for positive environmental change through Statements of Environmental Opportunity (SEO). The SEO profiles for the four NCAs within the study area are set out in Table 8.4. The extent of the NCAs are indicated on Figure 8.3 in Volume 3.

Table 8.4 National character areas: statements of environmental opportunity

Receptor	Description/value
NCA 81: Greater Thames Estuary	
SE01	Maintain and enhance the expansive, remote coastal landscape – with its drowned estuaries, low islands, mudflats, and broad tracts of tidal salt marsh and reclaimed grazing marsh – maintaining internationally important habitats and their wildlife, and underlying geodiversity.

Receptor	Description/value
SE03	Ensure that the tranquil and remote character of the estuary is maintained by conserving and enhancing important coastal habitats and distinctive historic and geological features, while providing increased opportunities for recreation and enjoyment of the landscape.
SE04	Encourage a strategic approach to development that is informed by and makes a positive contribution to local character, incorporates green infrastructure which provides ecosystem services where they are needed most, and promotes recreation and addresses climate change, while maintaining important open mosaic and coastal habitats, and historic and geological features.
NCA 119: North Downs	
SE01	Manage, conserve and enhance the distinctive rural character and historic environment of the North Downs, including the long-established settlement pattern, ancient routeways and traditional buildings. Protect the tranquility of the landscape and sensitively manage, promote and celebrate the area's rich cultural and natural heritage, famous landmarks and views for future generations.
SE04	Deliver integrated, well-managed multi-functional green space in existing and developing urban areas, providing social, economic and environmental benefits and reinforcing landscape character and local distinctiveness, particularly on or alongside the boundaries of the designated landscapes within the North Downs.
NCA 113: North Kent Plain	
SE01	Maintain the historic character and long tradition of a farmed landscape, creating habitats to establish more resilient and coherent ecological networks within the farmed and peri-urban areas, benefiting biodiversity and geodiversity, and helping to regulate water and soil quality. Protect traditional practices including the longstanding associations of the fruit belt, maintaining a strong sense of place and reinforcing Kent's reputation as the Garden of England.
SE03	Protect the distinct wooded areas of the landscape, particularly through the management of nationally important, ancient semi-natural woodlands, increasing the area of broadleaved woodland where appropriate, while increasing the connectivity of the mosaic of associated habitats; notably wooded heath and semi-improved grasslands and enhancing the recreational resource.
NCA 111: North Thames Basin	
SE01	Conserve the riparian landscapes and habitats, for their recreational and educational amenity for their internationally significant ecological value.
SE03	Protect and appropriately manage the historic environment for its contribution to local character and sense of identity and as a framework for habitat restoration and sustainable development. Ensure high design standards (particularly in the London Green Belt) which respect the open and built character of the Thames Basin. Enhance and increase access between rural and urban areas through good green infrastructure links to allow local communities recreational, health and wellbeing benefits.

8.4.2 The Project would fall within the nationally designated Kent Downs AONB and its recognised setting. The landscape within the designated area includes the designated Grade II* Cobham Hall (now a school) and Park which is included in Historic England's Register of Historic Parks and Gardens. This part of the AONB is experienced by visitors to Shorne Woods Country Park and by users of both the National Cycle Route (NCR) 177 and the regionally important Timeball & Telegraph Trail Long Distance Path (LDP).

8.4.3 Outside the AONB the Project would pass through Green Belt and near to areas and features designated for their biodiversity and heritage value (see Chapter 7: Cultural Heritage and Chapter 9: Terrestrial Biodiversity), including Ancient Woodland, Sites of Special Scientific Interest (SSSI), local nature reserves, scheduled monuments, listed buildings and conservation areas.

8.4.4 The landscape outside the AONB, and within the Greater London Green Belt, is experienced by the following visual receptors:

a. Residents at the urban edge, within rural villages and isolated rural properties

b. Recreational users of NCR 13 adjacent to the Thames Estuary, NCR 1 which follows the line of the former Thames and Medway Canal and NCR 117 which follows the line of the busy A2

c. Recreational users of common land at West Tilbury Marshes, open access land at Ashenbank Wood and at Orsett Fen

d. Visitors to Jeskyns Community Woodland, Coalhouse Fort, Grangewaters Country Park, the Thames Chase Community Forest

e. Recreational users of the Saxon Shore Way LDP which follows the flood defence of the River Thames, as well as recreational users on the local footpath network, green lanes and bridleways

8.4.5 The Project would also cross or pass close to recreational facilities including Southern Valley golf club, Orsett golf club and Stubbers adventure centre.

Key landscape receptors

8.4.6 The Kent Downs AONB Unit and the local planning authorities along the proposed Project route have made various landscape characterisation studies in the study area. The Project would pass through or near to 23 local landscape character areas which have been identified within these landscape characterisation documents:

a. Kent Downs AONB Unit (2017), Landscape Character Assessment Update, Draft

b. Gravesham Borough Council (2009), Landscape Character Assessment

c. Thurrock Borough Council (2005) Landscape Capacity Study

d. Lands of the Fanns Landscape Partnership (August 2016), Landscape Character Assessment, Final Report

8.4.7 There has been some redefining of the Landscape Character Area (LCA) boundaries near the AONB to take account of the overlapping characterisation work in this area. For the purposes of the *PEIR,* the two landscape character sub-areas which make up LCA 4 within the AONB are based on the Kent Downs AONB characterisation work. The landscape character areas within the AONB setting have therefore been refined. This refinement includes:

a. subdividing Higham Arable Farmlands In to three distinct areas of Chalk, Thong and Gadshill

b. the intimate wooded landscape between Bowesden Lane and Higham, which was formerly part of Shorne Woodlands, is identified as Shorne Wooded Slopes

8.4.8 However, based on the ZVI in Figure 8.1 in Volume 3 and the 2017/2018 winter surveys the following five areas within the 2km study area have not been carried forward due to their remoteness and being outside the ZVI for the Project. These will be reviewed during the Project design development as part of the DCO process. The areas are:

a. Meopham Downs

b. Luddesdown Downs

c. Bush Valley & Dean Farm

d. Ranscombe Farm

e. Cliffe Woods & Farmland

8.4.9 The nine remaining landscape character areas to the south of the River Thames, which have been taken forward in the *PEIR,* are listed in Table 8.5 along with an outline of their key characteristics.

Table 8.5 Landscape receptors to the south of River Thames

Receptor	Description	Landscape value (*DMRB*, *IAN 10/135*)
Kent Downs Area of Outstanding Natural Beauty		
LCA 4: West Kent Downs (sub area Cobham), coincides with Gravesham Borough Council's Ashenbank	The cultural integrity of the landscape is strong, with the estate parkland and management creating a distinctive character and sense of time-depth. Cobham Hall (which is on the site of a Roman villa) is a Grade I listed Elizabethan Manor House set in a parkland landscape designed by Humphrey Repton. Cobham Park has its origins as a medieval deer park and contains several veteran trees. The Park is included in Historic England's Register of Historic Parks and Gardens. There are also extensive	**High** Nationally valued accessible landscape designated as an AONB. Contains nationally important biodiversity designations and heritage assets as well as being important for

Receptor	Description	Landscape value (*DMRB*, *IAN 10/135*)
& Cobham Parklands	woodlands (containing exceptionally tall ash trees), parklands and wood pasture. Part of the park is now used as a golf course. The estate features include lodges and the recently restored Darnley Mausoleum. Ashenbank Wood (to the west of Cobham Park) contains a nationally designated SSSI and ancient woodland, a range of archaeological sites including a Bronze Age burial ground and WWII bunkers. It is an accessible area of woodland popular for recreation. The busy A2 runs to the north of this LCA and is separated from it by High Speed 1 (HS1). The A2, in relation to the landform within the LCA, is typically at a similar elevation or slightly below the ground levels within the LCA. High-sided vehicles on the A2 are glimpsed in some views out at the northern edge and traffic noise does permeate into the adjacent landscape. The A2 street lighting is a noticeable night-time feature which impacts on the darker night skies within the AONB. This highly accessible designated landscape is of national importance and has associated nationally important ecological assets. The area's special qualities of tranquility and scenic beauty underpin its designation, although these become increasingly compromised by its proximity to the A2.	the local community in terms of recreation and visual amenity.
LCA 4: West Kent Downs (Sub area Shorne), coincides with Gravesham Borough Council's Shorne Woodlands	The local character area of Shorne has been severed by the A2 road corridor from the more extensive landscape of similar character to the south. The A2 comprises two carriageways of four lanes which are typically at the same elevation or slightly below the ground levels within the LCA. Near Brewers Road Bridge and east to Park Pale, the road corridor is defined by a strong linear belt of mature trees. This belt of trees splits the A2 into two clearly distinct carriageways of four lanes. The depth of the tree belt sufficiently screens the two carriageways from each other and helps to integrate the busy A2 with the wooded context of the adjacent AONB. However, A2 traffic noise does permeate into the wooded landscape of Shorne Woods County Park. The A2 street lighting is a noticeable night-time feature which impacts on the darker night skies within the AONB. The wooded ridge forms a discrete tract of landscape lying between the extensive built-up areas of Rochester and Gravesend. It is bounded to the north by the open farmland of the Hoo Peninsula. The extent of woodland is the key distinguishing feature, in combination with the ridge landform. This	**High** Nationally valued accessible landscape designated as an AONB. The area's special qualities of tranquility and scenic beauty underpin its designation. Contains nationally important biodiversity designations, as well as being important for the local community in terms of recreation and visual amenity

Receptor	Description	Landscape value (*DMRB*, *IAN 10/135*)
	significant landform feature provides an attractive backdrop in views from the north. The woodland contains a nationally designated SSSI and ancient woodland, and much is actively worked coppice. The heathy vegetation, reflecting a local change in the underlying geology, adds to the area's ecological value. Shorne Woods are important for recreation, containing a country park and visitor centre. They also provide the backdrop to a hotel, set adjacent to a lake, at the south west edge of Shorne Woods Country Park. The tranquility of the area is noticeably compromised by proximity to the existing A2.	
Gravesham Borough Council (outside, but within the recognised setting to the Kent Downs AONB)		
Shorne and Higham Marshes	Shorne and Higham Marshes are east of Gravesend and directly south of the River Thames. The area is characterised by a sense of remoteness and eeriness, an unsettled flat topography, a lack of vegetation with wide open views, with the River Thames only realised as a tall ship passes beyond the flood defences. The importance and value of this landscape is further evidenced by the presence of Shornemead Fort, which forms part of a much wider historic military defence along both banks of the Thames Estuary From a cultural perspective the Thames Marshes provide the literary context to Charles Dickens' 'Great Expectations' where he wrote of the Thames Marshes as a "dark, flat, wilderness...intersected with dykes and mounds and gates, with scattered cattle feeding on it". The entire marshland area is an SSSI and a Ramsar site. Much of the area is used as a police firing range and is cordoned off from the PRoW by tall, intrusive fencing. The area is crossed by the Saxon Shore Way at the north edge of the area on the sea defence and NCR 1. The disused Thames Medway canal traverses the southern edge of the area. This landscape has a strong association with the Higham Arable Farmlands (north) to the south set against the wooded skyline of Shorne Woods within the AONB.	**High** Locally valued landscape associated with the Thames Estuary and provides part of the wider setting to the Kent Downs AONB. Contains nationally important biodiversity designations, and regional heritage assets. It is important for the future coast national trail and the local community in terms of recreation and visual amenity. This landscape has cultural associations with Charles Dickens.
Higham Arable Farmlands (Chalk) incorporating	Higham Arable Farmlands (Chalk) is in Green Belt east of Gravesend and south of Shorne and Higham Marshes. The landscape gently undulates and generally rises from north to the south. There are extensive views across open	**Medium** Locally valued landscape which provides the immediate setting to the Kent

Receptor	Description	Landscape value (*DMRB*, *IAN 10/135*)
the north edge of Shorne Woodlands	arable land of a typically regular pattern of medium to large fields, from within the character area and views out of the character area, towards the marshes and River Thames in the north. In general, there is a lack of roads crossing the area and a lack of tree cover. The tower of the Grade II* listed St Mary's Church in the village of Chalk forms a local landmark. This landscape has a strong association with Shorne and Higham Marshes to the north and the Essex landscape beyond, and to the south with the wooded skyline of Shorne Woods within the AONB.	Downs AONB. It contains nationally important biodiversity designation, regional heritage assets, and is important for the local community in terms of recreation and visual amenity
Higham Arable Farmlands* (Thong) incorporating the western edge of Shorne Woodlands and the linear A2 western corridor of Ashenbank and Cobham Parklands	Higham Arable Farmlands (Thong) is in Green Belt east of Gravesend and north of HS1 near Thong. The focus of this area is the rural settlement of Thong, a designated conservation area with associated listed building. It is set at the edge of an open arable landscape that separates it from Gravesend. The settlement to the east is set against the wooded backdrop of the AONB. There are views across the open arable land to the urban edge. Clay Lane Wood located at the south west corner of this area is ancient woodland. Pylons and the A2 form a prominent feature within this area. The relatively flat area of open arable fields west of Thong was once part of Gravesend Airfield, a former Fighter Command airfield during WWII. This landscape has a strong association with the wooded skyline of Shorne Woods within the AONB to the east.	**High** Locally valued landscape which provides the immediate setting to the Kent Downs AONB, containing nationally important biodiversity designation, regional heritage assets as well as being important for the local community in terms of recreation and visual amenity
Higham Arable Farmlands (Gadshill)	Higham Arable Farmlands (Gadshill) is in Green Belt between the settlements of Higham to the north and Strood to the south. The focus of this area is the chalk downland dry valley associated with the A289 corridor near Gadshill. This area has a distinct urban fringe character because of the presence of the settlements on higher ground to the north and south. The A2/M2 junction sits at the western edge of this area. This landscape has a strong association with the wooded slopes of Crabbles Wood to the north and the wooded skyline of Cobham Park, on higher ground, beyond the A2/M2 junction within the AONB to the west.	**High** Locally valued landscape which provides part of the wider north eastern setting to the Kent Downs AONB, and is important for the local community in terms of recreation and visual amenity
Istead Arable Farmlands	Istead Arable Farmlands is in Green Belt to the south of Gravesend and HS1. The landscape is gently undulating, allowing wide and open views out towards the urban edge of Gravesend and HS1 to the north. This is a transitional open arable agricultural landscape, divided by tracks and roads. Fields are	**Medium** Locally valued accessible landscape which provides the immediate setting to the Kent Downs AONB,

Receptor	Description	Landscape value (*DMRB*, *IAN 10/135*)
	medium-to-large and form a regular pattern with boundaries running distinctly from north to south and east to west. Minor clumps of native woodland appear sporadically across the landscape. The landscape to the north east falls within the Jeskyns Community Woodland. This landscape has a strong association with the wooded skyline of Shorne Woods and Ashenbank Wood within the AONB to the east.	containing nationally important biodiversity designation, as well as important for the local community in terms of recreation and visual amenity.
Gravesend Southern Fringe	Gravesend Southern Fringe is in Green Belt and forms an open, gently undulating, linear landscape characterised by the A2, HS1 and the south edge of Gravesend. This is a recreational landscape interspersed with small, truncated blocks of arable farmland. The area provides recreational links from the urban edge to the rural landscape to the south.	**Medium** Locally valued landscape which provides a buffer to the A2 corridor and important for the local community in terms of recreation and visual amenity.
Shorne Wooded Slopes incorporating the east part of Shorne woodlands	The Shorne Wooded Slopes are in the Green Belt between the rural settlement of Shorne Ridgeway to the west and the urban centre of Higham to the east. This is an intimate elevated landscape which is shielded from the A2/M2 junction and A289 at its south edge by a densely planted false cutting and dense unmanaged young woodland. The false cutting acts as a visual and noise buffer for the lower lying ground near Bowesden Lane. The main focus of the area is the elevated wooded ridgeline delineated by Pear Tree Lane and the associated rural ribbon development along it. The land on either side of the ridgeline falls steadily away to the north and south and is heavily wooded. Court Wood and Great Crabbles Wood in the east part of the area is ancient woodland. Views out of the character area are restricted due to the presence of the vegetated false cutting and a dense strip of unmanaged young woodland along its south edge and the wooded slopes elsewhere which provide a strong sense of enclosure.	**High** Locally valued landscape which provides the immediate setting to the Kent Downs AONB. Contains nationally important biodiversity designations, and is important for the local community in terms of recreation and visual amenity

8.4.10 Based on the ZVI in Figure 8.1 in Volume 3 and the 2017/2018 winter surveys, the following two areas within the 2km study area have not been carried forward due to their remoteness and limited exposure to the Project. These are:

a. (G) Mardyke

b. (K) West Thurrock & Grays Quarry Townscape

8.4.11 The 10-remaining local landscape character areas to the north of the River Thames which have been carried forward in the *PEIR* are listed in Table 8.6

along with an outline of their key characteristics. The location of these character areas is shown on Figure 8.3 in Volume 3.

Table 8.6 Landscape receptors to the north of River Thames

Receptor	Description	Landscape value
Thurrock Borough Council		
C3 Mucking Marshes	This marshland landscape is in the Green Belt and is a grazed, flat and low-lying area immediately adjacent to the north bank of the River Thames. Consequently, it is exposed and windswept. Settlement is limited to the west edge and comprises the village of East Tilbury, which provided the housing for the adjacent Bata factory, and ribbon development along Princess Margaret Road. The historic Coalhouse Battery and Coalhouse Fort are both located at the southern end of the character area. The latter forms an important historic Thames-side landmark.	**Medium** Locally valued landscape which contains nationally designated natural habitats and regionally important heritage assets, as well as important for the local community in terms of recreation and visual amenity.
C5 Tilbury Marshes	This marshland landscape is in the Green Belt and is an open, exposed, flat, low-lying area immediately adjacent to the north bank of the River Thames. It is under predominantly arable farmland but with smaller concentrations of rough grazing land and unused historic landfill. The enclosure pattern is defined by straight ditches and dykes creating predominantly rectilinear field shapes particularly in the west of the character area. To the east, fields are larger with irregular boundaries. In the south of the area adjacent to the River Thames there are two markedly different landmark buildings that visually articulate the long settlement period of this landscape and its changing function. The historic Tilbury Fort sits at the south west extent of the area and lies immediately adjacent to a decommissioned power station which is scheduled to be demolished before the anticipated construction of the Project. The power station is in the settled and busy industrial zone to the western edge of the area. The pocket of arable landscape at the eastern edge of the area forms the setting to historic Coalhouse Fort. Powerlines and raised landfill sites form notable features within the landscape. This area has a strong association with D6 Chadwell Escarpment Urban Fringe to the north with the tower of West Tilbury church forming a skyline landmark. To the south is the open, low-lying landscape of the Thames Estuary with the Kent landscape beyond.	**Medium** Locally valued landscape which contains nationally designated natural habitats and provides the setting to regionally important heritage assets, as well as important for the local community in terms of recreation and visual amenity

Receptor	Description	Landscape value
D4 White Croft/Orsett Heath Urban Fringe	This urban fringe landscape is in the Green Belt to the north of Grays and east of Chadwell St Mary. The area consists predominantly of gently undulating urban fringe farmland strongly influenced by the presence of transport corridors and utilities infrastructure. The focus of the area is near White Crofts, which is a bowl-shaped farmland landscape. The hedgerow lined Hornsby Lane, along with the adjoining Grade II listed Heath Place and its grounds provide a sense of the former rural farmland landscape. The settlement pattern consists of Orsett Heath and Southfields with farm steadings adjacent to the numerous minor roads that cross the area. The area is influenced by the northern urban edge of Chadwell St Mary, the eastern urban edge of Grays and the large junction on the A13 south of Baker Street. A local nature reserve sits adjacent to the A13-A1089 junction. Pylons and power lines are prominent features within this character area.	**Medium** Locally valued landscape which contains locally important biodiversity sites and is the setting of a regionally important heritage asset. It is important for the local community in terms of recreation and visual amenity
D5 Linford/Buckingham Hill Urban Fringe	This urban fringe landscape is in the Green Belt and forms a locally distinctive area of elevated landform, which forms a visually prominent, broad, flat to undulating topped ridge. This is the principal unifying feature within this area. This landscape has a diverse range of land uses including rough grazing on the ridge top, mineral extraction, industry, landfill and recreation. The settlement pattern consists of the settlement at Linford, and dispersed farm buildings. From the higher ground there are extensive views out to the Thames Estuary, Kent Hills to the south and Langdon Hills LCAs to the north. Pylons and power lines are visually intrusive features within this character area.	**Medium** Locally valued landscape which contains locally important biodiversity sites, as well as important for the local community in terms of recreation and visual amenity
D6 Chadwell Escarpment Urban Fringe	This urban fringe landscape is in the Green Belt and is defined by an east to west orientated steep sided, south facing escarpment indented by small dry valleys, and provides a marked contrast to the flat, drained farmland of Tilbury Marshes to the south. This is a small scale and intimate landscape interspersed with small copses, areas of scrub and irregular fields of rough grassland and pasture. It also includes narrow and winding lanes, enclosed by hedgerows. The settlement pattern is focused on West Tilbury where the church tower at West Tilbury is a focal point on the skyline, and isolated individual historic farmsteads. Pylons and power lines are visually intrusive features within this character area. The tower of the Grade II* listed West Tilbury church forms a local landmark.	**Medium** Locally valued landscape which provides the backdrop to the setting of regionally important heritage assets within the adjacent Thames marshes and the context of Queen Elizabeth I addressing her troops at Tilbury preparing to

Receptor	Description	Landscape value
	This area has a strong association with C5 Tilbury Marshes to the south, the Thames Estuary and the landscape of Kent beyond.	repel a Spanish invasion. Also contains locally important biodiversity sites, as well as important for the local community in terms of recreation and visual amenity
D7 West Tilbury Urban Fringe	This urban fringe landscape is in the Green Belt and forms a broad, open, large scale area of arable farmland between Chadwell St Mary and East Tilbury and is clearly defined by the adjacent escarpments to the north east and south, and the urban edge of Chadwell St Mary to the west and East Tilbury to the east. The settlement pattern within the area comprises scattered farmsteads and farm buildings. The East Tilbury (Bata) Conservation Area, which was designed and built to house the workforce of the British Bata Shoe Company, sits at the east edge of the area. Hedgerows are common along the historic lanes and tracks which cross the area. Heavy traffic on the local road network, the Tilbury Loop Railway Line, pylons and power lines are prominent and influencing features on the character of the area.	**Medium** Locally valued landscape which provides the backdrop to the setting of regionally important heritage assets as well as important for the local community in terms of recreation and visual amenity
Thurrock Borough Council – Land of the Fanns		
(H) Orsett Lowland Farmland	The Orsett Lowland Farmland is in the Green Belt and is a low lying, gently undulating fen edge landscape. The local mix of medium and small-scale pasture and arable farmland is focused on the historic nucleated settlement of Orsett, a designated conservation area. The Grade II listed Baker Street mill at the western edge of the settlement is a local landmark. There is a scheduled monument within arable fields to the west of Baker Street, which is clearly identifiable by cropmarks. There are some extensive views out to the north across (J) Thurrock reclaimed fen from higher ground. This landscape also had a former historical relationship with the former heathland at Orsett Heath to the south and is now severed by the A13. This landscape has a relationship with the open, large scale (J) Thurrock Reclaimed Fen to the north and its south edge is defined by the A13 corridor.	**Medium** Locally valued landscape which provides the setting to national and regionally important heritage assets as well as important for the local community in terms of recreation and visual amenity
Thurrock Borough Council and London Borough of Havering – Land of the Fanns		
(J) Thurrock Reclaimed Fen	Thurrock Reclaimed Fen is in the Green Belt and forms the focus of the Fanns Landscape. The west	**High**

Receptor	Description	Landscape value
	and northwest part of the area falls within the Thames Chase Community Forest. It is a low-lying, large scale, flat, inland basin associated with the upper reaches of the Mardyke. It is a predominantly open, sparsely settled arable landscape with a sense of place, remoteness and tranquility and with expansive views across the area. The lowest part of the area is Orsett Fen where the field boundaries are delineated by open ditches. The landscape is defined by rectilinear features such as former fen causeways, drainage ditches and gappy field boundary hedgerows. This landscape contrasts with the rising wooded slopes within both the (B) Brentwood Wooded Hills to the north, and the (F) Langdon Hills and Farmland to the east. The north west part of this area is affected by the M25 corridor. This landscape has a strong relationship with the wooded ridgelines of (F) Langdon Hills and Farmland to the east and (B) Brentwood Wooded Hills to the north.	Locally valued unique landscape which forms the focus of the Fann landscape. Provides the opportunity for recreation and visual amenity.
(A) Belhus Lowland Quarry Farmland	Belhus Lowland Quarry Farmland is in the Thames Chase Community Forest and Green Belt. It is a low-lying, gently rolling, mixed arable and pasture landscape. This area has historically been extensively quarried for aggregate with subsequent landfill which is evident in the landscape to the east of South Ockendon as evidenced by the concentration of lakes in the environs of the Grangewaters Country Park and structure tree planting associated with the restoration of former extraction/landfill sites to the north east. There is a concentration of heritage assets within the northern part of this area, including conservation areas at North Ockendon to the east and associated with the Grade II Listed Cranham Hall and Harwood Hall to the west of the M25. The Grade II listed Ockendon Hall and nearby Mount scheduled monument lies to the north east of South Ockendon and provides locally important features in the landscape often associated with established mature vegetation.	**Medium** Locally valued post-industrial landscape which provides the setting to several regionally important heritage assets. Important for recreation and visual amenity.
London Borough of Havering & Brentwood Borough Council – Land of the Fanns		
(B) Brentwood Wooded Hills	The Brentwood Wooded Hills are located within the Thames Chase community forest and Green Belt. It is a well-treed undulating rural pasture and arable landscape incised by small watercourses. It is in the north of the study area near the M25 junction 29. To the north of the junction the land steadily rises to a local ridgeline and the settlement of Great Warley, a designated conservation area. The upper slopes and ridgelines afford views out to the south and the (J)	**High** Locally valued accessible attractive woodland landscape which provides the setting to heritage

Receptor	Description	Landscape value
	Thurrock Reclaimed Fen. This landscape has several areas of ancient woodland which include the woodland adjacent to the M25 at junction 29. To the east is Thorndon Country Park which is Included in Historic England's Register of Historic Parks and Gardens. This landscape has a strong relationship with the adjacent large scale, low lying (J) Thurrock Reclaimed Fen to the south.	landscape assets. Important for recreation and visual amenity.

Key visual amenity receptors

Key visual amenity receptors south of River Thames

8.4.12 The key visual receptors within the 2km ZVI to the south of the River Thames and a brief description of their location, aspect and view are set out in Table 8.7. Their locations are shown on Figure 8.5 in Volume 3. The receptors are prefixed with “S” to reflect their location to the south of the Thames Estuary. The photographs from these key receptors are presented in Figure 8.6 in Volume 3. The 6 visualisation images for this section, with the Project overlaid, are presented in Figure 8.7 in Volume 3 and the five night-time photographs are presented in Figure 8.8 in Volume 3.

Table 8.7 Key visual receptors within 2km ZVI south of River Thames

Receptor and viewpoint reference	Description	Visual sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
S-01 National Cycle Route (NCR) 117, Park Pale overbridge *Viewpoint 2 (Photomontage)*	Route traverses on a west-east axis along the eastbound side of the A2 corridor within the Gravesend Southern Fringe, the Higham Arable Farmlands (North) and Kent Downs AONB (Shorne Woodlands), crossing the A2 at Park Pale. For the section between the Gravesend Southern Fringe and Brewers Road within the AONB, the NCR runs along the back of the A2 eastbound verge. Users experience open short-range views along and across the eight lanes of the A2 with its traffic forming the dominant element, but back-cloaked by the tree line along Thong Lane which helps separate the A2 from HS1. East of Brewers Road to Park Pale the route follows the golf course access road from which there are occasionally heavily filtered views to the A2 eastbound traffic and a gantry through intervening lane-side vegetation. At Park Pale where the NCR crosses over the A2 there are open views along and across all eight lanes of the A2, the west part of the A2/M2 junction and to HS1. These features are set within a well wooded context. The established row of mature vegetation within the wide A2 central reserve helps to break up the scale of the A2 and its traffic in	**High**

Receptor and viewpoint reference	Description	Visual sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	westerly views, so that either the eastbound side or westbound side is visible, but not both sides. Users along the entire section of the NCR within the study area are heavily exposed to traffic noise from the A2.	
S-02 PRoW, Park Pale Viewpoint 3	Local footpath network to the north and north west of A2/M2 junction within the Kent Downs AONB (Shorne Woodlands). Relatively secluded location where views to the junction are limited by a false cutting with associated established vegetation. The PRoW at the west edge of this area has slightly elevated views to the A2 and its traffic, with glimpses to HS1, near the overbridge at Park Pale and set against established vegetation within Cobham golf course beyond. Traffic noise permeates this area.	**High**
S-03 Shorne Woods Country Park (Randell Heath) Viewpoint 10	Popular park on the north side of HS1/A2 corridor within the Kent Downs AONB (Shorne). The park extends across a well-wooded, enclosed and undulating plateau landscape, which extends to the north edge of the AONB. There are filtered views and glimpses out from high ground at Randall Heath. To the north there are views out across the open arable slopes of the Higham Arable Farmlands (North) with the Thames Estuary beyond. To the south west there are more densely filtered winter views out across the south part of the Higham Arable Farmland (South) near the A2. Traffic noise permeates much of this area although there are pockets of lower ground within the dells such as Fairy Steps where traffic noise is noticeably reduced.	**High**
S-04 Timeball & Telegraph Trail LDP Viewpoint 5	Route traverses on a meandering west to east axis through the Istead Arable Farmlands (Jeskyns Community Woodland) to the south and skirts the west edge of Ashenbank Wood and crosses HS1 via a green bridge (West Kent Downs (sub area Cobham)). At the latter there are filtered views to the traffic on the A2 beyond Thong Lane. At Thong Lane overbridge, where the trail crosses over the A2, there are open views along and across all eight lanes of the A2. The Inn on the Lake Hotel forms a local feature on the eastbound side of the A2. The A2 and the hotel are set within a well-treed context. The trail then passes through Shorne Woods Country Park within the Kent Downs AONB (Shorne).	**High**
S-05 Ashenbank Wood Open Access Land and PRoW	Well-used enclosed area to the south of the HS1/A2 corridor within the Kent Downs AONB (Cobham). The higher ground lies within the north part of the area adjacent to HS1/A2 corridor. There are heavily filtered views or glimpses over HS1, which is in cutting, to the traffic on the A2, between Brewers Road and Thong	**High**

Receptor and viewpoint reference	Description	Visual sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
Viewpoint not provided	Lane. Traffic noise permeates the north part of this area.	
S-06 Darnley Trail, Cobham Park & PRoW Viewpoint 4	This PRoW runs along the north edge of the Registered Grade II Parks and Gardens parkland which forms the setting to Grade I listed Cobham Hall within the Kent Downs AONB (Cobham) adjacent to the HS1/A2 corridor. There is a mix of open and filtered views over HS1, which is typically in cutting, to the four lanes of traffic on the westbound carriageway of the A2, between Brewers Road and Park Pale. The A2 traffic for this section is back-cloaked by the mature line of trees within the wide A2 central reserve. Traffic noise permeates the north part of the park.	High
S-07 Mausoleum, Cobham Hall Park Viewpoint 1	Elevated location on the south side of HS1/A2 corridor within the Kent Downs AONB (Cobham), on the south side of the Cobham Park. The viewpoint is from the Mausoleum which is within a woodland setting and looks north towards the golf course which lies beyond the intervening woodland. The golf course and the present A2 and associated traffic are screened by the dense mature intervening woodland which surrounds and forms the immediate setting to the Mausoleum.	High
S-08 Jeskyns Community Woodland and open access land Viewpoint 6a (Photomontage) and Viewpoint 6b	Well used and popular urban edge attraction located to the south of the HS1/A2 corridor. The park extends across a rolling landscape south to the village of Cobham. The higher ground is defined by an undulating ridge which runs across the park on a north west to south east axis. From the higher ground there are extensive elevated southerly views across the park, HS1 and A2 corridor to the Higham Arable Farmlands (North) set against the wooded ridgeline of higher ground within the Kent Downs AONB (Shorne woodlands) to the north east and the urban edge of Gravesend to the north and west. Buildings within the settlement of Thong are discernible in views from the north edge of the Park. A 400kV powerline forms a prominent feature in these views.	High
S-09 Thong Village and PRoW Viewpoint 7 (Photomontage)	The village and PRoW are located within the east side of the Higham Arable Farmlands (North) at the interface of the undulating open arable farmland slopes to the west and the steep wooded slopes of the Kent Downs AONB (Shorne) to the east. There are views across the arable farmland to the Gravesend Urban Edge. The land falls noticeably to the south near Clay Lane Wood allowing some distant views out across the urban edge of Gravesend (Singlewell) to distant wooded hills at Bean. A 400kV powerline is a noticeable element in the view as it crosses to the west of the village.	High

Receptor and viewpoint reference	Description	Visual sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
S-10 Gravesend Urban Edge (Singlewell and Riverview Park) Viewpoint 8	Properties at the urban edge have south and easterly views out across the adjacent rising open arable fields and the settlement of Thong within the Higham Arable Farmlands (North), and back-cloaked beyond by steeply rising wooded slopes and a treed skyline within the Kent Downs AONB (Shorne). A 400kV powerline is a noticeable element in the view as it crosses to the open arable farmland west of Thong.	High
S-11 Gravesend Urban Edge (Riverview Park) Viewpoint 9	Properties at the urban edge have elevated, extensive north easterly views out across the adjacent Southern Valley golf club and falling open arable fields on both sides of the A226 within the Higham Arable Farmlands (North), with the Thames Marshes and Estuary stretching out beyond into the far distance. The cranes at London Gateway Port are a notable distant feature. The A226 and its traffic is a relatively minor feature in these views due to the intervening nature of its roadside vegetation. A 400kV powerline is a noticeable element in the view as it crosses the open arable farmland along the east edge of the golf course.	High
S-12 Gravesend Urban Edge (Chalk) Viewpoint not provided	Properties at the urban edge are typically well contained by the adjacent built form and dense vegetation pattern. The combination of established roadside vegetation (Castle Lane and A226) and local topography in the form of a local intervening ridgeline within the adjacent arable fields limits east and north easterly views out across the landscape.	High
S-13 Shorne Ifield Road Viewpoint 11	Local quiet rural road which delineates the north edge of the Kent Downs AONB linking the rural settlements of Thong and Shorne. Users on this local road have a series of extensive sequential filtered or open northerly views across the sloping arable landscape of the Higham Arable Farmlands (North) with the Thames Marshes, Thames Estuary and Thurrock beyond.	Walkers and cyclists – High
S-14 Southern Valley golf club and PRoW Viewpoint 12 (Photomontage)	The golf course and adjacent PRoW network are situated within a falling, predominantly gently rolling open arable landscape of the Higham Arable Farmlands (north). The northerly aspect of the area allows extensive views out to the Thames Estuary beyond. The cranes at London Gateway Port are a notable distant feature. Local topography and occasional field boundary vegetation provide some local containment in east-west views across the landscape. The wooded slopes and treed skyline within the Kent Downs AONB (Shorne) provide the southern backdrop to these views. The Gravesend Urban Edge at Riverview Park forms a notable skyline feature in south westerly views. The tower of the Grade II* listed	Golf Course – Medium PRoW – High

Receptor and viewpoint reference	Description	Visual sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	St Mary's Church at Chalk is a discernible feature in many views across the area. The A226 and its traffic is a relatively minor feature in these views due to the intervening nature of its roadside vegetation. A 400kV powerline is a prominent element in the view as it crosses the open arable farmland along the east edge of the golf course.	
S-15 Shorne, Residential Properties (A226 Gravesend Road) Viewpoint 13 Chalk (A226 Gravesend Road) Viewpoint 14	The clusters of sporadic residential ribbon development along the A226 are situated on the mid-slope within the Higham Arable Farmlands (North). The properties have typically southerly views across the A226 and the roadside vegetation to the rising open arable farmland beyond, which is set against the wooded higher ground and skyline of the Kent Downs AONB (Shorne). The tower of the Grade II* listed St Mary's Church at Chalk is a discernible feature in many views across the area. The Gravesend Urban Edge at Riverview Park forms a perceptible skyline feature in south westerly views. A 400kV powerline is a noticeable element in the view as it crosses the open arable farmland along the east edge of the Southern Valley golf club.	High
S-16 Shorne and Higham Rural Properties and PRoW (off Queens Fort Road) Viewpoint 15	The scattered rural farmsteads and residential properties, and the local footpath network to the north of the A226 are set within the open, lower undulating slopes of the Higham Arable Farmlands (North). Receptors located on the higher ground and with a westerly aspect have extensive southerly views to the rising open arable farmland north of the A226. The backdrop to these views is defined by the wooded higher ground and skyline of the Kent Downs AONB (Shorne). The Gravesend Urban Edge at Riverview Park forms a perceptible skyline feature in south westerly views. A 400kV powerline is a noticeable element in the view as it crosses the open arable farmland along the east edge of the Southern Valley golf club.	High
S-17 NCR 1 and PRoW (Former Thames and Medway Canal) Viewpoint 16	The network of PRoW across the lower lying flat land of the Higham and Shorne marshes have extensive southerly views across the rising arable farmland within the Higham Arable Farmlands (North), set against the backdrop of the wooded higher ground and skyline of the Kent Downs AONB (Shorne). The Gravesend Urban Edge at Riverview Park forms a perceptible skyline feature in south westerly views. Two 400kV powerlines form a noticeable element in the view as they cross the south edge of the marshes.	**High**
S-18 Saxon Shore Way LDP	The future England Coast Path will follow the south flood bank of the River Thames at the north edge of the	High

Receptor and viewpoint reference	Description	Visual sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
(Future England Coast Path) Viewpoint 17 (Photomontage)	Higham and Shorne Marshes. There are extensive 360-degree views across and along the estuary and its hinterland. Features on the opposite side (north side) of the estuary form part of the wider view. These include the large-scale block of the decommissioned Tilbury Power Station, which is a notable industrial landmark, and the array of power lines traversing Tilbury Marshes are also clearly visible. The estuary edge historic Coalhouse Fort is a perceptible feature. Beyond is the rising ground of D6 Chadwell Escarpment Urban Fringe. The tower of the Grade II* listed West Tilbury Church is a discernible feature. The cranes at London Gateway Port are a notable distant feature. To the south there are extensive views across Shorne Marshes to the rising arable farmland within the Higham Arable Farmlands (north), set against the backdrop of the wooded higher ground and skyline of the Kent Downs AONB (Shorne). The Gravesend Urban Edge at Riverview Park forms a perceptible skyline feature in south westerly views. Two 400kV powerlines form a noticeable element in the view as they cross the south edge of the marshes.	

Key visual amenity receptors north of River Thames

8.4.13 The key visual receptors to the north of the River Thames within the 2km ZVI and a brief description of their location and view are set out in Table 8.8. Their locations are shown on Figure 8.5 in Volume 3. The receptors are prefixed with "N" to reflect their location to the north of the Thames Estuary. The photographs from these key receptors are presented in Figure 8.6 in Volume 3. The six visualisation images for this section, with the Project overlaid, are presented in Figure 8.7 in Volume 3 and the four night-time photographs are presented in Figure 8.8 in Volume 3.

Table 8.8 Key visual receptors within 2km ZVI north of River Thames

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
N-01 NCR 13 and PRoW Viewpoint 18	The NCR and PRoW runs along the north bank of the River Thames at the south edge of C5 Tilbury Marshes. There are extensive 360-degree views across and along the estuary and its hinterland. Features on the opposite side (south side) of the estuary form part of the wider view. These include the rising arable farmland within the Higham Arable Farmlands (North), set against the backdrop of the wooded higher ground and skyline of the Kent Downs	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	AONB (Shorne). The Gravesend Urban Edge at Riverview Park forms a perceptible skyline feature in south westerly views. Two 400kV powerlines form a perceptible element in the view as they cross the south edge of Shorne Marshes. To the north are extensive views across scrub-covered artificially raised, level platforms of former landfill within the East Tilbury Marsh, and the lower lying, flat Tilbury West Marshes. In the west the view is dominated by the large-scale block of the decommissioned Tilbury Power Station, and the array of power lines which traverse West Tilbury Marshes with the cranes at Tilbury Docks visible beyond. The estuary edge historic Coalhouse Fort forms a local landmark feature in easterly views. In northerly views beyond the powerlines is the rising ground of D6 Chadwell Escarpment Urban Fringe. The tower of the Grade II* listed West Tilbury Church is a visible local feature.	
N-02 Coalhouse Fort and Open Space Viewpoint 19	The fort is a privately-owned Scheduled Monument with limited public access. The Fort's surrounding open space and scheduled monument is a popular local tourist attraction. It sits on the north bank of the River Thames within a flat low-lying location at the south edge of C3 Mucking Marshes. The fort sits within Thameside grounds that extend south to Coal House Point. From the park there are extensive views along and across the estuary. Features on the opposite side (south side) of the estuary form part of the wider view. These include Cliffe Fort and the rising arable farmland within the Higham Arable Farmlands (North), set against the backdrop of the wooded higher ground and skyline of the Kent Downs AONB (Shorne). The Gravesend Urban Edge at Riverview Park forms a discernible skyline feature in south westerly views. Two 400kV powerlines form a perceptible element in the view as they cross the south edge of Shorne Marshes. To the west are views across a low lying, adjacent arable field at the east edge of C5 Tilbury Marshes to a scrub-covered and artificially raised level platform of former landfill. The bulk of the decommissioned Tilbury Power Station, and the array of powerlines which traverse West Tilbury Marshes and the cranes at Tilbury Docks are visible beyond. In north westerly views beyond the powerlines is the escarpment at the south edge of D6 Chadwell Escarpment Urban Fringe and the urban edge of Chadwell St Mary.	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
N-03 Residential Properties on Princess Margaret Road Viewpoint not provided	The residential properties are located to the north of the Coalhouse Fort on slightly elevated ground at the interface of C3 Mucking Marshes and the south edge of D7 West Tilbury Urban Fringe. A cluster of properties at the south edge have a south westerly view across a low-lying arable field to the River Thames flood defence. Beyond, and on the opposite side (south side) of the River Thames the rising arable farmland within the Higham Arable Farmlands (North), set against the backdrop of the wooded higher ground and skyline of the Kent Downs AONB (Shorne) is visible. The Gravesend Urban Edge at Riverview Park is also a discernible skyline feature in the view.	**High**
N-04 Tilbury Fort Viewpoint 20	Tilbury Fort is a Scheduled Monument which is managed by English Heritage and is a popular national tourist attraction. It sits on the north bank of the River Thames, within a flat low-lying, predominantly industrial environment at the south west corner of C5 Tilbury Marshes. The fort sits on lower ground behind the flood defence wall. From the top of the fort defences there are extensive views over the flood defence across and along the estuary. Features on the opposite side (south side) of the estuary form part of the wider view. These include the waterfront of Gravesend. The farmland slopes within the Higham Arable Farmlands (north), set against the backdrop of the wooded higher ground and skyline of the Kent Downs AONB (Shorne) are discernible beyond the urban area. The bulk of the decommissioned Tilbury Power Station, and the array of powerlines which traverse Tilbury West dominate the east and north easterly view and the urban edge of Tilbury dominates the northern view. The escarpment at the south edge of D6 Chadwell Escarpment Urban Fringe and the urban edge of Chadwell St Mary are visible features beyond the urban edge of Tilbury. The tower at West Tilbury Church forms a visible feature.	**High**
N-05 Tilbury Urban Edge (Fort Road) Viewpoint 21 (Photomontage)	Residential properties at the east edge of Tilbury, within the Tilbury Docks urban area, have an easterly view across Fort Road and the low lying flat arable farmland of West Tilbury Marshes within C5: Tilbury Marshes. The Tilbury Loop Railway Line crosses the area on low embankment and its associated scrub vegetation and the overhead gantries form a notable foreground feature. The bulk of the decommissioned Tilbury Power Station, and the array of powerlines which traverse the west edge of Tilbury Marsh on the opposite side of the railway, are the prominent	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	features in the view. The escarpment at the south edge of D6 Chadwell Escarpment Urban Fringe forms a notable feature in the north easterly part of the view. The tower at West Tilbury Church forms a visible feature.	
N-06 Chadwell St Mary Urban Fringe (South) and PRoW Viewpoint 22	These scattered residential properties and the local footpath network are located on open rising ground within D6 Chadwell Escarpment Urban Fringe. These receptors have south easterly views across the lower lying flat ground arable farmland of West Tilbury Marshes within C5: Tilbury Marshes. The Tilbury Loop Railway Line crosses this area on low embankment and its associated scrub vegetation and the overhead gantries form a visible feature. The bulk of the decommissioned Tilbury Power Station, and the array of powerlines which traverse the west edge of West Tilbury marsh on the opposite side of the railway, are the prominent features in the view. The farmland slopes within the Higham Arable Farmlands (North) on the south side of the River Thames, set against the backdrop of the wooded higher ground and skyline of the Kent Downs AONB (Shorne) are discernible beyond.	**High**
N-07 Low Street, Low Street Lane Viewpoint 23	Cluster of residential properties on Church Road/Low Street Lane within low-lying ground at the interface between D7 West Tilbury Urban Fringe to the north and C5: Tilbury Marshes to the south. The Tilbury Loop Railway Line forms the south edge to these properties. The combination of vegetation within the settlement and along the railway typically screens or filters views out across West Tilbury Marsh to the south. The 400kV overhead powerlines beyond the railway are visible above or in gaps through this vegetation. Properties to the north of Church Road have a filtered northerly or easterly view though either vegetation at the curtilage of the property or lane-side vegetation to the adjacent arable field and an established treeline on the far side. The 400kV powerlines located beyond the tree line are visible above it.	**High**
N-08 Residents at property (Love Lane) and PRoW (Coal Road). Viewpoint 24	PRoW located at the west settlement edge of East Tilbury and east of the Tilbury Loop Railway Line has series of open views across the adjacent low lying flat arable field to the established vegetation which delineates the line of the railway within D7 West Tilbury Urban Fringe with views over to the arable landscape beyond. 400kV powerlines are visible over the line-side vegetation.	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
N-09 East Tilbury Urban Edge (Beechcroft Road) and PRoW Viewpoint 25 (Photomontage)	Residential properties and the local footpath network located at the west settlement edge of East Tilbury and north of the Tilbury Loop Railway Line have a mix of either filtered or open views across the adjacent low lying, flat arable fields to established lane-side vegetation along Low Street Lane within D7 West Tilbury Urban Fringe. The cluster of 400kV powerlines are a prominent feature as they cross the open arable landscape on either side of Low Street Lane. A rural ridgeline of lane-side hedgerows (Blue Anchor Lane) and blocks of established vegetation associated with the settlement of West Tilbury is visible beyond.	**High**
N-10 Linford Settlement Edge (Siddons Close and Lower Crescent) Viewpoint not provided	Residential properties located on low-lying ground at the south settlement edge of Linford have typically heavily filtered oblique south westerly views in the direction of West Tilbury across the adjacent discernibly flat arable fields within D7 West Tilbury Urban Fringe. The 400kV powerlines within the open arable farmland near Low Street Lane are a noticeable feature.	**High**
N-11 West Tilbury (off Blue Anchor Lane) and PRoW Viewpoint 26 (Photomontage)	Residential properties located on a local vegetated ridge at the interface of D7 West Tilbury Urban Fringe and D6 Chadwell Escarpment Urban Fringe have filtered north easterly views across the open, broad, shallow slopes of the adjacent arable farmland within D7 West Tilbury Urban Fringe to wooded ground near Linford, within D5 Linford/Buckingham Hill Urban Fringe. Vegetation along Low Street Lane and near Low Street on lower ground are discernible local features in the view. The cluster of powerlines either side of Low Street Lane form a clearly noticeable feature in many views.	**High**
N-12 PRoW (Coal Road) and Rural Residential Properties (Muckingford Road) Viewpoint 27	Coal Road has no associated boundary vegetation. It crosses the open broad shallow slopes and low-lying arable farmland within D7 West Tilbury Urban Fringe. It runs on a north west to south east axis between Muckingford Road and Station Road. There are several scattered rural properties located within this rural landscape. These receptors have typically open easterly views across the adjacent arable fields to residential and industrial development at the settlement edge of East Tilbury and the established vegetation at the edge of Linford. The listed industrial buildings of the former Bata Factory are a notable landmark in many of these views. There are also westerly views to a rural ridgeline of lane-side hedgerows (Blue Anchor Lane) and blocks of established vegetation associated with the settlement	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	of West Tilbury. The cluster of powerlines either side of Low Street Lane form a prominent feature in many views.	
N-13 Hoford Road and Scattered Rural Properties Viewpoint 28	Hoford Road is a Protected Lane with gappy hedgerows and established hedgerow trees on either side. It traverses the open broad, shallow slopes and low-lying arable farmland at the interface between D7 West Tilbury Urban Fringe and D4 White Crofts/Orsett Heath Urban Fringe. It runs on a south west to north east axis between Muckingford Road and Buckingham Hill Road. There are also several scattered rural properties located within this rural landscape. These receptors have typically filtered north and easterly views across the adjacent arable fields to the established vegetation within the Orsett golf club and at the edge of Linford. There are also filtered westerly views to vegetation along High House Lane on slightly higher ground with the urban edge of Chalford St Mary visible beyond. Three tower blocks at the north edge of Chadwell form a visible large-scale urban landmark to the north west. 400kV O/H powerlines which traverse the central part of this open arable farmland form a prominent feature in many views.	**High**
N-14 Chadwell St Mary Urban Edge (north) and PRoW Viewpoint 29	Residential properties and the local footpath located at the north edge of Chadwell St Mary within the Grays, Chadwell St Mary Urban Area, have northerly views across open arable farmland within a shallow, low lying valley within D4 White Crofts/Orsett Heath Urban Fringe. The arable farmland is backdropped by established vegetation within the Orsett golf club and an open arable ridge to the north east. Further west the established vegetation at Heath Place forms a notable feature in the west part of the view. There are also glimpses in some northerly views to traffic on the A13 where it crosses the landscape on embankment, beyond Hornsby Lane. The 400kV O/H powerlines within the adjacent open arable farmland form a prominent feature in many views.	**High**
N-15 Heath Place (Hornsby Lane) Viewpoint 30	Scattered rural properties set in a gently rolling arable landscape in the environs of Heath Place, located within D4 White Crofts/Orsett Heath Urban Fringe. These properties include the Grade II Listed Heath Place, a building which is set within mature grounds and forms a local intimate part of Hornsby Lane. Most views from these residential receptors are filtered by established vegetation at the curtilage of the property and along the local road network. Traffic on the A13,	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	where it is on embankment at the north edge of the area, is a noticeable feature in many northerly views. The 400kV O/H powerlines which traverse the arable landscape to the south of Heath Place form a noticeable feature in many views.	
N-16 Orsett Heath/Chadwell St Mary Viewpoint 31 (Photomontage)	Residential properties located at the north edge of Orsett Heath have northerly views across adjacent equestrian pasture fields and arable farmland within D4 White Crofts/Orsett Heath Urban Fringe. Vegetation along the local road network and at the curtilage of the rural properties filters views to the A13 on embankment and its traffic on the skyline. The 400kV powerlines within the adjacent arable farmland form a noticeable feature in many views.	**High**
N-17 Grays Urban Edge and PRoW (Long Lane) Viewpoint 32	Residential properties located at the north-east edge of Grays within the Grays, Chadwell St Mary Urban Area, to the north and south of Long Lane, have filtered north easterly views across adjacent arable farmland within D4 White Crofts/Orsett Heath Urban Fringe. Vegetation along Long Lane, the field boundary hedgerows and at the curtilage of the urban edge properties filter views to the A13/A1089 junction. Where traffic is on embankment it can be glimpsed against the skyline. 400kV powerlines within the adjacent arable farmland form a noticeable feature in many views.	**High**
N-18 Baker Street (B188) Viewpoint 33	Residential properties located at the south end of Baker Street to the south west of Orsett, within (H) Orsett Lowland Farmland, have glimpses and filtered south westerly views to traffic on the adjacent A13/A1089 link road in gaps in vegetation at the curtilage of properties. Much of this vegetation comprises coniferous hedgerow. Traffic on the A13 is also seen in filtered winter views and in glimpses where it is on embankment and overbridge as it passes over Baker Street. Further north properties have filtered and contained westerly views which focus on the Grade II Listed Baker Street mill and its immediate environs, located at the west edge of Orsett. 400kV O/H powerlines beyond the adjacent hedgerows are a perceptible feature in these views.	**High**
N-19 Baker Street (Stifford Clays Road) Viewpoint 34	Residential properties located on Stifford Clays Road at the west edge of Baker Street, within (H) Orsett Lowland Farmland, are typically well contained. Views out to the south west and west are typically blocked by boundary vegetation at the curtilage of the property and by local landform and vegetation within the	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	environs of the adjacent Grade II Listed Baker Street Mill. Views out to the north are typically contained by a woodland block on the north side of the lane, allowing limited winter glimpses out to the open arable landscape to the north and the wider large-scale landscape of (J) Thurrock Reclaimed Fen beyond.	
N-20 PRoW (Junction of Green Lane/Fen Lane Viewpoint 35	Residential properties located on Fen Lane at the north-west edge of Orsett, within (H) Orsett Lowland Farmland, have typically north westerly views out across the adjacent open arable farmland and the wider, low lying large scale flat landscape of (J) Thurrock Reclaimed Fen beyond. Distant wooded landscape within (B) Brentwood Wooded Hills forms the backdrop to the view. 400kV powerlines within the arable farmland form a noticeable feature in these views.	**High**
N-21 PRoW (nr Junction of Green Lane/Stifford Clays Road) Viewpoint 36 (Photomontage)	Green Lane is a rural lane with gappy hedgerows and established hedgerow trees on either side. It traverses the higher ground within open large-scale arable farmland at the interface between (H) Orsett Lowland Farmland and (J) Thurrock Reclaimed Fen. The lane runs on a west to east axis between Stifford Clays Road and Fen Lane. There are typically extensive filtered 360-degree views from the lane across the adjacent arable fields. The focus of the views is to the north across the wider, lower lying large scale flat landscape of (J) Thurrock Reclaimed Fen to the distant wooded landscape within (B) Brentwood Wooded Hills beyond. 400kV powerlines within the arable farmland form a noticeable feature in these views.	**High**
N-22 Private track at east edge of Grangewaters County Park Viewpoint 37	This popular park with its focus on a series of open water bodies, and set within a treed perimeter, is located between South Ockendon and the Mardyke, at the interface of the open, large scale arable farmland of (J) Thurrock Reclaimed Fen and the more contained and enclosed shallow valley of (G) Mardyke. Due to the nature of the lakeside vegetation easterly views out across the nearby Mardyke and the wider rural landscape with the (J) Thurrock Reclaimed Fen beyond are limited.	**High**
N-23 PRoW (off Molland Lane) Viewpoint 38	Residential properties located at the north-east edge of South Ockendon within (A) Belhus Lowland Quarry Farmland, between Mollands Lane and Hall Lane have filtered easterly views across adjacent arable farmland. Vegetation along the local road network, the field boundary hedgerows at the curtilage of the Urban Edge properties, and the structure planting	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	west of the Mardyke watercourse filter and limit views across the wider, open, low lying rural landscape with the (J) Thurrock Reclaimed Fen beyond. A 400kV powerline within the adjacent arable farmland forms a perceptible feature in many views.	
N-24 Orsett Fen and PRoW (east of Hobletts) Viewpoint 39	Local footpath network and scattered rural properties set within the open, large-scale, low lying arable landscape of (J) Thurrock Reclaimed Fen. The focus of the area is the Mardyke and the collection of tributaries at the low-lying flat ground around Orsett Fen. This landscape sits within a broad, open bowl, resulting in typically extensive 360-degree views across the area. These views are defined by distant higher wooded ground to the north within the (B) Brentwood Wooded Hills and to the east by woodland blocks and higher wooded ground within the (F) Langdon Hills and Farmland. To the south the views are defined by a more subtle, open arable farmed ridgeline within (H) Orsett Lowland Farmland. The views to the west are defined by a well-established pattern of structure planting which limits views out to (A) Belhus Lowland Quarry Farmland and the built edge of South Ockendon. A 400kV powerline within the west part of the area forms a perceptible feature in many views.	**High**
N-25 Bulphan Fen, PRoW, Judds Farm (Harrow Lane) Viewpoint 40	Local footpath network and scattered rural properties set within the open, large scale, low lying arable landscape of (J) Thurrock Reclaimed Fen. This area is typified by extensive 360-degree views across an open, large scale, flat arable landscape with the sky forming a major part of the view. The south westerly part of the view, in the direction of Orsett Fen, is typified by the foreground medium size arable fields delineated by either hedgerows or ditches. The hedgerows and trees form strong horizontal elements and set against the sky. Due to the scale of the landscape and the sense of remoteness and lack of infrastructure, the area is marked by a sense of tranquility. The 400kV overhead powerline which crosses the west side of this landscape forms a discernible linear landscape feature.	**High**
N-26 South Ockendon Hall and PRoW (Hall Lane) Viewpoint 41	Local footpath and Ockendon Hall are set in the medium-scale open, flat arable landscape of (A) Belhus Lowland Quarry Farmland. The Hall buildings and associated established mature vegetation and the well managed hedgerows provide structure, a sense of place and enclosure. There are views out from the Hall across the foreground open arable fields to the	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
	vegetated South Ockendon urban edge to the west and to mid-distance scattered woodland blocks to the north. In the breaks between the woodland there are views to the more distant rising wooded ground of the Brentwood Hills, set against the sky.	
N-27 South Ockendon (North) Viewpoint 42	Residential properties at the north edge of South Ockendon are set in the medium-scale open, flat arable landscape of (A) Belhus Lowland Quarry Farmland. There are northerly views out across the foreground open arable fields to mid-distance scattered woodland blocks. In the breaks between the woodland there are views to the more distant rising wooded ground of the Brentwood Hills, set against the sky.	**High**
N-28 Residential properties (B186 North Road) Viewpoint 43	Residential properties on B186 North Road are set in the medium-scale open, flat arable landscape of (A) Belhus Lowland Quarry Farmland. The properties have a mix of south and south westerly open and filtered views, depending on whether it is ground floor or upper storey, across the adjacent open arable fields to mid-distance scattered woodland blocks and hedgerows. The sky forms much of the view.	**High**
N-29 PRoW west of North Ockendon Viewpoint 44	Residential properties on B186 North Road are set in the medium scale open, flat arable landscape of (A) Belhus Lowland Quarry Farmland. The PRoW and properties have typically filtered south and south westerly views across the adjacent open arable fields to mid-distance scattered woodland blocks and hedgerows. The sky forms much of the view.	**High**
N-30 North Ockendon, Residential Properties (Junction of B1421/B186) Viewpoint 45 (Photomontage)	Residential properties on B1421 Ockendon Road are set in the medium scale open, flat arable landscape of (A) Belhus Lowland Quarry Farmland. The properties have south and northerly filtered views, across the adjacent open arable fields to mid-distance scattered woodland blocks and hedgerows. The sky forms much of the view.	**High**
N-31 Thames Chase Community Forest Forest Centre Viewpoint 46	Recreational access within a designed enclosed woodland landscape comprising areas of open grassland edged by woodland blocks. This landscape sits within the north west edge of the (J) Thurrock Reclaimed Fen. Users experience a series of sequentially changing views, ranging from contained views to laid out framed vistas across open grassland to the adjacent countryside. Elements of the M25 such as gantries and signs are present in some views.	**High**

Receptor and viewpoint reference	Description	Visual Sensitivity (see *DMRB IAN135/10, Annex 2, Table 1*)
N-32 Residential properties (B187 St Marys Lane) Viewpoint not provided	Residential properties on B187 St Marys Lane are set in the large-scale open, flat arable landscape of (J) Thurrock Reclaimed Fen. The properties have southerly filtered views, across the adjacent open arable fields to mid-distance scattered woodland blocks and hedgerows. The sky forms much of the view.	**High**

Future baseline

8.4.14 The main change to the landscape baseline between now and the Project construction would be on the Tilbury Marshes landscape, located on the north side of the Thames Estuary. The present large-scale landmark of the existing Tilbury Power Station is being demolished and this work is planned for completion this year.

8.4.15 There are two redevelopment proposals in the local area which will have a locally major change on the future baseline. The Tilbury2 development located on the western part of the site is a Nationally Significant Infrastructure Project which has completed the DCO planning process and is awaiting decision. RWE also have plans for the redevelopment of the remaining part of the site, although the plans and timescales are less developed.

8.5 Further baseline information and surveys required

8.5.1 In undertaking the work to date, and as a result of having a better understanding of the potential impacts of the emerging design, the landscape chapter in the ES will also include an assessment of the effects on the seascape of the Thames Estuary and an assessment of townscape effects on the built form which could be directly affected by the Project, namely Thong village in the vicinity of the A2 junction and Baker Street in the vicinity of the proposed A13 junction.

8.5.2 Further desk-based studies are required to identify Tree Preservation Orders which could be affected by the Project.

8.5.3 Further visual surveys and baseline photography will be carried out during winter 2018/19 and summer 2019 to capture the seasonal changes in the screening and filtering of intervening vegetation. Further night-time surveys and photography will be carried out during summer 2018. Noise surveys will be carried out in summer 2018 to identify the extent and conditions of existing tranquility, including background noise data on rural recreational receptors within the Kent Downs AONB, its setting and near to the Thames Estuary, as well as within the large-scale, open, Orsett Fen/Mardyke area.

8.5.4 An extended vertical analysis will be undertaken in Autumn 2018 which will help in our understanding of how visible the vertical elements of the Project will be, ie, where it is on a viaduct or an embankment. This exercise could potentially

identify additional visual receptors and help inform the visualisations assessment.

8.5.5 As part of ongoing engagement with the local authorities and the Kent Downs AONB there will be a need to discuss and agree the key receptor viewpoints to be used in the Landscape Visual Impact Assessment (LVIA) to support the ES. This will also be required to identify which key receptors are be used for the preparation of the photomontages and night-time photography. It is expected that most of these will fall within the 2km study area.

8.5.6 As part of the study area verification an extended 5km study area has also been prepared. From this, five other key receptors have provisionally been identified, based on a desk-top exercise using the ZTV on Figure 8.2 in Volume 3 and from survey work undertaken within the 2km study area. The suggested key receptors are set out in Table 8.9. This is not an exhaustive list and these more distant viewpoints will be discussed and agreed with the local authorities and Kent Downs AONB. The locations and their visibility to the Project will be verified by future winter field survey work during 2018/2019.

Table 8.9 Key visual receptors within 5km ZTV north of River Thames

Receptor	Location	Visual sensitivity (see *DMRB IAN 135/10 Annex 2 Table 1*)
N-25 Westley Heights, Langdon Hills	(F) Langdon Hills and Farmland.	**High**
N-27 Thorndon Country Park South	(B) Brentwood Wooded Hills.	**High**
N-29 Little Warley, PRoW	(B) Brentwood Wooded Hills.	**High**
N-37 Folkes Lane, Residential Properties	(B) Brentwood Wooded Hills.	**High**
N-38 Folkes Lane Thames Chase Community Forest	(B) Brentwood Wooded Hills.	**High**

8.6 Potential effects and mitigation measures

8.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. Note that this assessment is ongoing and is subject to change during development of the Project proposals.

8.6.2 A fully detailed assessment will be undertaken before DCO application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the ES.

Construction

8.6.3 Potential landscape changes caused by the Project during construction, and the measures proposed to manage them to the south of the River Thames, are given in Table 8.10. Please note for the purposes of the effects within the Kent Downs AONB, the character areas of sub-area Shorne and sub-area Cobham have been combined as the Project focuses on the A2/HS1 corridor which lies between them.

8.6.4 The potential landscape changes (Nature of effect) within the study area south of the River Thames, because of the Project construction (without mitigation) and the potential measures proposed to manage them are outlined in Table 8.10 below.

Table 8.10 Construction (landscape effects south of River Thames)

Item	Description
Receptor	Kent Downs AONB (LCA 4 West Kent Downs – sub-areas Shorne & Cobham)
Nature of effect	The Project would have both direct and indirect impacts on this nationally important landscape as a result of extensive construction activity along the east-west corridor of the present A2/HS2 within the AONB. The work would extend from the Thong Lane overbridge, which presently defines the western edge of the designation to the A2/M2 junction at the east edge of the designation. It would include the clearance of the important A2 central reserve vegetation, which presently helps to physically and visually split the 4 lanes of the westbound carriageway from the 4 lanes of the eastbound carriageway. There would also be further clearance of other highway estate vegetation along both sides of the A2 corridor as well as the removal of the establishing HS1 mitigation planting. Demolition work would occur at the Thong Lane and Brewers Road overbridges. Other activities would include regrading work to the existing A2 and HS1 earthworks to accommodate the carriageway widening of the A2 from 8 lanes to 14. There would also be side road realignment to Thong Lane (westbound side) and Pale Park Lane (eastbound side). Replacement overbridges would be installed at Thong Lane and Brewers Road along with possible retaining walls and reinforced earth slopes along much of the corridor for screening and potential traffic noise mitigation. New gantries and replacement street lighting would also be installed as part of the works. At this stage, it is not anticipated vegetation clearance would be required within either Cobham Park or Ashenbank Wood which are both to the south of HS1. The construction of the replacement Brewers Road overbridge and the working area for this have not been finalised and as such, due to the very tight land availability within the present highway estate, there may be a need to encroach into the Shorne Woods County Park. There would also be localised construction activity near Park Pale in the east part of the area. The Park Pale overbridge would remain in situ but there would be clearance and construction associated with an extension of the existing A2/M2 junction false cutting (eastbound side) westwards. The existing business would be retained although a new access and reworking of the external space would be required. A balancing pond would be excavated within the small-scale pasture landscape to the east of the business (eastbound side). It is anticipated the construction activity would result in construction noise being audible within this landscape. Outside the AONB, within the Higham Arable Farmlands (Thong), the removal of vegetation between the A2 and HS1, the woodland block on the north side of the

Item	Description
	A2, immediately west of Thong Lane, would be clear from within the A2/HS1 corridor within the AONB. The associated construction activities, the compound south of Thong village, along with National Grid construction activity would also be evident. These construction activities would encroach into the treed landscape of the A2/HS1 transport corridor both within the AONB and within its setting. The tree removal, combined with the above construction activities, would result in a clear widening of the infrastructure corridor, greater physical and visual severance and further isolating Shorne Woods Country Park to the north with Cobham parklands and Ashenbank Wood to the south. It is considered that the construction phase and associated noise would have a **Major negative** change on the character of the A2/HS1 corridor through the AONB.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare. light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	Shorne and Higham Marshes
Nature of effect	The Project would have an indirect impact on this landscape as a result of the construction activity within the adjacent Higham Arable Farmlands (North). The tunnel construction compound, construction work and associated activities between Thong Lane (defined by a tall line of vegetation located on a local ridgeline) and the A226 (located on lower ground and defined by linear vegetation and residential properties) would be located on an exposed open slope. This open slope forms the rural backdrop to this flat low-lying area. The indirect activities on this higher ground will include the field and vegetation removal; cutting excavation; gas pipeline installation; the presence of the tunnel construction compound and associated industrial features, including night-time lighting, along with the ridgeline cutting excavations and installation of the Thong Lane green bridge. This activity would result in a partial industrial backdrop to this remote and tranquil estuary edge landscape.

Item	Description
	It is considered that the construction phase within the adjacent Higham Arable Farmlands (North) would have a **Moderate negative** indirect change on the character of this low lying, remote estuary edge landscape.
Duration	Short to medium term
Mitigation	Mitigation will consider: • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	High Arable Farmlands (Chalk)
Nature of effect	The Project would have a direct impact on this intimate landscape as a result of extensive construction activity extending between HS1 which defines its south boundary and Thong Lane at its north edge. The work would include realigning the present A2 slightly to the north of its present position. There would be an extensive construction compound sited to the south-west of Thong village, with its associated industrial features and, night-time lighting. The most notable construction activity would be the new Project route/A2 junction and associated earthworks. Construction activities would be widespread through the area and would include important vegetation removal along the A2 and HS1 corridor and along Thong between the village and Gravesend Urban Edge, National Grid gas pipeline installation and compound and overhead powerline realignment, along with the cutting excavations and installation of the Thong Lane green bridges. This activity would result in the disruption and loss of important landscape features. It is considered that the construction phase and associated noise would have a direct **Major negative** change on the character of this intimate urban edge landscape.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained

Item	Description
	• construction programme using phased replacement planting
Receptor	Higham Arable Farmlands (Thong)
Nature of effect	The Project would have a direct impact on this landscape as a result of construction work and associated activities within the open rolling farmed slopes between Thong Lane (defined by a tall line of vegetation located on a local ridgeline) and Higham Road (located on lower ground at the intersection of the chalk dip slope and the Thames Marshes). The main construction work and activities would occur on the higher ground which lies to the south of the A226 (defined by linear vegetation and residential properties). The main activities on this higher ground would include the field and vegetation removal; cutting excavation; gas pipeline installation; the presence of the tunnel construction compound and associated industrial features, including night-time lighting, along with the ridgeline cutting excavations and installation of the Thong Lane green bridge. This activity would result in the disruption and loss of important landscape features. It is considered that the construction phase and associated noise would have a direct **Major negative** change on the character of this open, urban edge chalkland farmed landscape.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	Higham Arable Farmlands (Gadshill)
Nature of effect	The Project would have a localised indirect impact on this rural landscape as a result of the construction activity along the east-west corridor of the present A2/M2 at Park Pale, within the AONB and the tie-in with the A289. The main elements of the work would include regrading the existing A2 earthworks to accommodate the carriageway widening of the A2 from 8 lanes to 14 and tie-ins with the A289 link roads.

Item	Description
	It is considered that the construction phase and associated noise would have a **Minor negative** change on the character of this open, urban edge chalkland farmed landscape.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • good design in the routing of construction access to avoid key landscape features • protection and management of key landscape features within the Development Boundary which have been identified to be retained
Receptor	Istead Arable Farmlands
Nature of effect	The Project would have a direct impact on this landscape as a result of works to National Grid assets, along with indirect impacts as a result of the construction activity within the adjacent Kent Downs AONB and Higham Arable Farmlands (South) character areas to the north. The main elements of the construction work having the largest change would be the vegetation clearance between the A2 and HS1. In particular the loss of important mature vegetation, which sits on the skyline would result in a much wider ridgeline notch. It is anticipated the loss of this vegetation would significantly reduce the degree of screening that is presently afforded by the existing A2/HS1 infrastructure planting. Other construction work and activities which would have an impact include the installation of the Thong Lane replacement bridge and the structures and earthworks associated with the Project route/A2 junction. It is considered that these construction activities would have an indirect **Moderate negative** change on the character of this urban edge landscape within its north east part defined by the well-used recreational area of Jeskyns Community Woodland.
Duration	Short to medium term
Mitigation	Mitigation will consider: • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	Gravesend Southern Fringe
Nature of effect	The Project would have a localised, direct impact on this urban edge landscape as a result of alteration work at the east end of the area. The main element of work would include alteration and extension of the present A2 balancing pond on the north side of the A2 and work at the adjacent Valley Drive/A2 junction. It is considered that these construction activities would have a direct **Minor negative** change on the urban edge character of this area.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors

Item	Description
	• use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	Shorne Wooded Slopes
Nature of effect	The Project would have a localised indirect impact on this rural landscape as a result of the construction activity along the east-west corridor of the present A2/M2 at Park Pale, within the AONB and its tie-in with the A289. The main elements of the work would include regrading the existing A2 earthworks to accommodate the carriageway widening of the A2 from 8 lanes to 14 and tie-ins with the A289 link roads and the excavation of a balancing pond within the small-scale pasture landscape to the east of the business at Park Pale (eastbound side). It is anticipated the construction activity would result in construction noise being audible within this landscape. It is considered that the construction work along the A2/M2 corridor and A289 within the adjacent AONB and Higham Arable Farmlands (Gadshill) would have an indirect **Minor negative** change on this intimate small-scale wooded landscape.
Duration	Short to medium term
Mitigation	Mitigation will consider: • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained

8.6.5 The potential visual changes (nature of effect) within the study area south of the River Thames, as a result of the Project construction (without mitigation) and the potential measures proposed to manage them are outlined in Table 8.11 . The visual receptors identified by (S-x) in this Table cross-refer to the corresponding high sensitivity receptor type and view description set out in Table 8.7.

Table 8.11 Construction (visual effects south of River Thames)

Item	Description
Visual receptors	Kent Downs AONB (LCA 4 West Kent Downs)
Nature of effect	Although the woodland and nature of the landscape on both sides of the A2 corridor helps to limit more distant views to the A2, the consequence of the anticipated extensive construction activity along the A2 corridor within the AONB would be experienced by people from several vantage points which are in relatively close proximity to it. In addition, construction activity within the adjacent Higham Arable Farmlands (South) would also be experienced by people at the same vantage point at the west edge of the AONB. It is considered that the construction activity would have a **Major to moderate negative** change on the visual amenity of the area on people at the following receptors: • Users at the north edge of Ashenbank Wood (S-05) • Users on the Darnley Trail at the north edge of Cobham Park (S-06) • Visitors to Cobham Park at its entrance off Brewers Road • Visitors to the AONB and users of the local road network (Brewers Road, Thong Lane and Half Pence Lane) in the vicinity of the A2 junction roundabout • Users of Shorne Woods Country Park • Users of the Timeball & Telegraph Trail (S-04). Temporary route to be confirmed. • Users of the National Cycle Route (S-01) Temporary route to be confirmed • Visitors to the Inn on the Lake Hotel • Users on the Park Pale golf course access road • Local business at Park Pale • Users on the PRoW at Park Pale (S-02) • Potential for construction noise to impact on tranquility of all users/visitors to the AONB
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds/work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation

Item	Description
	• good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	Shorne and Higham Marshes
Nature of Effect	Typically, the PRoW network follows the north-south orientated tracks across the low-lying flat marshes, from which there are filtered and intermittent views out to the south due to the presence of adjacent vegetation. It is anticipated that the main visual impacts arising from the Project construction would be on views from the more elevated east-west orientated routes associated with the Thames Flood defence and the course of the disused Medway Canal. It is considered that the tunnel construction compound and the other construction work on the open slope between the A226 and Thong Lane would be visible in southerly views from these two receptors. It its considered the construction activity within the adjacent area would have a **Moderate** to **Slight negative** change on sequential views for people at the following vantage points: • Saxon Shore Way LDP (Future England Coast Path) (S-18) • National Cycle Route 1 (S-17)
Duration	Short to medium term
Mitigation	None identified – see Higham Arable Farmlands (Chalk)
Visual receptors	Higham Arable Farmlands (Chalk)
Nature of effect	Due to the open and gently rolling nature of this area, it is anticipated the Project construction within the west part of this landscape would be widely visible from many parts of the PRoW network and from its perimeter with the Gravesend Urban Edge to the west, the village of Shorne to the east and from Shorne Ifield Road which delineates the boundary of the Kent Downs AONB to the south. It is considered the construction activity would have a **Major** to **Moderate negative** change on the views experienced by people at the following vantage points: • Residents at the Gravesend Urban Edge (S-12) • Users on the PRoW network between Gravesend and the rural settlement of Shorne (S-13 & S-15)

Item	Description
	• Users on the local road network, which includes Shorne Ifield Road (S-11) and A226 Gravesend Road (S-15) • Residents on the A226 Gravesend Road (S-15) • Residents at Upper Iflield
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	Higham Arable Farmlands (Thong)
Nature of effect	Due to the open and gently rolling nature of this area, it is anticipated the widespread Project construction within this landscape would be widely visible from the PRoW network, from its perimeter with the Gravesend Urban Edge to the west and the village of Thong and Thong Lane in the east. It is considered the construction activity would have a **Major** to **Moderate negative** change on the views experienced by people at the following vantage points: • Residents at the rural settlement of Thong (S-09) • Residents at the Gravesend Urban Edge (S-10) • Users on the PRoW network between the Gravesend Urban Edge and the rural settlement of Thong (S-10 & S-09) (Temporary routes to be confirmed) • Users on the local road network (Thong Lane)
Duration	Short to medium term
Mitigation	Mitigation will consider:

Item	Description
	• use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	Higham Arable Farmlands (Gadshill)
Nature of effect	Due to the wooded nature of the A2/M2 infrastructure corridor at the west edge of this area, it is anticipated that the Project construction impacts on views within this landscape would be relatively localised. It is considered the construction activity would have a **Minor to negligible negative** change on the views for residential properties on Crutches Lane.
Duration	Short to medium term
Mitigation	Mitigation will consider: • good design in the routing of construction access to avoid key landscape features • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme to consider phased replacement planting
Visual receptors	Istead Arable Farmlands
Nature of effect	Due to local topography, and the linear east-west orientated intervening vegetation associated with HS1, the main visual impacts on this area would occur within the north east part of this landscape within the Jeskyns Community Woodland. The main impacts would occur as a result of widespread vegetation removal along the A2/HS1 corridor and in particular the established skyline trees to the north east near Thong Lane within the Kent Downs AONB. The loss of intervening vegetation would result in greater exposure to the A2/Project route junction construction work which would be visible beyond the retained HS1 vegetation. It is considered that the construction activity within the adjacent Higham Arable Farmlands (South) would have a **Moderate negative** change on the following

Item	Description
	visual receptors as a result of construction activities within Kent Downs AONB and Higham Arable Farmlands (South) • Jeskyns Community Woodland (S-08) • Timeball & Telegraph Trail (S-04)
Duration	Short to medium term
Mitigation	Mitigation will consider: • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme to consider phased replacement planting
Visual receptors	Gravesend Southern Fringe
Nature of effect	No change on visual amenity
Visual receptors	Shorne Wooded Slopes
Nature of effect	Much of the area is presently screened from the A2/M2 junction within the AONB and the A289 by a planted false cutting and dense unmanaged young woodland at the south west edge of this area. It is anticipated that this visual screen would be retained as part of the Project. However, there would be a localised impact on views from Bowesden Lane during the balancing pond construction. But within the elevated and wooded north and east part of this area, it is anticipated that most of the construction activity along the A2 corridor within the adjacent AONB would not be visible. It is considered that the construction activity along the A2 corridor near Park Pale would have a **Moderate to Minor negative** change on the following visual receptors as a result of construction activities within Kent Downs AONB: • Users on the Timeball & Telegraph Trail (Bowesden Lane) • Residential properties on Bowesden Lane.
Duration	Short to medium term
Mitigation	Mitigation will consider: • good design in the routing of construction access to avoid key landscape features • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme to consider phased replacement planting

8.6.6 The potential landscape changes (Nature of effect) within the study area north of the River Thames, because of the Project construction (without mitigation) and the potential measures proposed to manage them are outlined in Table 8.12.

Table 8.12 Construction (landscape effects north of River Thames)

Item	Description
Receptor	8: C3 Mucking Marshes
Nature of effect	This landscape has a strong easterly relationship with the Thames Estuary and due to its low lying, flat nature in association with the intervening ribbon development along Princess Margaret's Road, and the local landform within D7 West Tilbury Urban Fringe and C5 Tilbury Marshes, this area is relatively disconnected with the landscape to the west. It is therefore anticipated that the Project would have a limited indirect impact on this low-lying flat landscape because of relatively remote construction activity associated with the northern tunnel construction compound within the adjoining C5 Tilbury Marshes and the rest and service area (RaSA) and Tilbury Loop viaduct within D7 West Tilbury Urban Fringe to the west. It is considered that the construction activities would have a **Negligible negative** change as a result of indirect construction activities within C5 Tilbury Marshes and D7 West Tilbury Urban Fringe.
Duration	Short to medium term
Mitigation	None required
Receptor	2: C5 Tilbury Marshes
Nature of effect	It is anticipated that there would be widespread disruption to this low-lying flat landscape during the Project construction. The main impacts are likely to arise because of the extensive nature of the north portal's tunnel construction compound with its associated industrial features, storage areas for the tunnel arisings and night-time lighting along with activity associated with the loading and unloading of boats at the Thames Jetty. This major compound would also require a new access which is likely to be from Tilbury in the west. Other main construction work would include the activities associated with the earthworks at the new junction for the rest and service area (RaSA) and the diversion of School Road at the north edge of the area. It is considered that the construction activities would have a **Major adverse** change.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features

Item	Description
	• good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	6: D4 White Crofts and Orsett Heath Urban Fringe
Nature of effect	It is anticipated that there would be disruption throughout this landscape character during the Project construction. The construction activities would include clearance of arable farmland, the building of new earthworks, overbridges and 6-lane carriageways, with associated satellite compounds, material and topsoil stockpiles. Site clearance, including the removal of some vegetation within the immediate setting to the Grade II listed Heath Place and the construction of the adjacent overbridge is likely to have a major change on the character of the intimate, small scale landscape near Hornsby Lane. Construction activity would be more widespread in the north part of the area, which is affected by the presence of the A13, A1089 and A1013, due to the major re-working of the present junction and in particular the series of new link roads, including the realignment of the present A1013 which would run parallel and to the south of the A13. This would require widespread site clearance, earthmoving and storage stockpiles, a series of satellite compounds and stockpile associated with the construction of new overbridges and link roads, earth mounding within and to the perimeter of the junction, gantries and street lighting. Other work would include the dismantling, realignment and rewiring of a National Grid 400kV overhead powerline as well as local diversion and/or modification of other utilities infrastructure. It is considered that the construction activities would have a **Major negative** change as a result of direct construction activities throughout the character area.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution

Item	Description
	• protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	5: D5 Linford and Buckingham Hill Urban Fringe
Nature of effect	This landscape forms a local area of high ground to the north of the settlement of Linford and has a strong relationship with the low lying, flat Mucking Marshes to the south east of it. The Project construction would have a direct impact on its south west edge ie, near Orsett golf club and the wooded industrial landscape to the west of Linford. The Project construction would include clearance of arable farmland, the removal of vegetation near Hoford Road, the building of new earthworks, an overbridge and 6 lane carriageways, with associated satellite compounds, material and topsoil stockpiles. There would also be rewiring of a National Grid 400kV overhead powerline which passes to the west of Linford. It is considered that the combination of vegetation cover and industry at the west edge of this area would limit the impacts to its perimeter and buffer them from the wider character area to the east. It is considered that the construction activities would have a **Minor negative** change as a result of direct construction activities at the west edge of the character area.
Duration	Short to medium term
Mitigation	None required
Receptor	6 Chadwell Escarpment Urban Fringe
Nature of effect	The Project construction would have two direct impacts on this area. Within the east part of the area near Low Street (Station Road), and where the topography of the area is low lying, the vegetation clearance and construction work associated with the Tilbury Loop line viaduct would result in local direct disruption to this area. The intervening vegetation and buildings on Low Street would help to limit these impacts and buffer them from the wider more elevated part of this area to the west. In the west part of the area, near Biggin Lane, the sloping ground on either side has been identified as an area for flood compensation. This would require site clearance, earth moving and stockpiling, excavation of the ground to a lower level and reprofiling affected slopes. The affected land would be reinstated back to its original land use. Due to the elevated southerly aspect of this character area and its strong relationship with the adjoining low lying flat Tilbury Marshes it is considered that works within the adjoining area would have an indirect impact, particularly in regard to the extensive nature of the north tunnel portal compound and the likely scale of its associated industrial features, storage areas and night-time lighting along with the dismantling, realignment and rewiring of a National Grid 400kV overhead powerline, would have an influence on the character of the area. This area, due again to its elevation, also has a strong relationship with the open arable landscape to the north east within the West Tilbury Urban Fringe. The potential widespread disruption within this area, and in particular the extensive construction work associated with the flood compensation, would also have an influence on the character of the area.

Item	Description
	It is considered that the construction activities would have a **Moderate negative** change as a result of the direct and indirect construction activities within the area and within the adjacent Tilbury Marshes and West Tilbury Urban Fringe.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution protection and management of key landscape features within the Development Boundary which have been identified to be retained construction programme using phased replacement planting
Receptor	D7 West Tilbury Urban Fringe
Nature of effect	It is anticipated that there would be widespread disruption throughout this character area during the Project construction. Construction activity would mostly be focused on the open arable farmland between the settlements of West Tilbury and East Tilbury. The construction activities would include clearance of arable farmland, the building of new earthworks, the Tilbury Loop line viaduct, overbridges and 6-lane carriageways, with associated satellite compounds, material and topsoil stockpiles. Other activities would include the removal of trees to the east of Low Street along with extensive construction work associated with the flood compensation areas, which would include site clearance, earth moving and stockpiling, excavation of the ground to a lower level and reprofiling affected slopes. Construction activity associated with the RaSA and the realignment and rewiring of a National Grid 400kV overhead powerline would encroach within the south east part of this landscape, to the south of the Tilbury Loop line near Gravelpit Farm. It is considered that the construction activities would have a **Major negative** change as a result of the direct construction activities within the area.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors

Item	Description
	• use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	(H) Orsett Lowland Farmland
Nature of effect	This landscape sits to the north of the A13 and encompasses the small settlement of Baker Street. The south edge of the area is affected by road infrastructure due to the presence of the A13 and its junctions with the A1089 and A1013. This landscape has a strong relationship with the vast expanse of the open, low lying Thurrock Reclaimed Fen landscape to the north. The Project construction would directly impact on the west edge of this character area and includes demolition of properties and vegetation removal within the south part of the settlement of Baker Street, and vegetation removal which forms part of the setting to the Grade II Listed Baker Street Mill at the north-west corner of the settlement. The Project would directly impact on the open arable fields to the west of Baker Street on both sides of Stifford Clays Road. The fields to the south of the road form part of an extensive Scheduled Monument. Construction activity would be widespread in this part of the area, due to the major re-working of the present junction. This would require widespread site clearance, earthmoving and storage stockpiles, a series of satellite compounds and stockpile associated with the construction of new overbridges and link roads, earth mounding within and to the perimeter of the junction, gantries and street lighting. It is considered that the construction activities would have a **Major negative** change as a result of the direct and indirect construction activities within the area and the adjoining D4 White Crofts/Orsett Heath Urban Fringe.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation

Item	Description
	• good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	(J) Thurrock Reclaimed Fen
Nature of effect	It is anticipated that there would be disruption throughout this landscape during the Project construction. The main impact would occur within the relatively remote and tranquil landscape of the former low lying, flat Orsett Fen which forms the focus of this landscape located between the suburban townscape of South Ockendon in the west and the rural settlement of Bulphan to the north east. The main feature of the Project would be the construction work and activities associated with the combined 1km long viaduct and embankments as it crosses the extensive floodplain of this area. This would include a construction compound and pilling rig. Construction noise would be audible within this relatively remote landscape. Prior to this the flood compensation areas in this area would require site clearance of the arable fields located outside the existing flood plain, earth moving and stockpiling, excavation of the ground to a lower level and reprofiling affected slopes. The affected land would then be reinstated back to its original land use. Other construction activities would include clearance of arable farmland, the building of new earthworks, overbridges, 6-lane carriageways, with associated satellite compounds, material and topsoil stockpiles and balancing ponds. Further, more localised disruption would occur where there would be alteration to the M25 to the east of Upminster. Most of the construction activity here would be on the west side of the M25 to build out the new link up to junction 29. This would require vegetation removal on the existing M25 earthworks and within adjacent land, earth moving and the widening of several existing M25 structures. The latter would require satellite compounds and storage areas. A couple of flood compensation areas would also have to be provided. It is considered that the construction activities would have a **Major negative** change as a result of the direct construction activities within this area.
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding

Item	Description
	• opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	(A) Belhus Lowland Quarry Farmland
Nature of effect	This is an extensive landscape which focuses on the low-lying, gently rolling and well treed landscape around Belhus Woods Country Park and the former estates landscape lying between South Ockendon and Upminster. The Project construction would result in local disruption to the landscape within the north east part of the area, the character of which is already partly affected by the presence of the M25. The main construction work and activity would occur at the Project intersection with the M25 to the west of North Ockendon as a result of a new underbridge to take the Project beneath the M25 and associated temporary works to realign the M25 during this period. This work would require a compound with its associated industrial elements, storage compounds and night-time lighting. Other construction activities would include clearance of arable farmland, the building of new earthworks, an overbridge and 6 lane carriageways, with associated satellite compounds, material and topsoil stockpile. Specific localised changes would result in the demolition of residential properties on the B1421, on the west side of the M25 and land take and vegetation removal within the important Thames Chase community forest centre to the north. It is considered that the construction activities would have a **Moderate negative** change as a result of the direct construction activities within the area
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds/work areas and activities which lie immediately adjacent to key sensitive visual receptors • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation

Item	Description
	• good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Receptor	(B) Brentwood Wooded Hills
Nature of effect	This is an extensive landscape which focuses on the undulating, well-treed landscape around Thorndon Park to the north of the A129. The Project construction would result in alteration to the existing M25 junction 29 and along a short section of the M25 northwards. The main construction activities would be vegetation clearance within the highway estate near the junction and on both sides of the M25 to the north and gantry installation. At this stage it is not anticipated vegetation clearance outside the highway estate would be required and as such would help to buffer the impacts of the construction work from the wider landscape. The construction work would also include the dismantling, realignment and rewiring of a National Grid 400kV overhead powerline to the south of the M25 junction 29. It is considered that the construction activities would have a **Minor negative** change as a result of the direct construction activities within the present M25 highway estate.
Duration	Short to medium term
Mitigation	Mitigation will consider: • good design in the routing of construction access to avoid key landscape features • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme may use phased replacement planting

8.6.7 The potential visual changes (Nature of effect) within the study area north of the River Thames, as a result of the Project construction (without mitigation) and the potential measures proposed to manage them are outlined in Table 8.13. The visual receptors identified by (N-x) in this table cross refer to the corresponding high sensitivity receptor type and view description set out in Table 8.7.

Table 8.13 Construction (visual effects north of River Thames)

Item	Description
Visual receptors	C3 Mucking Marshes
Nature of effect	Due to the relatively disconnected nature of this area with the landscape to the west there are a limited number of receptors within this area which would have a potential view to the construction work associated with the main north tunnel portal compound within the adjacent C5 Tilbury Marshes. However, it is envisaged much of the construction work would be screened by intervening high ground of the landfill and by natural ground to the north, with only taller elements visible over. There is also the potential for some residential properties at the east edge of the area within East Tilbury to have a view to the construction work associated with the RaSA within the adjacent D7 West Tilbury Urban Fringe. It is considered that the construction activity within the adjacent character areas would have a **Moderate** to **Minor negative** change on the following visual receptors • Visitors to Coalhouse Fort and Open Space (N-02) • Residents at properties on Princess Margaret Road (N-03)
Duration	Short to medium term
Mitigation	Mitigation will consider: • opportunities to use compound hoarding as part of noise mitigation • protection and management of key landscape features within the Development Boundary which have been identified to be retained
Visual receptors	C5 Tilbury Marshes
Nature of effect	Other than areas of Common Land within the west central part of this area the visual receptors are limited to its perimeter. It is envisaged that the extensive nature of the north tunnel portal construction compound, associated industrial features, material stockpiles and storage areas, along with construction vehicles on the compound access road would be visible from these receptors at varying distances. It is considered that the construction activity within the area would have a **Moderate** to **Minor adverse** change on the following visual receptors: • Users on the conjoined Thames riverside National Cycle Route 13 & PRoW (N-01) • Users of PRoW linking Princess Margaret Road, Buckland and Station Road • Users of Common Land at Walton Common & Parsonage Common • Users and residents at properties at the east edge of Tilbury on Fort Road (N-05) and users of Cooper Shaw Road • Visitors to Tilbury Fort (N-04)
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors

Item	Description
	• use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	D4 White Crofts/Orsett Heath Urban Fringe
Nature of effect	This landscape has a relatively dense network of PRoW and local lanes as well as a mix of scattered rural properties and due to the widespread nature of the construction activity within this relatively compact landscape it would be experienced in relatively close proximity to the receptor. It is considered that the construction activity within the area would have a **Major** to **Moderate negative** change on the following visual receptors: • Residents at property at Brook Farm • Users on Brentwood Road • Users on the PRoW network (N-16) • Residents at the Grade II listed Heath Place (N-15) • Users on Hornsby Lane (N-15) • Residents at rural property on Hornsby Lane • Residents at properties and users on A1013 Stanford Road • Residents at properties on Heath Road • Users on A1089 Dock Approach Road • Users on Long Lane (N-17)
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds/work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views

Item	Description
	• use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • consider opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	D5 Linford/Buckingham Hill Urban Fringe
Nature of effect	Due to the relatively disconnected nature of this landscape to the Project and the intervening tree lines and industry within the south west part of the area, the views out to the construction work and activities within the adjacent open arable farmland, where the Project is located, are limited to receptors at the perimeter of the area. It is anticipated that where the construction work is visible it would be heavily filtered by the intervening vegetation. It is considered that the construction activity within the area and the adjacent D7 West Tilbury Urban Fringe would have a **Minor negative** change on the following visual receptors: • Users on Hoford Lane (Protected Lane) (N-13) • Residents at properties on Lower Crescent, Linford
Duration	Short to medium term
Mitigation	Mitigation will consider: • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	D6 Chadwell Escarpment Urban Fringe
Nature of effect	Due to the proximity of this landscape to the Project construction within the low-lying eastern part of the area at Low Street, the works associated with the Tilbury Loop line viaduct would impact on some views from the settlement. On the lower ground near Biggin Hill, to the south of the urban area of Chadwell St Mary, construction work associated with the potential flood compensation area would impact on views from residential properties on Biggin Hill Lane. Further west where this area is more elevated and exposed and has a strong relationship with the low-lying Tilbury Marshes to the south and the open arable farmland to the north east (West Tilbury Urban Fringe) there would be views from the more elevated receptors near the settlement at West Tilbury. It is considered that the construction activity within the west part of the area near Biggin Hill would have a **Major** to **Moderate negative** change and elsewhere as a result of construction activity within the adjacent C5 Tilbury Marshes and D7 West Tilbury Urban Fringe would have a **Moderate** to **Minor negative** change. The visual receptors affected would include:

Item	Description
	• Residents at properties on Biggin Hill Lane • Users on the PRoW network north of Biggin Hill Lane • Users at Hall Hill and West Tilbury church yard • Users on Station Road, West Tilbury • Residents at properties at Low Street (N-07)
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds/work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • Construction programme to consider phased replacement planting
Visual receptors	D7 West Tilbury Urban Fringe
Nature of effect	This landscape has a relatively dense network of PRoW and local lanes as well as a mix of scattered rural properties and due to the widespread nature of the construction activity within this relatively compact landscape it would be experienced in relatively close proximity to the receptor. It is considered that the construction activity within the area would have a **Major to Moderate negative** change on the following visual receptors: • Residents at properties at the settlement of West Tilbury on Church Lane and Blue Anchor Lane (N-11) • Residents at property at Holford Farm on Blue Anchor Lane (N-11) • Users on PRoW network between West Tilbury and East Tilbury (N-09 and N-11) • Users on Coal Road (N-08 and N-12) • Residents at properties at the edge of East Tilbury (N-09) • Residents at rural properties and users on Muckingford Road (N-12) • Residents at property at Becksland off Muckingford Road • Users on Hoford Lane (Protected Lane) (N-13)

Item	Description
	• Residents at rural property at High House on High House Lane • Users on Low Street Lane (N-07) • Residents at rural properties on Station Road/Love Lane (N-08)
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	(H) Orsett Lowland Farmland
Nature of effect	This landscape has a relatively dense network of PRoW and local lanes as well as a mix of scattered rural properties and urban properties. Due to the widespread nature of the construction activity within this relatively compact landscape it would be experienced in relatively close proximity to the receptor. The landscape to the west and northwest of Baker Street has a strong relationship with the low lying and open arable landscape of Orsett Fen within the adjacent (J) Thurrock Reclaimed Fen. It is considered that the construction activity within the area and the adjacent (J) Thurrock Reclaimed Fen would have a **Major** to **Moderate negative** change on the following visual receptors: • Residents at properties on B188 Baker Street (N-18) • Users on PRoW network near Baker Street • Residents at rural and settlement edge properties on Stifford Clays Road (N-19)
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors

Item	Description
	• use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	(K) West Thurrock & Grays Quarry Townscape
Nature of effect:	This urban landscape adjoins the D4 White Crofts/Orsett Heath Urban Fringe landscape which would experience widespread disruption during the Project's construction. Construction activity would be visible from several scattered locations at the edge of this urban area. It is considered that the construction activity within the area would have a **Major negative to Moderate negative** change on the following visual receptors: • Residents at urban edge properties on Courtney Road and Alexandra Close, Chadwell St Mary (N-14) • Residents of 3 tower blocks off Godman Road, Chadwell St Mary (N-14) • Residents at urban edge properties of Godman Road, Cedar Road and Barry Close, Chadwell St Mary (N-16) • Residents at urban edge properties on Heath Road and Greyhound Lane, Orsett Heath • Residents at urban edge properties on Foxes Lane and Gowers Lane, Orsett Heath
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements

Item	Description
	• opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	(J) Thurrock Reclaimed Fen
Nature of effect	This open, low-lying, flat, large scale, tranquil landscape is traversed by several PRoW and scattered farmsteads and residential properties. The construction work and activities associated with the viaduct and embankment across the Mardyke floodplain and the associated flood compensation areas would impact on several rural receptors within this area. In the north west part of the area where the Project lies within the M25 corridor the construction work would be most visible within the landscape to the west. It is considered that the construction activity within the more open and remote Orsett Fen area would have a **Major** to **Moderate negative** change and the construction work within the M25 corridor would have a **Moderate to Minor negative** change. The visual receptors affected would include: • Residents at settlement edge property at Old Rectory, Fen Lane • Users on Green Lane (N20 and N21) • Residents at rural property at Hobletts at south edge of Orsett Fen (N-24) • Users on PRoW network within Orsett Fen and Mardyke (N-24) • Users of Open Access Land at Orsett Fen • Users on PRoW network at Bulphan Fen (N-25) • Residents at properties in vicinity of Judds Farm, Harrow Lane (N-25) • Residents of rural property at Fen Farm, off Fen Lane • Users at Top Meadow Golf Course off Fen Lane • Users of Cranham Golf Course • Residents of rural properties (Franks Cottages) on B186 St Marys Lane and property at Franks Farm, west of M25 • Users of PRoW network on either side of M25 east of Cranham
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation • good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views

Item	Description
	• use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	(A) Belhus Lowland Quarry Farmland
Nature of effect	The Project would cut across the north east corner of this low-lying arable landscape where it is near the more open large-scale (J) Thurrock Reclaimed Fen landscape. The greater extent of tree cover and field boundary hedgerows within the landscape would help to break up the construction work and activities, particularly the extensive construction work associated with the Project route tie-in with the M25 to the south west of North Ockendon Elsewhere the construction work associated with the B186 North Road overbridge and the adjacent earthworks would be visible from nearby residential properties. The widening of the existing M25 cutting and encroachment into the Thames Chase community forest centre and associated vegetation clearance would impact on views for users in the south part of this locally important asset. It is considered that the construction activity within the area would have locally a **Major negative** change on some short-range views but typically the changes would be **Moderate** to **Minor negative.** Potential visual receptors which could be affected include: • Users on PRoW network in vicinity of South Ockendon Hall (N-26) • Residents of rural property at South Ockendon Hall (N-26) • Residents of rural properties at Groves Cottages off B186, North Road • Residents of rural properties and users on B186, North Road (N-28) • Users of PRoW network between South Ockendon and North Ockendon • Residents of rural properties on Church Lane, North Ockendon • Residents of rural properties and users on B1421 Ockendon Road in vicinity of M25 (N-30) • Users of the Thames Chase Community Forest Centre (N-31)
Duration	Short to medium term
Mitigation	Mitigation will consider: • use of well-designed construction hoarding to the perimeter of local compounds and work areas and activities which lie immediately adjacent to key sensitive visual receptors • use of artwork and imagery to integrate compound hoarding • opportunities to use compound hoarding as part of noise mitigation

Item	Description
	• good design in the layout and appearance of construction compounds and the siting of tall, large scale industrial elements within them to minimise visual intrusion on key views • use of sensitively designed topsoil stockpiles to provide screening to intrusive compound elements • opportunities to use stockpiled material as part of noise mitigation • good design in the routing of construction access to avoid key landscape features • good design in the layout and appearance of night-time lighting at compounds and during night-time construction activities to avoid light glare, light spill and light pollution • protection and management of key landscape features within the Development Boundary which have been identified to be retained • construction programme using phased replacement planting
Visual receptors	(B) Brentwood Wooded Hills
Nature of effect	The works within this area would be limited to the existing M25 estate. The main construction impact would be associated with the re-grading of the large scale existing M25 cutting and vegetation clearance near Beresden Lane at the north extent of the Project and to modifications to the M25 J29. It is considered that the construction activity within the area would have a **major negative** change on the view for the following visual receptors: • Users on PRoW to the south east of M25 J29 • Users on PRoW Beresden Lane at north extent of Project
Duration	Short to medium term
Mitigation	Mitigation will consider: • Protection and management of key landscape features within the Development Boundary which have been identified to be retained • Construction programme using phased replacement planting

Operation

8.6.8 Figure 8.1 in Volume 3 indicates the extent of the Project's operational visibility within 2km from the Development Boundary edge and as such provides the context within which the potential landscape and visual effects arising from it would occur. It should be noted that the grain of the LiDAR data within this area varies considerably and as such the ZVI indicated is very conservative in its extent. Based on field survey work during winter 2017/2018 it is believed that the ZVI does not fully consider the screening nature of the woodland within the AONB.

8.6.9 South of the Thames Estuary and within the setting to the Kent Downs AONB, as the Project traverses open large-scale arable farmland on the chalk dip slope of the North Downs it would be in deep cutting. This cutting would extend from the south tunnel portal, located to the south of the A226 up to a point just south of the present A2 to the south west of Thong. Further south, on higher ground the landscape becomes more enclosed because of the woodland cover within

the Kent Downs AONB. Here the Project would mostly be at a similar level to the present A2.

8.6.10 The main features within this area would be the new overbridges at Brewers Road and Thong Lane across the A2 in association with adjacent vegetation removal, the overbridges and earthworks at the Project route/A2 junction, and the overbridge at Thong Lane over the Project.

c. Based on the ZVI in Figure 8.1 in Volume 3 and the 2017/2018 winter surveys the following area within the 2km study area to the south of the River Thames has not been carried forward at this stage due to its remoteness and limited exposure to the operational Project. However, this will be subject to review as the Project design develops during the DCO. The area is Gravesend Southern Fringes.

8.6.11 The potential landscape changes (Nature of effect) arising from the Project operation (without mitigation) south of the River Thames, and the potential measures proposed to manage them are outlined in Table 8.14. The initial landscape measures being considered for the Project are indicated on the Outline EMP in Figure 2.4 in Volume 3.

Table 8.14 Operation (landscape effects south of River Thames)

Item	Description
Receptor	Kent Downs AONB (LCA 4 West Kent Downs)
Nature of effect	The 14-lane carriageway within the AONB, along with the realignment of the adjacent local roads, the encroachment within the HS1 land to the south, the longer overbridges at Brewers Road and Thong Lane, the associated loss of important established mature trees and HS1 mitigation planting, would result in a major alteration in the scale and rural appearance of the A2 corridor through the AONB. The loss of the important trees and the HS1 mitigation planting would also result in greater physical severance between the landscapes on either side of the A2 as well as a reduction in the containment of the road infrastructure, such as gantries, signs and street lighting, resulting in the A2 and HS1 corridor having a greater presence in the adjacent rural landscape. In addition, the increase in traffic flows along the A2/Project route, through the AONB may result in increased traffic noise within the adjacent landscape and recreational areas as well as within the historic Cobham Hall and Park. The A2/Project route junction on the eastbound side of the A2 and the loss of linear vegetation on the westbound side up to HS1, within the Higham Arable Farmlands (Thong), would have a major alteration to the scale and rural appearance, resulting in urban encroachment into the immediate western setting of the AONB. It is considered that the operational impacts of the Project route within the area and the adjacent Higham Arable Farmlands (Thong), would have a direct **Major negative** change on the character of the A2 corridor through the AONB and its immediate setting.
Duration	Permanent
Mitigation	Mitigation will consider: • A landscape earthworks and associated planting strategy which incorporates a 4m high environmental barrier along both sides of

Item	Description
	the A2/Project route corridor to provide a visual screen and possible noise buffer. The barrier would comprise a combination of free standing wall, retaining wall, geotechnical wall or earth bund depending on available land within the existing highway estate. • An architectural or artist-led approach for the design and materials of all hard features to ensure high quality finish • An architectural strategy for the green structures at Brewers Road and Thong Lane overbridges with associated native species linear shrub planting. To be developed in association with Biodiversity assessment, NMU (non-motorised users, ie, pedestrians, cyclists and horse riders) strategy and Green Infrastructure assessment • A landscape earthwork and associated woodland planting strategy which, over time, integrates the link roads, structures, traffic and gantries at the A2/Project route junction
Receptor	Shorne and Higham Marshes
Nature of effect	It is considered that the Project operation of the deep cutting within the adjacent Higham Arable Farmlands (Chalk) would have a limited indirect impact on the character of this area. It is considered that the operational impacts within the adjacent exposed, open arable landscape would have an indirect **Negligible negative** change on the character of this low lying, remote estuary edge landscape.
Duration	Short to medium term
Mitigation	Mitigation will consider future long-term management of key landscape features such as field boundary hedgerows within the adjacent Higham Arable Farmlands (Chalk).
Receptor	Higham Arable Farmlands (Thong)
Nature of effect	In the south part of the area the large scale A2/Project route junction with its array of overbridges, gantries, signs and embankments, along with the loss of vegetation on the south side of the present A2 up to HS1, would have a major alteration on the scale and rural appearance of this area. This, in association with the longer and more prominent Thong Lane overbridge and the loss of established trees within the adjacent AONB, would result in urban encroachment into this area and greater severance between the Gravesend Urban Edge to the west and the AONB to the east. North of the A2/Project route junction up to the local ridgeline delineated by Thong Lane, the Project would be in deep cutting as it traverses the open arable farmland. Although in cutting its scale and presence would form a physical scar in the landscape and would result in severance and urban encroachment into this area. This would be most evident at the pinch point between the settlement edge of Thong and the Gravesend Urban Edge at Thong Lane. Here the combination of a large-scale notch on a local ridgeline, the loss of roadside vegetation, a replacement overbridge and the loss of the rural gap between Thong village and Gravesend would have an urbanising impact on this area. The Project operation would also have a major change on the setting to the adjacent Thong Conservation Area.

Item	Description
	It is considered that the operational impacts within the area would have a direct **Major negative** change on this landscape which forms the setting to the AONB and the Thong Conservation Area as well as being Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • A landscape earthworks and associated woodland planting strategy which, over time, integrates the link roads, structures, traffic and gantries at the A2/Project route junction and re-connects Clay Lane Wood with AONB. • A landscape earthworks strategy to implement false cuttings (up to 4m in height) along perimeter link roads to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1m vertical (1v) to 10m horizontal (10h) for agriculture or 1v to 4m horizontal (4h) for woodland planting • An architectural strategy for the green structure at Thong Lane overbridge (over the Project route) with associated native species linear shrubs & coppiced woodland strip. To be developed in association with Biodiversity assessment, NMU strategy and Green Infrastructure assessment. • An architectural strategy for the green structures to reconnect links between Ashenbank Wood and Cobham Hall and Park to the south with Shorne Woods Country Park to the north. To be developed in association with Biodiversity assessment, NMU strategy and Green Infrastructure assessment. • A landscape strategy for the area to reflect the chalk/clay with flints landscape in collaboration with wider habitat creation.
Receptor	Higham Arable Farmlands (Gadshill)
Nature of effect	It is considered that the operation of the modified A2/M2 junction would have a limited indirect impact on the character of this area. It is considered that the construction activity within the area and adjacent AONB would have an indirect **Negligible negative** change on this landscape which forms the setting to the AONB.
Duration	Permanent
Mitigation	A mitigating landscape planting strategy is being considered that would, over time, integrate link roads, structures, traffic and gantries at the A2/M2 junction and the A289.
Receptor	Higham Arable Farmlands (Chalk)
Nature of effect	The operational road is in deep cutting as it traverses a local ridgeline and shallow local dry valley within this exposed dip slope chalk landscape. The cutting would be as narrow as possible to accommodate the 6-lane carriageway. The cutting face would comprise exposed chalk on the lower slope with a more relaxed upper grass slope. The cutting would widen out on the approach to the tunnel portal to accommodate the wider central verge and the provision of an access road which would climb up out of the cutting and run around above the tunnel portal before descending back down into the cutting on the opposite side. The line of the cutting across

Item	Description
	the area would be a relatively discreet feature in the landscape and the highway infrastructure such as signs and gantries would be contained within it. The south tunnel portal would be set down into the landscape just south of the A226. A tunnel operation building would sit above the tunnel but would be set down below ground level with a green roof to minimise its physical presence in the landscape. However, the ground level ancillary features which include a footbridge, access features above the tunnel portal and infiltration ponds, along with the scale and presence of the cutting and the local ridgeline notch at the south edge of the area would form a local physical scar in the landscape and result in severance and changes in the pattern of the agricultural fields. The hedgerows in this area are presently gappy and have, over time, been grubbed up to make larger fields. There would also be several infiltration ponds located within this landscape within a shallow dry valley to the east of the cutting. It is considered that the Project operation within the area would have a direct **Moderate negative** change on this landscape which forms the setting to the AONB and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • development of a minimally intrusive architectural south tunnel portal and associated features to reflect the importance of the area in regard to the AONB setting • development of an architectural or artist-led light structure at the former golf course. Opportunities to set the structure down into the cutting so that the top of parapet sits at or just below existing ground level, to be considered. To be developed in association with NMU strategy • a landscape planting strategy for the former golf course area to reflect the chalk landscape in collaboration with wider habitat creation • a landscape led approach to the design of the highway infiltration ponds to integrate with landscape and wider habitat creation areas • a hedgerow improvement strategy within the wider landscape to reflect the historic field pattern • a landscape earthworks strategy to be developed to minimise line of cutting on exposed slope by softening appearance of cutting crest and to set highway fence in to landscape.
Receptor	Istead Arable Farmlands
Nature of effect	The urbanising impact of the large scale A2/Project route junction with its array of overbridges, gantries, signs and embankments, along with the loss of vegetation on the south side of the present A2 up to HS1 on the adjacent Higham Arable Farmlands (Thong) and the AONB would extend in to the north east part of this area. This urban encroachment and greater severance between this area and the Higham Arable Farmlands would alter the scale and rural appearance of the A2 infrastructure corridor within the local area of Jeskyns Community Woodland.

Item	Description
	It is considered that the Project operation within the adjacent Higham Arable Farmlands (Thong) and the AONB would have an indirect **Moderate negative** change on this landscape which forms the setting to the AONB and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • a landscape earthworks and associated woodland planting strategy which, over time, integrates the link roads, structures, traffic & gantries at the A2/Project route junction and re-connects Clay Lane Wood with AONB • landscape earthworks strategy to implement false cuttings (up to 4m in height) along perimeter link roads to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • an architectural strategy for the green structures to reconnect links between Ashenbank Wood and Cobham Hall and Park to the south with Shorne Woods Country Park to the north. To be developed in association with Biodiversity assessment, NMU strategy and Green Infrastructure assessment
Receptor	Shorne Wooded Slopes
Nature of effect	It is considered that the Project operation of the modified A2/M2 junction and A289 within the adjacent AONB and Higham Arable Farmlands (Gadshill) would have a very limited indirect impact on the character of this area. It is considered that the Project operation within the adjacent AONB would have an indirect **Negligible negative** change on this landscape which forms the setting to the AONB and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider a landscape planting strategy which, over time, integrates link roads, structures, traffic and gantries at the A2/M2 junction and the A289.

8.6.12 The potential changes to visual amenity caused by the Project during operation, and the measures proposed to manage them to the south of the River Thames, are outlined in Table 8.15. The initial landscape measures being considered for the Project are indicated on the Outlime EMP, Figure 2.4 in Volume 3.

Table 8.15 Operation (visual effects south of River Thames)

Item	Description
Visual receptors	Kent Downs AONB (LCA 4 West Kent Downs)
Nature of effect	The widening of the A2 corridor, which would extend south to include the HS1 corridor, along with the associated loss of established trees within it, would result in greater visibility of the A2 corridor and its associated features from vantage points within the immediate landscape, particularly from the south at the north edges of Ashenbank Wood and Cobham Hall and Park. In addition, users

Item	Description
	crossing the A2 corridor at Thong Lane, Brewers Road and at Park Pale would experience a completely different scale of road corridor, and where the loss of the established vegetation would be noticed most. It is considered the Project operation on the visual amenity of the A2 corridor through the AONB would have a **Major** to **moderate negative** change in the view for the following visual receptors: • Users at the north edge of Ashenbank Wood. • Users on the Darnley Trail at the north edge of Cobham Park • Visitors to Cobham Park at its entrance off Brewers Road • Visitors to the AONB and users of the local road network (Brewers Road, Thong Lane & Half Pence Lane near the A2 junction roundabout • Users at the south edge of Shorne Woods Country Park. • Users of the Timeball & Telegraph Trail (Permanent route to be confirmed). • Users of the National Cycle Route 1 (Permanent route to be confirmed) • Visitors to the Inn on the Lake Hotel • Users on the Park Pale golf course access road • Workers at the local business at Park Pale • Users on the local footpath at Park Pale. • Potential for traffic noise due to increase in traffic volume to impact on tranquility of all users/visitors to the AONB.
Duration	Permanent
Mitigation	Mitigation will consider a landscape earthworks and associated planting strategy which incorporates a 4m high environmental barrier along both sides of the A2/Project route corridor to provide a visual screen and possible noise buffer. The barrier would comprise a combination of free standing wall, retaining wall, geotechnical wall or earth bund depending on available land within the existing highway estate. An architectural or artist-led approach for the design and materials of all hard features to ensure high quality finish
Visual receptors	Shorne and Higham Marshes
Nature of effect	The two main receptors within this area, which are elevated above the flat, low-lying marshland, have broad sweeping 360-degree panoramas. The gently curved line of the operational cutting, as it climbs the shallow dry valley of the chalk dip slope from south of the A226 to the notch on the local ridge line at Thong Lane, and the infrastructure within it, ie, gantries and signs, would form a relatively minor feature in these views. The footbridge near the former golf course and the Thong Lane overbridge on the ridge line would also form minor features in the view. This will be subject to further assessment as the Project design develops during the DCO process. It is considered the Project operation within the adjacent Higham Arable Farmlands (Chalk) area would have a **Minor negative** to **Negligible negative** change in the view for the following visual receptors: • Users of the Saxon Shore Way LDP (Future England Coast Path) • Users of National Cycle Route 1
Duration	Permanent

Item	Description
Mitigation	A potential mitigation measure being considered is a future long-term management of key landscape features such as field boundary hedgerows within the adjacent Higham Arable Farmlands (Chalk).
Visual receptors	Higham Arable Farmlands (Chalk)
Nature of effect	There are several rural visual receptors within this open landscape that would have a view to the Project as it traverses the local, shallow dry valley within the open arable farmland in the west part of the area. Although the Project would be in a 6-lane wide deep cutting, the line of the cutting would be visible in some views from the north and south and, in particular, northern elevated views from the edge of the AONB. East and west views across the area would typically look across the cutting, with the highway boundary fence delineating the line of the route, although with proximity and elevation the cutting and the infrastructure within it such as signs and gantries would become more evident. It is anticipated that the tunnel portal would not be visible in most views, other than from the immediate edge and the footbridge to the south of it near the former golf course. The ancillary elements above the tunnel portal, such as the emergency access road, car parking and the roof outline of the buried control building, the footbridge to the south, the large-scale local ridgeline notch and Thong Lane bridge and highway boundary fence lane would be visible features in the landscape. This will be subject to further assessment as the Project design develops during the DCO process. It is considered the Project operation within the area would have a **Major negative** change on views from the PRoW immediately adjacent to the cutting, but elsewhere would be **Moderate negative** to **Minor negative**. The following visual receptors within the area would be affected to some degree: • Residents at the Gravesend Urban Edge (Riverview Park) • Users on the local footpath network between Gravesend and the rural settlement of Shorne • Users on the local road network Shorne Ifield Road, A226 Gravesend Road) • Residents on the A226 Gravesend Road • Residents at Upper Iflield
Duration	Permanent
Mitigation	Mitigation will consider: • development of a minimally intrusive architectural south tunnel portal and associated features to reflect the importance of the area in regard to the AONB setting • a landscape planting strategy for the former golf course area to reflect the chalk landscape in collaboration with wider habitat creation • a landscape led approach to the design of the highway infiltration ponds to integrate with landscape and wider habitat creation areas • a hedgerow improvement strategy within the wider landscape to reflect the historic field pattern • a landscape earthworks strategy to be developed to minimise line of cutting on exposed slope by softening appearance of cutting crest and to set highway fence into landscape

Item	Description
Visual receptors	Higham Arable Farmlands (Thong)
Nature of effect	The main impact on views would be the operation of the large scale A2/Project route junction within the south, lower lying part of the area. The associated structures, particularly the overbridges and embankments along with moving traffic, street lighting, signs and gantries would create a busy urban infrastructure scene both during the day and night. The widening of the A2 corridor and associated vegetation clearance within the AONB to the south east and the presence of the longer Thong Lane bridge on higher ground beyond the junction would form the backdrop to some of the views. Elsewhere in the area the Project would be in 6-lane wide deep cutting. The line of the cutting would be visible in some views from the north and south. East and west views across the area would typically look across the cutting, with the highway boundary fence delineating the line of the route. The cutting would become more evident, along with the infrastructure such as signs and gantries, with proximity and elevation to it. It is considered the Project operation within the area would have a **Major** to **Moderate negative** change in the view for the following visual receptors: • Residents at the rural settlement of Thong • Residents at the Gravesend Urban Edge (Singlewell and Riverview Park) • Users on the local footpath network between Gravesend and the rural settlement of Shorne • Users on the local road network (Thong Lane) • Users on the Timeball & Telegraph Trail (Thong Lane) • Users on the National Cycle Route 117 (Permanent route to be confirmed)
Duration	Permanent
Mitigation	Mitigation will consider: • a landscape earthworks and associated woodland planting strategy which, over time, integrates the link roads, structures, traffic and gantries at the A2/Project route junction and re-connects Clay Lane Wood with AONB • landscape earthworks strategy to implement false cuttings (up to 4m in height) along perimeter link roads to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • a landscape strategy for the area to reflect the chalk/clay with flints landscape in collaboration with wider habitat creation.
Visual receptors	Higham Arable Farmlands (Gadshill)
Nature of effect	It is anticipated that the visibility of the Project on visual receptors within this area would be limited. The main impact will depend on how noticeable the loss of vegetation is along the A2 corridor within the AONB, between Park Pale and Brewers Road resulting in a more open view to the wider road corridor and the associated traffic, signs and gantries. This will be subject to further assessment as the Project design develops during the DCO process. It is considered the Project operation within the adjacent Kent Downs AONB (LCA4 West Kent Downs) to the west would have a **Minor negative** change in the view for residents at properties on Crutches Lane.

Item	Description
Duration	Permanent
Mitigation	A landscape planting strategy which, over time, integrates link roads, structures, traffic and gantries at the A2/M2 junction and the A289.
Visual receptors	Istead Arable Farmlands
Nature of effect	The main impact on views would be the operation of the large scale A2/Project route junction within the south, part of the Higham Arable Farmlands (Thong) area. The associated structures, particularly the overbridges and embankments along with moving traffic, street lighting, signs and gantries would create a busy urban infrastructure scene both during the day and night and set in the context of the existing foreground overhead pylons. The widening of the A2 corridor and associated vegetation clearance within the AONB to the south east and the presence of the longer Thong Lane bridge on higher ground to the east of the junction would form a noticeable interruption in the treeline which forms the backdrop to these views. It is considered the Project operation within the adjacent Kent Downs AONB (LCA4 West Kent Downs) and Higham Arable Farmlands (Thong) would have a **Moderate negative** change in the view for the following visual receptors: • Users of the Jeskyns Community Woodland • Users of the Timeball & Telegraph Trail
Duration	Permanent
Mitigation	A landscape earthworks and associated woodland planting strategy which, over time, integrates the link roads, structures, traffic and gantries at the A2/Project route junction and re-connects Clay Lane Wood with AONB.
Visual receptors	Shorne Wooded Slopes
Nature of effect	The Project would have a limited impact on views within this area due to the nature of the intervening vegetation and local landform where this area intersects with the AONB and the A2/M2 junction, and which would be unaffected by the Project. It is anticipated any long-term impacts would result from the presence of new gantries and signs along the A2 and the M2 junction. This will be subject to further assessment as the Project design develops during the DCO process. It is considered the Project operation within the adjacent Kent Downs AONB (LCA4 West Kent Downs) to the south west would have a **Minor negative** change in the view for the following visual receptors: • Users on the Timeball & Telegraph Trail (Bowesden Lane) • Residents at properties on Bowesden Lane.
Duration	Permanent
Mitigation	A potential mitigation measure being considered is a landscape planting strategy which, over time, integrates link roads, structures, traffic and gantries at the A2/M2 junction and the A289.

8.6.13 Based on the ZVI in Figure 8.1 in Volume 3 and the 2017/2018 winter surveys the following areas within the 2km study area to the north of the River Thames have not been carried forward at this stage due to their limited exposure to the

operational Project. However, this will be subject to review as the Project design develops during the DCO. These areas are:

a. C3 Mucking Marshes

b. D5 Linford/Buckingham Hill Urban Fringe

8.6.14 The potential landscape changes caused by the Project operation, and the measures proposed to manage them to the north of the River Thames, are outlined in Table 8.16 . The initial landscape measures being considered for the Project are indicated on the Outline EMP, Figure 2.4 in Volume 3.

Table 8.16 Operation (landscape effects north of River Thames)

Item	Description
Receptor	C5 Tilbury Marshes
Nature of effect	The operational road, within the north part of this flat, low lying marshland landscape would emerge from the cutting before climbing on to a 6-lane wide embankment on the approach to the grade separated junction and the viaduct over the Tilbury Loop railway beyond. The cutting would be as narrow as possible to accommodate 6 lanes of traffic and would comprise grassed slopes, although would widen out on the approach to the tunnel portal to accommodate the wider central verge. The line of the cutting, delineated by a perimeter grassed flood defence bund, in the context of the present artificial landform across this area, would be a relatively discreet feature in the landscape. It is anticipated that the north tunnel portal and much of the highway infrastructure such as signs and gantries would be contained within the cutting. However, as the Project, traffic and infrastructure emerge above ground in the north part of the area at the grade separated junction, it would have a local presence set among the array of O/H powerlines at this location and in the context of higher ground and associated trees to the east and west within the D7 West Tilbury Urban Fringe and D6 Chadwell Escarpment Urban Fringe respectively. Other than at the approaches to the grade separated junction in the north part of the area, it is anticipated the Project would not have street lighting elsewhere within this area. Traffic noise from the new road as well as visual intrusion would impact on the tranquility of this unique landscape. It is considered that the Project operation within the area would have a direct **Moderate negative** change on this landscape which forms the southern setting to the Low Street Conservation area and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • development of an architectural led design for the north tunnel portal and associated features to reflect the historic and marshland associations of the area • development of an architectural led design for the viaduct over the Tilbury Loop railway • a landscape planting strategy to be developed to reflect the marshland landscape • a landscape led approach to the design of the highway infiltration ponds to integrate with the landscape and wider habitat creation areas

Item	Description
	• a landscape-led enhancement strategy to the Thames-side landfill area to create a new recreational landscape which reflects the heritage and biodiversity qualities of the area
Receptor	D4 White Crofts/Orsett Heath Urban Fringe
Nature of effect	The operational Project would have a widespread impact on this relatively compact landscape area. Typically, the 6-lane carriageway with associated traffic, signs and gantries would form a major linear intervention as it runs, more or less at ground level through the centre of this low lying, open arable farmland area. The associated overbridges and their approach embankments, located in relatively close proximity to each other, would form locally prominent features. The alignment would follow the route of the existing overhead powerlines which traverse this area. Other than at the approaches to the Project route/A13 junction in the north part of the area, it is anticipated the Project would not have street lighting elsewhere within this area. The Project and several overbridges would also directly impact on the setting to the Grade II listed Heath Place, as it traverses the intimate rural landscape near Hornsby Lane. In the north part of the area to the south of the present A13 there would be disruption and encroachment of road infrastructure, including structures, embankments, signs, gantries and street lighting into the local landscape as a result of the intertwined string of new link roads connecting the A13 with the Project. This would also result in the realignment of the A1013 to the south of its existing position. These large-scale features along with the sprawling extent of the junction to the north and south of the existing A13 would result in further urban encroachment into the landscape both during the day and night-time between Baker Street and the West Thurrock & Grays Quarry Townscape Urban Edge. It is considered the Project operation within this area and the adjacent (H) Orsett Lowland Farmland would have a direct **Major negative** change on this landscape which forms the setting to a heritage asset and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • a landscape earthworks and associated planting strategy to be developed which, over time, integrates link roads, structures, traffic and gantries at A13 junction • a landscape earthworks strategy to be developed to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project to screen traffic and potentially reduce traffic noise. • Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • earthworks strategy to be developed to grade-out the side-road approach embankments to 1v to 10h to integrate structures • strategy for area to be developed to reflect the local landscape and the setting to heritage assets • a landscape-led approach to the design of the highway balancing ponds to integrate with landscape

Item	Description
Receptor	D6 Chadwell Escarpment Urban Fringe
Nature of effect	The operational Project would have localised impacts on this open exposed area. The focus of the Project would be the viaduct, traffic and associated signs and gantries over the Tilbury Loop railway within the east part of the area and the adjacent (D) West Tilbury Urban Fringe and set in the context of the array of overhead powerlines at this location. Street lighting may also be required for a section of the viaduct in relation to the approaches to the grade separated junction to the south. The large scale and massing of the viaduct would form a locally prominent structure within this area, although existing established trees along the railway and within the settlement of Low Street would help to soften its appearance and break up its mass. In the west part of the area, near Biggin Hill Lane, the flood compensation land would be reinstated back to agricultural land, albeit at a lower level, although the modification to the landform would potentially introduce some localised artificial topography. The more extensive area of flood compensation land to the north east, within the adjacent (D) West Tilbury Urban Fringe could require major modification to the shallow open gently rolling arable landscape. The actual extent of these areas and the modifications to the landform proposed, is the worst-case scenario. The requirement for the flood compensation will be reviewed as part of the ongoing Project design development during the DCO process. The grade-separated junction, associated signs and gantries and street lighting located within the adjacent low lying, flat marshes to the south east would typically be shielded by established trees within the settlement of Low Street and adjacent to the Tilbury Loop railway. It is considered the Project operation within this area would have a localised direct **Moderate negative** change on the character of this landscape, which forms the setting to the Low Street conservation area and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • a landscape planting strategy which, over time, integrates embankments or viaduct, underbridges, traffic and gantries near Low Street with the adjacent marsh landscape to the south and the arable landscape to the north • a landscape-led approach to the design of the flood compensation areas, to integrate with the landscape and the setting to heritage assets, including restoration and/or enhancement of field boundary hedgerows within the affected areas • retention of field and lane-side hedgerows and trees around the perimeter of the flood compensation area
Receptor	D7 West Tilbury Urban Fringe
Nature of effect	The operational Project would have a widespread impact on this open, low-lying arable farmland landscape. Typically, the 6-lane carriageway with its associated traffic, signs and gantries would form a major linear intervention as it runs, more or less at ground level, through the centre of this area. The associated overbridges and their approach embankments would form locally prominent features. The alignment would follow the route of the existing O/H powerlines which traverse this area. The route would also directly impact on a protected lane (Hoford Road)

Item	Description
	In the south part of the area the main focus of the Project would be the viaduct, traffic and associated signs and gantries over the Tilbury Loop railway which also crosses the eastern extent of the adjacent D6 Chadwell Escarpment Urban Fringe. The viaduct would be set in the context of the array of overhead powerlines at this location. Although it is anticipated that the viaduct would have street lighting on its southern part, on the approach to the grade separated junction south of the Tilbury Loop railway, the Project through the remainder of the area would not have street lighting. The extensive area of flood compensation on both sides of the route within the south part of this area could require major modification to the shallow, open, gently rolling arable landscape which forms the setting to Low Street and the West Tilbury conservation areas. The impacts on these areas would be reduced by the fact they would be reinstated back to agricultural land, albeit at a lower level. The main effects would be through some localised modification to the landform which could potentially introduce some localised artificial slopes. The actual extent of these areas and the modifications to the landform proposes, is the worst-case scenario. The requirement for the flood compensation will be reviewed as part of the ongoing Project design development during the DCO process. It is considered the Project operation within this area would have a direct **Major negative** change on this landscape which forms the setting to several heritage assets and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • A landscape earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • A green structure at Hoford Road to provide continuity in the vegetation along this protected lane. • A landscape earthworks strategy to be developed to grade-out side-road approach embankments to 1v to 10h to integrate structures • A landscape led approach to the design of the flood compensation areas to integrate with the landscape and the setting to heritage assets, including restoration and/or enhancement of field boundary hedgerows within the affected areas • Retention of field and lane-side hedgerows and trees around the perimeter of the flood compensation areas
Receptor	(H) Orsett Lowland Farmland
Nature of effect	The operational Project would have a localised impact on this open, low lying arable farmland landscape. Typically, the 6-lane carriageway with associated traffic, signs and gantries would be in cutting through the western part of this area near Baker Street, following the existing O/H powerlines which traverse this area. The associated overbridges and their approach embankments, located to the north west of Baker Street, would form locally prominent features in the rural landscape. The Project, in association with the modifications at the present A1089/A13 junction and the array of interconnecting new link roads on both sides of the A13 within this area and the adjacent D4 White Crofts/Orsett Heath Urban Fringe,

Item	Description
	would form a major intervention within this landscape. These large-scale features, along with the sprawling extent of the junction to the north and south of the existing A13, would result in further urban encroachment into the landscape both during the day and night-time between Baker Street and the West Thurrock & Grays Quarry Townscape urban edge. The Project would also directly impact on the setting to the Grade II listed Baker Street mill as it traverses the west edge of Baker Street. The eastbound link from the Project to the A13 on embankment would pass close to and encroach within the southern settlement edge resulting in greater severance between the settlement and the rural landscape to the south of the A13. It is considered the Project operation within this area and the adjacent D4 White Crofts/Orsett Heath Urban Fringe would have a direct **Major negative** change on this landscape which forms the setting to several heritage assets and is within the green belt.
Duration	Permanent
Mitigation	Mitigation will consider: • A landscape earthworks and associated planting strategy which, over time, integrates link roads, structures, traffic and gantries at A13 junction • A landscape earthworks to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • Development of a green bridge at Green Lane at the north edge of the area. To be developed in association with NMU strategy, biodiversity assessment and Green Infrastructure report • A landscape strategy for the area to reflect the local landscape, the townscape of Baker Street and the setting to heritage assets.
Receptor	(J) Thurrock Reclaimed Fen
Nature of effect	The operational Project would have a widespread impact on this broad, open large scale and relatively tranquil arable farmland landscape area. Typically, the 6-lane carriageway with associated traffic, signs and gantries, would form a major linear intervention as it traverses the low lying, flat flood plain of the Mardyke/Orsett Fen on a combination of viaduct, short structure and embankment for approximately 1.2km. The associated overbridge and its approach embankment to the west of the Mardyke, would form a locally prominent feature within this flat landscape. It is anticipated the Project would not have street lighting through this area. Traffic noise from the new road as well as visual intrusion would impact on the tranquility of this unique landscape. The extensive area of flood compensation on both sides of the route near the Mardyke/Orsett Fen could require localised lowering to the subtly higher arable farmland. The impact of the ground lowering would be reduced by the fact it would be reinstated back to agricultural land and therefore be of similar appearance and management as the present situation. The main impact would be through some localised modification to the landform which could potentially introduce some localised artificial slopes. The actual extent of these areas and the modifications to the landform propsed, is the worst-case scenario. The requirement for the flood compensation will be reviewed as part of the ongoing Project design development during the DCO process.

Item	Description
	The Project would also impact on this landscape, although to a lesser degree and potentially over a shorter timeframe, where it ties into and follows the M25 between the Thames Chase community forest centre and the M25 junction 29. The main impact on the landscape here is the asymmetrical widening of the M25 corridor on the west side resulting in localised incremental impacts on the landscape. It is considered the Project operation within the more remote and tranquil area of the Mardyke/Orsett Fen would have a direct **Major negative** change on this landscape which is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • A landscape planting strategy which, over time, integrates embankments/viaduct, traffic near the Mardyke/Orsett Fen to reflect the fen landscape of the area in collaboration with wider habitat creation. Includes investigating new carr woodland blocks in the wider fen landscape to create a more diverse mosaic of landscape features and potential for greater habitat diversity • A landscape earthworks strategy to implement 2m false cuttings on the embankments and noise barrier on viaduct/structure across the Mardyke/Orsett Fen for visual screening and potential to reduce traffic noise (to be investigated further) • A landscape earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • A landscape led approach to the design of the flood compensation areas to integrate with the landscape and the setting to heritage assets, including restoration and/or enhancement of field boundary hedgerows within the affected areas • Retention of field and lane-side hedgerows and trees around the perimeter of the flood compensation areas
Receptor	(A) Belhus Lowland Quarry Farmland
Nature of effect	The operational Project would have a localised impact on this low lying, arable farmland landscape. Typically, the 6-lane carriageway with associated traffic, signs and gantries would form a linear intervention as it runs, more or less at ground level through the north east part of this area. The associated overbridges and their approach embankments would form locally prominent features in the flat landscape. The Project would also require modification to the M25 where it ties into it to the west of North Ockendon. The junction itself would be relatively discreet with the northbound link passing beneath the M25 and contained by the Grays to Upminster railway on its west side. The southbound link, on the east side of the M25 would be at existing ground level and would be relatively well contained by the established vegetation and properties along Church Lane. However, there would be alteration to the character of the B1421 as a result of property demolition and the northbound link passing beneath it. The main impact on this area would be the widening of the existing cutting and permanent land take within the Thame Chase Community Forest Centre. This

Item	Description
	would impact on the vegetation on the west side of the M25 near the centre buildings. It is considered the Project operation within this area would have a direct **Moderate negative** change on this landscape which forms the setting to the Thames Chase community forest, and several heritage assets and is within the Green Belt.
Duration	Permanent
Mitigation	Mitigation will consider: • A landscape earthworks strategy to be developed to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • A landscape-led approach to the design of the flood compensation areas and balancing ponds to integrate with landscape
Receptor	(B) Brentwood Wooded Hills
Nature of effect	The operational Project would have a localised impact on this undulating wooded farmland landscape. South of the M25 the asymmetrical widened M25 and the modification to the junction would be contained by the surrounding tree and woodland blocks. North of the M25 junction 29 it is likely that there would be some isolated interventions such as gantries and carriageway widening but these would be limited to within the existing M25 highway estate. The main impact would be the regraded southbound cutting slope at the north extent of the Project. It is anticipated that the impacts of the Project operation would not be dissimilar to the present situation. It is considered the Project operation within this area would have a direct **Negligible negative** change on this landscape which forms the setting to the Thames Chase community forest, and is within the Green Belt.
Duration	Permanent
Mitigation	A potential mitigation measure being considered is a landscape planting strategy which integrates the linear interventions along the M25 corridor and replaces the planting lost during constriction.

8.6.15 The potential visual amenity changes as a result of the Project during operation and the measures proposed to manage them to the north of the River Thames are outlined in Table 8.17. The initial landscape measures being considered for the Project are indicated on the Outline EMP, Figure 2.4 in Volume 3.

Table 8.17 Operation (visual effects north of River Thames)

Item	Description
Visual receptors	C3 Mucking Marshes
Nature of effect	It is unlikely that the Project operation would be visible in views out of this area other than for the occasional glimpse from Princess Margaret Road at the west edge of this area to the services.

Item	Description
	It is considered the Project operation within the adjacent D7 West Tilbury Urban Fringe to the west would have a **Negligible negative** change in the view for users on Princess Margaret Road.
Duration	Permanent
Mitigation	A well designed architectural built form in association with an integrated landscape planting and earthworks strategy, which places the RaSA into its rural setting and screens it from nearby residential properties and PRoW.
Visual receptors	C5 Tilbury Marshes
Nature of effect	The main visual impact of the Project operation would be the earthworks and viaduct associated with the grade separated junction and the viaduct over the Tilbury Loop railway in the north part of the area and the eastern part of the adjacent D6 Chadwell Escarpment Urban Fringe. The structures with the traffic on it, the gantries and signs would be visible against the skyline, set among an array of O/H powerlines. It is considered the Project operation within the area and the adjacent D6 Chadwell Escarpment Urban Fringe to the north east would have a **Moderate negative to minor negative** change in the view for the following visual receptors: • Users of the Common Land at Walton Common and Parsonage Common • Users on Fort Road and Cooper Shaw Road
Duration	Permanent
Mitigation	Mitigation will consider: • development of an architectural-led design for the north tunnel portal and associated features to reflect the historic and marshland associations of the area • development of an architectural-led design for the viaduct over the Tilbury Loop railway • a landscape planting strategy to be developed to reflect the marshland landscape • a landscape-led enhancement strategy to the Thames-side landfill area to create a new recreational landscape which reflects the heritage and biodiversity qualities of the area
Visual receptors	D4 White Crofts/Orsett Heath Urban Fringe
Nature of effect	There would typically be views to the operational Project from receptors throughout the area to the 6-lane carriageway and the overbridges and to the string of link roads and structures to the south of the A13. It is considered the Project operation within the area would have a **Major negative to Moderate negative** change in the view for the following visual receptors: • Residents at rural property at Brook Farm • Users on Brentwood Road • Users on the PRoW network

Item	Description
	• Residents at the Grade II listed Heath Place • Users of Hornsby Lane • Rural residential property on Hornsby Lane • Residents at properties and users on A1013 Stanford Road • Residents at properties on Heath Road • Users on A1089 Dock Approach Road
Duration	Permanent
Mitigation	Mitigation will consider: • earthworks and associated planting strategy which, over time, integrates link roads, structures, traffic and gantries at A13 junction • earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • earthworks strategy to be developed to grade-out the side-road approach embankments to 1v to 10h to integrate structures • strategy for area to be developed to reflect the local lowland farmland landscape and the setting to heritage assets • landscape-led approach to the design of the highway balancing ponds to integrate with landscape
Visual receptors	D5 Linford/Buckingham Hill Urban Fringe
Nature of effect	Views out of the area to the operational Project would be limited to the south edge of Linford where residential properties have filtered views through vegetation at the settlement edge, across the adjacent farmland to the overbridge at Muckingford Road. It is considered the Project operation within the adjacent D7 West Tilbury Urban Fringe would have a **Minor negative** change in the view for residents at properties on Lower Crescent, Linford.
Duration	Permanent
Mitigation	Mitigation will consider: • earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • earthworks strategy to be developed to grade-out the side-road approach embankments to 1v to 10h to integrate structures
Visual receptors	D6 Chadwell Escarpment Urban Fringe
Nature of effect	The main visual impact of the Project operation would be the viaduct over the Tilbury Loop railway in the east part of the area and the south part of the adjacent D7 West Tilbury Urban Fringe. The structure with the traffic on it, the gantries and signs would be visible against the skyline, set among an array of

Item	Description
	O/H powerlines from properties at the north edge of Low Street and users on Station Road It is considered the Project operation within the area and the adjacent D7 West Tilbury Urban Fringe would have a **Major negative** to **Moderate negative** change in the view for the following visual receptors: • Users on Station Road • Users on Station Road, West Tilbury • Residents at properties on Low Street Lane, Low Street
Duration	Permanent
Mitigation	Mitigation will consider: • development of an architectural-led design for the viaduct over the Tilbury Loop railway • a landscape planting strategy to be developed to reflect the adjacent lowland arable farmland and marshland landscapes • a landscape-led approach to the design of the flood compensation areas to integrate with the landscape and the setting to heritage assets, including restoration and/or enhancement of field boundary hedgerows within the affected areas • retention of field and lane-side hedgerows and trees around the perimeter of the flood compensation areas
Visual receptors	D7 West Tilbury Urban Fringe
Nature of effect	The main visual impact of the Project operation would be the viaduct over the Tilbury Loop railway in the south part of the area and the south part of the adjacent D6 Chadwell Escarpment Urban Fringe. The structure with the traffic on it, the gantries and signs would be visible against the skyline, set among an array of O/H powerlines from properties at the east edge of East Tilbury and the adjacent PRoW network. There would typically be views to the operational Project from scattered rural properties and PRoW (Hoford Lane) throughout the area to the 6-lane carriageway and the overbridges. The services in the south east part of the area would be visible from adjacent rural properties on the rural lanes and a PRoW on Coal Road, south of the Tilbury Loop railway. It is considered the Project operation within the area and adjacent D6 Chadwell Escarpment Urban Fringe would have a **Major negative to Moderate negative** change in the view for the following visual receptors: • Residents at Buckland, off Station Road • Users on the PRoW network near Buckland • Residents at rural properties on Station Road and Love Lane • Residents at the settlement of West Tilbury on Church Lane and Blue Anchor Lane • Residents at Holford Farm on Blue Anchor Lane • Users on PRoW network between West Tilbury and East Tilbury • Users on Coal Road • Residents at the urban edge of East Tilbury • Residents at rural properties and users on Muckingford Road

Item	Description
	• Residents at Becksland, off Muckingford Road • Users on Hoford Lane (Protected Lane) • Residents at High House on High House Lane • Users on Low Street Lane • Residents at rural properties on Station Road/Love Lane • Users on PRoW network between West Tilbury and East Tilbury • Users on Coal Road (Green Lane) • Users on Low Street Lane • Residents at the urban edge of East Tilbury
Duration	Permanent
Mitigation	Mitigation will consider: • development of an architectural-led design for the viaduct over the Tilbury Loop railway • development of an architectural-led design for the services in association with a landscape and planting strategy to integrate it into the surrounding rural landscape and screen it in local views • a landscape planting strategy to be developed to reflect the lowland arable farmland landscape • a landscape-led approach to the design of the highway infiltration ponds to integrate with the landscape and wider habitat creation areas
Visual receptors	(H) Orsett Lowland Farmland
Nature of effect	There would typically be views to the operational Project from receptors throughout the area to the 6-lane carriageway, the overbridges, the array of link roads, and structures to the north of the A13. There would typically be views to the operational Project from both rural and settlement edge residential receptors on Stifford Clays Road and from residential properties on Baker Street. It is considered the Project operation within the area would have a **Major negative to Moderate negative** change in the view for the following visual receptors: • Residents at properties on B188 Baker Street • Users on Green Lane • Users on PRoW network near Baker Street • Residents at rural and settlement edge properties on Stifford Clays Road
Duration	Permanent
Mitigation	Mitigation will consider: • a landscape earthworks and associated planting strategy which, over time, integrates link roads, structures, traffic and gantries at A13 junction • a landscape earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project route to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting

Item	Description
	• a landscape earthworks strategy to be developed to grade-out the side-road approach embankments to 1v to 10h to integrate structures
Visual receptors	(K) West Thurrock & Grays Quarry Townscape
Nature of effect	There would typically be views to the operational Project from receptors at the north edge of this area to the 6-lane carriageway and overbridges within the adjacent D4 White Crofts/Orsett Heath Urban Fringe. It is considered the Project operation within the D4 White Crofts/Orsett Heath Urban Fringe would have a **Major negative to Moderate negative** change in the view for the following visual receptors: • Residents at urban edge properties on Courtney Road and Alexandra Close, Chadwell St Mary • Residents at 3 tower blocks off Godman Road, Chadwell St Mary • Residents at urban edge properties off Godman Road, Cedar Road and Barry Close, Chadwell St Mary • Residents at urban edge properties on Heath Road and Greyhound Lane, Orsett Heath • Residents at urban edge properties on Foxes Lane and Gowers Lane, Orsett Heath
Duration	Permanent
Mitigation	Mitigation will consider a landscape earthworks strategy to: • implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project route to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • to grade-out the side-road approach embankments to 1v to 10h to integrate structures
Visual receptors	(J) Thurrock Reclaimed Fen
Nature of effect	The main visual impact of the Project operation would be the combined 1.2km long curved viaduct and embankment across the Mardyke/Orsett Fen on rural views within this tranquil landscape. The structures with the traffic on it, the gantries and signs would be visible against the skyline. Although the viaduct over the Mardyke would allow north west/south west views under the structure, providing a visual connection to the landscape beyond the embankment section would block east/west views and sever the visual connection to much of Orsett Fen. Locally along the west side of the M25, the widened corridor would impact on views from adjacent nearby visual receptors. It is considered the Project operation within the area would have a **Major negative to Moderate negative** change on the view for the following visual receptors: • Residents at settlement edge property at Old Rectory, Fen Lane • Residents at rural property at Hobletts at south edge of Orsett Fen • Users on PRoW network within Orsett Fen and Mardyke

Item	Description
	• Users on PRoW network near Bulphan Fen • Residents at properties in vicinity of Judd's Farm, Harrow Lane • Residents at rural property at Fen Farm, off Fen Lane • Users at Top Meadow Golf Course off Fen Lane • Users of Cranham Golf Course • Residents at rural properties (Franks Cottages) on B186 St Mary's Lane and property at Franks Farm, west of M25 • Users of PRoW network on either side of M25 east of Cranham
Duration	Permanent
Mitigation	Mitigation will consider: • a landscape planting strategy which, over time, integrates embankments/viaduct, traffic near the Mardyke/Orsett Fen to reflect the fen landscape of the area in collaboration with wider habitat creation • a landscape earthworks strategy to implement 2m false cuttings on the embankments and noise barrier on viaduct/structure across the Mardyke/Orsett Fen for visual screening and potential to reduce traffic noise (to be investigated further) • a landscape earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project route to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • a landscape-led approach to the design of the flood compensation areas to integrate with the landscape and the setting to heritage assets, including restoration and/or enhancement of field boundary hedgerows within the affected areas • retention of field and lane-side hedgerows and trees around the perimeter of the flood compensation areas
Visual receptors	(A) Belhus Lowland Quarry Farmland
Nature of effect	There would typically be views to the operational Project from receptors within the rural landscape between North Ockendon and South Ockendon to the 6-lane carriageway and the overbridges. The Project link and the widening of the M25 corridor to the west would impact on residential properties to the west of North Ockendon and on visitors to the Thames Chase Forest Centre. It is considered the Project operation within the area would have a **Moderate negative to Minor negative** change in the view for the following visual receptors: • Users on PRoW network in vicinity of South Ockendon Hall • Rural property at South Ockendon Hall • Rural properties at Groves Cottages off North Road • Rural residential properties and users on North Road • Users of PRoW network between South Ockendon and North Ockendon • Rural residential properties on Church Lane, North Ockendon

Item	Description
	• Rural properties and users on B1421 Ockendon Road in vicinity of M25 • Visitors to Thames Chase Forest Centre
Duration	Permanent
Mitigation	Mitigation will consider: • earthworks strategy to implement false cuttings (up to 4m in height) and associated hedgerow and woodland planting along the Project to screen traffic and potentially reduce traffic noise. Crests to be rounded and back slopes to be regraded to either 1v to 10h for agriculture or 1v to 4h for woodland planting • earthworks strategy to be developed to grade-out the side-road approach embankments to 1v to 10h to integrate structures • strategy for area to be developed to reflect the local lowland farmland landscape and the setting to heritage assets • landscape-led approach to the design of the highway balancing ponds to integrate with landscape
Visual receptors	(B) Brentwood Wooded Hills
Nature of effect	The Project operation would have a limited impact on views within this area due to the landform and vegetation pattern within the surrounding landscape which would help to contain the operational changes to the immediate environs of the M25 corridor. The main impacts would therefore occur on receptors that abut the Project. It is considered the Project operation within the area would have a **Moderate negative** change in the view for the following visual receptors: • Users on PRoW to south east of M25 junction 29 • Users on PRoW Beresden Lane at north extent of Project
Duration	Permanent
Mitigation	Mitigation will consider a landscape planting strategy for replacement planting within the highway estate which, over time integrates the new features in to the landscape.

Chapter 9.

Terrestrial Biodiversity

9 Terrestrial Biodiversity

9.1 Introduction

9.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on terrestrial biodiversity related to the construction and operation of the Project.

9.1.2 Biodiversity is concerned with living organisms and their relationship both with each other and their environment. Terrestrial biodiversity comprises those habitats and species located outside of the marine environment. The conservation of biodiversity is important to maintain variable populations of the country's characteristic fauna and flora and the communities they comprise.

9.1.3 The indicative study area for terrestrial ecology comprises the proposed Development Boundary and a 500m buffer, but the study area has been increased where considered appropriate, for example when considering indirect effects. The approach taken in this chapter is to discuss ecology within the proposed Development Boundary as a whole rather than splitting it into discrete subsections. However, where appropriate to aid the presentation of the baseline data, the Development Boundary has been spilt into three broad areas:

a) South of the River Thames, including Gravesham and Kent

b) Thames crossing

c) North of the River Thames, including Thurrock, Brentwood, and Havering

9.1.4 Within this chapter the terms Essex and Kent are used frequently but it is recognised that this includes the relevant local authorities. Finally, terrestrial ecology is presented in taxonomic order presenting plants and habitats first and then faunal species according to taxonomic hierarchy.

9.1.5 The aims of this chapter are to, in relation to terrestrial biodiversity:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to terrestrial biodiversity

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on terrestrial biodiversity (and how these have been assessed for the purpose of this *Preliminary Environmental Information Report* (*PEIR*)

f. describe potential mitigation measures

9.1.6 There are expected to be interrelationships between the potential effects on biodiversity and other disciplines. See:

a. Chapter 6: Air Quality

b. Chapter 8: Landscape

c. Chapter 10: Marine Biodiversity

d. Chapter 11: Geology and Soils

e. Chapter 13: Noise and Vibration

f. Chapter 15: Road Drainage and Water Environment

9.1.7 The survey data contained within this chapter will also be used to inform the separate Habitats Regulations Assessment (HRA) which is being prepared to support the Project's Development Consent Order application. The HRA is required to identify if any Likely Significant Effects are predicted for sites that have been designated under the European Community (EC) Birds and Habitats Directives and internationally important wetland sites designated under the Ramsar Convention. The survey scope has been established to collect the necessary data for both the Environmental Information Report (EIA) and HRA assessments (as detailed in the following sections).

9.2 Planning policy and legislative requirements

Legislative requirements

9.2.1 The relevant legislation applicable to the terrestrial biodiversity assessment of the Project is presented below.

Table 9.1 Summary of legislative requirements

Legislation name	Summary of requirements
Article 4 of the European Community (EC) Birds Directive (2009)	Allows for Special Protection Area (SPA) designation on behalf of rare and vulnerable birds (as listed in Annex I of the Birds Directive) as well as for regularly-occurring migratory species. The project will aim to ensure no likely significant effects on any SPA sites. If a likely significant effect is anticipated, then mitigation measures will be adopted to enable the appropriate assessment to conclude that there is no adverse effect on site integrity.

Legislation name	Summary of requirements
EC Habitats Directive (1992), as amended	Allows for Special Areas of Conservation (SAC) designation; a European network of important high-quality sites that will make a significant contribution to conserving habitat types and species. The project will aim to ensure no likely significant effects on any SAC sites. If a likely significant effect is anticipated, then mitigation measures will be adopted to enable the appropriate assessment to conclude that there is no adverse effect on site integrity.
Ramsar Convention (1971)	Designates wetland sites of international importance. The project will aim to ensure no likely significant effects leading to a net loss of integrity of Ramsar sites and associated species or habitats.
EC Water Framework Directive (2000)	The purpose of the Directive is to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. It will ensure that all aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands meet 'good status' by 2015.
Wildlife and Countryside Act 1981 (as amended).	Notification of Sites of Special Scientific Interest (SSSI) and species that are legally protected included in Schedules 1, 5 and 8 of the Act. The project must, therefore, ensure no significant effects are likely on SSSIs and, if significant effects are anticipated, then mitigation measures will be implemented to reduce the potential for significant effects. The project must also ensure legislative compliance to legally protected species.
Countryside and Rights of Way Act (2000)	Improved provisions for the protection and management of SSSIs and legally protected species.
Section 41 of the Natural Environment and Rural Communities Act (NERC) (2006)	Identifies habitats and species of ‘principal importance for the conservation of biological diversity’ in England. The project must have regards to the protection and enhancement of habitats and species of principal importance and provide appropriate mitigation measures to offset any potential significant impacts.
The Hedgerow Regulations 1997	Affords protection to countryside hedgerows, but only those that meet the ecological and landscape criteria as important hedgerows as set out in the regulations.
Protection of Badgers Act 1992	Affords protection to badgers, *Meles meles*.

National Planning Statement for National Networks

9.2.2 The relevant parts of the NPSNN for the terrestrial biodiversity assessment of the Project are presented in Table 9.2 below.

Table 9.2 NPSNN Requirements and Project response

Requirement (with NPSNN paragraph numbers)	Project response
4.15 “All proposals for projects that are subject to the European Union’s Environmental Impact Assessment Directive and are likely to have significant effects on the environment, must be accompanied by an ES describing the aspects of the environment likely to be significantly affected by the project. The Directive specifically requires an environmental impact assessment to identify, describe and assess effects on human beings, fauna and flora, soil, water, air, climate, the landscape, material assets and cultural heritage, and the interaction between them. Schedule 4 of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 sets out the information that should be including a description of the likely significant effects of the proposed project on the environment, covering the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project, and also the measures envisaged for avoiding or mitigating significant adverse effects. Further guidance can be found in the online planning portal. When examining a proposal, the Examining Authority should ensure that likely significant effects at all stages of the project have been adequately assessed. Any requests for environmental information not included in the original environmental statement should be proportionate and focus only on significant effects. In this NPS, the terms ‘effects’, ‘impacts’ or ‘benefits’ should accordingly be understood to mean likely significant effects, impacts or benefits.”	The *PEIR* and the subsequent Environmental Statement (ES) will assess potential significant effects of the Project in accordance with the NPSNN requirements.
4.16 “When considering significant cumulative effects, any environmental statement should provide information on how the effects of the applicant’s proposal would combine and interact with the effects of other development (including projects for which consent has been granted, as well as those already in existence). The Examining Authority may also have other evidence before it, for example from a Transport Business Case, appraisals of sustainability of relevant NPSs or development plans, on such effects and potential interactions”.	The ES will assess potential cumulative significant effects of the Project in accordance with the NPSNN requirements.
4.22 “Prior to granting a Development Consent Order, the Secretary of State must, under the Habitats Regulations, consider whether it is possible that the project could have a significant effect on the objectives of a European site or on any site to which the same protection is applied as a matter of policy, either alone or in combination with other plans or projects. Applicants should also refer to paragraphs 5.20 to 5.38 of this national policy statement on biodiversity and	The Project team have consulted with Natural England and the proposals will be subject to a full HRA assessment in accordance with the NPSNN requirements.

Requirement (with NPSNN paragraph numbers)	Project response
geological conservation and to paragraphs 5.3 to 5.15 on air quality. The applicant should seek the advice of Natural England and, where appropriate, for cross-boundary impacts, Natural Resources Wales and Scottish Natural Heritage to ensure that impacts on European sites in Wales and Scotland are adequately considered".	
4.23 "Applicants are required to provide sufficient information with their applications for development consent to enable the Secretary of State to carry out an Appropriate Assessment if required. This information should include details of any measures that are proposed to minimise or avoid any likely significant effects on a European site. The information provided may also assist the Secretary of State in concluding that an appropriate assessment is not required because significant effects on European sites are sufficiently unlikely that they can be excluded."	An appropriate assessment will be required. The *PEIR* outlines the desk-based study data and field survey work undertaken and planned to ensure sufficient and robust information is available to inform any appropriate assessment.
4.25 "Where a development may negatively affect any priority habitat or species on a site for which they are a protected feature, any Imperative Reasons of Overriding Public Interest (IROPI) case would need to be established solely on one or more of the grounds relating to human health, public safety or beneficial consequences of primary importance to the environment."	If the Project proposals will negatively affect a priority habitat or species, then the case for IROPI will be set out in detail within the ES.
Applicants should comply with all legal requirements and any policy requirements set out in this NPS on the assessment of alternatives. In particular: • The EIA Directive requires projects with significant environmental effects to include an outline of the main alternatives studied by the applicant and an indication of the main reasons for the applicant's choice, taking into account the environmental effects. • There may also be other specific legal requirements for the consideration of alternatives, for example, under the Habitats and Water Framework Directives. • There may also be policy requirements in this NPS, for example the flood risk sequential test and the assessment of alternatives for developments in National Parks, the Broads and Areas of Outstanding Natural Beauty (AONB).	
5.22 "Where the project is subject to EIA the applicant should ensure that the environmental statement clearly sets out any likely significant effects on internationally, nationally and locally designated sites of ecological or geological conservation importance (including those outside England) on protected species and on habitats and other species identified as being of principal	The *PEIR* and the subsequent ES will set out the baseline regarding designated sites, protected species and habitats of principal importance.

Requirement (with NPSNN paragraph numbers)	Project response
importance for the conservation of biodiversity and that the statement considers the full range of potential impacts on ecosystems."	The *PEIR* also identifies the potential effects of the Project on these features and outlines potential mitigation measures.
5.23 "The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests."	The *PEIR* and subsequent ES identifies the opportunities to protect and enhance biodiversity and geological conservation interests.
5.25 "As a general principle, and subject to the specific policies below, development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives. The applicant may also wish to make use of biodiversity offsetting in devising compensation proposals to counteract any impacts on biodiversity which cannot be avoided or mitigated. Where significant harm cannot be avoided or mitigated, as a last resort, appropriate compensation measures should be sought."	The *PEIR* and subsequent ES identifies the opportunities to protect and enhance biodiversity interests, and to offset or compensate for any residual negative effects
5.27 "The most important sites for biodiversity are those identified through international conventions and European Directives. The Habitats Regulations provide statutory protection for European sites~~76~~ (see also paragraphs 4.22 to 4.25). The National Planning Policy Framework states that the following wildlife sites should have the same protection as European sites: • potential Special Protection Areas and possible Special Areas of Conservation • listed or proposed Ramsar sites; and • sites identified, or required, as compensatory measures for adverse effects on European sites, potential Special Protection Areas, possible Special Areas of Conservation and listed or proposed Ramsar sites."	Within the *PEIR* and the subsequent ES these sites are considered to have equivalent levels of protection.
5.28 "Many Sites of Special Scientific Interest (SSSIs) are also designated as sites of international importance and will be protected accordingly. Those that are not, or those features of SSSIs not covered by an international designation, should be given a high degree of protection. All National Nature Reserves are notified as SSSIs."	The *PEIR* and subsequent ES will give full consideration to the protection of SSSIs and associated features of interest.
5.29 "Where a proposed development on land within or outside a SSSI is likely to have an adverse effect on an SSSI (either individually or in combination with other developments), development consent should not normally be granted. Where an adverse effect on the site's notified special interest features is likely, an exception should be made only where the benefits of the development at this site clearly outweigh both the	The ES will assess potential cumulative significant effects of the Project in accordance with the NPSNN requirements.

Requirement (with NPSNN paragraph numbers)	Project response
impacts that it is likely to have on the features of the site that make it of special scientific interest, and any broader impacts on the national network of SSSIs. The Secretary of State should ensure that the applicant's proposals to mitigate the harmful aspects of the development and, where possible, to ensure the conservation and enhancement of the site's biodiversity or geological interest, are acceptable. Where necessary, requirements and/or planning obligations should be used to ensure these proposals are delivered."	
5.32 "Ancient woodland is a valuable biodiversity resource both for its diversity of species and for its longevity as woodland. Once lost it cannot be recreated. Aged or veteran trees found outside ancient woodland are also particularly valuable for biodiversity and their loss should be avoided. Where such trees would be affected by development proposals, the applicant should set out proposals for their conservation or, where their loss is unavoidable, the reasons for this."	The *PEIR* fully recognises the value of ancient woodland: the Project design has strived to avoid ancient woodland habitat. If significant effects are unavoidable the justification as to why and proposed mitigation measures will be fully detailed in the ES.
5.36 "Applicants should include appropriate mitigation measures as an integral part of their proposed development, including identifying where and how these will be secured. In particular, the applicant should demonstrate that: • during construction, they will seek to ensure that activities will be confined to the minimum areas required for the works; • during construction and operation, best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised (including as a consequence of transport access arrangements); • habitats will, where practicable, be restored after construction works have finished; • developments will be designed and landscaped to provide green corridors and minimise habitat fragmentation where reasonable; • opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals, for example through techniques such as the 'greening' of existing network crossing points, the use of green bridges and the habitat improvement of the network verge."	The landscape, biodiversity and other topic groups are working closely together to ensure that, during construction, activities will be confined to the minimum area, and that habitat creation, green infrastructure and other measures are developed in an integrated manner and deliver multiple environmental benefits. The integrated Project will be finalised for the subsequent ES.

Biodiversity plans and policy requirements

9.2.3 The relevant Planning Policies applicable to the terrestrial biodiversity assessment of the Project are presented below.

9.2.4 There are several policies that have been published which aim to help conserve and improve the function of the UK's ecosystems. Several of these policies are also referenced in Highways England's Biodiversity Plan which commits to protect and increase biodiversity on and around the road network.

Table 9.3 Summary of wildlife policy requirements

Policy name	Summary of requirement
Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services (Defra 2011)	A national strategy for England's wildlife and ecosystem services. It sets out the Government's ambition to halt overall loss of England's biodiversity by 2020, support healthy well-functioning ecosystems and establish coherent ecological networks. The project must, therefore, place biodiversity at the heart of the design process and explore opportunities for delivering a net gain in biodiversity.
Highways England's Biodiversity Plan (Highways England 2015)	Highways England's Plan is designed to deliver no net loss of biodiversity on the strategic road network by 2020 and to achieve net gain by 2040.
A Green Future: Our 25 Year Plan to Improve the Environment (Defra 2018)	This sets out the Government's comprehensive and long-term approach to protecting and enhancing the UKs natural landscapes and habitats in England for the next generation. Its primary goal is to ensure: cleaner air and water; plants and animals which are thriving.
National Pollinator Strategy (Defra 2014)	This strategy sets out a 10-year plan to help pollinating insects survive and thrive. The strategy includes information on the current evidence, and policy actions to support and protect pollinating insects which contribute to the UK's food production and the diversity of the environment.
Gravesham Local Plan	
Policy CS12 Green Infrastructure	A multifunctional linked network of green spaces, footpaths, cycle routes and wildlife stepping stones and corridors will be created, protected, enhanced and maintained. Sites designated for their biodiversity value will be protected, with the highest level of protection given to internationally designated Special Protection Areas, Special Areas of Conservation and Ramsar sites followed by nationally designated sites of Special scientific interest, followed by Local wildlife sites and then by other areas of more local importance for biodiversity. Where a negative impact on protected or priority habitats/species cannot be avoided on development sites and where the importance of the development is considered to outweigh the biodiversity impact, compensatory provision will be required either elsewhere on the site or off-site, including measures for ongoing maintenance.
Policy CS19 Development and design principles	New development will protect and, where appropriate opportunities arise, enhance biodiversity and the Borough's green infrastructure network.

Policy name	Summary of requirement
Brentwood Local Plan	
Policy C3 County Wildlife Site, Local Nature Reserves and Other Habitats and Natural Features of Local Value	Development, including changes of use, that would have an unacceptable detrimental impact, directly or indirectly, upon a county wildlife site, local nature reserve or any other site or natural feature of conservation interest (and their inter-relationships with each other) will not be permitted unless it can be clearly demonstrated that there are reasons for the proposal which outweigh the need to safeguard the substantive nature conservation value of the site or feature. In all cases where development is permitted, such damage will be kept to a minimum. Development that would affect a habitat or species identified in the Essex biodiversity action plan and/or Brentwood biodiversity action plan will only be permitted where the council is satisfied that it would have no unacceptable impact on that habitat or species.
Policy C4 Management of Woodlands	Existing woodlands should be retained with management appropriate to age, use, location and scientific interest. In any management scheme it is essential that the visual amenity, historical and ecological values of the woodland are safeguarded, and, where possible, enhanced.
Policy C5 Retention and Provision of Landscaping and Natural Features in Development	In proposals for development, existing trees, hedges, woods, ponds, watercourses and other natural features should be retained, with new landscape works required to enhance any new development. Development schemes should also consider opportunities for additional habitat creation in any proposals.
Policy C6 Tree Preservation Orders and Works to Preserved Trees	The council will seek to protect trees and woodlands that contribute to the amenity of an area by serving tree preservation orders, where it is considered that such tree(s) or woodland may be at risk of felling or damage. Applications for works to, or for the removal of, preserved trees will only be granted consent where there is a specific arboriculture justification or other very special circumstances.
Policy C7 Development Affecting Preserved Trees, Ancient Woodlands and Trees in Conservation Areas	Development that would damage, destroy or threaten the future survival of trees protected by a tree preservation order, or trees within an area identified as ancient woodland or in a conservation area will not be permitted unless the removal of the tree would be in the interests of good arboriculture practice or the development clearly outweighs the amenity and/or nature conservation value of the tree.
Policy C12 Landscape Improvements	The council will, in conjunction with its countryside management service, seek to encourage local land owners to implement schemes to improve the environment through planting, habitat creation, improved public access, management agreements and other measures, whilst also implementing its own program of environmental improvement schemes throughout both the urban and rural areas of the borough.

Policy name	Summary of requirement
Havering Local Plan	
Policy 30 Nature Conservation	Havering Local Plan Policy 30 Nature Conservation • The Council will protect and enhance the rich biodiversity and geodiversity in Havering by: Protecting Sites of Specific Scientific Interest, Local Nature Reserves and Sites of Importance for Nature Conservation. • Conserving and, where possible, extending wildlife corridors; • Preserving 'veteran' trees and ancient woodland outside protected areas; • Protecting recognised priority species and habitats; and • Supporting development that provides appropriate new biodiversity features on site.
Policy 31 Rivers and river corridors	Havering's rivers and river corridors fulfil important biodiversity, recreation, place making, amenity, freight transport and flood management functions which the Council will seek to optimise. To protect and enhance the biodiversity and amenity value of river corridors while accommodating future adaptations to flood defences, the Council will require development to be set back by 8 metres from main rivers, ordinary watercourses and other flood assets, and 16 metres from tidal rivers or defence structures
Policy DC60 Trees and Woodlands	The amenity and biodiversity value afforded by trees and woodland will be protected and improved by: • where appropriate, retaining trees of nature conservation and amenity value and making tree preservation orders • ensuring that adequate measures are put in place when granting planning permission to protect trees during construction works • supporting the implementation of the Thames Chase Plan and ensuring that, development within the area makes a positive contribution towards its implementation. • not granting planning permission for development that would adversely affect ancient and secondary woodland.
Thurrock Local Plan	
Policy CSTP19 Biodiversity	The Council will create a robust network of ecological sites centering on the designated sites, ie, SSSIs, SPAs, Ramsar, Local Nature Reserves and Local Wildlife Sites. These sites will be safeguarded and enhanced to mitigate the effects of past habitat loss and fragmentation, development and climate change.

Policy name	Summary of requirement
Policy PMD7 Biodiversity, geological conservation and development	Development proposals will be required to demonstrate that any significant biodiversity habitat or geological interest of recognised local value is retained and enhanced on-site. Where it can be demonstrated that this is not possible, and there is no suitable alternative site available for the development, developers will be required to show that their proposals would mitigate any loss of biodiversity. In circumstances where it can be demonstrated that neither retention on site nor mitigation is possible, developers will be required to provide appropriate compensation for any significant loss of biodiversity.

9.3 Methodology

9.3.1 This section summarises the methodology and approach used for the collection of the baseline information required for the assessment of the Project. As discussed in the introduction, the indicative study area comprises the proposed Development Boundary and a 500m buffer, which has been increased where considered appropriate.

9.3.2 Collection of baseline biodiversity information has involved two activities:

a. A high-level preliminary desk study which was undertaken in 2016.

b. A suite of field surveys that commenced in 2017 (All survey elements have commenced, but a number of elements have not yet been completed, or the data fully validated but all will be completed to inform the ES). As described in paragraph 9.1.3, where appropriate, the Development Boundary has been divided into three broad sections:

i. South of the River Thames

ii. Thames crossing

iii. North of River Thames.

9.3.3 The full details of the methodologies used for each ecological survey activity, as detailed in the *Lower Thames Crossing Scheme Number HE540039 Environmental Impact Assessment – Scoping Report* (Highways England, October 2017), are provided in Appendix F in Volume 2.

9.3.4 Two areas of methodology depart from that presented in the Scoping Report.

9.3.5 Firstly, initial consideration of the extensive woodland blocks near the Project have identified that most of the woodland blocks support numerous trees suitable for roosting bats, individual trees often containing multiple roost features. Full, detailed assessment of each potential roost feature on each individual tree within each woodland block would therefore require significant survey effort and would result in the identification of a large number of further survey requirements which would not be delivered in a reasonable timeframe. Natural England have therefore been consulted about an alternative approach to surveying and assessing potential bat roost features in trees.

9.3.6 Detailed assessment from the ground of a representative proportion of the trees present within each woodland block will be undertaken, with the type and suitability of any potential roost features recorded. The results of this sample exercise will then be scaled up to provide an indication of the nature of the overall bat tree-roost resource present within a woodland block. Aerial photographs will be considered, and a walkover survey of the area carried out to assess the size and connectivity of the woodland block as well as the type and quality of its surrounding habitats. This information will be brought together to enable an assessment of the suitability of the bat tree-roost resource within a woodland as a whole.

9.3.7 Secondly, consideration of barn owls was raised during the consultation to the Scoping Report. In response to this, survey work will be carried out to identify trees, barns and other structures suitable for supporting nesting barn owls within 500m of the proposed Development Boundary and an assessment of the suitability of habitat to support foraging barn owls. This information will be combined to assess the potential for significant effects on barn owls.

Desk study

9.3.8 The preliminary desk study for terrestrial biodiversity receptors involved a search for all designated sites potentially affected by the Project. This extended to a search of all European and internationally protected sites within a 30km radius of the Development Boundary to identify the presence of any SACs designated for bats, as recommended in the Design Manual for Roads and Bridges (DMRB) Volume 11 Section 4. No bat SACs were identified, but this search also informed the initial assessment of which European sites to screen for further assessment (as required for HRA), ie, all European sites on or within 2km of the Development Boundary, including SPA, SAC and Ramsar sites. These designated sites support habitats and/or species that are recognised as being important at a European or international level and are therefore granted the highest level of protection through both UK and European legislation.

9.3.9 Information on nationally and locally important designated sites, habitats and species was obtained from the sources set out in Table 9.4:

Table 9.4 Terrestrial desk study data sources to date

Data source	Information requested
Department for Environment, Food and Rural Affairs (Defra) Multi-Agency Geographic Information for the Countryside (MAGIC) website	Data pertaining to SSSI.
Kent and Medway Biological Records Centre (KMBRC) The Essex Wildlife Trust Biological Records Centre (EWTBRC)	Data on local (County) wildlife sites (LWS), legally protected and notable species.

Data source	Information requested
Local Biodiversity Action Plans (BAP) Essex Biodiversity Partnership (2011), Kent Biodiversity Partnership (2009) and Biodiversity Audits (eg, The Thames Estuary Partnership Habitat Action Plan) and Thurrock Council Biodiversity Audit	Reviewed to identify habitats and species of local importance, including LWS and Local Nature Reserves (LNR).
Data was collated for UK priority habitats using the Multi Agency Geographical Information for the Countryside (MAGIC) website.	Priority habitats listed on Section 41 of the NERC Act (2006).
Essex County Council, Buglife, University of East London and Natural England (2013) Thames Terrace Invertebrates: A Masterplan for Landscape-scale Conservation in the Greater Thames Marshes. English Heritage (2014) Essex Grazing Marsh Project.	Information on habitats of importance to invertebrate species located within the River Thames and adjacent areas.
Natural England's ancient woodland inventory (via the MAGIC website) and the Woodland Trust's ancient tree hunt.	Used to identify areas of ancient woodland and individual veteran and ancient trees within the Project survey area.
Natural England publications relating to the Thames Estuary and Marshes SPA and Ramsar sites: including the SPA and SAC Natura 2000 forms, Ramsar site Data Sheet. A report by Natural England entitled *'What do we know about the birds and habitats of the North Kent Marshes'* (Liley, 2011)	Information relating to European designated sites and assessment of the South Thames Marshes SSSI.
Map data from the Royal Society for the protection of Birds (RSPB).	Identifies all RSPB reserves within the Thames Estuary area.
Environmental Statement and associated documentation provided for the Tilbury 2 development.	Used to inform ecological baseline for the Project as the Tilbury 2 development is adjacent to the Project.
Environment Agency fish data for the Mardyke.	Used to inform ecological baseline for the Project.

9.3.10 The terrestrial field survey work commenced in April 2017 and has comprised the following activities, as outlined in Table 9.5. The area surveyed included the indicative Development Boundary plus a 50m buffer. The existing baseline has considered all completed and validated survey data, but in some cases survey work is ongoing and the final results will be presented within the ES.

Table 9.5 Terrestrial survey work commenced

Survey activity	Detail of survey activity
Extended Phase 1 habitat survey of potential route alignment	Survey recording not only habitat features but also features likely to be of value to legally protected and other notable species.
Phase 2 National Vegetation Classification (NVC) survey	Areas of botanically diverse habitat, detailed vegetation survey and assigning of habitat to NVC communities.
Open Mosaic Habitat survey	Open Mosaic Habitat Survey protocol will be followed to record botanical features and plant families of known importance to invertebrate assemblages. This information will supplement the Invertebrate survey described below.
Lichen and Bryophyte survey	Areas of ancient woodland likely to be directly affected by the Project and areas of brownfield habitat if there are records of scarce lower plants species present.
Invertebrate survey	Areas highlighted by the desk study and extended Phase 1 habitat survey as likely to support a diverse invertebrate assemblage.
Amphibians (great crested newt, *Triturus cristatus*) surveys	A great crested newt Habitat Suitability Index (HSI) assessment undertaken to confirm suitability to support great crested newts and then survey to establish presence or absence and if present population size.
Reptile Surveys	Recording the presence of and abundance of reptile species in areas of suitable habitat.
Ornithology Surveys	*Vantage point surveys* At the proposed crossing location covering winter, passage and breeding periods. *Transect surveys* All year covering winter, passage and breeding periods. Including nocturnal surveys covering areas of functionally linked habitat adjacent to the estuary used by SPA species. In addition, transects have been carried out within woodland considered to support important bird assemblages these being: Shorne and Ashenbank Woods, Cobham Wood, Great Crabbles Wood and Hangmans Wood. *Breeding bird surveys* Transect covering the Development Boundary. *Barn owl survey* Barns, trees and other structures within 500m of the Development Boundary.
Bats	*Preliminary Ground Level Tree Inspections* Trees identified as having bat roost potential during extended Phase 1 habitat and protected species surveys within the Development Boundary + 50m *Internal and External Building Inspections*

Survey activity	Detail of survey activity
	Buildings within the Development Boundary + 50m that have been identified as having the potential to be impacted by the proposed works. *Road/Rail Structure Inspections* Road/rail structures within the Development Boundary + 50m that have been identified as having the potential to be impacted by the proposed works. *Tree Climbing* Trees assessed as having moderate to high suitability to support roosting bats following preliminary ground level tree inspections. *Emergence/Re-entry* Buildings and road/rail structures assessed as having low, moderate or high suitability to support roosting bats following building and road/rail structure inspections. *Activity Transect* A series of transects covering an appropriate sample of the habitats available to bats along the length of the route, within the Development Boundary + 500m as well as adjacent habitats where there is the potential for impacts on bats. *Crossing Point* Linear features, suitable for use by commuting bats along the length of the route that will be bisected by the proposed development.
Dormouse (*Muscardinus avellanarius*)	Survey to find hazel (*Corylus avellana*) nuts that have been nibbled by dormice which is used as evidence of dormice being present. The placing of dormice nesting tubes within suitable woodland and hedgerow habitat.
Badger (*Meles meles*)	Survey to identify setts and other signs of badgers with a bait marking study to understand distribution and status of badger population.
Water Vole (*Arvicola amphibious*)	Survey to identify signs of water vole occupation within ditches and other water courses such as droppings, latrines and feeding signs.
Otter (*Lutra lutra*)	Survey to identify signs of otter occupation within ditches and other water courses such as spraint (otter droppings).
Harvest mice (*Micromys minutus*)	Search for nests in suitable habitat within the Development Boundary.

9.4 Existing environmental conditions

9.4.1 This section describes the current ecological baseline and captures a moment in time against which the potential effects of the proposed development will be assessed. There is some crossover between the terrestrial ecology and marine ecology chapters with regards to ornithological interests. The approach taken within the *PEIR* is that the terrestrial ecology chapter will present the results of the ornithology surveys and consider effects relating to bird species using the

intertidal area, whilst all other marine fauna and fauna (including the intertidal area) is covered by Chapter 10: Marine Biodiversity.

Designated sites

9.4.2 Table 9.6 identifies the European designated sites and their qualifying ecological features, as identified during the desk study. There are no European designated sites located north of the north tunnel portal. Additional information concerning European sites such as the published conservation objectives has not been used to inform the *PEIR*, but this information will be fully considered within the ES.

Table 9.6 European designated sites and their extent (ha)

Designated site	Important ecological feature (qualifying feature of designated site)	Extent (ha)	Distance from Development Boundary
South of River Thames			
North Downs Woodlands SAC habitats	• *Taxus baccata* woods of the British Isles (Yew dominated woodland; an Annex I priority habitat); *Asperulo-Fagetum* beech forests (Beech forests on neutral to rich soils. • Semi-natural dry grasslands and scrubland facies: on calcareous substrates *Festuco-Brometalia* (dry grasslands and scrublands on chalk or limestone).	288.58	9.7km at nearest point
River Thames crossing			
Thames Estuary and Marshes SPA	• Over-winter: hen harrier *Circus cyaneus* avocet *Recurirostra avosetta*, dunlin *Calidris alpine*, red knot *Calidris canuta*, black-tailed godwit *Limosa limosa*, grey plover *Pluvialis squtarola*, redshank *Tringa tonus*. • On passage: ringed plover *Charadrius hiaticula*).75,019 waterfowl over-winter, including avocet, grey plover, red knot, dunlin, black-tailed godwit and redshank.	4802.47	0.13km at nearest point
Thames Estuary and Marshes Ramsar site	• Saltmarsh • Grazing marsh • Floodplain grazing marsh and ditches • Saline lagoons	5588.59	Site partially within Development Boundary

Designated site	Important ecological feature (qualifying feature of designated site)	Extent (ha)	Distance from Development Boundary
	• One endangered plant species; 14 nationally scarce wetland plant species • 20 Red Data Book invertebrates • Over-winter: Dunlin, red knot, grey plover, redshank • On passage: ringed plover and black-tailed godwit • Assemblage of 45,118 waterfowl over-winter		
Holehaven Creek pSPA (based on current SSSI designation)	• Black-tailed godwit over-winter • 8,000 waterfowl during the winter, including curlew *Numenius arquata* and dunlin	272.81	7.21km at nearest point

9.4.3 Table 9.7 identifies the nationally statutory designated sites (SSSI and LNR) and their qualifying ecological features, as identified during the desk study. Additional information concerning nationally statutory designated sites such as the published condition assessment of each site has not been used to inform the *PEIR*, but this information will be fully considered within the ES

Table 9.7 Nationally designated sites and extent (ha)

Designated site	Important ecological feature (qualifying feature of designated site)	Extent (ha)	Distance from Development Boundary
South of River Thames			
Wouldham to Detling Escarpment SSSI	Representative examples of woodland, scrub and unimproved grassland habitats on chalk, which support several nationally rare and scarce species of plants and invertebrates.	311.17	5.05km at nearest point
Cobham Woods SSSI	Ancient woodland and parkland supporting rare plant species and breeding birds. Includes arable habitat supporting nationally scarce plant species.	242.74	0.37km at nearest point
Shorne and Ashenbank Woods SSSI	Ancient woodland and diverse invertebrate fauna.	197.44	Site partially within Development Boundary
Great Crabbles Wood SSSI	Ancient woodland; several scarce plants occur, including lady orchid *Orchis purpurea* and man orchid *Aceras anthropophorum.*	32.9794	0.17km at nearest point

Designated site	Important ecological feature (qualifying feature of designated site)	Extent (ha)	Distance from Development Boundary
River Thames Crossing			
South Thames Estuary and Marshes SSSI	Waterfowl (redshank, knot, dunlin, avocet, ringed plover, European white-fronted goose *Anas strepera*, teal *Anas crecca*, pintail *Anas acuta*, shoveler *Anas clypeata*, grey plover, curlew, black-tailed godwit and greenshank *Tringa nebularia).* Breeding bird community (garganey *Anas querquedula*, pintail, avocet and bearded tit *Panurus birmicus*). Specially protected birds (hen harrier, short-eared owl *Asio flammeus*, ruff *Philomachus pugnax*, common tern *Sterna hirundo*, avocet and golden plover *Pluvialis apricaria*) Habitats: Grazing marsh, dykes and fleets with the grazing marsh, saltmarsh, mudflats, freshwater pools, shingle and woodland habitats.	5288.98	Site partially within Development Boundary
Mucking Flats and Marshes SSSI	Mudflats, saltmarsh and grassland. Wintering wildfowl and waders.	312.71	Site immediately adjacent to Development Boundary
North of River Thames			
Hangman's Wood & Deneholes SSSI	Ancient and semi-natural woodland; medieval chalk mines which provide the most important underground hibernation site for bats in Essex. Species recorded include: brown long-eared bat *Plecotus auritus*, Natterer's bat *Myotis nattereri* and Daubenton's bat *Myotis daubentoniid.*	5.19	0.55km at nearest point
Cranham Marsh LNR	Marshland, sedge fen and ancient woodland.	12.97	0.24km at nearest point
Cranham Brickfields LNR	Former brickfield with large areas of grassland and scrub supporting rare plants (Dyer's Greenweed *Genista tinctoria*, Pepper Saxifrage *Silaum silaus*), reptiles (slow worm *Anguis fragilis*, common lizard *Zootoca vivipara*), invertebrates (stag beetle *Lucanus cervus*, butterflies) and great crested newt.	8.69	0.35km at nearest point

9.4.4 Figure 9.1 in Volume 3 shows the location of European, nationally designated sites and ancient woodland in relation to the Development Boundary.

9.4.5 Table 9.8 identifies the locally important non-statutory designated sites and their qualifying ecological features and ancient woodland sites, as identified during the desk study.

Table 9.8 Locally important ecological sites and extent (ha)

Local wildlife site/local nature reserves	Important ecological feature (qualifying feature of designated site)	Extent (ha)or length (m)	Distance from Development Boundary
South of the River Thames			
A226 Gravesend roadside nature reserve	The verge supports an assemblage of chalk grassland indicator plants.	352m	Site within Development Boundary
Claylane Wood	Area of ancient woodland.	11.18	Site within Development Boundary
Court Wood LWS	Ancient and ancient replanted woodland incorporating Court Wood and Starmore Wood.	45.59	1.52km at nearest point
Canal and Grazing Marsh, Higham LWS	The site includes Eastcourt Marshes and a long stretch of the Higham Canal which has recently been restored to open water, with common reed *Phragmites australis,* on some of the banks.	60.58	Site partially within Development Boundary
River Thames crossing			
Goshems Farm LWS	Old landfill area supports two important species populations: the nationally rare Red Data Book (RDB) plant Stinking Goosefoot *Chenopodium vulvaria* and the hornet robberfly *Asilus crabroniformis*. Note: during 2018 much of this site was lost to development and Thurrock indicated it will be deselected from the list of LWS.	74.0	Site within Development Boundary
Tilbury Centre LWS	Mosaic of grassland, ditches, a reed bed and a pond. A colony of Stonewort *Chara sp*., and the nationally rare great silver water beetle *Hydrophilus piceus,* as well as other rare invertebrates.	2.8	Site immediately adjacent to Development Boundary
Tilbury Marshes LWS	Relic grazing marsh, saltmarsh, brackish ditches and the grassland of Tilbury Fort. As well as a saltmarsh habitat and invertebrate assemblage.	39.8	Site immediately adjacent to Development Boundary

Local wildlife site/local nature reserves	Important ecological feature (qualifying feature of designated site)	Extent (ha)or length (m)	Distance from Development Boundary
North of the River Thames			
Terrels Heath LWS	Includes ancient woodland known locally as Chadwell Wood.	2.5	0.24km from Development Boundary
Rainbow Shaw LWS	Small ancient woodland fragment.	2.2	Site partially within Development Boundary
Clay Tye Wood	Possible ancient woodland and the only natural habitat within Greater London that supports nesting rooks *Corvus frugilegus*.	5.1	Site partially within Development Boundary
Franks Wood	Ancient and semi-natural woodland dominated by hornbeam *Carpinus betulus,* coppice.	16	0.14km at nearest point
Hobbs Hole Wood LWS	Ancient woodland, lowland mixed deciduous woodland.	1.8	Site partially within Development Boundary
Codham Hall Wood LWS	Ancient woodland, lowland deciduous woodland dominated by Hornbeam coppice, including Pedunculate Oak *Quercus robur*, Sweet Chestnut *Castanea sativa*, Sycamore *Acer psuedoplatanus* and Silver Birch *Betula pendula*.	5.0	Site immediately adjacent to Development Boundary
Warley Hall Wood LWS	Ancient woodland, lowland mixed deciduous woodland	4.46	0.94km at nearest point
Coombe Green Wood Ancient Woodland (Foxburrow Wood & Coombe Wood)	Ancient and semi-natural woodland, lowland mixed deciduous woodland on non-ancient site.	24.6	Site immediately adjacent to Development Boundary
Broom Hill LWS	Ancient acid grassland flora and diverse invertebrate community.	11.3	0.71km at nearest point

Local wildlife site/local nature reserves	Important ecological feature (qualifying feature of designated site)	Extent (ha)or length (m)	Distance from Development Boundary
Lytag brownfield LWS	Four reptile species; adder *Vipera berus*, grass snake, *Natrix natrix*, common lizard *Zootoca vivipara* and slow worm *Anguis fragilis,* a developing acid grassland and an important invertebrate community. Survey work undertaken for the Tilbury2 development have identified 10 invertebrate species listed under section 41 of the NERC Act (2006), and a further 5 found near the Lytag survey area. These indicate that the invertebrate assemblage at Lytag is of high conservation importance in a national context and Natural England have indicated the site would qualify for designation as an SSSI.	12.4	Site partially within Development Boundary
Low Street Pit LWS	Underlain by gravels supporting Thames Terrace Grassland and the national BAP species, the hornet robberfly.	3.5	Site within Development Boundary
West Tilbury Church LWS	Ancient grassland and botanical interest.	0.5	0.26km at nearest point
West Tilbury Hall LWS	River terrace with acidic grassland and a diverse invertebrate fauna.	2.5	0.37km at nearest point
Linford Pit LWS	Brownfield site supporting important invertebrate fauna.	14.3	0.06km at nearest point
Mucking Heath LWS	Ancient heathlands and acid grassland.	50.5	Site partially within Development Boundary
Blackshots Nature Area LWS	Rough grassland supporting an important invertebrate population and nesting habitat for ground nesting birds such as skylark *Alauda arvensis*.	18.7	Site within Development Boundary

9.4.6 Figure 9.1 in Volume 3 shows the location of non-statutory locally designated sites in relation to the Development Boundary.

Plants and habitats

National character areas

9.4.7 This section provides an overview of the National Character Areas (NCA) and habitat types within the Development Boundary and 50m buffer, then provides a greater detail on individual plant species records provided by the desk-based study. Finally, the results of the extended Phase 1 habitat survey undertaken to date are summarised.

9.4.8 An NCA is a natural subdivision of England based on a combination of landscape, biodiversity, geodiversity and economic activity (Natural England, undated). The Development Boundary traverses three distinct NCAs encompassing a wide diversity of habitat types which correlate closely with the three subdivisions of the Development Boundary. The three NCAs and subdivisions of the Development Boundary are:

a. The North Kent Plain (South of the River Thames crossing)

b. The Greater Thames Estuary (River Thames crossing)

c. The Northern Thames Basin (north of the River Thames crossing)

9.4.9 Information concerning NCAs is from the Natural England website.

9.4.10 The North Kent Plain is the area of land between the North Downs and the Thames Estuary, being low and gently undulating and within the Development Boundary is characterised by ancient semi-natural broadleaved woodland either side of the A2 trunk road. This includes several nationally important sites including Shorne and Ashenbank Woods SSSI and Cobham Woods SSSI (see Table 9.7). Ancient woodlands are habitats of principal importance listed under the NERC Act 2006. These habitats are considered to be important for the conservation of biodiversity in England and therefore require specific consideration as part of any development proposals.

9.4.11 The UK BAP suggests that only 1.2% of the land cover of Great Britain is ancient semi-natural woodland and that there has been a substantial decline and loss of ancient woodland habitat due to woodland clearance and replanting with non-native species over the last 50 years. Kent supports a significant proportion of the UK ancient woodland resource; the Kent BAP indicates that there is approximately 23,000ha of ancient semi-natural woodland in Kent. Within the Development Boundary and 50m buffer approximately 54ha of woodland that could be regarded as ancient woodland has been identified, of which only a small proportion will potentially be directly affected.

9.4.12 From the A2 the Development Boundary crosses arable farmland to reach the edge of the Greater Thames Estuary NCA. This encompasses the Thames Estuary, intertidal mudflats, saltmarsh and grazing marsh. This area is internationally important, with the grazing marsh supporting internationally important wintering and passage bird assemblages as well as rare plant and invertebrate species, reflected in the international and national designated sites located here. The Development Boundary crosses an area of reclaimed coastal grazing marsh with the pasture fields divided by ditches supporting a diverse

aquatic plant assemblage and an area of drier grazing marsh forming the Metropolitan Police firing range.

9.4.13 Coastal saltmarsh, coastal floodplain grazing marsh and intertidal mudflats are all habitats of principal importance listed under the NERC Act (2006).

9.4.14 The UK BAP estimates that there are approximately 32,500ha of saltmarsh within England but that saltmarsh is being lost in the UK, due to erosion and other factors, at a rate of 100ha a year. Within the Development Boundary and 50m buffer 0.4 ha of saltmarsh have been identified, which is unlikely to be directly affected as the tunnel passes directly underneath this habitat type.

9.4.15 Coastal and floodplain grazing marsh is defined as periodically inundated pasture, or meadow with ditches which maintain the water levels, containing standing or brackish fresh water. The ditches are especially rich in plants (Joint Nature Conservation Committee, 2008). The UK BAP estimates that within the UK there may be up to 300,000ha of grazing marsh with 200,000ha in England. The Kent BAP identifies 6,900ha of grazing marsh in the county.

9.4.16 The Essex BAP estimates that there are 6,500ha of coastal and floodplain grazing marsh in the county. The Phase 1 habitat classification does not specifically identify coastal and floodplain grazing marsh as a distinct habitat type.

9.4.17 However, most of this habitat type is located immediately adjacent to the sea wall and the tunnel will pass underneath this habitat type.

9.4.18 On the Essex side of the estuary habitat includes: arable farmland; saltmarsh; large areas of previously developed land, including former landfill sites; and areas used for the storage of pulverised fuel ash from the Tilbury Power Station. Interspersed among this are small areas of flower-rich dry acid grassland, scrub and remnants of a habitat type called Thames Terrace Grassland.

9.4.19 Thames Terrace Grasslands are a habitat type unique to the Thames Estuary and are situated on thin nutrient-poor soils overlying sands and gravels, supporting a mosaic of tall grasses and wildflowers along with shorter areas disturbed by grazing. Areas of bare ground are also present where the soil is particularly dry, or the sand and gravel substrate has slipped (Essex County Council et al., 2013). Today, true Thames Terrace Grasslands exist only in fragments in South Essex, through which the Development Boundary passes. Within the Development Boundary and 50m buffer approximately 8 ha (note this does not include areas of habitat that we have not yet had permission to access notably Blackshots Nature Area) of Thames Terrace Grassland have been identified, a proportion of which will be directly affected.

9.4.20 The decline of Thames Terrace Grassland is partly due to agricultural intensification and increased development (Essex County Council et al., 2013).

9.4.21 Previously developed land, so called ‘brownfield habitat’, is also declining. In 2012, Buglife assessed the status of these wildlife-rich brownfields and discovered that in the 6-year period since initial assessment, over half of the wildlife-rich brownfield sites had been either destroyed or had an outstanding planning permission. Only 98 of the 198 sites remained intact and secure in the short term (Robins et al., 2013). Brownfield land can support a habitat type classified by the UK BAP as ‘Open Mosaic Habitat (on previously developed

land)', which supports a diverse range of plant communities (Joint Nature Conservation Committee, 2010). Areas of brownfield land within the Development Boundary are considered to represent this habitat type and approximately 300ha have been identified, however a large proportion of this (70ha) will have been destroyed during 2018 due to the importing of spoil from Thames Tideway and spreading it to raise the height of the land at Goshems Farm LWS.

9.4.22 Collectively the previously developed land or brownfield habitat and remnant Thames Terrace grassland supports a diverse plant assemblage including several LWS (see Table 9.6).

9.4.23 Leaving the Greater Thames Estuary NCA, the Development Boundary heads north and slightly west through an area of predominantly intensively farmed arable land encompassed within the Northern Thames Basin NCA. Despite the predominance of arable farmland, the Development Boundary includes small areas of semi-natural habitat including ancient woodland and remnant heath and acid grassland. Both arable field margins and heath/acid grassland are listed as habitats of principal importance listed under the NERC Act (2006).

Desk study plant records

9.4.24 The Kent and Medway Biological Records Centre (KMBRC) provided detailed records for legally protected and scarce plant species within the southern portion of the Development Boundary including the following plant species protected under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended), detailed in Table 9.9.

Table 9.9 Records of plant species protected under Schedule 8 of the Wildlife and Countryside Act in Kent

Plant species	Habitat preference and location
Wild gladiolus *Gladiolus illyricus*	Heathland, but recorded from a chalk pit in Northfleet
Broad-leaved cudweed *Filago pyramidata*	Well drained arable fields, majority of records associated with arable habitat within the Cobham Woods SSSI.
Meadow clary *Salvia pratensis*	Chalk grassland, majority of records associated with chalk grassland habitat within the Cobham Woods SSSI.
Ground-pine *Teucrium botrys*	Chalk grassland and disturbed ground, the majority of records associated with arable habitat within the Cobham Woods SSSI.
Rough marsh-mallow *Althaea hirsuta*	Open dry calcareous soils, majority of records associated with chalk grassland habitat within the Cobham Woods SSSI.
Jersey cudweed *Gnaphalium luteoalbum*	Sandy fields and waste ground, located at Istead Rise, Nash Banks south of Gravesend.
Cut-leaved germander *Teucrium botrys*	Bare ground within open grassland, record from Rugby cement works Snodland.

Plant species	Habitat preference and location
Stinking goosefoot *Chenopodium vulvaria.*	Coastal grazing marsh and sea wall habitat.
Least lettuce *Lactuca saligna* (also a NERC Act (2006) Section 41 species).	Coastal grazing marsh and sea wall habitat, records from Cliffe Pools and Higham Marshes within the South Thames marshes SSSI.

9.4.25 Except for least lettuce, (where there are records of the plant within the portion of the South Thames Estuary SSSI that lies within the Development Boundary) none of the above legally protected plant species lie within the current Development Boundary. Based on the current design, the tunnel passes under the South Thames Marshes SSSI, so no direct impacts on habitat supporting least lettuce are predicted. Many of the remaining plant records from the KMBRC can be roughly grouped according to habitat type, with records of plants characteristic of ancient woodland, chalk grassland and arable field margins, and saltmarsh/coastal grazing marsh and sea wall habitat types being provided, as summarised in Table 9.10.

Table 9.10 Plant species records grouped by habitat type in Kent

Habitat type	Summary of plant species recorded
Ancient woodland	White helleborine *Cephalanthera damasonium*, wild strawberry *Fragaria vesca*, common cow-wheat *Melampyrum pratense*, wood-sorrel *Oxalis acetosella* and sanicle *Sanicula europaea*.
Chalk grassland	Man Orchid, Lady orchid, quaking-grass *Briza media*, carline thistle *Carlina vulgaris*, basil thyme *Clinopodium acinos*, common rock-rose *Helianthemum nummularium*, and field scabious *Knautia arvensis*.
Arable field margins	Corncockle *Agrostemma githago*, blue pimpernel *Anagallis arvensis* subsp. *Foemina*, stinking chamomile *Anthemis cotula*, cornflower *Centaurea cyanus*, dwarf spurge *Euphorbia exigua* and common cudweed *Filago vulgaris*.
Saltmarsh/coastal grazing marsh and sea wall	Slender hare's-ear *Bupleurum tenuissimum*, sea barley *Hordeum marinum,* divided sedge *Carex divisa*, frogbit *Hydrocharis morsus-ranae*, golden-samphire *Inula crithmoides*, common sea-lavender *Limonium vulgare.*

9.4.26 Of these species ground-pine, basil thyme, slender hare's-ear, divided sedge and sea barley are listed as species of principal importance under the NERC Act (2006). None of these species has been identified to date within the Development Boundary.

9.4.27 Ancient woodland, chalk (lowland calcareous) grassland, and arable habitat are targeted for action in the Kent BAP.

9.4.28 The EWTBRC provided detailed records for legally protected and scarce plant species along the northern portion of the Development Boundary. Only a single plant species protected (from sale only) under Schedule 8 of the Wildlife and

Countryside Act 1981 (as amended), was recorded, this being bluebell *Hyacinthoides non-scripta*, a relatively widespread woodland species.

9.4.29 The majority of the remaining plant records from the EWTBRC can be roughly grouped according to habitat type, with records of plants characteristic of ancient woodland, chalk grassland and arable, and saltmarsh/coastal grazing marsh and sea wall habitat types being provided, as summarised in Table 9.11.

Table 9.11 Plant species records grouped by habitat type in Essex

Habitat type	Summary of plant species recorded
Ancient woodland	Bluebell, Wood Spurge *uphorbia amygdaloides*, Butcher's-broom *Ruscus aculeatus.*
Chalk grassland and arable	Pyramidal Orchid *Anacamptis pyramidalis*, Common Spotted-orchid *Dactylorhiza fuchsii,* Yellow Vetchling *Lathyrus aphaca*, Common Twayblade *Listera ovata,* Bee Orchid *Ophrys apifera*, Man Orchid, Sainfoin *Onobrychis viciifolia.*
Coastal grazing marsh/saltmarsh and seawall	Slender Hare's-ear, Sea Barley, Dittander *Lepidium latifolium*, Stiff Saltmarsh-grass *Puccinellia rupestris*, Clustered Clover *Trifolium glomeratum*.

9.4.30 Of these species, Slender Hare's-ear and Sea Barley are listed as species of principal importance under the NERC Act (2006). None of these species has been identified to date within the Development Boundary.

9.4.31 Ancient woodland, species-rich grassland, coastal grazing marsh and hedgerows are targeted for action in the Essex BAP.

Extended phase 1 habitat Survey

9.4.32 The extended Phase 1 habitat survey has commenced but the data has not yet been validated for inclusion in the *PEIR*. Table 9.12 shows the estimated area of Phase 1 habitat types within Development Boundary and a 50m buffer.

Invasive plant species

9.4.33 Stands of invasive non-native plant species have been identified including Japanese knotweed *Reynoutria japonica* in discrete locations within the proposed Development Boundary. In addition, a number of watercourses within the Thames Marshes SSSI support aquatic invasive plant species including water fern *Azolla filiculoides* and Australian swamp stonecrop *Crassula helmsi.*

Table 9.12. Estimated area of Phase 1 habitat types within Development Boundary and a 50m buffer

Phase 1 habitat type		Estimated extent (ha) or length (km)[2]
Woodland and Scrub	Semi-natural broadleaved woodland	53.9 ha
	Broadleaved plantation	38 ha

[2] Note this is an estimate of the extent of habitat recorded within the main Development Area not the amount of a particular habitat type that will be directly affected.

Phase 1 habitat type		Estimated extent (ha) or length (km)[2]
	Dense scrub	39 ha
	Scattered scrub	3.1 ha
Grassland and Marsh	Unimproved acid grassland	2.3 ha
	Semi-improved acid grassland	6.4 ha
	Neutral grassland	43 ha
	Improved grassland	58 ha
	Marshy grassland	0.3 ha
	Poor semi-improved grassland	131 ha
Tall Herb and Fen	Tall ruderal	79 ha
Swamp, marginal and Inundation	Swamp	0.45 ha
	Marginal	0.6 ha
Open Water	Standing water	11.9 ha
	Running water	8.2km
Coastland	Mud/sand	23.3 ha
	Cobbles/shingle	0.98 ha
	Saltmarsh	0.4 ha
Rock exposure and waste	Artificial Spoil	228 ha
	Refuse tip	105 ha
Miscellaneous	Arable farmland	1466 ha
	Amenity grassland	64 ha
	Ephemeral/short perennial	1.7 ha
	Introduced shrub	0.05 ha
	Sea wall	0.28 ha
	Buildings	13 ha
	Bare ground	5.8 ha
	Other habitat	11.0 ha
Boundary Features	Hedgerows, ditches, fences and walls	67km

Invertebrates

9.4.34 The desk-based study data from the KMBRC indicate that since 2008, 81 invertebrate species have been recorded within 1km of the Development Boundary. This includes 10 Kent RDB species, 48 UK BAP priority species, 24 nationally scarce species and 52 species of principal importance under Section 41 of the NERC Act (2006).

9.4.35 Jersey tiger moth *Euplagia quadripunctaria* was recorded in 2014 which is protected under Annex II of the European Communities Council Directive of the Conservation of Natural Habitats and Wild Fauna and Flora, collectively known as the Habitats Directive (1992). Stag beetle, which is protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and Annex II of the Habitats Directive (1992), was also recorded.

9.4.36 The desk-based study data from the EWTBRC indicates that since 2008, 12 invertebrate species have been recorded within 1km of the Development Boundary. This includes 3 nationally scarce species, 8 species listed as being of principal importance in Section 41 of the NERC Act (2006), and also listed on the UK BAP priority species and 5 species listed in the International Union for Conservation of Nature and Natural Resources Red List species. White letter hairstreak *Satyrium w-album* which is protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) has also been recorded from within the Development Boundary.

9.4.37 The climatic conditions and topography of the Greater Thames Estuary NCA provide conditions conducive to a diverse assemblage of terrestrial invertebrates (Harvey, P., 2000), with lower than average rainfall, higher than average temperatures in summer and mild winters (Met Office, 2016). The Development Boundary runs through or passes near a range of habitats that are of particularly high value to invertebrates including ancient woodland, grazing marsh, mudflat, Thames Terrace Grassland, open mosaic habitat on previously disturbed ground (see paragraph 9.4.21), lowland heath and neutral grassland.

9.4.38 The majority of invertebrate records from both the KMBRC and EWTBRC are associated with these habitat types. A discussion of the invertebrate fauna of each of the broad habitat types is given below.

9.4.39 There is a concentration of ancient woodland habitat adjacent to the Development Boundary situated along the A2 corridor in Kent, as outlined in Table 9.5). The Shorne and Ashenbank Woods SSSI citation (Natural England, 2018) states that the woodlands support an important and diverse invertebrate fauna especially its beetles *Coleptera*, tree bugs *Hemiptera*, and dragonflies *Odonata.* It also states that the woodlands support the nationally scarce ruddy darter dragonfly *Sympetrum sanguineum,* the satin lustering moth *Tetheela fluctuosa* and rare beetle species *Mordella holomelaena* and *Peltodytes caesus*.

9.4.40 Smaller areas of ancient woodland that may also support scarce invertebrates are located around the M25/A127 junction in Essex, including Hobbs Hole, Codham Hall Wood and Coombe Green wood where they lie adjacent to the Development Boundary.

9.4.41 The ditches of coastal and floodplain grazing marsh are especially rich in plants and invertebrates (Joint Nature Conservation Committee, 2008). The Development Boundary passes under the South Thames Estuary and Marshes SSSI (Table 9.5) which is in part designated for the number of nationally rare and scarce invertebrate species it supports (Natural England, 2018a).

9.4.42 Over 100 nationally scarce species of invertebrates have been recorded here including the hoverfly *Lejops vittata*, the shorebug *Sadula opacula* and the dotted fan-foot moth *Macrochilo cribrumalis*, all of which are restricted to the

wetland, estuarine or coastal and floodplain grazing marsh habitats found within the SSSI. The water beetle fauna within the SSSI includes 4 species of *Bagous sp.* aquatic weevil, three species of *Berosus sp.* beetle and the great silver water beetle (Natural England, 2018a). The SSSI is also situated within Thames Estuary and Marshes Ramsar site (Table 9.6) which supports more than 20 British RDB invertebrates (Joint Nature Conservation Committee, 2000).

9.4.43 The Development Area Boundary includes mudflats within the Thames Estuary that are exposed during low tide. Mudflats have a high biological productivity with abundant invertebrates such as ragworms (*Nereididae*), lugworms *Arenicola marina*, sand hoppers *Talitrus saltator*, cockles (*Cardiidae*) and *Hydrobia* snails that provide food for internationally important populations of migrant and wintering birds (Buglife - The Invertebrate Conservation Trust, 2018).

9.4.44 More information on the mudflats can be found within Chapter 10: Marine Biodiversity.

9.4.45 As discussed in paragraphs 9.4.20 to 9.4.21 both Thames Terrace Grassland and brownfield habitat have declined. Very few of the remnant patches of Thames Terrace Grassland are protected by conservation designations (Applied Ecology Ltd, 2011). One such non-statutory designated site is Low Street Pit LWS (Table 9.6), selected for its diverse invertebrate fauna, with records of the UK BAP species hornet robberfly (Thurrock Council, 2007).

9.4.46 The decline of Thames Terrace Grassland has led to the associated invertebrate fauna becoming dependent on similar grasslands that occur within the NCA on drought-stressed substrates within brownfield land such as old sand and chalk quarries and pulverised fuel-ash lagoons (Essex Field Club, 2018). These sites are classified as ‘Open Mosaic Habitat (on previously disturbed land)’.

9.4.47 The invertebrate assemblages associated with this habitat type can be species-rich and include many uncommon species (Eyre *et al.*, 2002, 2004) and between 12% and 15% of all nationally-rare and nationally-scarce insects are recorded from brownfield sites (Gibson, 1998). The Thames Estuary NCA supports at least 15 priority species strongly associated with brownfield habitat, such as the streaked bombardier beetle *Brachinus sclopeta* and distinguished jumping spider *Sitticus distinguendus*. The region also contains an important population of the shrill carder bee *Bombus sylvarum* (Robins *et al.,* 2013) along with 100 RDB and 400 nationally scarce species (Buglife, 2008).

9.4.48 The Development Boundary includes large areas of open mosaic habitat, including the 4 non-statutory designated LWS: Lytag Brownfield LWS, Low Street Pit LWS, Goshems Farm LWS, and Tilbury Centre LWS. Lytag Brownfield LWS is noted as being of regional importance for its invertebrate assemblage. Goshems Farm LWS has been identified for its invertebrate interest with records of hornet robberfly, shrill carder bee, white-letter hairstreak and small heath *Coenonympha pamphilus* butterflies. Tilbury Centre LWS supports the nationally rare RDB great silver water beetle and UK BAP bumblebee species, *Bombus humilis* Information on these LWS is detailed in (Thurrock Council, 2007).

9.4.49 Note that survey work at Lytag has indicated the invertebrate assemblage is of national importance, this has been confirmed by Natural England who have indicated that the site may also meet the criteria for designation as a SSSI and they are currently reviewing whether to designate the site. Conversely, the majority of Goshems Farm has been destroyed by importing spoil from the Thames Tideway development. Thurrock District Council have indicated it may no longer support sufficient habitat to quality as an LWS.

9.4.50 Lowland heathland is also an important invertebrate habitat containing a mosaic of vegetation types and sward heights and supports many rare British species that are at the edge of their European range (Buglife, 2018a). The only ancient heathland left in Thurrock, Mucking Heath LWS (Table 9-8) lies adjacent to the Development Boundary north of the Thames Estuary in Essex, towards the A13, and is selected for its invertebrate interest including 4 nationally rare, 50 nationally scarce and over 100 local species (Thurrock Council, 2007).

9.4.51 The Development Boundary also passes through Blackshots Nature Area LWS (Table 9.8) where the A13 meets the A1089. This is the largest grassland LWS in Thurrock away from the coastal grazing marshes and supports an important invertebrate population including 7 Essex RDB species, as well as the UK BAP fly *Dorycera graminum* (Thurrock Council, 2007). Other areas present in Essex along the Development Boundary that are of potential value to invertebrates but have not been afforded any ecological designation. These include:

a. around North Road, North Ockendon, lies an area of rough grassland with scrub, bare ground and broadleaved woodland

b. further north, alongside the M25 are the Thames Chase Forest Centre and Folkes Lane Woodland which contain mosaics of woodland, meadows, scrub and ponds

Fish

9.4.52 The main freshwater watercourse within the Development Boundary is the Mardyke and data supplied by the Environment Agency indicate the Mardyke supports a diverse assemblage of coarse fish characteristic of a slow flowing lowland watercourse including roach *Rutilus rutilus*, tench *Tinca tinca* and rudd *Scardinius erythropthalamus* as well as a population of migratory eels *Anguilla anguilla*.

Amphibians

9.4.53 Great crested newt is listed on Appendix II of the Bern Convention (and on Annexes II and IV of the Habitats Directive (1992) as a protected species). In England and Wales, the great crested newt is protected under Schedule 2 of the Conservation of Habitats and Species Regulations 2017 and under Schedule 5 of the Wildlife and Countryside Act 1981(as amended).

9.4.54 Great crested newts spend most of their life cycle on land with breeding and larval development occurring in bodies of water.

9.4.55 The desk study data from the KMBRC indicate that since 2008, there are 17 great crested newt records within 1km of the Development Boundary. Twelve of these were recorded within Shorne and Ashenbank Woods SSSI (Table 9.5)

and 1 within Cobham Woods SSSI (Table 9.7). One record, located within South Thames Estuary and Marshes SSSI (Table 9.7), is 1.4km from the Development Boundary.

9.4.56 Populations of great crested newts in Essex are concentrated around Rochford, Chelmsford and Basildon (Essex Field Club, 2018a), although this may be down to lack of recording (Thurrock Council, 2007, Essex Field Club, 2018a). The desk study data from the EWTBRC indicate that since 2008, 1 great crested newt was recorded within 1km of the Development Boundary, in Keats Garden, just north of Tilbury Fort. Cranham Brickfields LNR (Table 9.7), located within 1km of the Development Boundary south-west of the M25/A127 junction, is in part designated for supporting great crested newt (Natural England, 2013).

9.4.57 Suitable foraging habitat is present within the Development Boundary in both Kent and Essex. This includes woodland, scrub, rough grassland, grazing marsh and open mosaic habitat on previously developed land. 196 water bodies that could act as potential breeding sites were identified within and up to 500m from the Development Boundary. Survey work to date has identified 13 ponds in Kent and 17 in Essex supporting great crested newts.

Reptiles

9.4.58 There are 4 species of reptile present within Kent and Essex which have the potential to be affected by the Project. These are adder, grass snake, common lizard and slow worm.

9.4.59 All these species are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and are species of principal importance listed under Section 41 of the NERC Act (2006). These 4 species are listed on both the Kent and Essex Local BAPs (Essex Biodiversity Project, 2011, Kent Biodiversity Partnership, 2009). Adder and grass snake are also listed in the Thurrock Local BAP (Thurrock Council, Undated).

9.4.60 There are two non-statutory designated sites within 2km of the Development Boundary which list species of reptile under the citation, these being: Lytag Brownfield LWS and Cranham Brickfields LNR. Lytag Brownfield LWS consists of acid grassland habitat which supports adder, grass snake, common lizard and slow worm. Cranham Brickfields LNR, 0.45km west of the Development Boundary, is a former brickfield with large areas of grassland and scrub which supports notable populations of slow worm and common lizard.

Adder

9.4.61 Historically the adder has a large range in Britain, but has suffered population declines in all regions studied, with the most marked declines in the Midlands (Joint Nature Conservation Committee, 2010a; Baker *et al.,* 2004).

9.4.62 Evidence shows that adders have declined within Kent and Essex, especially in areas close to urban centres, with development and increased human pressure probably causing local extinctions (Atkins, 2005). Adders are found throughout Kent except the south of the county (Kent Amphibian and Reptile Group, 2018a). Adders are the rarest of the reptiles found in Essex, having a localised distribution in less than 50% of the county (Harvey, updated 2017).

9.4.63 The KMBRC provided two records for adders within 2km of the Development Boundary, one from an area of scrub within the Development Boundary and one from a residential garden, approximately 2km south-west of the Development Boundary in 2016.

9.4.64 EWTBRC provided six records of adders concentrated in areas near Tilbury sewage treatment works and Tylers Common, which is 0.8km north-west of the Development Boundary at its closest point.

9.4.65 A single adder was observed during reptile survey at Low Street Pit LWS (within the Development Boundary).

Grass snake

9.4.66 Grass snakes are widespread throughout England and Wales but are absent from Scotland. The species has suffered declines in habitat availability due to agricultural intensification and other factors (Hilton-Brown and Oldham,1991; Joint Nature Conservation Committee, 2010b).

9.4.67 Grass snakes are probably the most widely distributed reptile species in Kent. They are more likely to be encountered close to freshwater. Increased populations of amphibian species such as marsh frog, which now forms an important dietary component in some areas, are likely to have resulted in local grass snake population increases (Kent Biodiversity Partnership, 2011).

9.4.68 In Essex, grass snakes are abundant in the south-west becoming scarcer towards the north of the county (Essex Field Club, 2018b).

9.4.69 Grass snake desk-based study records supplied by KMBRC provided 24 records within 2km of the Development Boundary. Two records relate to areas within the Development Boundary. The remaining records are from a variety of locations, including within Shorne Woods Country Park (0.2km north of the Development Boundary at its closest point) and an area east of Milton firing range (1.4km east).

9.4.70 Grass snake desk study records supplied by EWTBRC provided three records within 2km of the Development Boundary, the closest of which relates to an area adjacent to the Development Boundary within the Tilbury Sewage Works site in an area of scattered scrub and grassland. The remaining two records are 1.64km south-west and 2km north-west of the Development Boundary, respectively.

9.4.71 There were four incidental sightings of grass snakes during 2017. Two were observed in Kent, one within Shorne Woods, near the A2 road (more than 500m from the Development Boundary) and one near Shorne Marshes (within 500m of the Development Boundary). Two were observed in Essex, one within arable farmland near Tilbury Power Station and one near the Mardyke (both within the Development Boundary).

Slow worm

9.4.72 Historically a widespread species, slow worms have declined in all regions of England with the exception of the North West, with the biggest declines in the Midlands (Baker *et al.,* 2004). This is mainly due to brownfield site loss and continuing development pressure in the countryside (Joint Nature Conservation Committee 2010d).

9.4.73 Slow worms are found throughout Kent (Kent Amphibian and Reptile Group, 2018c) and population estimates at some brownfield sites, which are a good environment for shelter and basking, indicate over 2,000 per hectare (Kent Biodiversity Partnership, 2011). In Essex, slow worms are more common in the south, becoming scarcer in the north-west of the county (Essex Field Club, 2018d).

9.4.74 Slow worm desk-based study records within 2km of the Development Boundary in Kent supplied by KMBRC provided 68 records of which only one record relates to an area within the Development Boundary, in a residential garden.

9.4.75 Slow worm desk-based study records within 2km of the Development Boundary in Essex supplied by EWTBRC provided 3 records, none of which relate to areas within the Development Boundary, but one record relates to an area adjacent to the Development Boundary within the Tilbury sewage works site. The remaining two records relate to areas 1.64km and 1.75km south-west of the Development Boundary respectively.

Common lizard

9.4.76 Common lizards are widespread throughout the UK, but numbers are declining in southern and south-east England, with no increases anywhere else within the range (Hilton-Brown and Oldham, 1991). These declines are mainly due to brownfield site loss and continuing development pressure in the countryside (Joint Nature Conservation Committee, 2010c).

9.4.77 Common lizards are described as locally abundant in Kent (Kent Amphibian and Reptile Group, 2018b). Within Essex, common lizard are also widespread (Essex Field Club, 2018c).

9.4.78 Common lizard desk-based study records supplied by KMBRC provided 17 records within 2km of the Development Boundary, none of which relate to areas within the Development Boundary. A number of records relate to areas of scattered scrub within woodland clearings in Shorne Woods Country Park, the closest of which is 0.3km north of the Development Boundary.

9.4.79 Common lizard desk-based study records within 2km of the Development Boundary supplied by EWTBRC provided five records the closest of which relates to an area within the Tilbury sewage works site, adjacent to the Development Boundary. The remaining records relate to areas 0.13km to 2km west and south-west of the Development Boundary, respectively.

9.4.80 There have been two incidental sightings of a common lizard recorded during the 2017 extended Phase 1 habitat survey, adjacent to the Development Boundary. One common lizard was also observed during reptile survey refugia deployment at Low Street Pit LWS.

Reptile surveys

9.4.81 To date 15 areas of suitable reptile habitat have been surveyed, four areas were in Kent (referred to as south of the crossing) and 11 in Essex (north of the crossing). Surveys were undertaken in accordance with best practice (Gent & Gibson, 1998

9.4.82 Results of the reptile surveys undertaken to date are shown in Table 9.13 Results of the reptile surveys In the survey areas in Kent, common lizard was

the only species recorded, found in three out of the four survey areas. All four reptile species were recorded in Essex. Of the 11 Essex survey areas, adder was recorded in nine and grass snake was recorded in two. Common lizard and slow worm were recorded in all 11 survey areas.

Table 9.13 Results of the reptile surveys to date

Survey Area	Adder peak count		Grass snake peak count		Slow worm peak count		Common lizard peak count	
	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
North (N)								
N-A	0	2	0	0	9	13	5	13
N-B	1	0	0	1	1	1	4	9
N-C	1	1	0	0	8	10	8	6
N-D	1	2	0	0	20	6	4	10
N-E	0	2	0	0	20	7	4	18
N-F	0	1	0	0	2	1	4	4
N-G	0	0	0	0	3	1	1	8
N-H	0	2	0	0	12	10	4	8
N-I	1	1	0	0	2	4	3	10
N-J	2	3	1	2	5	2	10	30
N-K	0	0	0	0	4	1	0	7
South (S)								
S-A	0	0	0	0	0	0	0	0
S-B	0	0	0	0	0	0	0	2
S-C	0	0	0	0	0	0	4	6
S-D	0	0	0	0	0	0	0	6

9.4.83 Using guidance detailed within Froglife Advice Sheet 10 (Froglife, 1999), an initial population size class assessment was undertaken. This method uses the maximum number of adults seen by one person in a day to predict the population size within the area. Population size classes are presented in Table 9.14.

Table 9.14 Population size class assessment

Species	Low population	Good population	Exceptional population
Adder	<5	5-10	>10
Grass snake	<5	5-10	>10
Common lizard	<5	5-20	>20
Slow worm	<5	5-20	>20

9.4.84 Good populations of slow worm and common lizard were estimated in five and three survey areas respectively, all within Essex. Low populations of all four species were estimated in all other survey areas.

Ornithology

9.4.85 This section provides an overview of the ornithology desk study results received, specifically in relation to the habitat types present within the Development Boundary. The results of the surveys undertaken to date are summarised.

9.4.86 As detailed in paragraph 9.4.8, the Development Boundary crosses 3 NCAs. Table 9.15 details the habitat features within each NCA that are present within the Development Boundary, that provide key habitat types for birds and which specific ornithological assemblages are supported by these habitats. These specific assemblages have formed the basis of the ornithological surveys.

Table 9.15 NCA features in relation to bird assemblages

National Character Area	Habitat features important to birds	Ornithological assemblage present
The North Kent plain	Ancient woodland	woodland
The Greater Thames Estuary	Thames Estuary	estuarine
The Northern Thames Basin	Arable habitat	farmland

9.4.87 Within the UK there has been a general decline in bird numbers, with the 'all bird species index' declining 7% since 1970. In relation to the assemblages present within the Development Boundary:

a. The breeding farmland bird index has declined by 56% since 1970.

b. The breeding woodland bird index has declined by 23% since 1970.

c. The breeding water and wetland bird index has declined by 8% since 1970.

d. The wintering water bird index has declined by 8% since 2010. (Wild bird populations in the UK, 1970 to 2016 (Department for Environment Food & Rural Affairs, 2017)).

9.4.88 Within this section the focus is on the three different assemblages described above. The bird species that will be discussed specifically are:

a. Birds with legal protection under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). This protects certain species from disturbance while breeding in addition to the usual protection against destruction of active nests, which applies to all bird species.

b. Birds listed in the protected area designations in Table 9.6 and Table 9.7, specifically species within the designation of international (Ramsar site and

SPA) and national (SSSI) importance, including Mucking Flats and Marshes SSSI and the South Thames Estuary SSSI.

c. Species listed in Birds of Conservation Concern (BoCC) (Eaton et al., 2015) as 'red' or 'amber'. The majority of red listed species would also be listed on Section 41 of the NERC Act (2006).

9.4.89 BoCC red listed species of conservation concern have undergone severe decline and amber listed species have undergone decline to a less severe extent. The assessment criteria for the categorisation include conservation status, globally, at a European level and within the UK, historical decline, population trends, rarity, localised distribution and international importance. Green list species, those of least conservation concern, will not be discussed, within the *PEIR*, but an appendix of green list species that have been observed on survey work carried out to date will be provided in the ES.

9.4.90 Ornithological desk-study data from KMBRC and EWTBRC has been analysed in relation to Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) designated species and the BoCC Red and Amber list species. Records were provided for 44 species of birds protected under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). A narrative concerning these species is detailed below.

9.4.91 Of the Schedule 1 species highlighted by the desk study records, the following are also listed on the designation for the Thames Estuary and Marshes SPA and Ramsar site: avocet, black-tailed godwit, greenshank and hen harrier, while bearded tit is listed on the SSSI designation.

9.4.92 Some Schedule 1 species are vagrants or migrants passing through, meaning they are unlikely to be observed near the Development Boundary. These include: bee-eater *Merops apiaster*, black necked grebe *Podiceps nigricollis*, black winged stilt *Himantopus himantopus*, black tern *Chlidonias niger*, Caspian gull *Larus cachinnans*, common scoter *Melanitta nigra*, honey buzzard *Pernis apivorus*, Leach's petrel *Oceanodroma leucorhoa*, osprey *Pandion haliaetus*, roseate tern *Sterna dougallii*, scaup *Aythya marila* and snow bunting *Plectrophenax nivalis*.

9.4.93 Species such as woodlark *Lullula arborea*, goshawk *Accipter gentilis*, firecrest *Regulus ignicapilla* and common crossbill *Loxia curvirostra* are likely to be associated with woodland within and/or adjacent to the Development Boundary.

9.4.94 Farmland birds listed in Schedule 1 - barn owl *Tyto alba*, brambling *Fringilla montifringilla*, fieldfare *Turdus pilaris*, quail *Coturnix coturnix* and redwing *Turdus iliacus* - have the potential to be present within the Development Boundary, specifically to the north of the Project within the Northern Thames Basin NCA. Of these, barn owl is resident year-round, quail is a summer visitor the remainder are winter visitors.

9.4.95 Of the remaining Schedule 1 species, Cetti's warbler *Cettia cetti*, hobby *Falco subbuteo* and bittern *Botaurus stellaris* are associated with reed bed habitat. Cetti's warbler records were widespread, bittern records were from Gravesend in Kent and in Essex from Chafford Gorges WT site in Thurrock. Hobby records were associated with marsh and reed bed habitat, such as Shorne Marshes and

Filborough Marshes in Kent and Chafford Gorges WT site, and the Mardyke in Essex. Within the vicinity of the Development Boundary records for black redstart and little ringed plover are often associated with industrial or brownfield sites (Parrinder, 1989; Greater Manchester Biodiversity Action Plan, 2009), while peregrine may breed on manmade structures in the area and have been observed perched on top of electricity pylons. Red kite records were predominantly from Kent. This species is a generalist raptor and forages over a variety of habitats. Kingfisher as a species is highly associated with water courses, but relatively widespread within the desk-based study area.

9.4.96 The ecological desk-study provided numerous records of those bird species listed as interest features of statutory-designated species (see Table 9-4 and Table 9.5 for the sites and the bird species concerned). The clear majority of these records were concentrated either on or near the Thames Estuary. These desk study records have not been repeated here but highlight the importance of the estuary to bird species within the vicinity of the Project.

9.4.97 Up-to-date British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) data for all relevant sites, including the Thames Estuary and Marshes SPA is currently being collated and will be included in the ES.

9.4.98 The desk-study data provided records of bird species associated with the woodland assemblage of the North Kent Plain NCA and the farmland bird assemblage of the Northern Thames Basin NCA. Table 9.16 highlights the species recorded.

Table 9.16 Desk study records for woodland and farmland bird species

Bird assemblage	Species for which there are desk-based study records
Woodland bird assemblage North Kent Plains NCA	Bullfinch *Pyrrhula pyrrhula*, hawfinch *Coccothraustes coccothraustes*, lesser spotted woodpecker *Dendrocopos minor*, pied flycatcher *Ficedula hypoleuca*, mistle thrush *Turdus viscivorus*, song thrush *Turdus philomelos*, spotted flycatcher *Muscicapa striata*, tawny owl *Strix aluco*, treecreeper *Certhia familiaris*, tree pipit *Anthus trivialis* and woodcock *Scolopax rusticola*.
Farmland bird assemblage Northern Thames Basin NCA	Common redpoll *Acanthis flammea*, cuckoo *Cuculus canorus*, dunnock *Prunella modularis*, grasshopper warbler *Locustella naevia*, grey partridge *Perdix perdix*, house martin *Delichon urbicum*, house sparrow *Passer domesticus*, kestrel *Falco tinnunculus*, lesser redpoll *Acanthis cabaret*, linnet *Linaria cannabina*, meadow pipit *Anthus pratensis*, nightingale *Luscinia megarhynchos*, redstart *Phoenicurus*, reed bunting *Emberiza schoeniclus*, skylark, stock dove *Columba oenas*, starling *Sternus vulgaris*, swift *Apus*, tree sparrow *Passer montanus*, turtle dove *Streptopelia turtur*, yellow wagtail *Motacilla flava* and yellowhammer *Emberiza citronella.*

9.4.99 Table 9.5 highlights the ornithological survey activities that have commenced; the initial focus has been on intertidal habitat within the Thames Estuary and areas of potential functional habitat close to the estuary including the jetty location, woodland habitat along the A2 corridor and Hangman's Wood in

Essex. It is these initial results that are presented within the *PEIR*. Full results of all the ornithological survey work will be presented within the ES.

9.4.100 The preliminary results of intertidal surveys are detailed in Table 9.17. This presents the peak count for each species observed and which of the four VPs the peak was recorded from.

9.4.101 Figure 9.1 in Volume 3 shows the locations of each of the 4 VPs (NE = north-east and so on).

Table 9.17 Peak count of waterfowl recorded during the tidal surveys

Species	Breeding season 2017 peak	Passage season 2017 peak	Winter season 2017 peak
Species listed on citation for Thames Estuary SPA, Ramsar site and SSSI			
Avocet	59 (VP NE)	6 (VP NE)	19 (VP NE)
Black-tailed godwit	300 (VP NE)	35 (VP NE)	40 (VP NE)
Curlew	14 (VP NE)	61 (VP SE)	28 (VP NE)
Dunlin	1 (VP NE)	120 (VP NE)	800 (VP NE)
Grey plover	0	0	56 (VP NE)
Knot	0	0	13 (VP NE)
Lapwing	2 (VP NE)	5 (VP NE)	83 (VP SE)
Little egret	4 (VP NW)	4 (VP NW)	2 (VP NE)
Little grebe	0	0	1 (VP NE)
Redshank	72 (VP SE)	7 (VP SE)	17 (VP SE)
Ringed plover	15 (VP NW)	162 (VP NE)	75 (VP NE)
Ruff	2 (VP SE)	0	0
Shelduck	24 (VP NE)	15 (VP NE)	18 (VP NE)
Shoveler	0	0	2 (VP NW)
Teal	16 (VP NE)	16 (VP NE)	253 (VP NE)
Whimbrel	5 (VP NE)	3 (VP NE)	10 (VP NE)
Species listed on citations as being part of a waterfowl assemblage			
Bar-tailed godwit	0	9 (VP NE)	8 (VP NE)
Brent goose	0	0	1 (VP SE)
Canada goose *Branta canadensis*	17 (VP NW)	105 (VP NW)	0
Common sandpiper	3 (VP SE)	6 (VP SE/NW)	0
Cormorant *Phalacrocorax carbo*	2 (VP NE)	3 (VP NE)	3 (VP NW)
Egyptian goose *Alopochen aegyptiaca*	0	0	2 (VP SW)

Species	Breeding season 2017 peak	Passage season 2017 peak	Winter season 2017 peak
Great crested grebe *Podiceps cristatus*	2 (VP NE)	0	0
Grey heron *Ardea cinerea*	0	1 (VP NE)	1 (VP NE/NW)
Greylag goose	1 (VP NE)	2 (VP NW)	0
Mallard	10 (VP NW)	3 (VP NE)	20 (VP NE)
Mediterranean gull	1 (VP NW)	1 (VP SE)	0
Mute swan	0	0	3 (VP NW)
Oystercatcher	7 (VP NE)	8 (VP NE)	0
Red-breasted merganser *Mergus serrator*	0	0	1 (VP NW)
Turnstone	8 (VP SE)	7 (VP SE)	16 (VP SE)
Wigeon *Anas penelope*	0	8 (VP NE)	300 (VP SE)

9.4.102 In addition to the above wader and waterfowl observations, four species of raptor have been recorded during both the breeding and the passage seasons. These are: marsh harrier, kestrel and peregrine falcon. Short-eared owl, listed on the SSSI designation for the South Thames and Estuary Marshes, was recorded once incidentally near the estuary in Essex in April 2017. No hen harrier observations were recorded.

9.4.103 Nocturnal surveys, using infrared night vision equipment, commenced in November 2017 focusing on areas of potential functionally linked habitat and at low tide within the proposed jetty location.

9.4.104 Peak counts for the nocturnal surveys of potential functional habitat are detailed in Table 9.18, while the results from the jetty location are presented in Table 9.19.

Table 9.18 Nocturnal peak counts of potential functional habitat

Bird species	BoCC	Kent	Essex
Estuary designated site species			
Avocet[3][4]	Amber	-	4
Black-tailed godwit	Red	-	13
Dunlin	Amber	-	810
Grey plover[3]	Amber	-	1
Lapwing	Red	55	13

[3] Species are those listed on both the Thames Estuary SPA and Ramsar site designations
[4] Refers to Schedule 1 species

Bird species	BoCC	Kent	Essex
Little grebe	Green	-	4
Redshank[2]	Amber	1	72
Shelduck	Amber	-	9
Water rail	Green	Heard only	-
Whimbrel	Red	-	-
Other bird species	**BoCC**	**Kent**	**Essex**
Barn owl[4]	Green	-	1
Black-headed gull	Amber	-	1
Canada goose	Introduced	6	13
Coot *Fulica atra*	Green	-	1
Grey heron	Green	3	-
Lesser black-backed gull	Amber	2	-
Mallard	Amber	7	20
Moorhen	Green	-	4
Mute swan	Amber	4	-
Pochard	Amber	-	9
Snipe	Red	4	2
Tawny owl	Amber	-	1
Teal	Amber	5	54
Wigeon	Amber	35	-
Duck (species unidentified)		45	-

Table 9.19 Nocturnal peak counts of the jetty location

Bird Species	Peak Count
Dunlin	16
Redshank	2
Medium wader possibly redshank	8
Small wader/grebe	8
Barn owl	1
Tawny owl	1

9.4.105 Of the bird species listed in Table 9.20 and Table 9.21, lapwing were recorded mainly on the Kent side of the estuary roosting in fields, while waterfowl within Kent were predominantly recorded in the RSPB reserve or on areas of flood water near the sea wall.

9.4.106 In Essex the highest numbers of waterfowl species were observed from surveys at Tilbury Fort. A roost of dunlin and redshank was observed here in November and December. In addition, there is an inlet into the Thames which is the only location where avocet, grey plover and black-tailed godwit have been recorded during nocturnal surveys.

9.4.107 As outlined in Table 9.5, transects have been carried out on areas of potential functional habitat. Table 9.22 presents the results of species recorded to date that are listed individually on the citation for the Thames Estuary and Marshes SPA, Ramsar site and SSSI, while additional species that would form part of the waterfowl assemblage are detailed in Table 9.23.

Table 9.20 Species observed during transects of potential functional habitat

		Kent			Essex		
		Survey period			Survey period		
Species	**BoCC**	**Breeding**	**Passage**	**Winter**	**Breeding**	**Passage**	**Winter**
Curlew	Red					✓	✓
Dunlin [5]	Amber						✓
Gadwall	Amber			✓		✓	
Golden plover	Red						✓
Lapwing	Red	✓		✓	✓	✓	✓
Little egret	Green	✓	✓		✓	✓	✓
Little grebe	Green	✓	✓	✓		✓	✓
Redshank	Amber						✓
Shelduck	Amber	✓			✓		✓
Shoveler	Amber						✓
Teal	Amber					✓	
Whimbrel	Red				✓		

Table 9.21 Species contributing to the waterfowl assemblage

		Kent			Essex		
		Survey period			Survey period		
Species	**BoCC**	**Breeding**	**Passage**	**Winter**	**Breeding**	**Passage**	**Winter**
Canada goose	Introduced					✓	
Common sandpiper	Amber				✓	✓	
Coot	Green	✓	✓	✓			

[5] Species highlighted are listed on the Thames Estuary and Marshes Ramsar site and SPA.

		Kent			Essex		
		Survey period			Survey period		
Species	**BoCC**	**Breeding**	**Passage**	**Winter**	**Breeding**	**Passage**	**Winter**
Green sandpiper* [6]	Amber		✓		✓		
Grey heron	Green	✓	✓	✓		✓	✓
Greylag goose	Amber			✓			✓
Mallard	Amber	✓	✓	✓	✓	✓	✓
Moorhen	Green	✓	✓	✓		✓	✓
Mute swan	Amber	✓	✓	✓			
Oystercatcher	Amber					✓	✓
Snipe	Red					✓	✓
Tufted duck *Aythya fuligula*	Green	✓					
Wigeon	Amber				✓		

9.4.108 Non-waterfowl species recorded during the transects are detailed in Table 9.22.

Table 9.22 Non-waterfowl species observed during transects of potential functional habitat

		Kent			Essex		
		Survey period			Survey period		
Species	**BoCC**	**Breeding**	**Passage**	**Winter**	**Breeding**	**Passage**	**Winter**
Barn owl*[7]	Green			✓	✓		
Black-headed gull	Amber	✓			✓	✓	✓
Bullfinch	Amber						✓
Cetti's warbler*	Green	✓	✓	✓	✓	✓	✓
Common gull	Amber					✓	✓
Corn bunting	Red				✓	✓	✓
Cuckoo	Red	✓			✓		
Dunnock	Amber	✓	✓	✓	✓	✓	✓
Fieldfare*	Red			✓		✓	✓
Grasshopper warbler	Red	✓	✓				

[6] '*' Refers to Schedule 1 species.
[7] '*' Refers to Schedule 1 species.

		Kent			Essex		
		Survey period			Survey period		
Species	**BoCC**	**Breeding**	**Passage**	**Winter**	**Breeding**	**Passage**	**Winter**
Great black-backed gull	Amber				✓		
Grey wagtail	Red					✓	
Herring gull	Red				✓	✓	
Hobby	Green	✓			✓		
House martin	Red	✓			✓	✓	
House sparrow	Red	✓	✓		✓	✓	✓
Kestrel	Amber	✓	✓	✓	✓	✓	✓
Kingfisher*	Amber		✓			✓	
Linnet	Red	✓	✓		✓	✓	✓
Little ringed plover *	Red				✓		
Marsh harrier*	Amber	✓	✓			✓	✓
Marsh tit *Poecile palustris*	Red				✓	✓	
Meadow pipit	Amber	✓	✓	✓	✓	✓	✓
Mistle thrush	Red	✓	✓	✓		✓	✓
Nightingale	Red				✓		
Peregrine*	Red					✓	✓
Redwing*	Red			✓		✓	✓
Reed bunting	Red	✓	✓	✓	✓	✓	✓
Skylark	Red	✓	✓		✓	✓	✓
Song thrush	Red	✓	✓	✓	✓	✓	✓
Starling	Red	✓	✓	✓	✓	✓	✓
Stock dove	Amber	✓	✓		✓	✓	✓
Swift	Amber	✓	✓		✓	✓	
Whinchat	Red	✓				✓	
Willow warbler	Amber				✓	✓	
Yellow wagtail	Red					✓	
Yellowhammer	Red					✓	✓

9.4.109 The species detailed in Table 9.22 are predominately farmland bird species associated with the Northern Thames Basin NCA farmland bird assemblage. Exceptions to this are: the gull species recorded are more generalist and are associated with the River Thames (specifically great black-backed gull) and forage in a range of habitats, including urban areas, (specifically herring gulls)

(Rock, 2005). Grey wagtail and kingfisher are closely associated with water courses. Hobby and marsh harrier are associated with reed bed and wetland habitats. Little ringed plover were recorded from temporary flooded pools near to Tilbury Power Station. The peregrine was seen sitting on overhead electricity pylons next to the power station.

9.4.110 Table 9.23 shows transects that were carried out in woodland along the A2 corridor in Kent and Hangmans Wood in Essex.

Table 9.23 Species observed during transects in woodland habitat within Kent and Essex

		Kent			Essex		
		Survey period			Survey period		
Species	**BoCC**	**Breeding**	**Passage**	**Winter**	**Breeding**	**Passage**	**Winter**
Bullfinch	Amber	✓	✓	✓			
Dunnock	Amber	✓	✓	✓	✓		✓
Fieldfare	Red			✓			
Hawfinch	Red			✓			
House sparrow	Red				✓		
Kestrel	Amber	✓	✓	✓			
Kingfisher* [8]	Green		✓				
Lesser redpoll	Red			✓			
Linnet	Red	✓					
Mallard	Amber		✓				
Marsh tit	Red	✓	✓	✓			
Meadow pipit	Amber	✓					
Mistle Thrush	Red	✓					
Redwing	Red			✓			
Skylark	Red		✓				
Song thrush	Red	✓	✓	✓			
Starling	Red	✓	✓		✓		✓
Stock dove	Amber	✓	✓	✓			
Swift	Amber	✓					
Willow warbler	Amber	✓					
Wood warbler	Red	✓					

[8] '*' Refers to Schedule 1 species.

		Kent			Essex		
		Survey period			Survey period		
Species	BoCC	Breeding	Passage	Winter	Breeding	Passage	Winter
Phylloscopus sibilatrix							
Woodcock	Red			✓			

9.4.111 The woodland areas in Kent were found to contain a more diverse range of species than Hangman's Wood in Essex, where only three red or amber listed species were recorded. This was expected to an extent as the North Kent Plain NCA contains a large extent of ancient woodland habitat, this habitat type being much less frequent in Essex. Of the species recorded within Kent, hawfinch and lesser redpoll were recorded in Shorne Woods only, wood warbler and woodcock were only recorded in Cobham Woods.

9.4.112 The results of bird surveys across the wider route, which are currently being validated and analysed, will be provided in the ES.

Bats

9.4.113 All UK bat species are protected, both under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and as European Protected Species under Schedule 2 of the Conservation of Habitats and Species Regulations (2017). Furthermore, barbastelle *Barbastella barbastellus*, Bechstein's bat *Myotis bechsteinii*, noctule *Nyctalus noctula*, soprano pipistrelle *Pipistrellus pygmaeus*, brown long-eared bat and lesser horseshoe bat *Rhinolophus hipposideros* are listed as species of principal importance under the NERC Act (2006). Barbastelle, Bechstein's bat, lesser horseshoe bat and greater horseshoe bat *Rhinolophus ferrumequinum* are additionally listed on Annex II of the Habitats Directive (1992). A summary of the local and national trends for UK bat species is provided in Table 9.24.

9.4.114 A review of the desk study identified a single statutory designated site for which bats were listed as a designated feature. Hangman's Wood and Deneholes SSSI is, as detailed in Table 9.7, the most important underground bat hibernation site in Essex. Brown long-eared bat, Natterer's bat and Daubenton's bat have been recorded using the series of medieval chalk mines that are present across the site. Hangman's Wood and Deneholes SSSI is located outside of the Development Boundary, approximately 500m to the west.

9.4.115 As detailed in paragraph 9.4.8, habitats along the Project can be broadly split into three NCAs, and the bat baseline is described in relation to this. South of the River Thames the Development Boundary is characterised by a large extent of ancient semi-natural broadleaved woodland, which is likely to be well used by roosting and foraging bats, particularly where suitable connectivity is present in the form of linear features such as hedgerows.

9.4.116 The Greater Thames Estuary NCA and the habitats immediately adjacent are considered suboptimal for bats due to reduced cover and the greater degree of exposure to the elements in the open landscape along the estuary.

9.4.117 The Northern Thames Basin NCA primarily consists of intensively managed arable land. However, small areas of semi-natural habitat remain, and bats within this NCA are likely to be focused within these remaining areas, although areas of arable land may be used in a more limited manner, particularly where well connected through linear features, such as hedgerows.

Table 9.24 UK bat species, local and national trends

Rarity	Species	Kent (Mammals of Kent, 2015)	Essex (Essex Bat Group, 2018) (Mammals of Essex, 2014)	UK Population Trend (from Bat Conservation Trust (BCT))
Rarest	Barbastelle	Single unconfirmed record from mid-Kent in 2009.	Possibly more widespread than previously thought but scarce. Required roost habitat scarce with single maternity colony recorded in north-west Essex and only a small number of individually hibernating bats recorded.	Data insufficient (BCT 2018a)
	Bechstein's bat	Single hibernation and swarming records. Two lactating females trapped in west Kent (2009) leading to identification of 3 tree roosts with a cumulative colony count of >33.	No data	Data insufficient (BCT 2018a)
Rarer	Nathusius' pipistrelle *Pipistrellus nathusii*	Migratory with more frequent recordings than areas further north. First maternity roost identified in 2012 in south-east Kent.	Migratory, may breed in small numbers. Considered rare but may be under-recorded.	Data insufficient (BCT 2018a)
	Brandt's bat/Whiskered bat *Myotis brandtii/Myotis mystacinus*	Whiskered – historically considered rare but recently identified in 12 woodlands sites**. Brandt's – No maternity colonies identified and few positive records.	Whiskered – Rare with only a single record from mid-Essex in 1987. Brandt's – No data	Population considered stable between 1999-2016* (BCT 2018b)

Rarity	Species	Kent (Mammals of Kent, 2015)	Essex (Essex Bat Group, 2018) (Mammals of Essex, 2014)	UK Population Trend (from Bat Conservation Trust (BCT))
	Daubenton's bat	Can be seen over most water bodies. Very few summer roosts identified but one of two species most frequently recorded in winter using underground sites.	Widespread, relatively frequent near still water.	Population considered stable since 1999 (BCT 2018c)
	Natterer's bat	As one of two species most frequently recorded in winter using underground sites most records are from hibernating bats. 15 new woodland sites found during BCT Bechstein's Bat Survey.	Widespread, relatively scarce with most records coming from hibernation sites or summer roosts, often in barns or churches.	Evidence to suggest an increase since 1999*** (BCT 2018d)
	Leisler's bat *Nyctalus leisleri*	Rare. In recent years have been more frequently recorded in parts of the south-east of Britain.	Widespread, but scarce and possibly declining. Found in Essex in all months but no evidence of hibernation recorded.	Data insufficient (BCT 2018a)
	Noctule	Scarce with only single individuals or small numbers seen occasionally. Only three tree roosts recorded in the last 10 years.	Recorded in most areas of Essex but usually only individuals or very small numbers recorded, a decline on numbers recorded in 1980s.	Population considered stable since 1999 (BCT 2018e)
	Serotine *Eptesicus serotinus*	Uncommon with declines in the number of summer roosts, and numbers within roosts, noted over last 10 years.	Widespread but scarce. Roosts infrequently found and seldom recorded in winter.	Population considered stable since 1999 (BCT 2018f)
	Grey long-eared bat *Plecotus autriacus*	Only two confirmed records both from 1980s.	No data	Data insufficient (BCT 2018a)

Rarity	Species	Kent (Mammals of Kent, 2015)	Essex (Essex Bat Group, 2018) (Mammals of Essex, 2014)	UK Population Trend (from Bat Conservation Trust (BCT))
	Greater horseshoe bat	No data	No data	Population considered to have increased significantly since 1999 (BCT 2018g)
	Lesser horseshoe bat	Not recorded in Kent since 1954	No data	Population considered to have increased since 1999 (BCT 2018h)
Common	Common pipistrelle *Pipistrellus pipistrellus*	Most abundant bat species in Kent.	Widespread, occasionally common. Most frequently encountered bat in Essex.	Population considered to have increased since 1999 (BCT 2018i)
	Soprano pipistrelle	Widespread with most known maternity roosts near rivers. Average maternity colony size in Kent has declined.	Widespread, occasionally common	Population considered to have increased since 1999 (BCT 2018j)
	Brown long-eared bat	Widespread but often under-recorded. The most frequently captured species in woodlands during BCT Bechstein's Bat Survey.	Widespread, relatively frequent	Population considered stable since 1999 (BCT 2018k)
Data Insufficient	Alcathoe *Myotis alcathoe*	Single individual identified in west Kent in 2010 as part of the BCT Bechstein's Bat Survey.	No data	Data insufficient (BCT 2018a)
	Greater mouse-eared bat *Myotis myotis*	Single individual recorded in Dover in 1985.	No data	Data insufficient (BCT 2018a)

** This should be considered with caution due to the combining of species trend information from two species.*

*** As part of the BCT Bechstein's Bat Survey in 2009 and 2010, whiskered bats were found to be the second most frequently trapped bats after brown long-eared bats.*

**** Caution advised: species exhibits regular roost switching behaviour.*

9.4.118 Desk-study data from a 5km radius of the Project, provided by KMBRC, identified 406 records of bats since 2006. These records identified 12 species and included both activity and roost records. The results of this data search are summarised in Table 9.25.

Table 9.25 Summary of desk study data from KMBRC

Species	Number of Records by type				
	Activity [9]	Hibernation roost[10]	Maternity roost[11]	Unknown roost[12]	Other[13]
Brandt's bat	-	-	-	-	1
Brown long-eared bat	5	16	-	3	12
Common pipistrelle	76	4	2	3	32
Daubenton's bat	5	23	4	2	4
Khul's pipistrelle	-	-	-	-	1
Leisler's bat	8	-	1	1	5
Nathusius' pipistrelle	-	1	-	-	3
Natterer's bat	3	24	-	-	4
Noctule	17	-	-	-	1
Serotine	12	-	-	2	1
Soprano pipistrelle	32	-	2	2	7
Whiskered bat	-	-	-	-	2
Species Groups					
Bat	3	1	-	1	1
Common/Soprano pipistrelle	13	-	1	5	6
Long-eared bat spp.	2	-	-	6	4
Myotis spp.	4	1	-	-	-
Nyctalus spp.	2	-	-	-	-
Pipistrellus spp.	17	-	-	2	5
Whiskered/Brandt's bat	-	3	-	-	-
Whiskered/Brandt's/ Alcathoe bat	-	8	-	-	-

[9] Activity records are those records where bats were observed or heard in flight.
[10] Hibernation roost records are those records where bats were found to be hibernating. Hibernation roosts may be used between November and March.
[11] Maternity roost records are those records where bats were found to be rearing young. Maternity roosts may be used between May and August.
[12] 'Unknown roost' includes those records where the type of roost was not specified.
[13] 'Other' records consist of those that do not match the other categories provided and include records such as grounded or dead bats, captured/handled bats (eg, from harp traps), bat signs and those where information on the nature of the record was not provided.

9.4.119 Hibernation roosts were identified for five species, as well as four species groups. These records primarily related to brown long-eared bat, Daubenton's bat and Natterer's bat.

9.4.120 Brown long-eared bat hibernation records, consisting of one or two individuals, were identified in four locations. This included eight records between 2011 and 2015 which were located within or immediately adjacent to the Development Boundary, near Shorne Wood Country Park. Hibernating brown long-eared bats are known to use former air raid shelters within Shorne Wood Country Park, part of Shorne and Ashenbank Woods SSSI, and it is considered likely that these records are associated with this known hibernation site.

9.4.121 Daubenton's bat hibernation roost records were identified in three locations, the closest located approximately 900m south-east of the Development Boundary, where a peak count of seven was recorded in 2015. A peak count of 28 was recorded from Hangman's Wood and Deneholes SSSI in 2006.

9.4.122 Natterer's bat hibernation roost records were recorded from 7 locations. This included three records (each recording a single individual) located within or immediately adjacent to the Development Boundary, near Shorne Wood Country Park. A peak count of 27 was recorded from Hangman's Wood and Deneholes SSSI in 2006.

9.4.123 The remaining hibernation roost records related to between one and three individuals, with the closest records located approximately 970m south-east of the Development Boundary near Shorne (Whiskered/Brandt's/Alcathoe bat, Whiskered/Brandt's bat and bat spp.).

9.4.124 Maternity roosts were identified for four species and one species group, the closest located approximately 300m east of the Development Boundary (Leisler's bat and common/soprano pipistrelle). The largest maternity colony identified within the KMBRC data was a soprano pipistrelle maternity roost, recorded in 2007, of 100 individuals located approximately 4.1km east of the Development Boundary.

9.4.125 Desk-study data from a 5km radius of the Project, provided by EWTBRC, identified 304 records of bats since 2006. These records identified 9 species and included both activity and roost records. The results of this data search are summarised in Table 9.26.

Table 9.26 Summary of desk-study data from EWTBRC

Species	Number of records by type				
	Activity [14]	Hibernation Roost[15]	Maternity Roost[16]	Unknown Roost[17]	Other[18]
Brown long-eared bat	2	5	4	7	8
Common pipistrelle	12	7	2	8	44
Daubenton's bat	1	24	-	11	6
Leisler's bat	1	-	-	-	2
Nathusius' pipistrelle	-	-	-	-	1
Natterer's bat	-	15	1	8	5
Noctule	21	-	-	-	16
Serotine	-	-	-	1	4
Soprano pipistrelle	6	2	3	-	29
Species Group					
Bat	1	1	-	5	2
Long-eared bat spp.	-	-	-	2	2
Myotis spp.	2	3	-	2	-
Pipistrellus spp.	1	3	-	9	12

9.4.126 Hibernation roost records were identified for five species and three species groups. These records primarily related to Daubenton's bat and Natterer's bat.

9.4.127 Daubenton's bat hibernation records related to three sites: Hangman's Wood and Deneholes SSSI, where records identified a peak count of 26 individuals in 2014; Grays Chalk Quarries, approximately 2.6km to the west, where records identified a peak count of 16, again in 2014; and a single record associated with Chalford Tunnel, approximately 3.7km west, from 2015.

9.4.128 Natterer's bat hibernation records were recorded from four locations; Hangman's Wood and Deneholes SSSI, where records identified a peak count

[14] Activity records are those records where bats were observed or heard in flight.
[15] Hibernation roost records are those records where bats were found to be hibernating. Hibernation roosts may be used between November and March.
[16] Maternity roost records are those records where bats were found to be rearing young. Maternity roosts may be used between May and August.
[17] 'Unknown roost' includes those records where the type of roost was not specified.
[18] 'Other' records consist of those that do not match the other categories provided and include records such as grounded or dead bats, captured bats (eg, from harp traps), bat signs and those records where information on the nature of the record was not provided.

of 28 individuals in 2014, Grays Chalk Quarries, where a peak of seven individuals was recorded in 2012, a single record from Chalford Tunnel from 2015 and two records from a disused boiler house, approximately 1.2km east of the Project, where a peak of six individuals was recorded in 2008.

9.4.129 The remaining hibernation records related to between 1 and 22 individuals, with the closest records within Hangman's Wood and Deneholes SSSI (brown long-eared bat) with a maximum of two individuals recorded.

9.4.130 Of records identified as maternity roosts, most recorded only low numbers, or no count information was provided. The closest was approximately 1km east of the Development Boundary (common pipistrelle and brown long-eared bat). A notable exception to this was a record of a soprano pipistrelle maternity roost consisting of 968 individuals, located approximately 4.3km west of the Development Boundary.

9.4.131 The bat surveys commenced with ground level tree assessments which were undertaken between January and April. These surveys focused on individual trees and small wooded areas and have identified 261 trees as having between low and high suitability for roosting bats. Of these 210 were assessed as being of moderate or high suitability and will be subject to further surveys. No confirmed roosts have been identified at the current time.

9.4.132 Although trees and structures that may be suitable for roosting bats were highlighted during the extended Phase 1 habitat survey of 2017, no surveys specifically targeting bats commenced until 2018. Table 9.5 highlights the bat survey work that has commenced.

9.4.133 Activity transects and crossing point surveys commenced in April 2018 with 21 transects and 13 crossing points included. Following these surveys, the development of the proposed design and ongoing consideration of aerial photographs and site walkovers, a further seven transects are to be included in the survey scope from May onwards.

Dormice

9.4.134 Hazel dormouse is legally protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and is afforded significant further protection as a European Protected Species under the Conservation of Habitats and Species Regulations 2010 (as amended). In addition, it is a species of principal importance under Section 41 of the NERC Act (2006) and a species targeted for action under the UK local BAPs.

9.4.135 The population of dormouse has declined substantially in Britain in the past century because of habitat loss and fragmentation (Hurrell and McIntosh, 1984). Dormice have very specialised habitat requirements and are closely linked to ancient woodlands (Bright *et al*., 1994; Bright *et al*., 2006).

9.4.136 Despite the national decline, dormice are still widespread in Kent, the county being a stronghold for the species (Kent Biodiversity Partnership, 2004). There is a concentration of ancient woodland habitat within and adjacent to the Development Boundary along the A2 corridor in Kent, likely to support dormice. This has been confirmed with the desk study data from the KMBRC, which provided 256 dormouse records in this area. The majority of these records are concentrated within Ranscombe Wood and Clay Pond Wood as well as Shorne

and Ashenbank Wood and Randall Wood which are part of the Cobham Woods SSSI and Shorne and Ashenbank Woods SSSI complex respectively.

9.4.137 Dormice are thought to be less widespread in Essex. Desk study data from the EWTBRC indicates a single dormouse nest was found in Cranham Marsh Nature Reserve in 1998. Cranham Marsh Nature Reserve is located approximately 1km east of the Development Boundary. The majority of the Development Boundary in Essex is within arable farmland considered to be suboptimal for dormice, but a concentration of small woodland areas around the M25/A127 junction in Essex may provide more suitable habitat.

9.4.138 None of the citations for statutory or non-statutory designated sites within the Development Boundary in either Kent or Essex mention dormice as being a designated interest feature.

9.4.139 Survey work commenced in 2017, and 22 areas in Essex were checked for signs of hazelnuts that had been nibbled by dormice, which is used as evidence of their presence. Fruiting hazel was present in 5 areas. Dormouse boxes and tubes were erected in 2018 at 15 sites in Essex and 9 sites in Kent. The presence of dormice has been confirmed within Shorne Woods in Kent, but, to date, no other evidence for the presence of dormice has been identified to date.

Water voles

9.4.140 Water vole is protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). Water vole is also a species of priority importance under the NERC Act (2006). Water voles were once widespread and common along British waterways; however, the water vole has undergone a dramatic decline in the UK due to a number of factors including habitat loss, population fragmentation and predation from American mink (Strachan *et al.*, 2011). Water vole are listed as a priority species on both the Kent BAP (Kent Biodiversity Partnership, 2009) and Essex BAP (Essex Biodiversity Project, 2011).

9.4.141 Survey work has been carried out in accordance with best practice (Dean *et al.,* 2016 in areas of suitable habitat along the entire Project. A total of 193 water bodies have been surveyed with a total length of 78.3km.

9.4.142 In Kent, a total of 57 water bodies within South Thames Estuary and Marshes SSSI were surveyed over a total length of 14.5km. Of these water bodies, 36 were confirmed to have water voles present. A population estimate has been carried out on all water bodies confirmed to contain water voles (Dean *et al.,* 2016) and it was found that one water body had a high population of water voles, 7 water bodies had a medium population and 28 water bodies had a low population.

9.4.143 In Essex, a total of 136 water bodies were surveyed with a total length of 63.9km. Of these water bodies, 47 were found to have water voles present, with another 11 found to have burrows but no other confirmatory signs. A population estimate has been carried out (Dean *et al.,* 2016) and it was found that four water bodies had high water vole populations, 14 water bodies had medium populations, and that 29 had low populations. Thirty-six of these water bodies with water vole presence are located adjacent to the River Thames, with the remaining 11 water bodies located near to the Mardyke.

Otter

9.4.144 Otter is a European Protected Species and is also protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). Historically otters were widespread across the UK, but the otter population suffered serious declines in the post-war years due to persecution and the use of organochloride pesticides. Recently the otter population has been increasing, and otters have been spreading across England from the strongholds of Scotland and the north and west of England (Chanin, 2003). The most recent national survey of otters found that although they were spreading into the South East, less than 10% of surveyed sites had otters. In Kent the records were located to the south west of the county, near the coast, and in Essex the records were located to the north of the county. There were no records of otter near the Project (Crawford, 2010). Otter are listed as a priority species on both Kent BAP (Kent Biodiversity Partnership, 2009) and Essex BAP (Essex Biodiversity Project, 2011).

9.4.145 Otters in England are predominantly found along freshwater watercourses. These areas can vary from canals, rivers, lakes and marshland habitat with numerous wet ditches. Within the Development Boundary, suitable habitats are restricted to the marshes and ditches located adjacent to the River Thames on both the Kent and Essex sides, and the Mardyke and associated ditches in Essex.

9.4.146 The desk study revealed no sites in Kent or Essex were found to be designated for otters, and in Kent there are no desk-based study records within 2km of the Development Boundary. In Essex there are two desk-based study records of otter within 2km of the Project, located at the far north of the Development Boundary on the River Ingrebourne within the M25, with both records occurring on the same day in 2014.

9.4.147 In Kent a solitary potential otter field sign was identified in a ditch within the South Thames Estuary and Marshes SSSI. In Essex, there has been one record of an otter field sign, which was an old otter spraint found on the Mardyke. These are the only records of otter found to date.

Badger

9.4.148 Badgers are protected under Schedule 6 of the Wildlife and Countryside Act 1981 (as amended) and the Protection of Badgers Act (1992). Badgers are found in a wide range of habitats, from urban environments to upland habitats, although predominantly badgers prefer habitats with woodland and scrub to build setts and grassland where they can forage (Cresswell *et al.,* 1990). Badgers are widespread and common throughout Britain.

9.4.149 In Kent there are 82 desk-based study records of badgers found within 2km of the Development Boundary. These records are of an unknown nature as badger records are kept confidential, but the records are widespread across the entire length of the Project in Kent. In Essex there are 52 records of badgers within 2km of the Development Boundary. The majority of these records relate to setts that have been assessed by the Essex Wildlife Trust, and these are located along the entire length of the Project in Essex.

9.4.150 During the 2017 badger survey, there have been a total of four main setts identified in Kent, and a further 47 other setts (not considered to be main setts)

have also been identified. In Essex there has been a total of eight main setts identified, with a further 102 non-main setts also identified. In addition to these setts numerous other signs of badgers have also been identified including badger paths, latrines and badger hair. In addition to these field records, badgers have also been recorded as incidental sightings during the nocturnal bird surveys, with a total of five badgers being recorded. One of these records was located in the South Thames Estuary and Marshes SSSI in Kent, and the other four 4 records were all in the fields adjacent to the River Thames in Essex.

Other Section 41 mammals

9.4.151 There are three terrestrial mammal species listed under Section 41 of the NERC Act (2006) found within Kent and Essex that have the potential to be affected by the Project, namely: brown hare *Lepus europaeus*; harvest mouse *Micromys minutus*; and Western European hedgehog *Erinaceus europaeus* (subsequently referred to as 'hedgehog').

Brown hare

9.4.152 The brown hare used to be common and widespread throughout lowland Britain, but they have become more patchily distributed and less abundant where they do occur (Wheeler *et al*., 2012).

9.4.153 In Britain, brown hares are usually associated with lowland pasture and arable farmland, feeding mainly on grasses and herbs as well as agricultural crops (Wheeler *et al*., 2012). Woods and hedgerows also provide daytime shelter, particularly in winter.

9.4.154 In Kent, numbers have declined dramatically and the distribution in the county is now limited. They are found within five natural areas: Greater Thames Estuary; High and Low Wealds; the North Downs; and Romney Marshes (Kent Biodiversity Partnership, 2011).

9.4.155 Brown hare desk study records within 2km of the Development Boundary supplied by the KMBRC provided 35 records of brown hare, from 15 discrete locations within 2km of the Development Boundary.

9.4.156 Hares are present in all districts of Essex (Essex Biodiversity Project, 2011). The species was once much more abundant and the area with the most noticeable decline is south Essex.

9.4.157 The EWTBRC provided eight records of brown hare, from three discrete locations within 2km of the Development Boundary.

9.4.158 Survey work has provided three incidental sightings of brown hare, all from Essex. Two sightings were in brownfield habitat just east of Tilbury Power Station, while the other was in arable habitat to the south-west of Thames Industrial Park.

Harvest mouse

9.4.159 Nationally, harvest mice are considered to be a declining species, subject to approximately a 71% decline over the past 18 years, and as a result they were added to the UK BAP species review in 2007 (Joint Nature Conservation

Committee, 2010f). Changes in habitat management and agricultural methods are thought to be the main cause for the loss of populations.

9.4.160 Harvest mice occupy a wide range of habitats, and are found in rough and tussocky grassland, ungrazed and uncut meadows, reed beds and riparian margins, and the rank grassland associated with young plantations (Bullion, 2012); they rarely occur in cereal crops or mature woodland.

9.4.161 The KMBRC provided one recent (2011) and three historic records of harvest mice from the period 1965 to 2002 from three discrete locations, all within 2km of the Development Boundary.

9.4.162 Field surveys have provided one incidental sighting of a harvest mouse. This is for a harvest mouse nest located in a reed-filled ditch at Coles Farm, Essex, just to the north east of Tilbury Power Station.

Hedgehog

9.4.163 Nationally, hedgehogs are considered to be a declining species, subject to an approximately 20% decline over 4 years (2001 to 2005) (equivalent to a greater than 50% decline over 25 years) and so were added to the UK BAP species review in 2007 (Joint Nature Conservation Committee, 2010g). Population estimates outlined in Macdonald and Burnham (2011), indicate a population decline from around 30 million in the 1950s to 1.5 million in 1995. Road casualty counts carried out between 1990 and 2001 suggest they have declined by as much as half in that decade alone.

9.4.164 Hedgehogs occur in a wide variety of habitat types including grasslands, forests and suburban areas (Morris, 2012). They require a secure winter site for nesting and this is a crucial factor in their distribution and habitat use.

9.4.165 Hedgehog desk study records within 2km of the Development Boundary supplied by the KMBRC provided 138 records from the period 1964 to 2016, from 63 discrete grid reference locations.

9.4.166 Hedgehog desk study records within 2km of the Development Boundary, supplied by the EWTBRC provided nine records of hedgehog from 8 discrete locations.

9.5 Further baseline information and surveys required

9.5.1 Additional desk study information pertaining to the terrestrial environment to be collected to inform the assessment of the potential effects of the Project is outlined in Table 9.27. Data from surveys that are currently ongoing or have not yet been started will be included in the ES. This will include arboricultural (tree) surveys which are due to commence this winter, bird surveys (ongoing until March 2019), surveys for bats, Section 41 mammals, invertebrates, lichens and bryophytes, reptiles, Phase 1 and detailed botanical surveys, otters, water voles, dormice and badgers. Surveys will include any ‘gap filling’ for newly identified areas within the Development Boundary which have not been surveyed to date.

Table 9.27 Additional desk-based study data to be collected

Data source	Information to be used
KMBRC and EWTBRC, update of desk study carried out in 2016 to include any changes to the Development Boundary.	To inform ecological baseline for the Project.
Wetland Bird Survey (WeBS) provided by the British Trust for Ornithology (BTO) for the Thames Estuary.	Information on annual core count data and estuary-wide low tide dot density maps for SPA bird species.
Environment Agency – a National Vegetation Classification (NVC) survey carried out in 2016/2017 of selected areas of saltmarsh in the Thames Estuary.	To inform assessment of the value of and potential effects upon saltmarsh habitat in the Thames Estuary.
Survey work completed on behalf of the Ingrebourne valley restoration	To inform terrestrial and marine ecological baseline for the Project.

Future baseline conditions

9.5.2 Future baseline is used describe how the existing ecological baseline is likely to change over time if the proposed development were not to be undertaken, ie, the crossing not built and operated.

9.5.3 It is likely that the extent and distribution of habitat types would remain largely the same as at present, the majority comprising arable farmland. However, the extent of Open Mosaic Habitat at Goshems Farm LWS will reduce due to the importation of material from Thames Tideway Tunnel and Lytag LWS may be damaged or destroyed by the proposed Tilbury2 development.

9.5.4 The distribution of fauna species is also likely to remain largely the same as at present, although the extent and distribution of invertebrate and reptile species will decline with the loss of habitat at Goshems Farm LWS and potentially Lytag LWS. In addition, in the absence of significant changes in the management practices of farmland and woodland there is likely to be a continued long-term decline in farmland and woodland bird species reflecting such ongoing trends nationally and likely a continued decline in mammal species such as brown hare and hedgehog.

9.6 Potential effects and mitigation measures

9.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. It should be noted that this assessment is ongoing and is subject to change through ongoing development of the Project proposals.

9.6.2 A full detailed assessment will be undertaken before DCO application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the ES.

Construction

Table 9.28 Potential effects and mitigation measures during construction

Item	Description
Receptor	Thames Estuary and Marshes SPA/Ramsar Site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Noise, lighting and visual disturbance and possible displacement of bird species forming the interest features of the SPA/Ramsar due to general construction activities. This is most likely to occur to those bird species using the Thames Estuary close to the north tunnel portal.
Likely duration	Construction Phase
Potential mitigation	Erection of acoustic fencing and landscape bunding to shield areas from disturbance. Minimise light spillage from construction lighting. Preparation of Code of Construction Practice outlining measures to reduce noise and visual disturbance.
Receptor	Thames Estuary and Marshes SPA/Ramsar Site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Noise, lighting and visual disturbance and possible displacement of bird species forming the interest features of the SPA/Ramsar due to operation of jetty (if required) on River Thames during the construction phase. This is most likely to occur to those bird species using the Thames Estuary close to the north tunnel portal
Likely duration	Construction Phase
Potential mitigation	*Potential mitigation:* Erection of acoustic fencing and landscape bunding to shield areas from disturbance. Minimise light spillage from construction lighting. Code of Construction Practice outlining measures to reduce noise and visual disturbance.
Receptor	Thames Estuary and Marshes SPA/Ramsar site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Pollution from surface water runoff and accidental spillage contaminating mudflats, grazing marsh and other habitats used by birds and other interest features.
Likely duration	Construction Phase
Potential mitigation	Code of Construction Practice to set out methods to minimise impacts from construction activity, including requirements for pollution prevention and control measures, surface and groundwater management
Receptor	European designated sites within 20km of the Project.
Potential nature of effect	Noise and disturbance from construction causing a displacement of recreational users away from the Thames Estuary causing them to access other European designated sites to undertake recreation activities causing disturbance or damage to the interest features of these sites.

Likely duration	Construction Phase
Potential mitigation	Depending on results of assessment, and if significant displacement of recreation users is predicted, then mitigation may be required. For example, improving access to countryside either side of the Project or provision of alternate green space for recreation away from European sites.
Receptor	Thames Estuary and Marshes SPA/Ramsar site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Disruption to hydrological regime (surface and groundwater) and functioning of the SPA/Ramsar. This is likely to be the area around the south tunnel portal.
Likely duration	Construction Phase
Potential mitigation	The location of both tunnel portals outside of immediate groundwater zone for the designated sites, in particular the southern portal has been embedded in the Project design. Other potential measures will be determined following detailed hydrological modelling of the hydrological functioning of the designated sites.
Receptor	Great Crabbles Wood SSSI, Shorne and Ashenbank Wood SSSI.
Potential nature of effect	Direct loss of ancient woodland habitat and fragmentation of remaining woodland. Potential for noise disturbance and air quality effects also – see operational effects. This will affect woodland habitat either side of the A2, south of the crossing.
Likely duration	Construction Phase
Potential mitigation	Continue to develop the route to avoid ancient woodland habitat where possible. If loss unavoidable, then replacement woodland planting and translocation of ancient woodland soils to preserve some of the ground flora. Consider green bridge(s) or other infrastructure supporting scrub/hedge habitat to link woodland habitats either side of the Project route alignment. Potential suitable areas for compensatory ancient woodland soil translocation and replacement tree planting are identified in Drawing 2.4 Outline Environmental Masterplan.
Receptor	LWS supporting relict Thames Terrace Grassland and Open Mosaic Habitat on Previously Developed Land
Potential nature of effect	Direct loss of habitat and fragmentation of remaining habitat. This will directly affect habitat north of the crossing including Goshems Farm LWS (what area remains following existing development activities), Low Street Pit LWS, Blackshots Nature Area and potentially Lytag LWS. Note Lytag is considered to be of national importance and may potentially be designated as a SSSI.
Likely duration	Construction Phase
Potential mitigation	Continue to develop the route alignment to avoid, where possible, LWS supporting these habitat types. If loss unavoidable then replacement habitat creation will be required near existing habitats to facilitate colonisation by plant and invertebrate species.

Receptor	Ancient woodland outside of designated sites
Potential nature of effect	Direct loss of habitat, and fragmentation of remaining habitat. Likely to affect Claylane Wood and Hobbs Hole Wood. For potential noise and air quality effects see operational phase.
Likely duration	Construction Phase (including third party utility diversions)
Potential mitigation	Continue to develop the route and utility diversions to avoid ancient woodland habitat where possible. If loss unavoidable, then replacement woodland planting and translocation of ancient woodland soils to preserve some of the ground flora. Consider green bridge(s) or other infrastructure supporting scrub/hedge habitat to link woodland habitats either side of new route alignment. Potential suitable areas for compensatory ancient woodland soil translocation and replacement tree planting are identified in Figure 2.4 Outline Environmental Masterplan in Volume 3.
Receptor	Hedgerows
Potential nature of effect	Loss of hedgerow length and fragmentation of hedgerow network along the whole of the Development Boundary.
Likely duration	Construction Phase
Potential mitigation	New hedgerow planting and reinforcement/enhancement of remaining hedgerow network, either side of the Project, through additional landscape planting. Consider green bridge(s) or other infrastructure supporting scrub/hedge habitat to link woodland habitats either side of A2 and new route.
Receptor	Invertebrate assemblage
Potential nature of effect	Loss of habitat and LWS supporting valuable invertebrate assemblages and fragmentation of remaining habitat. This will directly affect habitat north of the crossing including Goshems Farm LWS (what area remains following existing development activities), Low Street Pit LWS, Blackshots Nature Area and potentially Lytag LWS. Note Lytag is considered to be of national importance and may potentially be designated as a SSSI.
Likely duration	Construction Phase
Potential mitigation	Continue to develop the route to avoid, where possible, LWS supporting these invertebrate assemblages. If loss unavoidable, then replacement habitat creation in close proximity to existing habitats to facilitate colonisation by plant and invertebrate species. New habitat creation will require a management plan covering ongoing habitat management requirements. Potential suitable areas for habitat creation are identified in Drawing 2.4 Outline Environmental Masterplan.
Receptor	Great crested newts
Potential nature of effect	*Potential nature of effect:* Incidental mortality, loss of breeding ponds and loss of terrestrial foraging and hibernation habitat. Fragmentation of remaining habitat by route.
Likely duration	Construction Phase
Potential mitigation	Continue to develop the route alignment to avoid, where possible, habitat supporting great crested newts. If loss unavoidable then appropriate mitigation would be agreed with Natural England. This

	could include habitat creation consisting of new ponds and terrestrial/hibernation habitat together with potential translocation of great crested newts from within the footprint of the Project. If survey work indicates fragmentation of great crested newt populations to be a significant impact, consider culvert or similar features in appropriate locations to facilitate movement of great crested newts across the route. Mitigation for great crested newts could potentially be accommodated within habitat creation measures for invertebrates/reptiles and water voles and any flood compensation measures required.
Receptor	Reptile assemblage
Potential nature of effect	*Potential nature of effect:* Incidental mortality, Loss of breeding terrestrial foraging and hibernation habitat. Fragmentation of remaining habitat by route alignment.
Likely duration	Construction Phase
Potential mitigation	Continue to develop the route alignment to avoid, where possible, habitat supporting reptile assemblages. If loss unavoidable then replacement habitat creation containing all the habitat features required by reptiles will be required, together with a capture and translocation of reptiles from within the Project footprint. If survey work indicates fragmentation of reptile populations to be a significant impact, consider culvert or similar in appropriate locations to facilitate movement of reptiles across the route alignment. Potential suitable areas for habitat creation are identified in Drawing 2.4 Outline Environmental Masterplan.
Receptor	Breeding bird species
Potential nature of effect	Loss of habitat for nesting and foraging. Includes loss of arable habitat for ground nesting species and woodland/scrub/hedgerow habitat for other species. Disturbance to nesting birds.
Likely duration	Construction Phase
Potential mitigation	Replacement tree/scrub and hedgerow nesting habitat. If survey work shows the farmland bird assemblage to be of significant value, then there may be a requirement for measures to enhance the farmland bird assemblage within farmland close to the Development Boundary. Look to undertake the majority of tree/scrub and other vegetation clearance outside of bird breeding season (late February to August). If clearance of vegetation outside this period, or earth movement required when ground-nesting birds are present then area will be subject to a nesting bird check by an ecologist before works proceed. If nesting birds present works will cease until young have fledged.
Receptor	Barn owls
Potential nature of effect	Loss of large holes in trees, barns and other structures used for nesting to accommodate the route. Disturbance to nesting barn owls. This is most likely to occur north of the crossing within farmland habitat and in the vicinity of the north tunnel portal where nesting barn owl confirmed.
Likely duration	Construction Phase

Potential mitigation	Replacement nesting opportunities in the form of barn owl boxes that would be erected in wider countryside at least 1km from the route alignment. Structures likely to support barn owls will be checked for presence of breeding barn owls prior to demolition. If barns owls are in residence demolition will cease until young have fledged.
Receptor	Bats
Potential nature of effect	Incidental mortality through loss of trees, buildings and other structures used by roosting bats and disturbance to roosting bats.
Likely duration	Construction Phase
Potential mitigation	Structures suitable to support roosting bats will be subject to survey to establish presence of roosting bats. If bats present, then structure will be retained if possible. If it is not possible to retain then structure will have to be demolished and an appropriate licence obtained from Natural England at the appropriate time of year with replacement roosting opportunities provided, either construction of a dedicated roost building or bat boxes, dependent on significance of roost identified.
Receptor	Dormice
Potential nature of effect	Incidental mortality through direct loss of woodland habitat for breeding and foraging and fragmentation of remaining woodland habitat. Disturbance during the breeding period.
Likely duration	Construction Phase
Potential mitigation	Enhancement of remaining woodland habitat to support a greater abundance of dormice for example by coppicing and provision of dormice boxes. Capture of resident dormice from within the Project footprint and relocation to adjacent retained woodland. Replacement tree/scrub and hedgerow planting to provide breeding and foraging habitat. Consider green bridge(s) or other infrastructure supporting scrub/hedge habitat to link woodland habitats either side of A2 and new route alignment to facilitate the movement of dormice.
Receptor	Water voles
Potential nature of effect	*Potential nature of effect:* Incidental mortality and direct loss of habitat for breeding and foraging.
Likely duration	Construction Phase
Potential mitigation	*Potential mitigation:* Replacement habitat creation to create suitable habitat for water voles, ideally in close proximity to habitat being lost. Potential suitable areas for habitat creation are identified in Drawing 2.4 Outline Environmental Masterplan. Habitat will require creation in advance (minimum one year) for vegetation cover to be sufficiently established to support water voles and will require evidence that mink are absent or a trapping programme to eradicate mink carried out. Then a trapping and capture programme to translocate water voles from within the Project footprint to the newly created receptor site. Additional works likely to be required to ensure licence compliance showing a net benefit for water voles (not just like for like replacement of habitat) for example habitat enhancement or mink eradication on adjacent watercourses.

	Land required for flood compensation measures could potentially help deliver some of the water vole mitigation requirements.
Receptor	Otters
Potential nature of effect	Incidental mortality through being run over by site traffic and plant. This is most likely close to the Mardyke.
Likely duration	Construction Phase
Potential mitigation	Consider fencing in appropriate locations to minimise contact with site traffic and plant.
Receptor	Badgers
Potential nature of effect	Incidental mortality through loss of setts and being run over by site traffic and plant. Fragmentation of foraging habitat. Badgers have been identified across the whole Development Boundary.
Likely duration	Construction Phase
Potential mitigation	Closure of setts under licence and creation of new artificial setts. Consider fencing in appropriate locations to minimise contact with site traffic and plant. If survey work indicates fragmentation of foraging habitat to be a significant impact, consider culvert or similar in appropriate locations to facilitate movement of badgers across the route alignment.
Receptor	Harvest mice
Potential nature of effect	Incidental mortality through loss of breeding and foraging habitat. Fragmentation of foraging habitat. This is most likely within reed lined ditches close to the north tunnel portal.
Likely duration	Construction Phase
Potential mitigation	Replacement breeding and foraging habitat, such as dense tall grassland and riparian reeds, this could be incorporated within the water vole habitat creation.
Receptor	Hedgehogs
Potential nature of effect	Incidental mortality through vegetation clearance during hibernation period and being run over by site traffic and plant. Fragmentation of foraging habitat.
Likely duration	Construction Phase
Potential mitigation	Look to undertake removal of potential hibernation features before hedgehogs enter hibernation and provide alternate hibernation features in suitable locations using vegetation cleared from the route corridor for example. Consider fencing in appropriate locations to minimise contact with site traffic and plant. If survey work indicates fragmentation of foraging habitat to be a significant impact, consider culvert or green bridge(s) in appropriate locations to facilitate movement of hedgehogs across the route alignment.

Operation

9.6.3 The potential effects of the Project during operation and the measures proposed to manage them are outlined below. Note the mechanism by which the potential mitigation measures will be secured and delivered will be detailed within the ES.

Table 9.29 Potential effects and mitigation measures during operation

Item	Description
Receptor	Thames Estuary and Marshes SPA/Ramsar site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Noise, lighting and visual disturbance and possible displacement of bird species forming the interest features of the SPA/Ramsar. This is most likely to occur to birds feeding on mudflats close to the north tunnel portal.
Likely duration	Operational Phase
Potential mitigation	Landscape bunding around both tunnel portals, ensure light spillage onto SPA and adjacent areas of functionally linked habitat is minimised. Landscape planting and or fence/screening of the Project where it is in close proximity to the SPA and functionally linked habitat.
Receptor	Thames Estuary and Marshes SPA/Ramsar site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Pollution from surface water runoff and accidental spillage from vehicles contaminating mudflats, grazing marsh and other habitats used by birds and other interest features.
Likely duration	Operational Phase
Potential mitigation	All road runoff to be discharged via suitable balancing ponds incorporating pollution prevention and control measures.
Receptor	Thames Estuary and Marshes SPA/Ramsar site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Disruption to hydrological regime (surface and groundwater) and functioning of the SPA/Ramsar.
Likely duration	Operational Phase
Potential mitigation	Location of the southern portal outside of immediate groundwater zone for the designated sites. Other potential measures will be determined following detailed hydrological modelling of the hydrological functioning of the designated sites. Mitigation measures are likely to be engineering solutions to limit effect of water drawdown or similar effects. All surface water discharge via suitable balancing ponds.
Receptor	Thames Estuary and Marshes SPA/Ramsar site, Holehaven Creek pSPA, South Thames Estuary and Marshes SSSI and Mucking Flats and Marshes SSSI.
Potential nature of effect	Changes in air quality from vehicle emissions causing a change in the vegetation composition of habitat that supports SPA and Ramsar interest features and the SSSI interest features. Amendments to the route to ensure the location of both tunnel portals more than 200m radius from boundary of designated sites, this being the maximum distance that airborne emissions from vehicles likely to be deposited, thereby helping to avoid significant impacts.
Likely duration	Operational Phase

Potential mitigation	Detailed assessment of air quality effects will be carried out within the ES. Completion of air quality assessment will be used to inform mitigation requirements if changes in air quality are predicted.
Receptor	North Downs Woodlands SAC and Thorndon Park SSSI.
Potential nature of effect	Changes in air quality from vehicle emissions due to changes in vehicle movements in the local network due to the route causing a change in the vegetation composition of habitat that supports SAC and the SSSI interest features.
Likely duration	Operational Phase
Potential mitigation	Detailed assessment of air quality effects will be carried out within the ES. Completion of air quality assessment will be used to inform mitigation requirements if changes in air quality are predicted.
Receptor	European Designated Sites within 20km of the Project.
Potential nature of effect	Noise and disturbance from operation causing a displacement of recreation users causing them to access other European designated sites for recreation activities causing disturbance or damage to the interest features of these sites.
Likely duration	Operational Phase
Potential mitigation	This will be assessed within the ES but if considered significant there may be a requirement for the provision of alternate green space for recreation away from European sites and improving access to countryside either side of the Project.
Receptor	Great Crabbles Wood SSSI, Shorne and Ashenbank Wood SSSI.
Potential nature of effect	Pollution from surface water runoff and accidental spillage from vehicles contaminating habitats used by SSSI interest features.
Likely duration	Operational Phase
Potential mitigation	All road runoff to be discharged via suitable balancing ponds incorporating pollution prevention and control measures.
Receptor	Great Crabbles Wood SSSI, Shorne and Ashenbank Wood SSSI.
Potential nature of effect	Changes in air quality from vehicle emissions causing a change in the vegetation composition of ancient woodland habitat that supports the SSSI interest features.
Likely duration	Operational Phase
Potential mitigation	Detailed assessment of air quality effects will be carried out within the ES. Completion of air quality assessment will be used to inform mitigation requirements if changes in air quality are predicted.
Receptor	Breeding bird species
Potential nature of effect	Noise, visual and lighting disturbance to breeding birds.
Likely duration	Operational Phase
Potential mitigation	Ensure light spillage from Project onto adjacent areas of habitat minimised. Landscape planting and/or fence/screening of Project where appropriate to minimise noise and other disturbance into adjacent habitat.

Receptor	Barn owls
Potential nature of effect	Fragmentation of foraging habitat and key flight lines between foraging areas and nest sites. Risk of being run over by site traffic
Likely duration	Operational Phase
Potential mitigation	If survey work establishes key foraging habitat/flight lines that would be bisected by the route then consideration will be given to provision of green bridge(s) or other appropriate green infrastructure or tall hedge/tree lines of closely-spaced trees next to the road on both sides to facilitate safe passage of barn owls across the route (forcing them up and over the road). Monitoring will be undertaken to demonstrate efficacy of mitigation measures. Habitat creation away from the verge for other species such as farmland birds will help to provide additional foraging habitat for barn owls.
Receptor	Bats
Potential nature of effect	Fragmentation of foraging habitat and key foraging and/or commuting routes.
Likely duration	Operational Phase
Potential mitigation	If survey work establishes key foraging/commuting routes that would be bisected by the route then consideration will be given to provision of green bridge(s) or other appropriate green infrastructure or culverts to facilitate passage of bats across or under the route., Monitoring will be carried out to demonstrate efficacy of mitigation measures. Reinforcement of hedgerow planting and habitat creation for other species will provide additional foraging habitat for bat species.
Receptor	Water voles
Potential nature of effect	Fragmentation of habitat and reduced movement of individuals between resident colonies.
Likely duration	Operational Phase
Potential mitigation	Ensure culverts or other crossing points of watercourses of sufficient size and design to facilitate passage through by water voles.
Receptor	Otters
Potential nature of effect	Incidental mortality through being run over by vehicles and reduced movement of individuals between watercourse catchments
Likely duration	Operational Phase
Potential mitigation	Ensure culverts or other crossing points of watercourses of sufficient size and design to facilitate passage through by otters together with fencing to guide them away from crossing the carriageway.

9.6.4 While survey work is still being undertaken to further inform the assessment and appropriate mitigation, it should be noted that, where possible, potential opportunities are being sought to address some environmental impacts through careful environmental design as shown in Figure 2.4 Outline Environmental Masterplan (EMP) in Volume 3. The principles of the environmental design reflect the requirements of the mitigation set out above; for example, the proposed green structures would mitigate any fragmentation effects and improve mobility of species through the provision of green corridors between

existing habitats. The Outline EMP currently identifies a number of different opportunities for ecological mitigation and/or compensation areas based on the current state of the design development and our understanding of the potentially significant ecological impacts from survey data collected to date. The mitigation and compensation areas shown in the Outline EMP will be further refined once survey works are completed and the design and construction requirements are finalised.

Chapter 10.

Marine Biodiversity

10 Marine Biodiversity

10.1 Introduction

10.1.1 This chapter sets out the preliminary environmental information for the assessment of potential effects on the marine environment related to the construction and operation of the Project.

10.1.2 The Thames Estuary is a significant biodiversity asset, and the Project has the potential to affect the estuary via several effect pathways, including noise from piling, reduced water quality from sediment disturbance and loss of benthic habitats under the footprint of in-river structures (such as the jetty).

10.1.3 The aims of this chapter are to, in relation to marine biodiversity:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to marine biodiversity

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on the marine environment (and how these have been assessed for this *Preliminary Environmental Information Report (PEIR)*)

f. describes potential mitigation measures

10.1.4 There are expected to be interrelationships between the potential effects on marine biodiversity and other disciplines reported on in the *PEIR*. See:

a. Chapter 6: Air Quality

b. Chapter 9: Terrestrial Biodiversity

c. Chapter 13: P Noise and Vibration

d. Chapter 15: Road Drainage and Water Environment

10.2 Planning policy and legislative requirements

Legislative requirements

10.2.1 The relevant legislation applicable to the marine biodiversity assessment of the Project is presented below:

Table 10.1 International and national legislation relevant to the marine environment

Legislation name	Summary of requirements
Marine and Coastal Access Act 2009	The Act provides the framework for strategic marine planning aimed at more efficient, sustainable use and protection of marine resources. Part 4 of the Act puts in place a marine licensing system, which is managed by the Marine Management Organisation (MMO). Construction and operation of a Project jetty would require a marine licence. The Act also enables the designation of Marine Conservation Zones (MCZs) in the territorial waters adjacent to England and Wales. Although not located in an MCZ, two recommended MCZs (rMCZ- Swanscombe and Upper Thames Estuary) are relevant to the proposed temporary jetty. Potential effects on an MCZ or rMCZ require an MCZ assessment to be completed.
EU Marine Strategy Framework Directive (MSFD) (2008/56/EC)	The MSFD requires that member states manage their seas to achieve or maintain Good Environmental Status (GES) by 2020. The MSFD has been transposed into UK law through the Marine Strategy Regulations 2010. Potential Project-related effects on the marine environment have been measured against the relevant management measures for achieving GES in the Thames area.
Conservation of Habitats and Species Regulations (2010)	The Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations) implement EC Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna (the Habitats Directive). The Regulations also set out protection for European Protected Species (EPS), including marine mammals. Due to the proximity of designated sites, and the potential presence of cetaceans (whales, dolphins and porpoises) and pinnipeds (seals), Project activities will be assessed for their potential to cause 'likely significant effects' on designated habitats and features.
The Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (the Ramsar Convention or Wetlands Convention)	Ramsar sites are wetlands of international importance designated under the Convention. Via UK policy statements, sites are designated as part of the EU Natura 2000 network under the EC Birds and Habitats Directives. Due to the proximity of the Thames Estuary and Marshes Ramsar site, Project activities will be assessed for the potential to affect site integrity.

Legislation name	Summary of requirements
Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000)	The Wildlife and Countryside Act (WCA), as amended by Schedule 9 of the Countryside and Rights of Way Act 2000, provides protection to Sites of Special Scientific Interest (SSSI) and a schedule of species with elevated protection. The WCA is relevant due to the proximity of SSSI sites, and the potential for effects on protected species such as the tentacled lagoon worm, and various marine mammals and fish.
The Natural Environment and Rural Communities Act (NERC Act) 2006	The Act imposes a 'duty to conserve biodiversity' on public authorities, including members of the Examining Authority and the relevant Sectaries of State in the case of Nationally Significant Infrastructure Projects. Section 41 of the Act provides details of the habitats and species which are of 'Principal Importance' for the purposes of conserving biodiversity in England. Potential effects related to development of a Project jetty have been considered in relation to the habitats and species of Principal Importance which have been previously identified in the Project area of the estuary.
Port of London Act 1968 (as amended)	Under Section 66 of the Port of London Act, a River Works Licence is required for any works in the River Thames, below the mean high-water mark, including any works under the river or overhanging the river.
Eels (England and Wales) Regulations 2009	Sets targets for the recovery of European eel stocks and requires EU Member States to develop management plans. The Thames Estuary is considered an important area for eel, and so effects related to development of a Project jetty have been considered with eel in mind.
Conservation of Seals Act 1970	Seals are protected under the Conservation of Seals Act 1970. The Act does not prohibit the killing of seals but regulates the way in which seals can be killed if they are deemed a nuisance. The Thames Estuary is a known site for seals, and so effects related to development of a jetty have been considered.
Water Framework Directive (WFD) (2000/60EC)	The WFD establishes a legal framework to protect and restore clean water across Europe. The aim of the WFD is to ensure that all water bodies achieve Good Ecological Status (GES) or Potential (for 'heavily modified' and 'artificial' water bodies). The Thames Estuary is a transitional water body, and activities related to the development of the Project have been considered to achieve GES and no deterioration of status.
The Water Resources Act 1991	Aims to prevent and minimise pollution of water, which includes the release of silt from dewatering and dredging activities. The potential for Project-related activities to affect water quality in the Thames Estuary has been considered in relation to the Act.

National Policy Statement for National Networks

10.2.2 The relevant NPSNN for the marine biodiversity assessment of the Project are presented in Table 10.2.

Table 10.2 NPSNN Requirements and Project response

Requirement (with NPSNN paragraph numbers)	Project response
4.15 "All proposals for projects that are subject to the European Union's Environmental Impact Assessment Directive and are likely to have significant effects on the environment, must be accompanied by an environmental statement (ES), describing the aspects of the environment likely to be significantly affected by the project. The Directive specifically requires an environmental impact assessment to identify, describe and assess effects on human beings, fauna and flora, soil, water, air, climate, the landscape, material assets and cultural heritage, and the interaction between them. Schedule 4 of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 sets out the information that should be included in the environmental statement including a description of the likely significant effects of the proposed project on the environment, covering the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project, and also the measures envisaged for avoiding or mitigating significant adverse effects. Further guidance can be found in the online planning portal. When examining a proposal, the Examining Authority should ensure that likely significant effects at all stages of the project have been adequately assessed. Any requests for environmental information not included in the original environmental statement should be proportionate and focus only on significant effects. In this NPS, the terms 'effects', 'impacts' or 'benefits' should accordingly be understood to mean likely significant effects, impacts or benefits."	The *PEIR* assesses potential significant effects of the project in accordance with the NPSNN requirements.
4.23 "Applicants are required to provide sufficient information with their applications for development consent to enable the Secretary of State to carry out an Appropriate Assessment if required. This information should include details of any measures that are proposed to minimise or avoid any likely significant effects on a European site. The information provided may also assist the Secretary of State in concluding that an appropriate assessment is not required because significant effects on European sites are sufficiently unlikely that they can be excluded."	An appropriate assessment will be required as part of the Development Consent Order (DCO) submission. The *PEIR* outlines the desk-based study data and field survey work carried out and planned to ensure sufficient information is available for an appropriate assessment.
4.48 "Issues relating to discharges or emissions from a proposed project which affect air quality, water quality, land quality and the marine environment, or which include noise and vibration, may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes. Relevant permissions will need to be obtained for any activities within the development that are regulated under those regimes before the activities can be operated."	The Project team has engaged with the Environment Agency (EA) and other relevant authorities to secure the licences and permissions required for the Project.
4.52 "There is a statutory duty on applicants to consult the Marine Management Organisation (MMO) on nationally significant projects which would affect, or would be likely to affect, any relevant marine areas as defined in the Planning	To date, the Project team has engaged with the MMO, and it is planned that further meetings will be arranged to

Requirement (with NPSNN paragraph numbers)	Project response
Act (as amended by section 23 of the Marine and Coastal Access Act 2009). The Secretary of State's consent may include a deemed marine licence and the MMO will advise on what conditions should apply to the deemed marine licence. Where appropriate, the MMO should actively participate in examinations, and Examining Authorities engage with such matters, to help ensure that nationally significant infrastructure projects are licensed in accordance with environmental legislation, including European directives."	discuss and agree future work before an application is made.
5.22 "Where the project is subject to EIA the applicant should ensure that the environmental statement clearly sets out any likely significant effects on internationally, nationally and locally designated sites of ecological or geological conservation importance (including those outside England) on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity and that the statement considers the full range of potential impacts on ecosystems."	The *PEIR* sets out the marine baseline regarding designated sites, protected species and habitats of principal importance. The *PEIR* also identifies the potential effects of the Project on these features and highlights potential mitigation measures. These will be further developed in the ES.
5.23 "The applicant should show how the Project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests."	The *PEIR* identifies the opportunities taken to protect and enhance biodiversity and geological conservation interests.
5.25 "As a general principle, and subject to the specific policies below, development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives. The applicant may also wish to make use of biodiversity offsetting in devising compensation proposals to counteract any impacts on biodiversity which cannot be avoided or mitigated. Where significant harm cannot be avoided or mitigated, as a last resort, appropriate compensation measures should be sought."	The Project has gone through a rigorous and robust appraisal of reasonable alternatives which has influenced the ongoing design process. For example, a bored tunnel poses fewer risks to marine biodiversity and was therefore favoured over alternatives, such as a bridge and immersed tunnel. The *PEIR* also explores offsetting for residual effects that cannot be avoided or mitigated as a last resort.
5.27 "The most important sites for biodiversity are those identified through international conventions and European Directives. The Habitats Regulations provide statutory protection for European sites (see also paragraphs 4.22 to 4.25). The National Planning Policy Framework states that the following wildlife sites should have the same protection as European sites: • potential Special Protection Areas and possible Special Areas of Conservation;	Within the *PEIR* these sites have all been considered as receiving the same level of protection as designated European sites.

Requirement (with NPSNN paragraph numbers)	Project response
• listed or proposed Ramsar sites; and • sites identified, or required, as compensatory measures for adverse effects on European sites, potential Special Protection Areas, possible Special Areas of Conservation and listed or proposed Ramsar sites."	
5.30 "Marine Conservation Zones (MCZs), introduced under the Marine and Coastal Access Act 2009, are areas that have been designated for the purpose of conserving marine flora or fauna, marine habitat or types of marine habitat or features of geological or geomorphological interest. The protected feature or features and the conservation objectives for the MCZ are stated in the designation order for the MCZ, which provides statutory protection for these areas. Measures to restrict damaging activities will be implemented by the Marine Management Organisation (MMO) and other relevant organisations. As a public authority, the Secretary of State is bound by the duties in relation to MCZs imposed by sections 125 and 126 of the Marine and Coastal Access Act 2009."	The *PEIR* assesses potential effects on MCZs and treats rMCZs as having equivalent protection.
5.36 "Applicants should include appropriate mitigation measures as an integral part of their proposed development, including identifying where and how these will be secured. In particular, the applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works. • During construction and operation, best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised (including because of transport access arrangements). • Habitats will, where practicable, be restored after construction works have finished. • Developments will be designed and landscaped to provide green corridors and minimise habitat fragmentation where reasonable. • Opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals, for example through techniques such as the 'greening' of existing network crossing points, the use of green bridges and the habitat improvement of the network verge."	The landscape, biodiversity and other topic groups are working closely together to ensure habitat creation, green infrastructure and other measures are developed in an integrated manner. Best practices, such as those related to potential noise and lighting, will be implemented throughout construction to reduce or limit effects.
5.68 "The construction of national networks infrastructure on the coast may involve, for example, dredging, dredge spoil deposition, marine landing facility construction, and flood and coastal protection measures which could result in direct effects on the coastline, seabed, marine ecology and biodiversity, and the historic environment."	The *PEIR* and subsequent ES will assess potential effects on the coastline, seabed, marine ecology and biodiversity.
5.69 "Additionally indirect changes to the coastline and seabed might arise as a result of a hydrodynamic response to some of these direct changes. This could lead to localised or more	The *PEIR* and subsequent ES will assess potential indirect

Requirement (with NPSNN paragraph numbers)	Project response
widespread coastal erosion or accretion and changes to offshore features such as submerged banks and ridges, marine biodiversity and the historic environment."	changes to the coastline and seabed.
5.71 "Applications for development in a Coastal Change Management Area (CCMA) should make it clear why there is a need for it to be in a CCMA."	The *PEIR* assesses the implications for any relevant CCMA.
5.72 "For any projects involving dredging or disposal into the sea, the applicant should consult the Marine Management Organisation (MMO), and where appropriate, for cross-boundary impacts, Natural Resource Wales and Scottish Natural Heritage, at an early stage. The applicant should also consult the MMO on projects which could impact on coastal change, since the MMO may also be involved in considering other projects which may have related coastal impacts."	To date, the Project team has engaged with the MMO, and it is planned that further meetings will be arranged to discuss any need for dredging and other aspects of the Project.
5.73 "The applicant should examine the broader context of coastal protection around the proposed Project, and the influence in both directions, ie, coast on Project, and Project on coast."	Following discussion with the EA, the *PEIR* and subsequent ES will address any implications for coastal protection.
5.74 "The applicant should be particularly careful to identify any effects of physical changes on the integrity and special features of Marine Conservation Zones, candidate marine Special Areas of Conservation (SACs), coastal SACs and candidate coastal SACs, coastal Special Protection Areas (SPAs) and potential coastal SPAs, Ramsar sites, Sites of Community Importance (SCIs) and potential SCIs and sites of Special Scientific Interest. For any projects affecting the above marine protected areas, the applicant should consult Natural England and where appropriate, for cross-boundary impacts, Natural Resource Wales and Scottish Natural Heritage, at an early stage."	The *PEIR* assesses the implications for any relevant designated sites, and the Project team have engaged with Natural England.
5.226 "The Secretary of State should be satisfied that a proposal has had regard to the River Basin Management Plans and the requirements of the Water Framework Directive (including Article 4.7) and its daughter directives, including those on priority substances and groundwater. The specific objectives for particular river basins are set out in River Basin Management Plans. In terms of Water Framework Directive compliance, the overall aim of projects should be no deterioration of ecological status in watercourses, ensuring that Article 4.7 of the Water Framework Directive Regulations does not need to be applied. The Secretary of State should also consider the interactions of the proposed project with other plans such as Water Resources Management Plans, Shoreline/Estuary Management Plans and Marine Plans."	The *PEIR* and the subsequent ES will consider the implications of the Project for other marine plans.

Planning policy requirements

10.2.3 This chapter has been prepared with reference to the relevant national, regional and local plans and policies. A list of those relevant to the marine environment is provided in the Table 10.3.

Table 10.3 Plans and policies relevant to the marine environment

Policy name	Summary of requirements
UK Biodiversity Action Plan (*BAP*)	The plan lists priority species and habitats which form the basis of much of the biodiversity work in each of the devolved administrations of the UK. Several *BAP* habitats and species are known to be present in the Thames Estuary. As such, Project-related effects with the potential to impact these habitats and species have been considered in the assessment.
Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services (Defra)	A national strategy for England's wildlife and ecosystem services. It sets out the Government's ambition to halt overall loss of England's biodiversity by 2020, support healthy well-functioning ecosystems and establish coherent ecological networks. The Project must, therefore, place biodiversity at the heart of the design process and explore opportunities for delivering a net gain in biodiversity.
Highways England's Biodiversity Plan (Highways England 2015*)*	Highways England's Plan is designed to deliver no net loss of biodiversity on the strategic road network by 2020 and to achieve net gain by 2040.
A Green Future: Our 25 Year Plan to Improve the Environment (Defra 2018)	This sets out the Government's comprehensive and long-term approach to protecting and enhancing the UK's natural landscapes and habitats in England for the next generation. Its primary goal is to ensure: cleaner air and water; plants and animals which are thriving.
Thames Estuary 2100 Plan	The Thames Estuary 2100 project was established by the Environment Agency in 2002 with the aim of developing a strategic flood risk management plan for London and the Thames Estuary through to the end of the century. Within the plan, there is a commitment to look for opportunities to support biodiversity within the flood plain of the Thames Estuary.
London Biodiversity Action Plan (2006)	The plan details the habitats and species of priority to London, and the measures required to maintain and protect their status. Several migratory fish species migrate past the proposed location of the Project jetty, so potential effects have been considered in relation to the London BAP.

Policy name	Summary of requirements
Essex Biodiversity Action Plan 2011	The Action Plan details guidance for biodiversity work in Essex and focuses on 19 Priority Habitats of the Biodiversity 2020 Strategy, as well as the list of Priority Species and Habitats provided for in Section 41 of the 2006 Natural Environment and Rural Communities Act. Coastal saltmarsh is one of the 19 Priority Habitats, and the aim is to enhance and extend the habitat along the Essex coast.
Gravesham Local Plan	*Policy CS12 Green Infrastructure* Sites designated for their biodiversity value will be protected, with the highest level of protection given to internationally designated Special Protection Areas, Special Areas of Conservation and Ramsar sites followed by nationally designated sites of Special Scientific Interest, followed by local wildlife sites and then by other areas of more local importance for biodiversity. Where a negative impact on protected or priority habitats or species cannot be avoided on development sites, and where the importance of the development is considered to outweigh the biodiversity impact, compensatory provision will be required either elsewhere on- or off-site, including measures for ongoing maintenance. *Policy CS19 Development and design principles* New development will protect and, where appropriate opportunities arise, enhance biodiversity and the Borough's green infrastructure network.
Thurrock Local Plan	*Policy CSTP19 Biodiversity* Thurrock Council will create a robust network of ecological sites centring on the designated sites, ie, SSSIs, SPAs, Ramsar, Local Nature reserves and Local Wildlife Sites. These sites will be safeguarded and enhanced to mitigate the effects of past habitat loss and fragmentation, development and climate change. *Policy PMD7 Biodiversity, geological conservation and development* Development proposals will be required to demonstrate that any significant biodiversity habitat or geological interest of recognised local value is retained and enhanced onsite. Where it can be demonstrated that this is not possible, and there is no suitable alternative site available for the development, developers will be required to show that their proposals would mitigate any loss of biodiversity. In circumstances where it can be demonstrated that neither retention onsite nor mitigation is possible, developers will be required to provide appropriate compensation for any significant loss of biodiversity.

10.3 Methodology

10.3.1 This section details the methodology and approach used to collect the baseline information required for assessment of the Project's potential effects on the marine environment.

Study area

10.3.2 The preliminary baseline study area for marine habitats and sessile species (that is, species that are generally immobile) has been restricted to the section of the development area around the River Thames, hereafter referred to as the Thames Crossing area (see Figure 10.1 in Volume 3).

10.3.3 However, many marine receptors such as migratory fish, seals, dolphins and whales can have wide migratory and foraging ranges. As a result, the assessment will consider information from a wider study area that does not have a defined spatial extent. This will account for connections to populations potentially some distance away from the Thames Crossing area, including those associated with several remote European designated sites.

Baseline

10.3.4 To date, characterisation of the marine environment around the Thames Crossing area has only involved a preliminary desk-based study. More detailed analysis of the collated data is being undertaken for the ES. Targeted survey and modelling work to complete gaps identified in the baseline is also planned. Potential survey and modelling activities are summarised in Table 10.7.

10.3.5 The Thames Estuary has been subject to numerous environmental studies over the last 20 years. These include data collection to support long-term monitoring programmes (eg, National Marine Monitoring Programme; Environment Agency tideway fish monitoring programme) and specific Project-related studies to support Environmental Impact Assessments (EIAs) for major infrastructure developments (such as the London Gateway; Tilbury2; Tilbury Energy Centre).

10.3.6 These studies provide a well-developed understanding of the marine environment near the Thames Crossing area, and provide a preliminary scoping mechanism against which the effects from comparable activities can be assessed. Further, more detailed analysis of these data sources will be carried out.

10.3.7 The data sources used to describe the existing environment are given at the start of the preliminary baseline descriptions for each of the following receptor groups:

a. Designated sites

b. Marine habitats

c. Benthic invertebrates

d. Physical environment

e. Fish

f. Marine mammals

10.4 Existing environmental conditions

Designated sites

10.4.1 The preliminary desk-based study for marine receptors involved a search for all designated sites with marine components, with the potential to be affected by the Project. This included a search for all European sites with marine components, including Special Areas of Conservation (SACs); Special Protection Areas (SPAs); and Ramsar wetland sites, and national designations (eg, MCZs).

10.4.2 Where SPA sites have been identified as being potentially affected by the Project, the ornithological features are considered separately in Chapter 9: Terrestrial Biodiversity. Supporting marine habitat features such as mudflats and saltmarsh are considered within this chapter.

10.4.3 Owing to the transient nature and mobility of certain marine receptors, notably fish and marine mammals, the review has considered the full extent of the Tidal Thames (from Teddington Lock in the west, to Sheerness in the east) as being an important area for mobile species. The review has also explored possible links to populations from distant protected areas, including SACs that have been designated for one or more Annex II species: bottlenose dolphin, *Tursiops truncatus*, common seal, *Phoca vitulina*, grey seal *Halichoerus grypus* and harbour porpoise, *Phocoena phocoena* and MCZs.

10.4.4 Documented records of fish within the Thames Estuary include species of conservation importance, including migratory species that use the river as a conduit to transit between marine and freshwater habitats. Given the potential for protected migratory species to pass through the study area, a review was carried out of European sites located upriver of the Thames Crossing area.

10.4.5 For cetaceans listed in Annex II of the Habitats Directive and present in the study area, namely the harbour porpoise *Phocoena phocoena*, the assessment considered Species Management Units (JNCC, 2015), as these provide an indication of the spatial scales at which effects need to be assessed for cetaceans in UK waters (*IAMMWG*, 2015).

10.4.6 Similarly, for pinnipeds, the assessment considered the presence of seal management units in UK waters (*SCOS*, 2015). However, the precise management unit boundaries are not necessarily influenced by the biology of each respective species. Therefore, the assessment will also consider the potential for functional linkage between the marine area potentially affected by the Project and populations of SAC-qualifying features beyond the management unit boundaries.

10.4.7 Preliminary information on designated sites, habitats and species was obtained from the following data sources:

a. Department for Environment, Food and Rural Affairs (Defra) Multi-Agency Geographic Information for the Countryside (MAGIC) tool

b. Natural England (NE) – MCZs

c. Joint Nature Conservancy Council (JNCC) website

d. Zoological Society of London (ZSL) – Thames Marine Mammal Survey Report 2015

e. ZSL – Smelt Survey Report 2015

f. Environment Agency – Tidal Thames Fish Survey Programme

European sites

10.4.8 There are no European designated sites with marine interest features that could be directly affected by the marine works. However, indirect effects on supporting habitats and food resources for mobile receptors (birds) that are components of designated sites are considered.

10.4.9 The Thames Estuary and Marshes SPA (and Ramsar) and Holehaven Creek potential Special Protection Area (pSPA) (see Figure 10.1 in Volume 3) are designated for several over-wintering and on-passage bird populations, including an assemblage of over-wintering waterfowl. These birds are reliant on mudflat and saltmarsh habitats within the Project site that extend for 15km along the estuary.

10.4.10 Designated sites with bird interest features reliant upon marine habitats (eg, saltmarsh and mudflats) within the estuary, namely SPAs and Ramsar wetland sites, are specifically addressed in Chapter 9: Terrestrial Biodiversity. To help inform that assessment, acknowledgement is given to the discussions in this chapter concerning intertidal habitats, benthic invertebrates and the physical environment.

10.4.11 Table 10.4 identifies the European designated sites and their qualifying ecological features, as identified during the preliminary desk-based study.

Table 10.4 European designated sites and their qualifying features

Designated site	Important ecological feature (qualifying feature of designated site)
Thames Estuary and Marshes Ramsar site	Key ecological features: • saltmarsh • grazing marsh • floodplain grazing marsh and ditches • saline lagoons • one endangered plant species; 14 nationally scarce wetland plant species • 20 Red Data Book invertebrates • over-winter: Dunlin *Calidris alpine*, red knot *Calidris canuta*, grey plover *Pluvialis squtarola*, redshank *Tringa tonus* • on-passage: ringed plover and black-tailed godwit • Assemblage of 45,118 waterfowl over-winter

Designated site	Important ecological feature (qualifying feature of designated site)
Thames Estuary and Marshes SPA	Supporting marine habitats, including mudflats and saltmarsh, for: • over-winter: Hen harrier *Circus cyaneus*, avocet *Recurirostra avosetta*, dunlin, red knot, black-tailed godwit *Limosa limosa*, grey plover, redshank • on-passage: ringed plover *Charadrius hiaticula* • 75,019 waterfowl over-winter, including avocet, grey plover, red knot, dunlin, black-tailed godwit, redshank
Holehaven Creek pSPA (based on current SSSI designation)	Supporting marine habitats, including mudflats and saltmarsh.

National sites

10.4.12 The Upper Thames Estuary rMCZ is situated to the west of the Thames Crossing study area, between Richmond and Battersea Bridges (see Figure 10.1 in Volume 3). The site is recommended for designation as an important spawning area for smelt (*Osmerus eperlanus*) (see paragraph 10.4.86).

10.4.13 The Swanscombe rMCZ is also situated to the west of the Thames Crossing study area (see Figure 10.1 in Volume 3) and is recommended for designation as an important area for the nationally rare tentacled lagoon worm *Alkmaria romijni* (see paragraph 10.4.43) and several broad-scale habitat types.

10.4.14 Both the Upper Thames Estuary and Swanscombe sites are currently recommended for designation. As such, only from the point Defra opens a public consultation proposing the recommended MCZs for formal designation is an MCZ assessment necessary to consent the activities of a Project that can affect an MCZ feature.

10.4.15 Although an MCZ assessment is not formally required, both sites will be considered as though they are designated and an MCZ assessment will be completed if it is deemed that a proposed Project activity has the potential to significantly affect an MCZ feature.

10.4.16 More detailed information for designated sites will be provided in the ES once further analysis of the baseline has been carried out.

10.4.17 Table 10.5 lists the nationally designated sites, and their qualifying ecological features, identified during the preliminary desk-based study.

Table 10.5 Nationally designated sites and their qualifying features

Designated site	Qualifying feature
Upper Thames Estuary (formerly Thames Estuary) rMCZ	Smelt *Osmerus eperlanus*
Swanscombe (formerly Thames Estuary) rMCZ	• Tentacled lagoon worm *Alkmaria romijni* • Intertidal mixed sediments • Intertidal sand and muddy sand • Subtidal coarse sediment • Subtidal mud • Subtidal sand • Sheltered muddy gravels
South Thames Estuary and marshes SSSI	Supporting marine habitats, including mudflats and saltmarsh.
Mucking Flats and marshes SSSI	
Holehaven Creek SSSI	

Marine habitats

10.4.18 The marine habitats of the Thames Estuary adjacent to the Thames Crossing area have been extensively studied. The studies include the Thames Estuary Benthic Programme (TEBP), the Thames Estuary Partnership's (TEP) Habitat and Species Audit for the tidal Thames and various Project ESs – notably, the recent EIA carried out for the proposed Tilbury2 port developments. In addition, an extensive programme of marine survey works has been completed for RWE's proposed Tilbury Energy Centre.

10.4.19 Recently published work highly relevant to the Project area is the study (Physalia, 2017)) completed on behalf of the Thames Tideway Tunnel for a jetty at the Goshems Farm site. The benthic studies commissioned to support the planning application and marine licence are particularly relevant and provide comprehensive coverage of the marine habitats within the Thames Crossing study area.

10.4.20 The estuary around the Project is characterised by extensive areas of intertidal habitat. These intertidal habitats, areas of mudflats, sandflats and saltmarsh provide key foraging, breeding and nursery habitat for aquatic invertebrates and fish which support bird and mammal populations.

10.4.21 The importance of these habitats is recognised by the designation of large parts of the estuary as protected areas. Intertidal mudflats and saltmarsh are all Habitats of Principal Importance listed under the NERC Act 2006.

10.4.22 The following preliminary desk-based study data sources were reviewed to describe the marine habitats in the Thames Estuary:

a. *Thames Estuary Benthic Programme*, National Rivers Authority, 1992

b. *Tidal Thames Habitat Action Plan*, Thames Estuary Partnership Biodiversity Action Group, 2002

c. *Benthic Ecology of the Thames Estuary*, ABPmer Marine Environmental Research Ltd, 2007

d. *London Gateway Container Terminal Environmental Statement*, 2006

e. RWE Tilbury studies, 2008, unpublished

f. *Thames Estuary 2100 (TE2100) plan*, TE2100, 2012

g. *Tilbury2 Phase 1 survey report*, Thomson Ecology, 2017

h. *Thames Tideway Tunnel Jetty ecology reports*, Physalia, 2017

i. Clean Safe Seas Environmental Monitoring Programme (CSEMP) (formerly known as the National Marine Monitoring Programme)

j. UK BAP list, section 41 of the NERC Act 2006

k. UK BAP priority habitats, MAGIC website (Defra)

Thames Crossing study area

10.4.23 The intertidal areas of the Thames Estuary are typically characterised by mixed coarse sediments, mud and sandflats backed by seawalls, with some areas of saltmarsh.

10.4.24 The habitat components of the designated sites within the Thames Crossing study area (Thames Estuary and Marshes SPA/Ramsar site and Holehaven Creek pSPA) include extensive areas of intertidal mudflats and saltmarsh. Subtidal habitats include areas of mixed coarse sediments, sand and mud.

10.4.25 Phase 1 habitat surveys carried out in support of the Tilbury2 development consent order application in 2017 along a 2.2km stretch of the estuary west of the Thames Crossing area section described the intertidal habitats as including areas of mud and sand, shingle and cobbles, boulders and rocks, eelgrass beds and areas of dense saltmarsh (Thomson Ecology, 2017). Intertidal mud was found in a continuous band along the breadth of the lower extent of the intertidal zone.

10.4.26 In 2017, a desk-based study and field surveys (Physalia, 2017) were completed to support the planning and marine licence applications for the Thames Tideway Tunnel jetty at Goshems Farm. This work included marine habitat mapping, and benthic invertebrate and sediment sampling. Given that the proposed location of the Project jetty is on the same footprint of the Thames Tideway Tunnel jetty, it is considered that the outputs of this study provide a good level of confidence as to the likely habitat and community composition at the site.

10.4.27 The Thames Tideway Tunnel jetty survey work was specifically designed to address the nature and value of the benthic habitats, and the potential presence and distribution of the protected tentacled lagoon worm *Alkmaria romijni* near the Goshems Farm location.

Mud and sandflats

10.4.28 The intertidal zone adjacent to the existing Goshems Farm jetty is described as an area of elevated mud and sand banks, intersected by tidal channels (Physalia, 2017). Sediment cores collected from across the intertidal zone were all found to comprise a significant component of sand (fine (125 – 250µm) and very fine (63 – 125µm)). In 10 of the 16 samples collected, sands accounted for over 50% of the total sediment dry weight.

10.4.29 Mud and silt fractions (sediment particles < 63µm) dominated 6 of the 16 samples at between 50% and 70% of total sediment dry weight. Samples with a < 63µm fraction more than 95% total dry weight are not uncommon in Thames estuarine muds. The report also concluded that the sediments in this reach of the estuary are not accumulating muds (Physalia, 2017).

Brown algal beds

10.4.30 Patches of rock armour that exist within the intertidal zone near the Goshems Farm jetty were colonised by bladder wrack *Fucus vesiculosus*. The width of this feature was variable and covered an area of >2Ha (Thomson Ecology, 2017).

Saltmarsh

10.4.31 The Tilbury2 Phase 1 habitat survey reported the presence of saltmarsh habitat in the Thames Crossing study area. Species recorded included sea purslane *Atriplex portulacoides*, sea couch *Elytrigia atherica*, sea plantain *Plantago maritima*, sea arrowgrass *Triglochin maritima*, sea aster *Aster tripolium*, cord-grass (Spartina sp.) and greater sea-spurrey *Spergularia media* (Thomson Ecology, 2017).

10.4.32 In the area of the Thames Tideway Tunnel jetty at Goshems Farm, sea purslane was recorded as being dominant; sea couch as abundant; sea aster, sea plantain and sea arrowgrass as frequent; saltmarsh rush *Juncus gerardii*, common saltmarsh-grass *Puccinellia maritima*, cord-grass and greater sea-spurrey as occasional; and English scurvygrass *Cochlearia anglica*, sea-milkwort *Glaux maritima*, dittander *Lepidium latifolium* and common sea lavender *Limonium vulgare* as rare (Thomson Ecology, 2017).

10.4.33 The saltmarsh community showed clear zonation, with the upper shore areas being dominated by sea crouch facies and the mid-shore by sea purslane and sea plantain. In addition, where there was no rock armour present, patches of cord-grass were identified in the lower shore areas (Thomson Ecology, 2017).

10.4.34 More detailed information with respect to marine habitats will be provided in the ES.

Benthic invertebrates

10.4.35 The benthic invertebrate community of the Thames Estuary has been well documented through regulatory monitoring programmes such as the TEBP and the CSEMP. The regulatory monitoring programmes provide a good baseline for macroinvertebrate communities throughout the estuary.

10.4.36 More recently, the lower Thames Estuary has been subject to numerous marine studies in support of major infrastructure developments, including those associated with London Gateway, Tilbury2 and RWE's Tilbury site.

10.4.37 The macroinvertebrate community composition in estuarine water bodies is driven largely by salinity conditions and by sediment type. Salinity conditions around the Thames Crossing area are typically variable, being largely dependent on the relative freshwater input into the estuary. As outlined in the previous section, the intertidal habitats in the area are dominated by muds and sands.

10.4.38 Estuarine benthic invertebrate communities are typically characterised by low numbers of species, but high abundance counts. This is due to the wide range of physical conditions, including salinity, temperature, suspended sediments and dissolved oxygen, that are experienced in estuaries, with few species being able to adapt to the wide-ranging environmental conditions.

10.4.39 The intertidal areas near the Project are dominated by the muddy macroinvertebrate community characterised by the *Hediste diversicolor* and *Scrobicularia plana* biotope, and by the sandy mud community dominated by the *Hediste diversicolor* and *Macoma balthica* biotope (Physalia, 2017).

10.4.40 In the recent Thames Tideway Tunnel jetty work at Goshems Farm, a total of 38 invertebrate taxa were recorded. Table 10.6 provides a summary of the key taxa recorded.

Table 10.6 Key benthic taxa recorded at the Thames Tideway Tunnel jetty at Goshems Farm (Physalia, 2017)

Group	No. of taxa	Example species recorded
Oligochaetes	3	*Tubificoides bendii*
Polychaetes	12	*Nephthys hombergii; Hediste diversicolor*
Bivalve molluscs	4	*Macoma balthica; Abra alba; Scrobicularia plana; Mytilus edulis*
Amphipod shrimps	1	*Corophium volutator*

10.4.41 The Thames Tideway Tunnel jetty study also reported that the densities and distributions of the macroinvertebrate community varied considerably across the intertidal area. Much of this variance was attributed to the sediment characteristics, which varied in terms of relative contributions of mud and sand fractions. Overall, the benthic invertebrate resource near the jetty was assigned a moderate value as a resource for wading and migratory birds.

Tentacled lagoon worm

10.4.42 The tentacled lagoon worm *Alkmaria romijni* is a bristleworm that requires muddy sediments in brackish water. It is generally found in sheltered estuaries and lagoons. It is a nationally scarce marine organism, safeguarded under Schedule 5 of the Wildlife and Countryside Act 1981 and is listed on section 41 of the NERC Act 2006.

10.4.43 The worm has previously been reported in the Thames Estuary. As a result, the proposed boundary of the Swanscombe rMCZ to the west of the Thames Crossing study area has been determined to fit more closely around these records. The worm is also a designated feature of the Medway estuary MCZ, located to the east of the Thames Crossing study area.

10.4.44 A primary objective of the Thames Tideway Tunnel study was to confirm the presence or absence of the tentacled lagoon worm near the proposed jetty location. No specimens of the worms were identified in the 48 samples collected as part of the study for the jetty.

10.4.45 During consultation on the MCZ assessment completed as part of the Tilbury2 DCO submission, it was agreed with the MMO, NE and EA that there were currently no records of the worm in the Thames Estuary as far downstream as the Gravesend/Tilbury area, and that there was a low risk of the worm colonising areas close to Tilbury.

Other species of conservation concern

10.4.46 Several other benthic invertebrate species of conservation concern have been recorded in the lower Thames Estuary. The desk-based work completed for the Thames Tideway Tunnel jetty at Goshems Farm identified 2 species with the potential to occur near the jetty. These were the lagoon sea slug *Tenellia adspersa* and the amphipod mudshrimp *Corophium lactustre* (Physalia, 2017). Both species are listed under section 41 of the NERC Act 2006 as priority species.

10.4.47 No specimens of either species were identified during the survey work. Both species are primarily associated with epifaunal communities on hard substrata, which is a limited resource in the Project study area.

Invasive non-native species

10.4.48 Several estuarine/marine invasive non-native species (INNS) have been documented in the Thames Estuary. It is thought that these species have been introduced to the estuary either accidentally or deliberately by the transport and discharge of ballast water, and to a lesser extent by transport of fouling organisms on hulls or through aquaculture.

10.4.49 Confirmed INNS in the Thames Estuary include:

a. Chinese mitten crab *Eriocheir sinensis*

b. slipper limpet *Crepidula fornicata*

c. polychaete *B. ligerica*

d. carpet sea squirt *Didemnum vexillum*

e. pacific oyster *Crassostrea gigas*

10.4.50 The Chinese mitten crab is present in the Thames Crossing study area. The species was first recorded in the Thames Estuary in the early 20th century and is thought to have been introduced via ballast water. The crab is a voracious predator and burrows into soft banks, resulting in negative effects on native species and habitats (NBN Atlas, 2018).

10.4.51 Further consideration of the potential effects to benthic invertebrates will be provided in the assessment once the detailed baseline has been established.

Physical environment

10.4.52 The Thames Estuary extends from Teddington Weir in the west, to the Seaward Limit in the east, the latter being defined by a straight line between Havengore Creek in Essex to Warden Point in Kent.

10.4.53 The estuary near the Thames Crossing area has a width of approximately 900–1000m. At low water, intertidal mud/sand flats are exposed both on the northern and southern shores. The depth of the main channel in this area ranges between 13–14m below Chart Datum.

10.4.54 The Thames Estuary is macrotidal with a mean spring tide range of 5.2m at Sheerness, which gradually increases upstream to 5.9m at Tilbury and 6.6m at London Bridge. Maximum tidal flow speeds near the Thames Crossing are reported to be in the region of $2ms^{-1}$, approximately 2 hours after high water on spring tides. Minimum flow speeds are reported in the region of 0.1–0.75ms-1 as low water approaches (RWE, 2008 unpublished). Actual tides and flows can prove to be highly variable with strong winds and prolonged periods of heavy rainfall affecting predictions.

10.4.55 The average tidal excursions in the lower reaches of the estuary are approximately 13–14km on spring tides, with a summer average net daily seaward movement of approximately 1–2 km (RWE, 2008 unpublished).

10.4.56 Freshwater input to the estuary at Teddington Weir averages 800 million litres per day although it may fall as low as 200 million litres during periods of low flow and be much greater during periods of high rainfall. Significant freshwater flows also enter the estuary via wastewater effluent streams from the major sewage treatment works at Beckton and Crossness.

10.4.57 The estuary is a fully mixed water body and, as such, salinity progressively increases with distance from Teddington. The location where salinity reaches full seawater is heavily dependent on time of year and freshwater flows into the estuary.

10.4.58 EA data recorded at Gravesend gave a mean salinity value of 17.69 with a standard deviation of 3.91. The lowest salinity values recorded were 6.68 and the highest 24.07.

10.4.59 Suspended solids loading in the Thames Estuary are similarly influenced by factors such as location in the estuary, state of tide, freshwater flows and degree of mixing. Inglis and Allen (1957) reported suspended solids concentrations for the Thames Estuary in the range of 20–500 mg l-1, with the highest concentrations recorded near the bed.

10.4.60 Surface water temperature in the estuary varies between 6ºC and 20ºC and is highly dependent on the time of year and the freshwater flows entering the estuary (Crane, 2006).

10.4.61 Levels of dissolved oxygen in the estuary are highly variable and are primarily influenced by the freshwater and sewage effluent inputs and temperature. The rate of oxygen consumption increases during the summer months when temperatures are at their highest and can also increase during periods of heavy

rainfall when Combined Sewer Overflow events discharge large volumes of nutrient rich effluent into the tideway (Crane, 2006).

10.4.62 Sediment transport in the Thames Estuary is complex. Modelling of fine sediment transport in the estuary downstream of Gravesend found a net spring and neap tide sediment flux out of the estuary (ie, export of sediment). The model also showed that tidal currents transported most of the sediment with negligible wave influence (HR Wallingford, 2002).

10.4.63 Mean sediment particle size becomes markedly smaller into the inner estuary. Mucking Flats are typified by mud sediments, whereas Blyth Sands are muddy towards the high-water mark becoming sandy towards the low-water mark, with a transition zone between the two (HR Wallingford, 2002). These findings concur with the relative mud/sand ratios that were reported during the Thames Tideway Tunnel jetty work.

10.4.64 Sediment quality in the Thames Estuary is highly variable. The estuary has been affected by various industries over the decades, and as a result some areas have been exposed to the release of a variety of contaminants. Much of this legacy contamination is bound within the sediments but can be at risk of release to the water column if disturbed during activities such as dredging.

10.4.65 Sediment samples collected near Tilbury Port and tested by the Port of London to provide a baseline for their maintenance dredging programme reported some samples as exceeding the Centre for Environment, Fisheries and Aquaculture Science (Cefas) action level 1 (Port of London Authority (PLA), 2007). Exceedances were mainly for tributyltin, chromium, copper, mercury, nickel, lead and zinc.

10.4.66 Owing to the patchy distribution of potentially contaminated sediments, sediment samples to facilitate quantification of the risk of contaminant release during possible dredging activities may need to be collected to help establish a robust baseline. The need to collect these samples will be confirmed, in consultation with the MMO and PLA, once the jetty design and operation are more fully understood in terms of any dredging requirements.

10.4.67 More detailed information with respect to the physical baseline will be provided in the ES. Further consideration of the potential effects to physical processes will be provided in the assessment once the detailed baseline has been established.

Fish

10.4.68 Several existing data sources, detailed below, have been initially used to inform the baseline conditions. Further analysis of these and other data sources will be used to further refine the baseline, including those listed in paragraph 10.4.74.

10.4.69 Annual cooling water intake screen surveys were carried out at West Thurrock Power Station between 1974 and 1991 and are summarised by Thomas (1998). The fish appearing on the screens were categorised as:

a. migratory (those species moving between the sea and freshwater for spawning)

b. freshwater (occurring and breeding in freshwater)

c. estuarine (spending most of their life in the estuary)

d. marine-estuarine-dependent (require an estuarine stage in life-cycle)

e. marine stragglers (abundant in marine and uncommon in estuaries)

10.4.70 Species diversity in the Thames Estuary is driven by the seasonal movement of fish, with high species numbers in the autumn and winter and low numbers in the summer (Thomas, 1998). More up-to-date screen monitoring was undertaken by the ZSL at the Tilbury Power Station intakes between 2006 and 2010. This data has been requested and will be incorporated into the baseline for the ES.

10.4.71 The EA conducts extensive monitoring within the Thames Estuary that has been ongoing since 1994. Several programmes make up the monitoring, which includes the WFD transitional water body monitoring for fish (previously known as the Tideway Monitoring Programme), the CSEMP and the joint Cefas-EA bass survey programme.

10.4.72 The monitoring sites for these combined programmes extend from Teddington in the west to the Medway approaches in the east, with a total of 26 sites. Ongoing records continue to be collected through the regular monitoring work carried out by the EA and Cefas. This baseline data has been requested and will be incorporated into the baseline for the ES.

10.4.73 These datasets will be supplemented by that sought from online databases, review of EIA chapters for relevant developments in the Thames, ongoing scientific studies and peer-reviewed papers as appropriate.

10.4.74 The following desk-based study data sources, that describe fish populations in the tidal Thames, will be reviewed:

a. Fish sampling from five power station cooling water intake screens around the coast of England (1972-ongoing), Cefas.

b. Tilbury Power Station cooling water intake screen surveys (2006-2010), ZSL and EA.

c. West Thurrock Power Station cooling water intake screen surveys, EA.

d. Thames Herring Survey, Cefas.

e. *Thames Area Annual Fisheries Report*, EA.

f. Fisheries activity and expenditure in England (April 2016 to March 2017), EA.

g. Transitional and Coastal Water Bodies (TraC) Fish Monitoring: The results of ongoing annual WFD fish monitoring, EA.

h. FishBase (www.fishbase.org).

i. *Seasonal Changes in Fish & Epibenthos of the Lower Thames Estuary* (2002), MAES.

j. Spatial & Seasonal Changes in the Fish & Epibenthos of the Lower Thames Estuary (2006/2008), MAES.

k. *Thames spawning activity* (2002), Colclough et al.

l. Conservation of Tidal Thames fish through the Planning Process, ZSL

m. *Eel Management Plan*, ZSL

10.4.75 An initial review of the status and ecology of demersal and pelagic fish, elasmobranchs and diadromous fish has been carried out, including species of commercial and/or conservation importance. Further consideration of the potential impacts to fish and fisheries will be provided in the assessment, once the baseline is further established.

10.4.76 Marine habitats that provide suitable nursery areas for fish are considered in paragraph 10.4.20.

Preliminary desk-based study

10.4.77 Previous studies have identified a wide range of fish present in the Thames Estuary, including species that support commercial fisheries such as for plaice *Pleuronectes platessa*, sprat *Sprattus sprattus*, herring *Clupea harengus*, Dover sole *Solea solea*, thornback ray *Raja clavata* and bass *Dicentrarchus labrax*) (Crane, 2006).

10.4.78 Since 1964, 125 species have been recorded in the Thames Estuary (ZSL, 2016). Reports of fish within the estuary include species of conservation importance and migratory species that use the river as a conduit to transit between the marine and freshwater environments.

10.4.79 Baseline fisheries surveys were carried out during 2007 and 2008 to support an application for Tilbury Power Station (RWE, 2008 unpublished data). Surveys were carried out in the subtidal and intertidal areas to sample both adults and juveniles.

10.4.80 A mixed assemblage of fish was identified from the surveys with subtidal species including (* identifies fish that are listed as priority species under section 41 of the NERC Act 2006):

a. bass

b. smelt *Osmerus eperlanus**

c. flounder *Platichthys flesus*

d. Dover sole*

e. sprat

f. pout *Trispoterus luscus*

g. whiting *Merlangius merlangus**

h. herring*

i. dab Limanda limanda

j. sand goby *Pomatoschistus minutus*

k. common goby *Pomatoschistus microps*

l. lozano's goby *Pomatoschistus lozanoi*

m. painted goby *Pomatoschistus pictus*

n. transparent goby *Aphia minuta*

Intertidal surveys recorded the following species:

a. common goby

b. bass

c. 3-spined stickleback *Gasterosteus aculeatus*

d. flounder

e. mullet *mugilidae*

f. sand goby

g. eel *Anguilla anguilla**

h. sprat

Species of conservation importance

10.4.81 Certain fish species are protected under a range of legislation. These include the EU Habitats Directive, the Wildlife and Countryside Act 1981 (and amendments) and the Berne Convention. They are also included on the OSPAR[19] threatened species list, the International Union for Conservation of Nature (IUCN) red list and the Priority Species List under section 41 of the NERC Act 2006.

10.4.82 A review of the fish communities in the Thames Estuary carried out as part of the Tilbury2 development (Thomson Ecology, 2017) highlighted a number of species of conservation importance, including allis shad *Alosa alosa*, twaite shad *Alosa fallax*, short-snouted seahorse *Hippocampus hippocampus*, raitt's sandeel *Ammodytes marinus*, European eel, herring, cod, angler fish *Lophius piscatorius*, whiting, smelt, plaice, Atlantic salmon *Salmo salar*, sea trout *Salmo trutta*, mackerel *Scomber scombrus* and sole.

10.4.83 European eel are catadromous species with juveniles arriving in estuaries in the spring, moving upstream to the freshwater catchment using the tidal stream. After a period in the freshwater environment, adult eel then migrate back out to sea to spawn.

[19] OSPAR (Oslo/Paris Convention) is the mechanism by which 15 Governments and the EU cooperate to protect the marine environment of the North-East Atlantic.

10.4.84 Annual recruitment of European eel into rivers has declined by over 90% in the past 30 years across its geographic range and, as a result, in 2008 the IUCN classified the European eel as critically endangered. In a UK context, the Thames Estuary is particularly important for eel. The lower estuary currently supports a low level commercial Fyke net fishery for adult silver eels (ZSL, 2017).

10.4.85 Since the late 1970s smelt have begun returning to the Thames and are found in increasing numbers each year. Cefas data shows the Thames Estuary contains more smelt per 1000m^2 than any other estuary around the south and east coast of Britain (Rogers *et al*., 1998). In 1967-73, smelt were reported at all power stations on the Thames Estuary during the power station screen surveys undertaken by Cefas (English Nature, 2003). The Thames Estuary smelt population is now considered to be one of the largest breeding populations in the UK (ZSL, 2015a). For the monitoring period 2011 to 2015, smelt was the most abundant pelagic species recorded by the EA during WFD TraC fish monitoring at Woolwich and Greenwich (EA, 2018).

10.4.86 The Upper Thames Estuary rMCZ is designated as an important area for smelt spawning. It is recognised that smelt, as a migratory species, will necessarily pass through the Project study area during their migrations through the estuary. As such, consideration will be given in the ES to the potential impacts on the species during these migrations and to any supporting habitat, such as spawning grounds.

10.4.87 Sea lamprey *Petromyzon marinus* is listed as a priority species in section 41 of the NERC Act 2006 and is present in Annex II of the Habitats Directive and Appendix III of the Berne Convention. Sea lamprey migrate through the estuary to spawning grounds in the freshwater catchment, and populations have been increasing in the Thames Estuary with improved water quality.

10.4.88 River lamprey *Lampetra fluviatilisis* is listed as a priority species in section 41 of the NERC Act 2006 and is present in Annex II and V of the Habitats Directive and Appendix III of the Berne Convention. There are some records of river lamprey in the Thames Estuary from power station screen surveys. River lamprey spend their adult phase at sea and migrate through the estuary during the autumn before spawning in the freshwater catchment the following spring.

10.4.89 Atlantic salmon and sea trout migrate through the Thames Estuary to spawn in the freshwater catchment. Both species are anadromous, with much of their feeding and growth occurring in the marine environment. Adults return to their natal streams to spawn, migrating through the Thames Estuary between May and November each year. Juveniles remain in freshwater for between one to three years before undergoing physiological changes and migrating to sea as smolts. This seaward migration typically occurs between April and May of each year.

10.4.90 In the Thames, the numbers of returning adults for both salmon and sea trout is relatively low. Issues such as low flows, barriers to migration, poor water quality and loss of freshwater habitat are thought to be contributing to the low returns/poor spawning success.

Marine mammals

10.4.91 Several species of marine mammal have been recorded in the Thames Estuary. Increasing populations of common seals *Phoca vituli*na and grey seals *Haliochoerus grypus* have been reported throughout the estuary, as far as Richmond lock. Harbour porpoise *Phocoena phocoena* also frequent the estuary year-round (ZSL, 2015b). Bottlenose dolphins *Tursiops truncatus* and whales are also present, but much less frequently (ZSL, 2015b).

10.4.92 The baseline environment for marine mammals will be established through a more detailed desk-based study and will draw on existing and readily available information to describe the species' distribution, behaviour and habitat use. This information will form the basis of the assessment in the ES of potential impacts on significant habitat and resources, numbers near the Project and potential effects on wider populations.

10.4.93 The desk-based study incorporates studies undertaken in the Thames and southern North Sea area that provide valuable information on abundance, distribution and ecology. The most recent and valuable monitoring (and reporting) of marine mammals in the Thames Estuary has been undertaken by ZSL. ZSL has been monitoring cetaceans in the estuary since the early 2000s using aerial, boat and land-based transects and GPS (Global Positioning System) tagging. The baseline will incorporate the robust and current information available from ZSL's annual seal population surveys (carried out since 2013) to determine the distribution and vulnerabilities of pinnipeds in the estuary.

10.4.94 Analysis of the following data sources will further inform the marine mammal baseline:

a. SCANS-III, Sea Mammal Research Unit

b. *Scientific Advice on Matters Related to the Management of Seal Populations* (2011-2017), Special Committee on Seals (SCOS)

c. *Thames Estuary Marine Mammal Sightings Survey* (2004-2014), ZSL

d. Habitat and foraging maps of harbour seals in the Thames, ZSL

e. *Greater Thames Estuary Seal Surveys Report* (2015), ZSL

f. *Underwater Noise Impact Assessment on Marine Mammals and Fish during Pile Driving of Proposed Round 2 Offshore Windfarm in the Thames Estuary* (2006), RPS Energy

g. *Offshore Energy Strategic Environmental Assessment: Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil and Gas Storage Environmental Report* (2009), DECC

Designations

10.4.95 The Habitats Directive provides the primary basis for the regulatory protection of cetaceans. All species are listed in Annex IV of the directive, meaning that a strict protection regime must be applied across their entire range.

10.4.96 Common seal, grey seal, harbour porpoise and bottlenose dolphin are also listed in Annex II of the Habitats Directive affording them protection within designated (Natura) sites (SACs), managed in accordance with the specific requirements of the species. The assessment of potential impacts on European designated sites under the directive will be addressed in the Habitats Regulations Assessment for the Project.

10.4.97 Cetaceans are also protected under Schedule 5 of the Wildlife and Countryside Act 1981. It is illegal to kill, injure or take the wild mammals listed on that schedule. Section 9(4)(b) further prohibits the disturbance of any such mammal while it is occupying a place it uses for shelter or protection.

10.4.98 Marine mammals are also protected by the Conservation of Seals (England) Order 1999 and the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas.

10.4.99 The Thames Estuary has a common seal population resident throughout the year. This population seems relatively stable, as a very similar number of common seals were counted during the 2013 and 2014 seal population counts. This gives a population estimate of 669 common seals in 2013 and 679 common seals in 2014 (ZSL, 2015). Blyth Sands is a known haul-out site for common and grey seal. Large groups of common seals have also been observed hauled-out on other sandflat sites within the estuary (ZSL, 2008). Seals are naturally gregarious and tend to haul-out in large groups during the breeding season or at times of moulting and resting (Reeves *et al*, 2002).

10.4.100 During the ZSL grey seal breeding survey, three major haul-out sites were identified: Pegwell Bay, Dengie Flats and Hamford Water (ZSL, 2015). Grey seals have been recorded in the estuary, but often as solitary animals (ZSL, 2008).

10.4.101 The long-term monitoring survey of marine mammals in the Thames Estuary (Thames Marine Mammal Sighting Survey), which is coordinated by ZSL will be used to establish the baseline against which potential Project effects will be assessed.

10.4.102 Harbour porpoise and bottlenose dolphins are regularly sighted in the Thames Estuary, with harbour porpoise being the most regularly sighted species. Harbour porpoise are also the most frequently stranded cetacean species in the estuary. ZSL's monitoring has shown that the harbour porpoise are present in the estuary year-round with peaks in abundance between April and August (ZSL, 2017).

Ornithology

10.4.103 The Thames Estuary provides large areas of coastal habitats that are important to a wide range of wildfowl and wading birds that feed on the mudflats and saltmarsh areas. Many of these birds are listed on protected area designations (ie, SPAs).

10.4.104 Section 9.4.90 of Chapter 9: Terrestrial Biodiversity provides an overview of the ornithology desk-based study, specifically in relation to the habitat types present within the development boundary. The chapter also describes surveys to be carried out in 2018 and 2019 to complete the baseline. The details of this will be provided in the ES.

10.5 Other baseline information to be obtained

10.5.1 To date, only a preliminary desk-based study review of available marine baseline data and information has been conducted. A further, more detailed, review will be completed to establish a more complete baseline for the ES.

10.5.2 Following detailed review of the data and reports available to the desk-based study, and further consultation with MMO, NE, EA and PLA to review the baseline, there may be a requirement for a programme of marine surveys and modelling to facilitate the assessment of Project effects. This will be reported on in the ES.

10.5.3 Marine surveys and modelling that may be required are detailed in Table 10.7. For survey and modelling work carried out following the detailed desk-based study, detailed survey methodologies will be agreed with the relevant regulatory body and will be provided in the ES.

Table 10.7 Potential marine surveys and modelling

Activity	When	Where	Purpose
Intertidal/subtidal macroinvertebrate survey	Single event, 2018	Within and adjacent to the footprint of the proposed jetty and dredge works (if required)	Confirmation of presence/absence of conservation species eg, tentacled lagoon worm
Intertidal/subtidal sediment survey	Single event, 2018	Within and adjacent to the footprint of the proposed jetty and dredge works (if required)	Quantification of sediment chemistry characteristics to inform assessment of potential contaminant release during dredge and piling works
Underwater noise survey	Single event, 2018	Adjacent to the proposed jetty location	Quantification of the baseline underwater noise environment
Underwater noise modelling	2018/19	Desk-based use of established modelling packages	To quantify any effects of jetty construction and tunnel operation on sensitive marine receptors such as fish and mammals
Hydrodynamic/sediment transport modelling	2018/19	Desk-based use of established modelling packages	To quantify any effects of jetty construction and operation on the hydrodynamic and sediment transport regimes

Future baseline conditions

10.5.4 The future baseline is used to describe how the existing conditions would likely change over time if the proposed development were not to be proceed, ie, if the Project was not built and operated.

10.5.5 It is likely that the extent and distribution of the intertidal and subtidal habitats would remain largely the same as at present. Development of Tilbury 2 and the Tilbury Energy Centre have the potential to affect existing hydrodynamic and sediment patterns, and thus the habitats that they influence.

10.5.6 Similarly, populations of marine species near the Project area would remain largely the same, although the adjacent developments have the potential to directly and indirectly affect benthic infauna and fish.

10.6 Potential effects and mitigation measures

10.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. It should be noted that this assessment is ongoing and is subject to change through ongoing development of the Project proposals. The mitigation proposed in the table below is based on validated survey data carried out to date and our professional judgement.

10.6.2 A full, detailed assessment will be undertaken before DCO application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the ES.

Construction

Table 10.8 Potential effects and mitigation measures on marine receptors during construction

Item	Description
Receptor	Thames Estuary and Marshes Ramsar; Thames Estuary and Marshes SPA; Holehaven Creek potential (p) SPA; South Thames Estuary and Marshes SSSI; Mucking Flats and Marshes SSSI; Holehaven Creek SSSI
Potential nature of effect	Temporary disturbance and loss of supporting benthic habitats/macroinvertebrate resource because of piling and dredging activities during construction and operation of the marine jetty.
Likely duration	Construction and operation of the marine jetty.
Potential mitigation	Jetty design which limits footprint and the need for dredging where practicable. Use of best practice methods with respect to dredging operations.
Receptor	Thames Estuary and Marshes SPA; Thames Estuary and Marshes Ramsar; South Thames Estuary and Marshes SSSI

Item	Description
Potential nature of effect	Temporary deterioration of water quality resulting in contamination of supporting benthic habitats/macroinvertebrate resource. May be caused by surface water discharges (including dewatering) and accidental spillages.
Likely duration	Construction of the tunnels.
Potential mitigation	Preparation of Code of Construction Practice (CoCP) outlining pollution prevention and surface water control measures to be implemented.
Receptor	Upper Thames Estuary rMCZ
Potential nature of effect	Temporary underwater noise and deterioration of water quality, causing adverse effects on migrating smelt, such as a barrier to migration, due to piling, dredging and general construction and decommissioning activities of the marine jetty.
Likely duration	Jetty construction and decommissioning phases.
Potential mitigation	Jetty design which limits the number of piles and requirement for dredging where practicable. Where possible, use of soft start and vibro-piling techniques to limit extent and duration of noise emissions. Best practice methods for dredging operations.
Receptor	Swanscombe rMCZ
Potential nature of effect	Temporary disturbance of tentacled lagoon worm and supporting habitats through smothering effects because of dredging activities during construction and operation of the jetty.
Likely duration	Construction and operation of the jetty.
Potential mitigation	Jetty design which limits need for dredging during construction and operation where practicable. Best practice methods for dredging.
Receptor	Marine habitats (including intertidal and subtidal)
Potential nature of effect	Temporary disturbance and loss of benthic habitats because of piling and dredging activities.
Likely duration	Jetty construction phase.
Potential mitigation	Jetty design which limits footprint and need for piling and dredging where practicable. Best practice methods for dredging operations.
Receptor	Benthic invertebrates
Potential nature of effect	Temporary disturbance of benthic invertebrates because of underwater noise from piling and dredging activities during construction and decommissioning of the jetty.
Likely duration	Jetty construction and decommissioning phases.
Potential mitigation	Jetty design which limits the number of piles and requirement for dredging where practicable. Where possible, use of soft start and vibro-piling techniques to limit extent and duration of noise emissions. Best practice methods for dredging operations.
Receptor	Benthic invertebrates
Potential nature of effect	Temporary deterioration of water quality resulting in disturbance of macroinvertebrate resource from dredging and surface water discharges (including dewatering) and accidental spillages.

Item	Description
Likely duration	Jetty construction and tunnel construction phases
Potential mitigation	Jetty design which limits need for dredging where practicable. Preparation of the CoCP outlining pollution prevention and surface water control measures to be implemented. Best practice methods for dredging operations.
Receptor	Fish (including those of conservation concern)
Potential nature of effect	The construction activities have the potential to cause temporary disturbance to sensitive fish species through noise and vibration resulting from piling operations for jetty construction, vessel movements and the effects from tunnel-boring machines (TBMs) during tunnel construction.
Likely duration	The disturbance effect will be temporary and restricted to the period of piling, barge operations and TBM activity.
Potential mitigation	Where possible, use of best practice techniques such as soft start and ramp-up will be used for piling operations.
Receptor	Fish (including those of conservation concern)
Potential nature of effect	Dredging operations would result in direct loss of habitat within the footprint of the works as well as areas upstream and downstream through any changes to hydrodynamics. These effects will be temporary and localised.
Likely duration	Construction and operation of the jetty.
Potential mitigation	Jetty design which limits footprint and the need for dredging where practicable. Best practice methods for dredging operations.
Receptor	Fish (including those of conservation concern)
Potential nature of effect	Dewatering operations and handling of fuels and chemicals onsite have the potential to lead to the release of pollutants/contaminants. Any effect on water quality has the potential to affect sensitive fish species such as smelt which are sensitive to changes in water quality.
Likely duration	Construction of the tunnel, and operation of the jetty
Potential mitigation	Preparation of CoCP outlining pollution prevention and surface water control measures to be implemented.
Receptor	Fish (including those of conservation concern)
Potential nature of effect	Dredging operations have the potential to result in sediment disturbance and the potential release of sediment bound chemicals. Any effect on water quality has the potential to adversely affect sensitive fish species such as smelt which are sensitive to changes in water quality.
Likely duration	Construction and operation of the jetty.
Potential mitigation	Jetty design which limits need for dredging where practicable. Best practice methods for dredging operations.

Item	Description
Receptor	Fish (including those of conservation concern)
Potential nature of effect	Potential disturbance effects from artificial lighting used during jetty construction and decommissioning. Result could be localised displacement of fish away from the jetty.
Likely duration	Jetty construction and decommissioning phases.
Potential mitigation	The jetty design will include a lighting plan which will also consider construction and decommissioning. The plan will be designed to include features such as directional lighting, consideration for times of use and so on.
Receptor	Marine mammals
Potential nature of effect	The construction activities have the potential to cause temporary disturbance to sensitive marine mammals through underwater noise and vibration resulting from piling operations for jetty construction, vessel movements and the effects from the TBMs during tunnel construction.
Likely duration	Jetty and tunnel construction phases.
Potential mitigation	Where possible, use of best practice techniques such as soft start and ramp-up will be used for piling operations.Vibro-piling is stated as the preferred method of construction with minimal impact piling.
Receptor	Marine mammals
Potential nature of effect	Dredging operations have the potential to result in sediment disturbance and the potential release of sediment-bound chemicals. Any effect on water quality has the potential to adversely affect mammal species.
Likely duration	Construction and operation of the jetty.
Potential mitigation	Jetty design which limits the need for dredging where practicable. Best practice methods for dredging operations.
Receptor	Marine mammals
Potential nature of effect	Potential disturbance effects from artificial lighting used during jetty construction and decommissioning. May result in localised displacement away from areas adjacent to the jetty.
Likely duration	Jetty construction and decommissioning phases.
Potential mitigation	The jetty design will include a lighting plan which will also consider construction and decommissioning. The plan will be designed to include features such as directional lighting and consideration with regard to times of operation.
Receptor	Marine mammals
Potential nature of effect	Potential adverse effects resulting from increased collision risk with vessels used during construction. The effects have the potential to harm marine mammals.
Likely duration	Jetty and tunnel construction phases.

Item	Description
Potential mitigation	No specific mitigation proposed. Construction vessels will be stationary or slow-moving. Marine mammals are highly mobile and so effects are considered unlikely.

Operation

The design of the Project will mean that tunnel dewatering flows are likely go to soakaways. Therefore, the operational impacts on marine biodiversity are beyond the scope of this assessment.

Chapter 11.

Geology and Soils

11 Geology and Soils

11.1 Introduction

11.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on geology and soils related to the construction and operation of the Project.

11.1.2 Geology and soils provide an important part of determining the environmental character of an area. Rocks provide the parent material which create soils and influence the type of vegetation that naturally occurs in an area or can be grown for agricultural purposes. Aquifers within the underlying geology provide us with vital drinking water and baseflow to the water environment and minerals are sustainable resources which can be utilised within the construction industry.

11.1.3 Road schemes can impact the geology and soils through the areas which they pass, but conversely the existing soil conditions from previous industrial use can impose constraints on a proposed development. The Government is committed to maintaining and protecting geology and soils receptors and, when possible, improving the quality by remediation of contaminated sites.

11.1.4 The aims of this chapter are to, in relation to geology and soils:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements, and describe how the Project will respond to them

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on geology and soils (and how these have been assessed for the purpose of this *PEIR*)

f. describes potential mitigation measures

11.1.5 There are expected to be interrelationships between the potential effects on geology and soils and other disciplines reported on in the *PEIR*. Please refer to:

a. Chapter 6: Air Quality

b. Chapter 7: Cultural Heritage

c. Chapter 9: Terrestrial Biodiversity

d. Chapter 12: Materials

e. Chapter 14: People and Communities

f. Chapter 15: Road Drainage and Water Environment

11.2 Planning policy and legislative requirements

Legislative requirements

11.2.1 The relevant legislation applicable to the geology and soils assessment of the Project is presented below:

Table 11.1 Legislative requirements

Legislation name	Summary of requirements
Town and Country Planning (Environmental Impact Assessment) Regulations 2017	Schedule 4, paragraph 4 states that the Environmental Statement (ES) should include: "A description of the factors specified in regulation 4(2) likely to be significantly affected by the development: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage including architectural and archaeological aspects, and landscape." Paragraph 5 states: "A description of the likely significant effects of the development on the environment resulting from, inter alia: (b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources; (d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);"
Environmental Protection Act 1990 including Part 2A	The Environmental Protection Act 1990 (EPA) defines, within England, Wales and Scotland, the fundamental structure and authority for waste management and control of emissions into the environment. The Act was intended to strengthen pollution controls and support enforcement with heavier penalties. Before the Act there had been separate environmental regulation of air, water and land pollution and the Act brought in an integrated scheme that would seek the "best practicable environmental option". Part 2A of the EPA (which was inserted into that Act by section 57 of the Environment Act 1995) contains a regulatory regime for the identification and remediation of contaminated land. In addition to the requirements contained in the primary legislation, operation of the regime is subject to regulations and statutory guidance. The main objective underlying the introduction of the Part 2A contaminated land regime was to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment, assessed in the context of the current use and circumstances of the land.

Legislation name	Summary of requirements
	The identification of contaminated land, as defined in Part 2A of the EPA, comprises a risk-based approach. For harm to the non-aquatic environment or pollution of controlled waters to occur, there must be a 'pollutant linkage'. This linkage is based on the following being present: • A source of contamination (hazard). • A pathway for the contaminant to move from source to receptor. • A receptor (target), which is affected by the contaminant. This includes humans, ecosystems, controlled waters, physical systems and built structures, which could be affected by the hazard.

National Planning Statement for National Networks

11.2.2 The NPSNN for the geology and soils assessment of the Project is presented below:

Table 11.2 NPSNN requirements and Project response

Requirement	Project response
5.22 "Where the project is subject to EIA the applicant should ensure that the environmental statement clearly sets out any likely significant effects on internationally, nationally and locally designated sites of ecological or geological conservation importance (including those outside England) on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity and that the statement considers the full range of potential impacts on ecosystems." 5.23 "The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interest."	The effects of the Project on soils will be assessed in the ES. Designated sites within the study area will be detailed and the likely effects assessed in the ES. Where possible the Project will demonstrate how it can take advantage of opportunities to conserve and enhance geological conservation interests.
5.25 "As a general principle, and subject to the specific policies below, development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives. The applicant may also wish to make use of biodiversity offsetting in devising compensation proposals to counteract any impacts on biodiversity which cannot be avoided or mitigated. Where significant harm cannot be avoided or mitigated, as a last resort, appropriate compensation measures should be sought."	The *PEIR* has included a preliminary assessment of the likely effects to geological receptors from the Project. A full assessment, along with the provision of mitigation measures will be provided in the ES.
5.168 "Applicants should also identify any effects, and seek to minimise impacts, on soil quality, taking into account any mitigation measures proposed. Where possible, developments should be on previously developed (brownfield) sites provided that	An intrusive investigation will be carried out to establish the soil quality and contamination levels especially in previously developed land. The effects relating to contamination encountered will

Requirement	Project response
it is not of high environmental value. For developments on previously developed land, applicants should ensure that they have considered the risk posed by land contamination and how it is proposed to address this."	be identified, the impacts assessed, and mitigation measures proposed. It is anticipated that there will be areas deemed to be brownfield land within the Development Boundary.
5.169 "Applicants should safeguard any mineral resources on the proposed site as far as possible." 5.182 "Where a proposed development has an impact on a Mineral Safeguarding Area (MSA), the Secretary of State should ensure that the applicant has put forward appropriate mitigation measures to safeguard mineral resources."	A mineral safeguarding assessment report will be prepared, and the findings discussed with relevant parties to determine a suitable approach aimed at minimising the effects on mineral resources within the Development Boundary.
5.116 "The effects of land instability may result in landslides, subsidence or ground heave. Failing to deal with this issue could cause harm to human health, local property and associated infrastructure, and the wider environment. They occur in different circumstances for different reasons and vary in their predictability and in their effect on development."	An intrusive site investigation will be carried out to establish ground conditions across the Project. The results will be used to inform ground instability and include mitigation within the design of the Project.
5.117 "Where necessary, land stability should be considered in respect of new development, as set out in the National Planning Policy Framework and supporting planning guidance. Specifically, proposals should be appropriate for the location, including preventing unacceptable risks from land instability. If land stability could be an issue, applicants should seek appropriate technical and environmental expert advice to assess the likely consequences of proposed developments on sites where subsidence, landslides and ground compression is known or suspected. Applicants should liaise with the Coal Authority if necessary."	An intrusive site investigation will be carried out to establish ground conditions across the Project. The results will be used to inform ground instability and include mitigation within the design of the Project.
5.118 "A preliminary assessment of ground instability should be carried out at the earliest possible stage before a detailed application for development consent is prepared. Applicants should ensure that any necessary investigations are undertaken to ascertain that their sites are and will remain stable or can be made so as part of the development. The site needs to be assessed in context of surrounding areas where subsidence, landslides and land compression could threaten the development during its anticipated life or damage neighbouring land or property. This could be in the form of a land stability or slope stability risk assessment report."	An intrusive site investigation will be carried out to establish ground conditions across the Project. The results will be used to inform ground instability and include mitigation within the design of the Project.
5.119 "Applicants have a range of mechanisms available to mitigate and minimise risks of land instability. These include:	An intrusive site investigation will be carried out to establish ground conditions across the Project The results will be used to inform ground instability and

Requirement	Project response
• Establishing the principle and layout of new development, for example avoiding mine entries and other hazards. • Ensuring proper design of structures to cope with any movement expected, and other hazards such as mine and/or ground gases; or • Requiring ground improvement techniques, usually involving the removal of poor material and its replacement with suitable inert and stable material. For development on land previously affected by mining activity, this may mean prior extraction of any remaining mineral resource."	include mitigation within the design of the Project.
4.48 "Issues relating to discharges or emissions from a proposed project which affect air quality, water quality, land quality and the marine environment, or which include noise and vibration, may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes. Relevant permissions will need to be obtained for any activities within the development that are regulated under those regimes before the activities can be operated."	Relevant legislative requirements will be captured in the ES.

Planning policy requirements

11.2.3 The planning policy applicable to the geology and soils assessment of the Project is presented below:

Table 11.3 Planning policy requirements

Policy name	Summary of requirement for this topic
Thurrock Local Development Framework – Core Strategy and Polices for Management of Development (as amended) Adopted January 2015	This document is the *Adopted Core Strategy and Policies for Management of Development for Thurrock*. The policies cover spatial development issues in relation to education, health, community safety, energy management, sustainable development, climate change and flood management. It also contains policies on more traditional but important planning activity such as housing, employment, leisure and sport, natural and historic environment and community facilities. Policy PMD1[20] covers Minimising Pollution and Impacts on Amenity, Health, Safety and the Natural Environment and states: "The Council will require assessments to accompany planning applications where it has reasonable grounds to believe that a development may suffer from, or cause: iii. Contaminated land/soil; vi. Water pollution; x. Ground instability;

[20] Policies for the Management of Development (PMD)

Policy name	Summary of requirement for this topic
	Where the assessment confirms such potential harm, planning permission will only be granted if satisfactory solutions can be achieved through design, or suitable mitigation measures can be put in place through conditions or a planning obligation. Where an assessment is not forthcoming the Council may refuse permission on a precautionary basis." Policy PMD7 covers Biodiversity, Geological Conservation and Development. This policy states:"1. Development proposals will be required to demonstrate that any significant biodiversity habitat or geological interest of recognised local value is retained and enhanced on-site. Where it can be demonstrated that this is not possible, and there is no suitable alternative site available for the development, developers will be required to show that their proposals would mitigate any loss of biodiversity or geological interest. In circumstances where it can be demonstrated that neither retention on site nor mitigation is possible, developers will be required to provide appropriate compensation for any significant loss of biodiversity or geological interest, such that there is no overall net loss of biodiversity habitat or features of geological conservation interest in Thurrock. The Council will seek to achieve net gains in biodiversity where such gains would be possible, with particular reference to the desirability of recreating priority habitats and the recovery of priority species. 2. The Council will not permit development that would result in the loss, or partial loss, of a locally designated biodiversity or geological site, except in exceptional circumstances where it can be demonstrated that there is no alternative, subject to the sequential approach outlined in (1) above. 3. To enable the Council to determine an application which would result in a loss of biodiversity or geological value, the developer will be required to submit a detailed justification setting out: i. why the loss is considered to be unavoidable ii. an assessment of what species and habitat would be lost or adversely affected as a result of development (including an ecological survey where appropriate) iii. how the loss or adverse effect is proposed to be mitigated onsite through habitat restoration or creation; and/or compensated for through the acquisition and management of a suitable site within the area, or a financial contribution towards the purchase and management of such a site or management of an existing site to bring it up to a necessary standard. 4. Thurrock Council will require development proposals to incorporate biodiversity or geological features into the design as far as possible. These may include green roofs, brown roofs and the creation of green corridors for wildlife. 5. Where it is necessary to secure the biodiversity or geological interest of a development site, the Council will seek the provision and implementation of a Biodiversity or Geological Management Plan." CSTP19 [21]– Biodiversity states: "5. Biodiversity and Geodiversity Action Plans I. The Council is committed to delivering the actions set out within the Thurrock, Essex and UK Biodiversity Action Plans. II. The Council will promote small-scale biodiversity interventions such as green roofs.

[21] Core Strategy Thematic Policies (CSTP)

Policy name	Summary of requirement for this topic
	III. The Council supports the production and implementation of the Geodiversity Action Plans being developed by local 'geo' groups in Eastern England as part of the East of England Geodiversity Partnership." CSTP32 – Safeguarding Minerals Resources states: "1. Mineral Safeguarding Area All site allocations for mineral extraction identified in the forthcoming Thurrock Local Plan will be based on the MSA to be identified in the forthcoming Thurrock Local Plan and on the Proposals Map. All areas identified in the MSA will be safeguarded from non-mineral related development. Applications for non-mineral related development on the site allocations will be assessed against the policies provided in the forthcoming Thurrock Local Plan. CSSP5 Sustainable Greengrid promotes productive land and natural system opportunities, which includes soils."
Gravesham Local Plan Core Strategy (Adopted Sept 2014)	No specific policies relating to contaminated land or geodiversity are included in the local plan.
London Borough of Havering, *Core Strategy and Development Control Policies Development Plan Document* (Adopted 2008)	This Core Strategy establishes the Council's vision for how the borough will look in 2020, and the objectives for delivering this. Relevant policies are detailed below. CP13 - MINERALS EXTRACTION Safeguarding Planning permission will not be granted for non-mineral development within the Minerals Safeguarding Area defined on the Proposals Map unless the applicant can demonstrate that: • the development will not sterilize the minerals resource within the timescale that the mineral is likely to be needed • the mineral concerned is no longer of any value or potential value • the minerals can be extracted prior to the development taking place and this does not render the site unsuitable for the proposed surface development • it is not practicable or economic to extract the minerals prior to the development taking place • in the Green Belt the development is required for agriculture, forestry or nature conservation or for open air recreation and would be otherwise acceptable in the Green Belt • there is an overriding need for the incompatible development. CP16 - BIODIVERSITY AND GEODIVERSITY The Council will seek to protect and enhance the borough's rich biodiversity and geodiversity, in particular, priority habitats, species and sites. It will increase public awareness and appreciation of biodiversity and will seek to put in place a strategic framework for the development and delivery of the London Riverside Conservation Park. CP15 - ENVIRONMENTAL MANAGEMENT To reduce their environmental impact and to address the causes and adapt to and mitigate the effects of climate change in their location, construction and use new development should:

Policy name	Summary of requirement for this topic
	• avoid an adverse impact on water quality • take the necessary measures to address contaminated land issues Major new development will be required to adopt high standards of sustainable construction and design and to incorporate on-site renewable energy equipment to reduce predicted CO_2 emissions in line with regional and national policy. DC53 - CONTAMINATED LAND Planning permission for development will only be granted where both of the following criteria are met: • where the development is on or near a site where contamination is known, or expected to exist, a full technical assessment of the site's physical stability, contamination and/or production of landfill gas must be undertaken. Where the assessment identifies an unacceptable risk to human health, flora or fauna or the water environment, the applicant will be required to agree acceptable long-term remediation measures before any planning permission is granted to ensure there is no future harm with regard to the future use of the site. Where feasible, on-site remediation, especially bio-remediation, is encouraged • the development does not lead to future contamination of the land in and around the site. DC58 - BIODIVERSITY AND GEODIVERSITY Biodiversity and geodiversity will be protected and enhanced throughout the borough by: • protecting and enhancing Sites of Special Scientific Interest, and all sites of Metropolitan, Borough or Local Importance for Nature Conservation as identified in Protecting the Borough's Biodiversity Supplementary Planning Document and shown on the Proposals Map. Planning permission for development that adversely affects any of these sites will not be granted unless the economic or social benefits of the proposals clearly outweigh the nature conservation importance of the site and only then if adequate mitigation can be provided and no alternative site is available • not granting planning permissions which would adversely affect priority species/habitats identified in either the London or Havering Biodiversity Action Plans unless the economic or social benefits of the proposals clearly outweigh the nature conservation importance of the site and only then if adequate mitigation measures to secure the protection of the species/habitat can be provided and no alternative site is available • protecting and promoting the linking of habitats via the wildlife corridors shown in figure 4 (page 83) • protecting the individual quality and character of, and promoting access to, each Countryside Conservation Area shown on the Proposals Map • protecting and enhancing the biodiversity of the Blue Ribbon Network including rivers and their associated corridors. DC59 - BIODIVERSITY IN NEW DEVELOPMENTS Enhancements to biodiversity and geodiversity will be sought, in line with London and Havering Biodiversity Action Plan targets, as an integral part of new development.

Policy name	Summary of requirement for this topic
Medway Local Plan (Adopted 14 May 2003)	This sets out the policies and proposals for the control and regulation of development within Medway, both general and site specific, and the reasons for them. POLICY BNE23: CONTAMINATED LAND Development on land known or likely to be contaminated or affected by adjacent or related contamination must be accompanied by the findings of a detailed site examination to identify contaminants and the risks that these might present to human health and the wider environment. Appropriate measures to reduce, or eliminate, risk to building structures, services and occupiers of the site and of adjoining sites must be agreed. Such remedial measures must be satisfactorily implemented before the development is occupied.
Brentwood Replacement Local Plan (adopted August 2005)	PC1 Land Contaminated by Hazardous Substances Where development is proposed on land which is suspected of being contaminated by hazardous substances arising out of previous land uses such as industry, gas works, waste tips or landfill sites, an environmental survey assessing the nature and extent of the contamination will be required to accompany the application. Where appropriate, development will only be permitted where the applicant can ensure, to the council's satisfaction, that the land is capable of being decontaminated and reclaimed for beneficial use in accordance with an agreed remediation and validation scheme prior to the grant of planning permission; and appropriate measures to deal with contamination of the development site are undertaken before the implementation of any planning permission.
Kent Minerals and Waste Local Plan 2013-30 (adopted July 2016)	Policy DM7 Safeguarding Mineral Resources Planning permission will only be granted for non-mineral development that is incompatible with minerals safeguarding, where it is demonstrated that either: 1. the mineral is not of economic value or does not exist; or 2. that extraction of the mineral would not be viable or practicable; or 3. the mineral can be extracted satisfactorily, having regard to Policy DM9, prior to the non-minerals development taking place without adversely affecting the viability or deliverability of the non-minerals development; or 4. the incompatible development is of a temporary nature that can be completed and the site returned to a condition that does not prevent mineral extraction within the timescale that the mineral is likely to be needed; or 5. material considerations indicate that the need for the development overrides the presumption for mineral safeguarding such that sterilisation of the mineral can be permitted following the exploration of opportunities for prior extraction; or 6. it constitutes development that is exempt from mineral safeguarding policy, namely house holder applications, infill development of a minor nature in existing built up areas, advertisement applications, reserved matters applications, minor extensions and changes of use of buildings, minor works, non-material amendments to current planning permissions; or 7. it constitutes development on a site allocated in the adopted development plan
Essex Minerals Local Plan (Adopted July 2014)	Policy S8- Safeguarding mineral resources and mineral reserves By applying Mineral Safeguarding Areas (MSAs) and/or Mineral Consultation Areas (MCAs), the Mineral Planning Authority will safeguard mineral resources of national and local importance from surface development that would sterilise

Policy name	Summary of requirement for this topic
	a significant economic resource or prejudice the effective working of a permitted mineral reserve, Preferred or Reserve Site allocation within the Minerals Local Plan. The Minerals Planning Authority shall be consulted, and its views taken into account, on proposed developments within MSAs and MCAs except for the excluded development identified in Appendix 5. Mineral Safeguarding Areas Mineral Safeguarding Areas are designated for mineral deposits of sand and gravel, silica sand, chalk, brickearth and brick clay considered to be of national and local importance, as defined on the Policies Map. The Mineral Planning Authority shall be consulted on: a) all planning applications for development on a site located within an MSA that is 5ha or more for sand and gravel, 3ha or more for chalk and greater than 1 dwelling for brickearth or brick clay; and b) any land-use policy, proposal or allocation relating to land within an MSA being considered by the Local Planning Authority for possible development as part of preparing a Local Plan (with regard to the above thresholds). Non-mineral proposals that exceed these thresholds shall be supported by a minerals resource assessment to establish the existence or otherwise of a mineral resource of economic importance. If, in the opinion of the Local Planning Authority, surface development should be permitted, consideration shall be given to the prior extraction of existing minerals. Mineral Consultation Areas MCAs are designated within and up to an area of 250 metres from each safeguarded permitted minerals development and Preferred and Reserve Site allocation as shown on the Policies Map. The Mineral Planning Authority shall be consulted on: a) Any planning application for development on a site located within an MCA except for the excluded development identified in Appendix 5, b) Any land-use policy, proposal or allocation relating to land within an MCA that is being considered as part of preparing a Local Plan Proposals which would unnecessarily sterilise mineral resources or conflict with the effective workings of permitted minerals development, Preferred or Reserve Mineral Site allocation shall be opposed.

11.3 Methodology

11.3.1 The assessment methodology is comprised of the collection of available baseline information and site surveys to gather data to characterise the underlying ground conditions across the Project. The approach is consistent with the methodology drawn from Volume 11, Section 3, Part 11 of the *Design Manual for Roads and Bridges* (Highways Agency, 2009).

11.3.2 Baseline information about the existing environmental conditions has been compiled from the following sources:

a. *Potential Sources Study Report* (*PSSR*) (Highways England, 2016)

b. historical borehole logs and geological maps from British Geological Survey (BGS) and recent ground investigation information (where available)

c. information on important geological sites from Joint Nature Conservation Committee (JNCC) Geological Conservation Review Database, Natural England/MAGIC websites and local sites such as the Essex Field Club and Geological Conservation Kent

d. aquifer designation maps obtained from the Environment Agency (EA)

e. landfill data obtained from various sources including the EA, local landfill operators (eg, Veolia Environmental Services), local councils and BGS (information contained in the PSSR)

f. pollution incident data from the EA and Landmark

g. mineral safeguarding information from local authorities

h. unexploded Ordnance (UXO) data from Zetica (Zetica UXO, 2017)

i. LandIS Soil Site Reports, purchased from The National Soil Resources Institute

j. *Soils of Kent* (Fordham and Green, 1980)

11.3.3 Preliminary site walkover surveys have been conducted which focused on areas of potential interest to geology, soils and potentially contaminated land as identified by the desk-based research.

11.3.4 The study area for the field and desk-based assessment includes the land within the Development Boundary, plus a buffer zone of 250m. The Development Boundary includes all the temporary laydown and construction areas and permanent land take required for the Project.

11.3.5 The study area has been defined to reflect the surrounding geological and environmental features (eg, landfill sites) and the distance over which significant effects can reasonably be thought to have the potential to occur.

11.4 Existing environmental conditions

11.4.1 For this chapter, three design areas have been used to present the baseline information; south of the River Thames, tunnel and north of the River Thames. The design areas cover the following elements:

a. south of the River Thames includes from the A2 to the south portal

b. tunnel includes the south portal, tunnel and the north portal

c. north of the River Thames includes from the north portal to the M25 junction 29.

Geology

11.4.2 A PSSR has been prepared during the options assessment phase (Highways England, 2016). This report provides geological and ground condition

information across the study area. Relevant information has been taken from the PSSR and amended with recent ground investigation data where available.

Generalised geological succession

11.4.3 The generalised geological succession of the area is detailed in Table 11.24 – Table 11.4, which has been divided into the sections as detailed above.

11.4.4 It should be noted that for Table 11.24 – Table 11.4, the stratigraphy and thicknesses quoted have been extrapolated from available historical BGS borehole logs and the geological maps. For Table 11.24 – Table 11.4, the stratigraphy and thicknesses quoted have been extrapolated from available historical BGS borehole logs and the geological maps.

11.4.5 The distribution of the solid and drift deposits is shown in Figures 11.1 and 11.2 in Volume 3. Geological cross-sections are being prepared based on recent site investigation data and historical BGS borehole logs and will be included in the ES.

South of the River Thames

Table 11.4 General geological succession – south of the River Thames

Formation period/series/group	General description	Estimated stratigraphical thickness
General Made Ground	Likely to be associated with infrastructure earthworks and previously developed areas (eg, the A2 and former Gravesend military airport).	0.5–3m
Head (Quaternary/Pleistocene)	Undifferentiated, pebbly sandy clay; some gravel.	1–10m
London Clay (Palaeogene/Eocene/ Thames Group)	Dark bluish to brownish grey clay, containing variable amounts of fine-grained sand and silt.	1–10m
Harwich Formation (Palaeogene/Eocene/ Thames Group)	Cross-bedded shelly sand (the Oldhaven Beds) with a basal pebble bed.	10–15m
Lambeth Group Woolwich Formation (Upnor Formation) (Palaeogene/Palaeocene/ Lambeth Group)	The upper beds are clay with shells, ferruginous sand, lignitic sand and lignite. The lower beds are coarse sand with pale grey clay partings and coarse gravel of black flint.	10–15m
Thanet Sand Formation (Thanet Sand) (Palaeogene/Palaeocene/ Lambeth Group)	Greenish to brownish grey silty, fine-grained sand, clayey and siltier in the lower part, with a conglomerate of flint pebbles and nodular flints at the base.	10–30m

Formation period/series/group	General description	Estimated stratigraphical thickness
Seaford Chalk Formation (Cretaceous/Upper Cretaceous/White Chalk Subgroup)	Fossiliferous nodular chalk with bands of nodular flints, hardgrounds and marl seams.	Not proven, but estimated to be up to 70m thick

11.4.6 The bedrock geology underlying the area comprises the White Chalk which outcrops at the surface.

11.4.7 Overlying the White Chalk, the high ground around the A2 link road from Cobham through the Shorne Wood Country Park to Higham comprises the London Clay Formation underlain by the Harwich Formations at the highest parts, which unconformably overlays the Lambeth Group and Thanet Formation. The geological maps show that the London Clay Formation has been worked near Shorne Wood.

11.4.8 The land generally falls from the A2 road towards the River Thames and marshes to the north. Head Deposits are found in localised outcrops overlying the White Chalk on the lower parts of the hillsides.

Tunnel

Table 11.5 General geological succession – tunnel

Formation period/series/group	General description	Estimated stratigraphical thickness
General Made Ground	Likely to be associated with the development of the North Kent Railway Line, flood defences and Medway Canal.	0.5–2m
Made Ground (Landfill)	Made Ground associated with Filborough Landfill on the southern side of the river and Goshems Farm historical landfill site, Pulverised Fuel Ash (PFA) landfills and land raising activities on the northern side of the river.	6–8m
Topsoil and Head (Quaternary/ Pleistocene)	Clays and silts.	1–8m
Alluvium (Quaternary/ Holocene)	Marine and Estuarine Alluvium. Silt and clay with lenses and beds of peat, and seams of sand and gravel.	3–20m
River Terrace Gravels (Taplow Gravel) (Quaternary/ Pleistocene)	River Terrace Deposits (Gravel, sandy and clayey in part).	5–8m

Formation period/series/ group	General description	Estimated stratigraphical thickness
Seaford Chalk Formation (Cretaceous/ Upper Cretaceous /White Chalk subgroup)	Fossiliferous nodular chalk with bands of nodular flints, hardgrounds and marl seams.	Not proven, but estimated to be up to 70m thick

11.4.9 Around the south portal, Head Deposits are encountered overlying the White Chalk. Made Ground is known to be present associated with the North Kent Railway and Medway Canal.

11.4.10 On the northern side of the Thames, Made Ground (Landfill) of up to approximately 8m thickness has been encountered which is associated with Goshems Farm Landfill area and PFA landfills (see paragraph 11.4.899), including at the north portal.

11.4.11 In the low-lying marshes on either side of the River Thames and beneath the River Thames Channel the geology consists of Alluvium overlying River Terrace Deposits overlying the White Chalk.

11.4.12 Depths of the Alluvium have been found to range from 3 to 20m in the marshes on either side of the River Thames and thin out to approximately 3m thick within the River Thames Channel. Within the Alluvium, pockets of amorphous and pseudo-fibrous peat were identified. The G*eology of London special memoir* (BGS, 2004) notes that the total thicknesses of peat beds exceeds 2m in large areas between the confluence of the rivers Thames, Lea and Tilbury. Organic rich peat naturally decays and releases ground gases during this process, which could lead to a potential ground gas risk in these areas.

11.4.13 River Terrace Deposits are present beneath the Alluvium in the marshes on either side of the Thames and beneath the River Thames Channel. These are generally found to be 5–8m thick.

North of River Thames

Table 11.6 General geological succession – north of River Thames

Formation period/series/ group	General description	Estimated stratigraphical thickness
General Made Ground	Made Ground associated with developed/built up areas.	0.5–2m
Made Ground (Landfill)	Made Ground (Landfill) on the northern side of the River Thames associated with historical and current landfill sites along the Project (See sections 11.4.93 and 11.4.92).	6–8m
Alluvium (Quaternary/ Holocene)	Marine and Estuarine Alluvium.	1–20m

Formation period/series/ group	General description	Estimated stratigraphical thickness
	Silt and clay with lenses and beds of peat, and seams of sand and gravel.	
Head Deposits (Quaternary/Pleistocene) River Terrace Gravels (Taplow Gravel, Lynch Hill Gravel, Boyn Hill Gravel, Black Park Gravel, Kempton Park Gravel) (Quaternary/Pleistocene)	Undifferentiated, pebbly sandy clay; some gravel. River Terrace Deposits – gravel, sandy and clayey in part.	1–5m 1–20m
London Clay Formation (Palaeogene/ Eocene/Thames Group) Harwich Formation (Palaeogene/ Eocene/Thames Group)	Dark bluish to brownish grey clay, containing variable amounts of fine-grained sand and silt. Cross-bedded shelly sand (the Oldhaven Beds) with a basal pebble bed.	Up to 150m 0–12m
Lambeth Group (Woolwich Formation, Upnor Formation) (Palaeogene/ Palaeocene/ Lambeth Group) Thanet Formation (Thanet Sand) (Palaeogene/ Palaeocene/Lambeth Group)	The upper beds are clay with shells, ferruginous sand, lignitic sand and lignite. The lower beds are coarse sand with pale grey clay partings and coarse gravel of black flint. Greenish to brownish grey silty, fine-grained sand, clayey and siltier in the lower part, with a conglomerate of flint pebbles and nodular flints at the base.	5–20m Up to 32m
Seaford Chalk Formation (Cretaceous/Upper Cretaceous/White Chalk Subgroup)	Fossiliferous nodular chalk with bands of nodular flints, hardgrounds and marl seams.	Up to 70m

11.4.14 General Made Ground is anticipated to be present on the northern side of the River Thames associated with previous and current developed areas and various light industrial activities. Low Street Brickworks historical landfill is present adjacent to the north of the Tilbury Loop Railway Line. In this location the Alluvium overlies River Terrace Deposits which overlie the White Chalk.

11.4.15 Further to the north the land slopes up from the River Thames Valley and the East Tilbury Marshes. Here the Thanet Sand Formation unconformably overlies the White Chalk.

11.4.16 Adjacent to the north of the A13 junction there is Made Ground/landfill associated with Millers Sand and Gravel Pits historical landfill site (see section 11.4.966). Around the A13 the geology is topography related, with River Terrace Deposits overlying the Lambeth Group on the highest ground. Underlying the Lambeth Group is the Thanet Formation which in turn is underlain by the White Chalk.

11.4.17 On the lower slopes of the hills, the Thanet Formation is generally overlain by River Terrace Deposits and outcrops in places. Head Deposits generally occur lower down on the hill sides. The Black Park Gravel Member is located to the south of the A13.

11.4.18 From Orsett northwards the geology comprises Head Deposits, Alluvium and River Terrace Deposits (Lynch Hill Gravel) overlying the London Clay Formation.

11.4.19 The Alluvium deposits follow the location of the Mardyke River and increase in width as the river valley moves northwards. From the A127 following the Mardyke River Valley, Head Deposits are the predominant Quaternary superficial deposits above the London Clay Formation.

11.4.20 The Head Deposits are present on the gently sloping valley sides from the Upminster-Grays Railway Line in the west to beyond Bulphan in the east. In the centre of the Mardyke River Valley and along the various subsidiary channels there are extensive deposits of Alluvium. River Terrace Deposits (Boyn Hill Gravel) are also present overlying the London Clay Formation in the North and South Ockendon area.

11.4.21 In localised areas no superficial deposits are present and there are outcrops of London Clay at the ground surface.

11.4.22 There are many old clay pits within the London Clay Formation. These old clay pits are shown on BGS maps as Worked Ground and Made Ground (described as wholly or partly backfilled pits). Between Ockendon and the M25 junction there is Made Ground (Landfill) associated with the Ockendon Landfill Complex (see section 11.4.977) and at Hall Farm and Groves Farm there are historical landfill sites (see section 11.4.988).

Geological conservation review

11.4.23 The JNCC Geological Conservation Review database has been studied for features such as geological Sites of Special Scientific Interest (SSSIs), and there are no entries identified within the study area. This is confirmed on the Natural England and MAGIC online viewers.

Local geological sites

11.4.24 The Essex Field Club website and Geological Conservation Kent website were used to research local geographical sites of importance.

11.4.25 Features identified within study area are detailed in the table below and shown on Figure 11.3 in Volume 3.

Table 11.7 Local geological sites

Site name	Approximate location and National Grid Reference (NGR)	Description
South of River Thames	No local geological sites identified	-
Tunnel	No local geological sites identified	-
North of River Thames		
Low Street Pit, Station Road, West Tilbury, Thurrock,	Adjacent to east of Development Boundary NGR: TQ672775	Potential local geological site. former sand and gravel pit which has been excavated down to the Thanet Sand which is exposed on the pit floor. Currently wooded and designated as a local wildlife site.
West Tilbury Wells	Just outside the western Development Boundary. NGR: TQ660777	Historical site. Medicinal spring or well.
East Tilbury Marshes, Thurrock	Just outside the eastern Development Boundary. NGR: TQ688784	General geological site. East Tilbury Marshes Gravel, which underlies the Alluvium of the modern Thames floodplain. Extensively quarried at East Tilbury. These quarries are the only exposure of this gravel, which was deposited by the Thames when it was a large, braided river flowing across a wide floodplain during a period of cold climate.
Turners Farm Gravel Pit, Mucking, Thurrock	NGR: TQ677801	Potential local geological site. Disused gravel pit with fine vertical exposures of Mucking Gravel.
Orsett Cock Quarry	South of A13 NGR: TQ655811	Potential local geological site. Excellent exposures of the pebble beds of the Upnor Formation. It is the best inland exposure of this particular formation.

Site name	Approximate location and National Grid Reference (NGR)	Description
Orsett Depot Quarry	South of A13 NGR: TQ656809	Historical site. A large disused sand and gravel pit formerly providing excellent exposures on the faces.
Ockendon Clay Plant (Grange Farm Clay Pits), South Ockendon, Thurrock	South of proposed route near Ockendon Landfill Complex NGR: TQ609839	Historical site. London Clay has been worked at South Ockendon since at least 1930. The clay exposed was the lower part of the London Clay formation. The pits are private property and there is no public access.
Cranham	East of M25 junction 29 NGR: TQ580884	General information. Temporary exposures of London Clay.
Upminster Brickworks (site of), Upminster, London Borough of Havering,	South of A127 NGR: TQ568889	Historical site. Two pits were in operation – a southern pit with well-laminated brickearth and a northern pit (north of Bird Lane) in London Clay. At the base of the brickearth in the southern pit was Boulder Clay or Till.
Hall Lane Road Cutting (A127), Upminster, London Borough of Havering,	On route of Southend Arterial Road NGR: TQ565890	Historical site. The road cutting on the eastern side of the valley shows gravel, sand and silt overlying chalky Till, or Boulder Clay. The London Clay here forms the base of the section and in places several steep-sided 'channels' cut in to the clay could be seen which were lined with chalky Till and infilled with disturbed gravel.

Site name	Approximate location and National Grid Reference (NGR)	Description
Coombe Green Sand Pit	East of M25 near Coombe Green NGR: TQ57669045	Shallow overgrown sand pit which has a very small exposure of typically fine-grained Bagshot Sand (extremely rare in Essex).

11.4.26 The local geological sites detailed above are either considered to be historical sites or potential geological sites. None of the sites have been formally designated. Additional information regarding the above sites will be obtained and reviewed within the ES.

Hydrology

11.4.27 A full description of hydrological features is included in Chapter 15: Road Drainage and Water Environment. However, to give context on how these receptors relate to contaminated land, pertinent details are included below for information.

South of the River Thames

11.4.28 There are no significant surface water features identified.

Tunnel

11.4.29 The main watercourse is the Thames which crosses the Project in a roughly east to west route.

11.4.30 The Shorne Marshes are located on the southern side of the Thames. This area is drained by a network of man-made channels which discharge into the Thames. The disused and partially infilled Thames and Medway Canal crosses the Project to the south of the Shorne Marsh area.

11.4.31 To the north of the Thames, several artificial drainage ditches are identified which are associated with Goshems Farm historical landfill site and Tilbury Power Station. Further information is included within the site walkover survey details in Appendix H.1 in Volume 2.

11.4.32 Ditches associated with the Tilbury Main are located between Goshems Farm historical landfill site and East Tilbury historical landfill site. They flow south before discharging into the Thames.

North of River Thames

11.4.33 To the north of the Tilbury Loop Railway Line, a pond was identified during the site walkover survey on farmland to the north of the railway which was said (by anecdotal evidence) to be groundwater fed.

11.4.34 Further to the north several drainage ditches are present between the A13 and the M25 junction 29.

11.4.35 The Mardyke River and associated tributaries are present to the north of the A13.

Hydrogeology

11.4.36 A full description of hydrogeological features is included in Chapter 15: Road Drainage and Water Environment. However, to give context on how these receptors and potential pathways relate to contaminated land, relevant details are included below for information.

Aquifer status

11.4.37 The Project's Geographic Information Systems (GIS), using information obtained from the EA, shows the location of aquifers, groundwater Source Protection Zones (SPZ) and abstraction licences. These aquifers are summarised in Table 11.8 and information gathered in relation to them will be used to assess the potential impacts from contaminated land to groundwater.

Table 11.8 Aquifer status

Geological formation	Aquifer status
Superficial aquifers	
Alluvium	Secondary undifferentiated[22]
Head Deposits	Secondary undifferentiated
River Terrace Gravels	Secondary A[23]
Bedrock aquifers	
London Clay	Unproductive[24]
Lambeth Group	Secondary A
Thanet Formation	Secondary A
Chalk	Principal[25]

South of the River Thames

11.4.38 The White Chalk is a Principal aquifer in this area which outcrops to the surface in places. The Thanet Sand and Harwich Formation which overlie the Chalk in places are Secondary A aquifers.

Tunnel

11.4.39 In the Thames valley, the hydrogeology is influenced by the River Thames. There is a high probability of hydraulic continuity of river water with the River Terrace Gravels aquifer and the Chalk aquifer, with tidally fluctuating water levels expected in both strata. The White Chalk is the Principal aquifer in this

[22] This classification has been assigned in cases where it has not been possible to attribute either category Secondary A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
[23] Permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.
[24] These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
[25] These are rocks or drift deposits that have a high intergranular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

area, overlain by the Alluvium which is a Secondary (undifferentiated) aquifer and River Terrace Deposits which are Secondary A aquifers.

North of the River Thames

11.4.40 To the north of the River Thames, superficial aquifer groundwater levels are likely to be shallow comprising a perched water body especially when underlain by low permeability bedrock (London Clay Formation or Lambeth Group). Hydraulic connection with surface water bodies may also influence superficial groundwater levels especially near the Mardyke River and locally near flooded former gravel pits such as the pond noted at Ockendon Landfill Complex. Head Deposits comprise a widespread secondary undifferentiated superficial aquifer north of the A13 although their lithology is likely to be of clay and therefore generally not water bearing.

11.4.41 The Secondary A aquifers (Thanet Formation and Lambeth Group) are the dominant aquifers near the A13 and to the north of the River Thames valley. Perched water is anticipated in the Lambeth Group due to interlayering of fine sands, silts and clays but may also be influenced by regional piezometric levels where deeper. A regionally influenced water table is likely in the Thanet Formation. Similar piezometric levels to the underlying Chalk aquifer will occur in any areas where the aquifers are in hydraulic continuity.

Source Protection Zones and abstractions

11.4.42 Full details of the locations of the SPZ and abstraction points are detailed in Chapter 15: Road Drainage and Water Environment and shown in Figure 15.5 in Volume 3. Relevant details are included below and will be used in the assessment of contaminated land and included in the ES.

South of the River Thames

11.4.43 The SPZ 3 crosses the study area on the eastern and western extents of the A2.

11.4.44 A previously unidentified groundwater abstraction well (unlicensed) is present at Southern Valley Golf Course.

Tunnel

11.4.45 There are no SPZ or groundwater abstraction licences within the study area.

North of the River Thames

11.4.46 The Project crosses the SPZ 2 (outer) and SPZ 3 (total catchment) in the locality of Linford. The SPZ 1 (inner zone) is located to the east centred on Linford.

11.4.47 There are five groundwater abstraction points located within the study area. Three are in the SPZ 3 to the south of Linford and the other four are to the north of the A13 near Orsett Fen.

Site walkover surveys

11.4.48 Preliminary site walkover surveys were carried out by appropriately qualified staff between July 2017 and October 2017. The objectives of the surveys were

to gather information on existing site conditions within the Development Boundary and to inform the planning of the ground investigation.

11.4.49 It was not the objective of the site walkover to visit the entire route, but to focus on areas of potential interest in relation to geology, soils and potentially contaminated land, as identified by the PSSR.

11.4.50 Access to conduct the surveys was limited to Public Rights of Way and areas where access had been agreed with third-party landowners. At the request of the landowners, access and observations of farmland with crops were generally made from the site boundary and existing farm tracks where present.

11.4.51 The condition of existing roads, earthworks and structures was not inspected during any of the walkover surveys.

11.4.52 The key observations noted during the surveys are summarised in the following sections and presented in Figure 11.4 in Volume 3. Table H.1 to H.3 in Appendix H in Volume 2 provides a full description of observations recorded during the site walkover survey, along with photographs.

South of the River Thames

11.4.53 The area around the proposed Project route/A2 junction to Gravesend link includes a highway maintenance depot and Singlewell Maintenance depot which is on the High-Speed Rail (HS1) route from London to Folkestone. Fly tipping was noted adjacent to a public footpath.

11.4.54 Between the A2 Trunk Road and Thong Lane evidence of a former road was identified, potentially associated with the former RAF Gravesend airfield. Evidence of buried services (gas main and sewerage) and fly tipping were noted along the road.

11.4.55 Further to the north on the eastern side of Thong Lane, Hartshill Nursery (which houses Bayliss Landscape Contractors) is located on the site of a former quarry. Potential sources of contamination were identified such as fuel tanks and waste materials.

11.4.56 Southern Valley Golf Club is located on the eastern side of Thong Lane. Anecdotal evidence indicates that the golf club may have been landscaped using Made Ground and fill excavated during the construction of Bluewater Shopping Centre which was a former chalk pit/quarry on A2. The golf course was part of the former RAF Gravesend, a World War 2 (WW2) airfield.

11.4.57 No evidence of the former quarries that were present historically on Thong Lane was found.

Tunnel

11.4.58 On Lower Higham Road there is a foam concrete cement works at the location of Filborough Farm historical landfill site (see paragraph 11.4.88). Fly tipped construction waste was noted at a layby on Lower Higham Road and on a public footpath.

11.4.59 At Shorne Marshes, further to the north, several drainage ditches and ponds are present.

11.4.60 To the north of Shorne Marshes is the North Kent Railway Line adjacent to the Thames and Medway Canal which has been partially infilled. Milton Rifle Range

(currently part of the Metropolitan Police training facility) is adjacent to the south bank of the Thames, as well as a large electricity substation.

11.4.61 North of the Thames and around the north portal there is a large area of land raising and filling being carried out by Ingrebourne Valley Limited. This area is mainly a landfill site (Goshems Farm Historical Landfill Site) with smaller areas of PFA 'ashfields' from the adjacent Tilbury Power Station.

11.4.62 The former Tilbury Power Station is located approximately 450m to the west of the Development Boundary. There are associated areas of historic PFA landfill, some of which have been capped and revegetated and others which have been recently uncapped to allow mining for construction materials. A waterlogged area was noted along with drainage ditches of stagnant appearance. Tilbury Power Station was in the process of being demolished at the time of the walkover. To the west of Goshems Farm there is East Tilbury landfill site; however, this was not visited during the site walkover survey.

North of River Thames

11.4.63 Around the proposed Tilbury junction there is farmland which is bisected by the Tilbury Loop Railway Line.

11.4.64 To the north of Muckingford Road there is an active sand and gravel extraction quarry in which un-bunded fuel tanks storage and waste skips were sited directly on the ground.

11.4.65 Adjacent to the north of the Tilbury Loop Railway Line there is Low Street historical landfill site which is currently used for lorry turning and skip storage for the adjacent scrap metal yard. The scrap metal yard carries out processing and recycling of scrap metal from local activity such as the dismantled Tilbury Power Station. Fly tipping was noted on Low Street Lane.

11.4.66 Further to the north in Orsett, there is the Orsett Golf Club which is adjacent to a sand and gravel extraction quarry. The quarry was noted to be in a disused and overgrown state.

11.4.67 Dansand Quarry is located on the southern side of the A13 junction, which is used for sand and gravel extraction and stockpiling and recycling soil, construction and road materials.

11.4.68 Adjacent to the north of the A13 junction there is a former landfill site which is adjacent to a former works (now Baker Street housing estate). No evidence of the landfill or works was apparent.

11.4.69 Further to the north around the Ockendon link there is the Ockendon Landfill Complex (operated by Veolia) which comprises areas of active and historic landfill. A pond was noted in this area.

11.4.70 Further to the north at the M25 junction there is agricultural land bisected by the Upminster Grays Railway Line. There is evidence of fly tipping on fields adjacent to Ockendon Road. There is a fishing lake which is assumed to be artificial.

11.4.71 Along the B187 road there are several light industrial activities such as an industrial estate and scrap metal works.

Historical development

11.4.72 A detailed desk-based study is being prepared which will include a review of historical Ordnance Survey maps and aerial photographs. This will be reviewed as part of the ES. The following has been summarised from the existing Options Phase PSSR.

South of the River Thames

11.4.73 This area is mainly rural in nature and dominated by the urban development of Gravesend to the west of the Project. In the 1920s and 1930s major improvements to the A2 between Dartford and Gravesend were made. The A2 was formerly known as Watling Street, a Roman road that is now buried beneath the A2 trunk road. This was upgraded during the 1950s to a dual carriageway and further expanded and realigned during the 1970s.

11.4.74 HS1 was constructed alongside the A2 and M2 in 2002. Following the construction of HS1, the A2 was diverted to run alongside the railway between Ebbsfleet and Cobham.

11.4.75 Gravesend developed significantly during the twentieth century, extending eastwards up to Thong Lane and the area known as Chalk.

11.4.76 Gravesend military airport was present to the west of Thong Lane between circa 1932 to 1956 when it was partially redeveloped into a housing estate and a golf course.

Tunnel

11.4.77 The Thames and Medway Canal was constructed between 1804 and 1824. Circa 1846 the North Kent Railway was constructed alongside the canal.

11.4.78 Adjacent to the south of the Thames is the Milton Rifle Range which was constructed circa 1860 and is now used by the Metropolitan Police.

North of the River Thames

11.4.79 Before the 1900s the area was predominantly rural. Throughout the area there are several historic fortifications and buildings. In 1856 the London, Tilbury and Southend Railway was constructed. This included a loop line via Tilbury just north of the Thames and the main line running through West Horndon towards the north end of the study area. The Upminster-Grays single line branch, constructed in 1892–1893, passes under the M25, through South Ockendon and over the A13.

11.4.80 The villages of East Tilbury, Chadwell St Mary and the Port of Tilbury expanded considerably during the twentieth century.

11.4.81 During WW2, two groups of anti-aircraft gun emplacements with connecting roads were constructed near East Tilbury and were in use up to the 1950s. It is also reported there were anti-glider trenches and gun emplacements located in Tilbury Marshes.

11.4.82 During the 1980s, the A13 and A1089 (Tilbury Port access road), were constructed among many other local road upgrades. In 1947 Tilbury A Power Station was constructed alongside the Thames to the west with Tilbury B added

in 1969. Adjacent land to the east of the power station was used to dispose of the ash (PFA) generated.

11.4.83 Extraction of sand and gravel between the Thames and the A13 took place extensively during the second half of the 20th century. At the same time, near South Ockendon, several clay pits were excavated to support the cement industry.

Landfills

11.4.84 There are several landfills, both historic and active, within 250m of the Development Boundary. Full details are in Appendix G in Volume 2 and the locations are shown on Figure 11.5 in Volume 3. The landfill figure has been developed through collation of information from the desk-based study records as detailed in the PSSR.

11.4.85 Key landfills within the study area are summarised below. It should be noted that there may be unrecorded or pre-1947 Planning Act landfill sites such as infilled quarries which may not have been detailed in EA data or local authority data, and therefore may not have been captured at this stage.

11.4.86 The landfill status will be reviewed during the preparation of the ES.

South of the River Thames

11.4.87 No landfills have been identified in the study area around the A2 junction. The Gravesend link has three known decommissioned quarries along the route (along Thong Lane) that may have been infilled and could present a settlement risk and/or contain contaminative or gassing materials. No evidence of the quarries was observed during the site walkover survey.

Tunnel

11.4.88 A small historic landfill site (Filborough Farm) is located to the north of Lower Higham Road. This received inert and commercial waste until 1991. As identified during the site walkover survey, this is now the location of a foam concrete cement works (see paragraph 11.4.588).

11.4.89 A large area of historic landfilling (Goshems Farm) situated at the north portal. It is understood that the landfill ceased accepting waste in 1958 (start date is known), although it is currently undergoing permitted capping and land raise operations. It is understood that there may be waste including household and refuse ash (PFA) deposited between 6 and 8m thickness.

11.4.90 Immediately north and west of Goshems Farm Landfill, PFA originating from Tilbury Power Station is known to have been deposited at the surface with an estimated thickness of approximately 3m. Anecdotal evidence obtained during the site walkover indicated that areas of the PFA landfill had been recently excavated for construction materials, while other areas remain capped and grassed over.

11.4.91 According to anecdotal evidence, historically re-excavated PFA has been found to contain additional contaminative contents illegally tipped within it, such as asbestos.

11.4.92 East Tilbury former co-disposal hazardous waste landfill site is adjacent to the east of Goshems Farm Landfill and was active from 1932 to 1991. This landfill site accepted domestic, industrial, commercial and liquid hazardous waste.

North of River Thames

11.4.93 Low Street Landfill and Low Street Brickworks are adjacent to the south east of the railway line. Low Street former landfill was visited during the site walkover survey (see paragraph 11.4.655). The landfill received industrial and commercial waste between 1967 and 1969 and is currently used for lorry turning and skip storage by the adjacent scrap metal yard. Low Street Brickworks received industrial waste between 1956 and 1977 and is now a scrap metal yard.

11.4.94 There are several closed landfill sites on the eastern boundary of the study area including Love Lane, Saltings and Princess Margaret Road landfill, all of which are no longer operating.

11.4.95 To the north of the railway line near Linford, there is a large historical landfill site, Linford Quarry, which operated between 1984 and 1993 and accepted inert and industrial waste. In the same area there are two landfills, Linford Landfill and Rainbow Shaw Landfill which appear to have current licences.

11.4.96 Adjacent to the north of the A13 is Millers Sand and Gravel Pits landfill which received commercial and household waste between 1948 and 1965. No evidence of the landfill was identified during the site walkover survey and a housing estate (Baker Street) has been built on the western edge of the former landfill and former petrol filling station/works yard.

11.4.97 In Ockendon the route passes through an area of current and historical landfill sites, referred to as the ‘Ockendon Landfill Complex’ which is a former quarry. The historical Grange Farm Landfill in Ockendon received industrial, commercial and household waste between 1974 and 1990. There is no detail available about the historical Ockendon Grays Landfill. The Ockendon Area II and Area III Landfill is an active landfill site operated by Veolia. Further details from the site walkover survey are provided in paragraph 11.4.699.

11.4.98 To the west and east of the B186 road are Groves Farm historic landfill site which received inert commercial and household waste between 1959 and 1978, and Hall Farm historic landfill site which received inert, commercial and household waste between 1959 and 1984.

11.4.99 At the northern end of the Project to the west of the M25 junction 29 there is a historic landfill known as land adjoining Chapmans Farm; however, operational dates and waste accepted is unknown.

11.4.100 A review of available Landmark data on the GIS database indicates that there are several licensed waste management facilities (non-landfill), which are detailed below:

a. metal recycling site (scrap yard) at Low Street Brickworks, Station Road, Tilbury

b. industrial waste landfill at Tilbury B Power Station, Fort Road, Tilbury

Pollution incidents

11.4.101 Recorded pollution incident data (from 2001 to 2018) was obtained from the EA and Landmark. The Category 2[26] (major) pollution incidents within 250m of the Development Boundary are summarised below. No Category 1 (significant) impacts were identified. The Category 3 and 4 pollution incidents have not been included in Table 11.9. It should be noted that the data only includes pollution incidents which have been recorded by the EA. Further pollution incidents may have occurred which were not reported or recorded and therefore would not be captured in this dataset.

Table 11.9 Summary of pollution incidents

Location	Categorisation	Pollution type and cause	Date
South of the River Thames			
None identified			
Tunnel			
None identified			
North of River Thames			
Kemps Farm, South Ockendon	Category 2 (significant impact to land	Commercial waste and contaminated construction and demolition material and waste from fly tipping	5 January 2017
Dansand Quarry	Category 2 (significant impact to land	Dust and smoke relating to fires	5 July 2011
Dansand Quarry	Category 2 (significant impact to land)	General biodegradable materials and wastes.	5 June 2014
Dennises Lane	Category 2 (significant impact to land)	No relevant information	5 January 2017
East Tilbury Quarry	Prosecution relating to authorised processes	Illegal dumping of asbestos waste – Suspended prison sentence served on waste carrier	No date provided

11.4.102 The approximate locations of the pollution incidents are presented in Figure 11.6 Volume 3.

Potential contaminative uses

11.4.103 A review of the historical development on and around the study area has been carried out using GIS datasets obtained from Landmark Envirocheck during the PSSR preparation. The datasets were collected in collaboration with Ordnance Survey via a review of available historical maps.

[26] The categories are defined as follows:
Category 1 – major, serious, persistent and/or extensive impact or effect on the environment, people and/or property
Category 2 – significant impact or effect on the environment, people and/or property
Category 3 – minor or minimal impact or effect on the environment, people and/or property
Category 4 – substantiated incident with no impact

11.4.104 The datasets researched are titled Historical Land Use Data, Historical Tanks and Energy Facilities, Potentially Contaminative Land Uses and Potentially Infilled Land. Figure 11.7 in Volume 3 illustrates the locations of the industrial uses and contaminative land uses. The features located within the study area are listed below, along with others identified during the gathering of other baseline information.

South of the River Thames

a. Three historic quarries; one adjacent to the south of the A2 and two either side of Thong Lane are present which were visited during the site walkover survey.

b. Historic tank of unknown use adjacent to the north of the A2 on Franklin Road. Two historic tanks associated with the current and historic Esso petrol stations on either side of the A2.

c. Council yards/depot on southern side of A2.

d. Military land associated with the former Gravesend military airport.

e. Electrical substation approximately 170m north of the A2.

Tunnel

a. On the southern side of the River Thames former quarrying was identified at Filborough Farm (landfill site).

b. Infilled canal, police firing range and railway line.

c. A cemetery is present approximately 100m north of Rochester Road.

d. On the northern side of the Thames, Goshems Farm historical landfill site and East Tilbury landfill site, Tilbury Power Station (industrial land) is shown to the west.

North of River Thames

a. There is a vehicle garage present at the Brentwood Road roundabout (adjacent to the south of the A13).

b. In this section of the route, there are several historic quarries within the study area, some of which relate to areas which were historically or currently being used as landfill sites. Some of these quarries may have been infilled with Made Ground or waste but are not registered landfill sites.

c. Several historic landfill sites (including the PFA landfill) are within the study area and the active Ockendon Landfill Complex.

d. Several industrial areas such as the scrapyard at Low Street are indicated along this part of the route.

e. The locations of several historical tanks (of unknown use) are shown within 250m of the Project. These are mainly around the proposed junction with the A13 at the new housing development (Baker Street).

11.4.105 A geo-environmental Conceptual Site Model (CSM) report and detailed desk-study report are currently being updated which will highlight areas of potential contamination and associated potential contaminant linkages. These reports will be reviewed during the preparation of the ES chapter.

Man-made mining and natural cavities

11.4.106 Data regarding natural and man-made cavities has been obtained for the Options Phase PSSR via the Peter Brett Associates and Ove Arup & Partners databases and through the Landmark Envirocheck database, (version 2005). Figure 11.5 in Volume 3 shows the currently known cavity locations. Figure 11.4 in Volume 3 shows the location of quarries identified during the site walkover survey. The features within 250m of the Development Boundary are summarised below.

South of the River Thames

11.4.107 There are several man-made mining cavities and 2 natural cavities shown by the Gravesend link and proposed junction with the A2. These are likely to be associated with the chalk outcrops in this area.

11.4.108 Other areas of chalk, sand and gravel extraction have occurred near the A2 at Shorne. The majority of these have been backfilled. The material used for backfilling is unknown but may have included waste products.

11.4.109 Small scale lignite mining took place in 1947 when a seam up to 4m thick was found south of the A2 near Cobham Hall. The drift mine produced around 80 tonnes per week. There were plans proposed for expansion, but these were abandoned due to difficulties encountered, included flooding which was controlled by pumping. The mine was closed in 1953. During the site investigation and construction of HS1 the adits and lignite were encountered.

11.4.110 Three quarries were identified along Thong Lane from historical mapping and were visited during the site walkover survey. No remaining evidence of the quarries was observed.

Tunnel

11.4.111 No man-made mining or natural cavities have been identified within this design area.

North of River Thames

11.4.112 Areas of chalk, sand and gravel extraction have occurred in the area between East Tilbury and Chadwell St Mary and along the A13. The majority of these have been backfilled or have ceased operation.

11.4.113 A small currently active sand and gravel extraction quarry was noted on farmland to the north of Muckingford Road. This was visited during the site walkover survey. Further information is provided in paragraph 11.4.64.

Historical mineral planning permission

11.4.114 The historical mineral planning permission figure (Figure 11.8 in Volume 3) has been developed from a GIS dataset obtained through BGS. The dataset entails planning permission granted historically for mineral abstraction. There are several BritPits (British Pits) within the study area. These indicate surface or underground mineral workings in the area.

South of the River Thames

11.4.115 There is one area of approved planning permission for mineral extraction adjacent to the south of the A2 and approximately half is within the Development Boundary. From the BGS Mineral Resources Plan for Kent (BGS, 2002) this is an area called Scalers Hill and the mineral is Common Clay and Shale.

11.4.116 Another approved area is indicated on the northern side of the A2 within Shore Country Park. Again, from the BGS Mineral Resources Plan this is called Shorne Wood and the mineral is also Common Clay and Shale. Most of this permission is outside the Development Boundary but the south eastern corner encroaches upon it.

Tunnel

11.4.117 South of the River Thames there is one area of approved planning permission for sand and gravel extraction adjacent to the north of Lower Higham Road.

North of River Thames

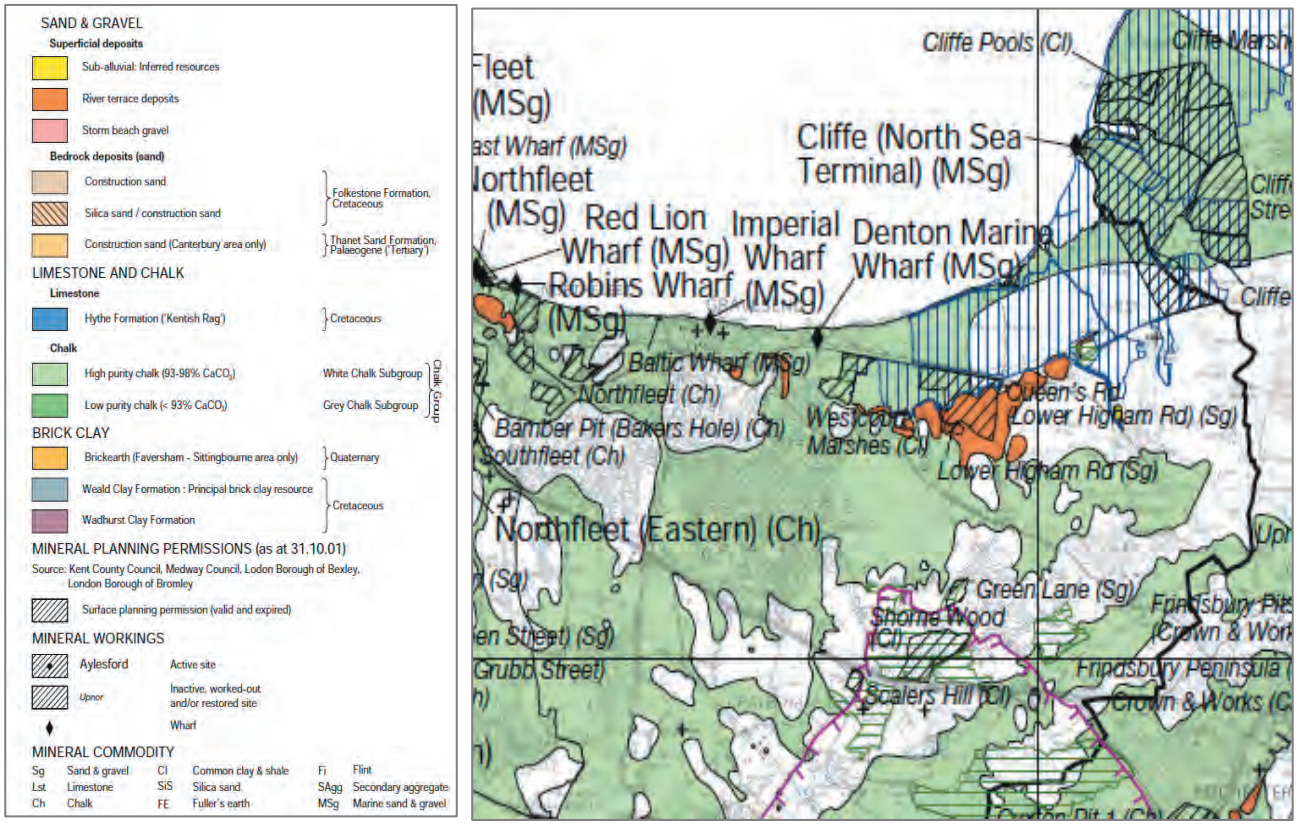
11.4.118 There are areas of approved and refused planning permission around Station Road, the northern part of Goshems Farm, Linford and around the A13. These mainly related to sand and gravel extraction and as shown on the BGS Mineral Resources Plan for Essex (BGS, 2002) relate to areas which have been backfilled and are now considered to be landfill sites.

11.4.119 The main area of valid permission relates to the location of the current Ockendon landfill site operated by Veolia (see paragraph 11.4.97).

Minerals/Mineral Safeguarding Areas

11.4.120 Extractable economic minerals are present within the Development Boundary and relevant information is detailed below. Information is presented with regards to Mineral Safeguarding Areas (MSAs) and potential resources. The minerals indicated could potentially be used within the Project for construction materials. Further consideration to this is given in Chapter 12: Materials.

Plate 11.1 Extract from BGS Mineral Resources Plan for Kent

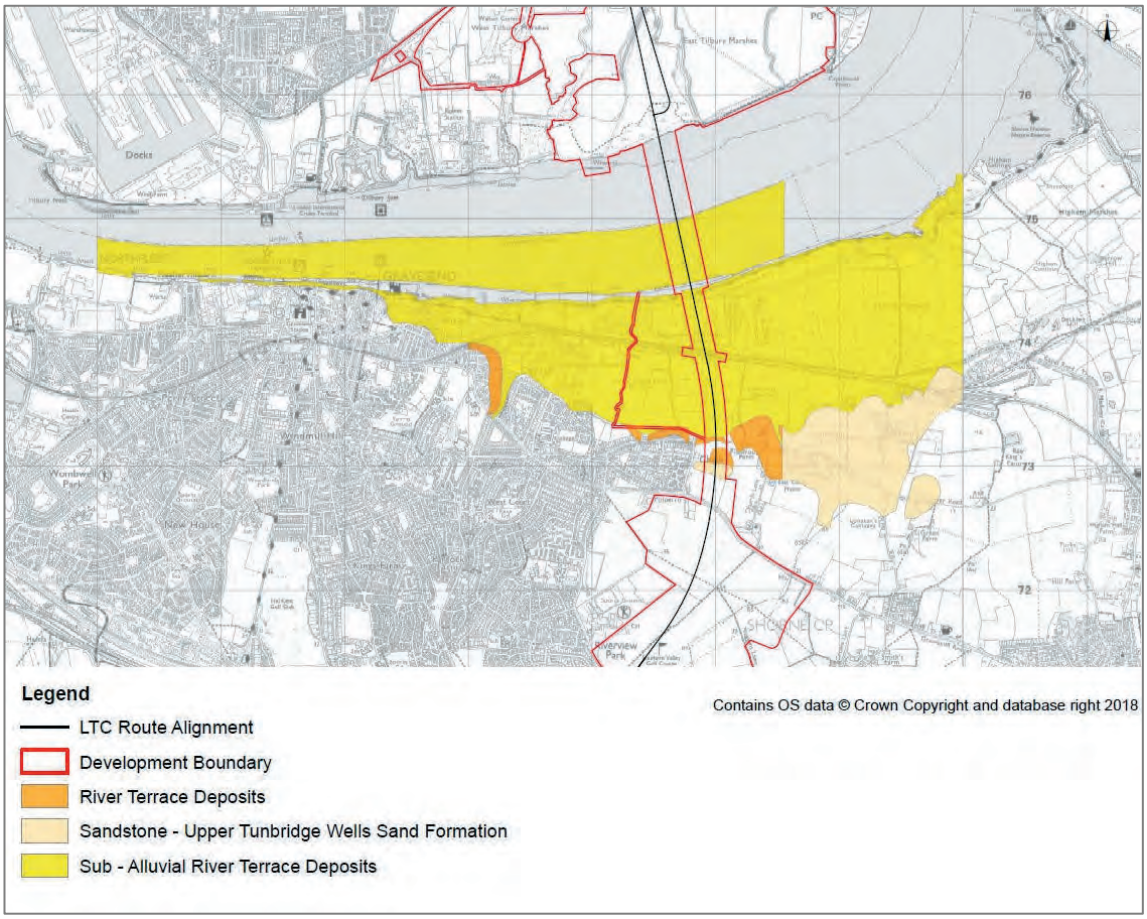


South of the River Thames and Tunnel

11.4.121 Plate 11.1 (above) is an extract from the BGS Mineral Resources Plan for Kent. This shows that there are high purity chalk (93-98% CaCO3) resources in this area. River Terrace Deposits are indicated to the south of the Ramsar site near to Lower Higham Road. However, the Gravesham Mineral Safeguarding Areas plan (see Plate 11.2) indicates that these are not MSAs.

11.4.122 Plate 11.2 indicates that the sub-alluvial River Terrace Deposits along the banks of the River Thames and an area of River Terrace Deposits to the south are indicated in the MSA. Note that the Shorne Marshes Ramsar Site and Higham Marshes (see Chapter 9: Terrestrial Biodiversity) are within the MSA so it is considered unlikely that this area will be suitable for extraction of minerals due to its designation.

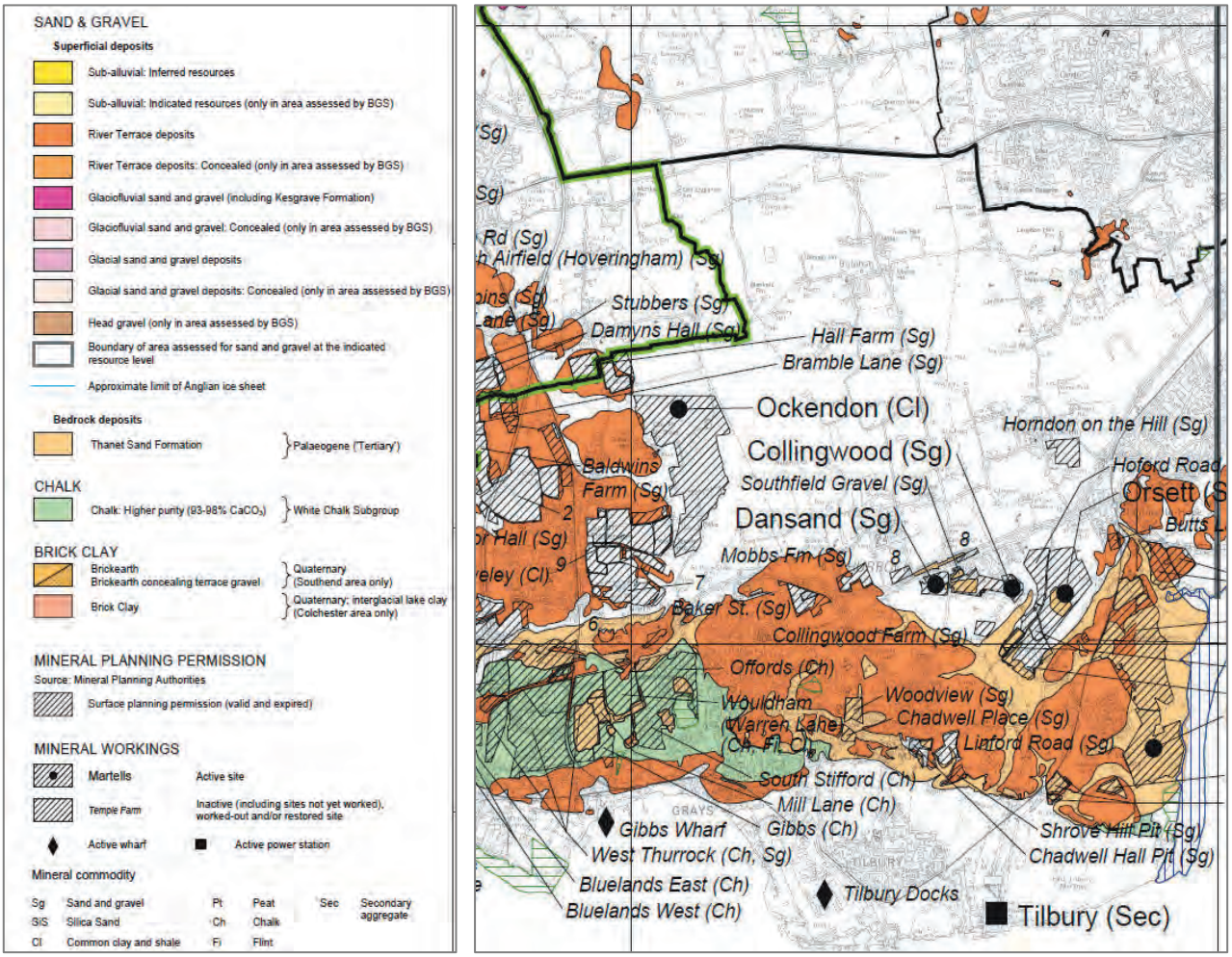
Plate 11.2 Extract from Kent Minerals and Waste Local Plan – Gravesham Borough Council – Mineral Safeguarding Areas



North of River Thames

11.4.123 Plate 11.3 indicates that there are no mineral resources underlying the north portal.

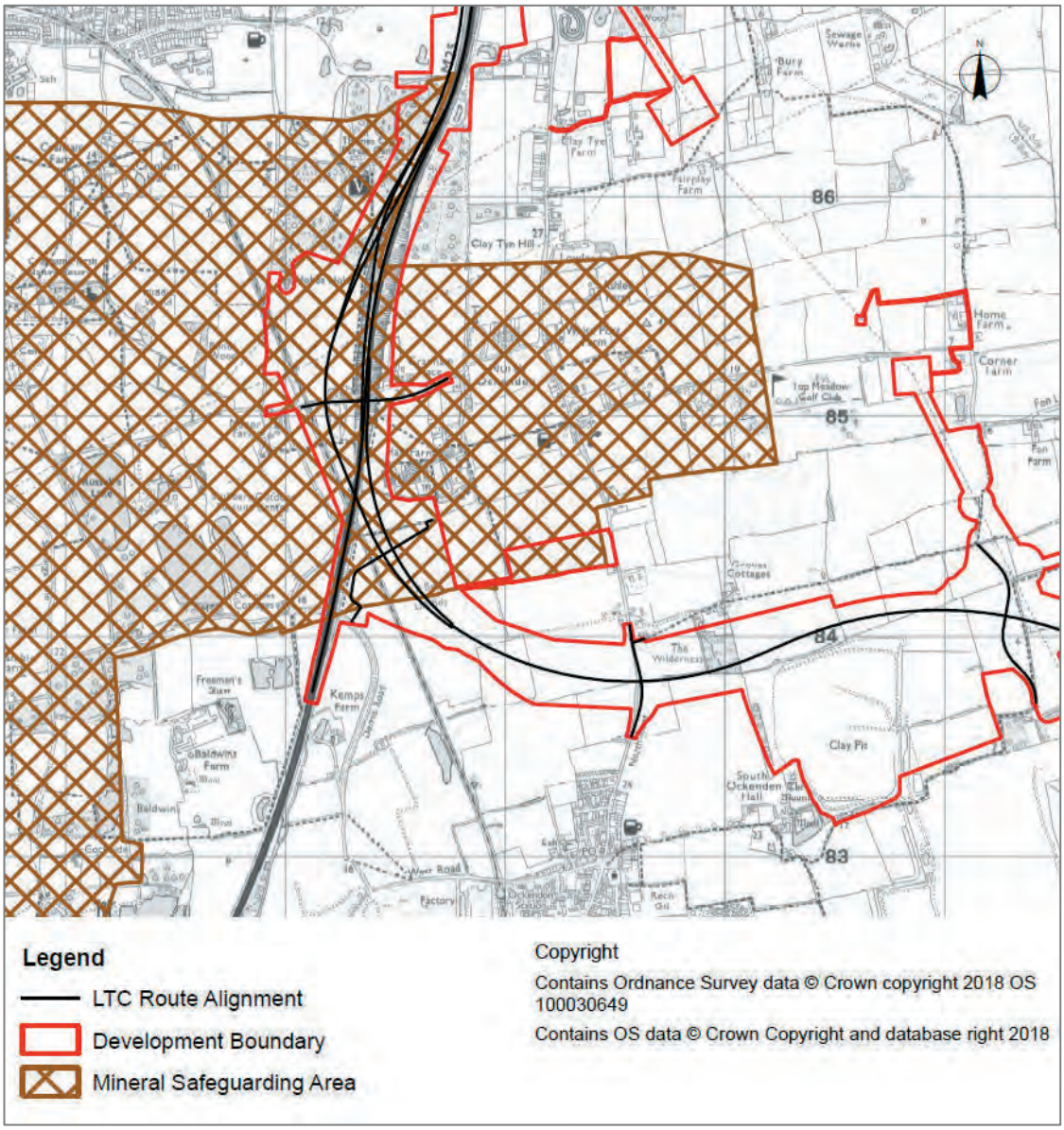
Plate 11.3 Extract from Essex Mineral Resources Plan



11.4.124 Plate 11.3 shows the presence of River Terrace Deposits overlying the Thanet Sand within the Development Boundary between Goshems Farm and Ockendon including the presence of active mineral workings such as Dansand Quarry (Sand and Gravel). The Veolia Ockendon Landfill site is shown as a former mineral workings area for Common Clay and Shale.

11.4.125 The London Borough of Havering Local Development Framework Proposal Map (see Plate 11.4) shows that there is an MSA between Dennis Road (to south) to the B187 (North Ockendon) which is likely to be associated with the presence of the Lynch Hill Gravel.

Plate 11.4 Extract from the London Borough of Havering Local Development Framework Proposal Map: south (October 2008)



11.4.126 An MSA study report is being prepared and will be included within the final ES. The findings will be discussed with mineral officers within the appropriate local authorities.

Soils

11.4.127 A range of information on the soils present is available from published sources. A description of the soils is presented below and has been divided into the three sections: South of the River Thames, Tunnel and North of the River Thames.

11.4.128 Note that while the baseline conditions immediately adjacent to the River Thames are described here, this includes areas which will not be directly affected by construction activities.

11.4.129 Available soil Project information is presented in Figures 14.3 to 14.5 in Volume 3.

11.4.130 Information relating to agricultural land quality and use (for example Agricultural Land Classification (ALC)) can be found in Chapter 14: People and Communities.

South of the River Thames

11.4.131 To the south of the Thames the soils are generally described as well-drained loamy soils. Immediately north of the A2 the soils belong to the Fyfield Association. They are described as deep, well drained and often stoneless coarse loamy and sandy soils with a naturally low fertility. South of Chalk the soils belong to the Coombe Association and are described as well drained calcareous fine silty soils which can be deep in valley bottoms. There are also likely to be some soils belonging to the Frilsham Association, described as well drained fine loamy soils overlying chalk.

11.4.132 All these soil types have relatively high permeabilities and high soil moisture storage capacities. They are classed as having a moderate potential to attenuate pesticide leaching and the area is considered to have a minor flood risk potential.

Tunnel

11.4.133 Soils adjacent to the Thames are mapped as belonging to the Wallasea Association. These are described as deep stoneless non-calcareous and calcareous clayey soils developed in Marine Alluvium. These soils are seasonally waterlogged and affected by fluctuating groundwater levels with relatively slow conductivity.

11.4.134 Given the clay nature of these soils they have the potential to swell and shrink leading to foundation damage. They potentially contain elevated levels of sulphate which can lead to higher iron corrosion risk. They are also classed as having limited ability to attenuate non-absorbed pesticides which can then leach into the groundwater.

North of River Thames

11.4.135 A range of soil types are present between Tilbury and junction 29 of the M25. North of Tilbury to the A13 the soils are generally described as freely-draining slightly acid loamy soils.

11.4.136 Around Orsett and to the south of the A13 the soils are mapped as belonging to the Fyfield and Hucklesbrook Associations. Both are well-drained coarse loamy soils in places developed over gravels. These are described as having relatively high permeabilities and high soil moisture storage capacities. Both are classed as having low leaching capacity in relation to pesticides.

11.4.137 These give way north of the A13 to slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils along with loamy soils with naturally high groundwater around junction 29. The soils north of the A13 to South Ockendon Hall comprise the Windsor and Fladbury Associations. The Windsor Association are described as slowly permeable and seasonally waterlogged clayey soils.

11.4.138 The Fladbury Association are described as stoneless clayey soils affected by groundwater.

11.4.139 To the west of South Ockendon Hall the soils are mapped as comprising the Shabbington Association. These are described as deep-fine loamy and fine loamy over sandy soils variably affected by groundwater.

11.4.140 All the soils north of the A13 are described as moderately to highly aggressive in relation to iron corrosion. They are also generally classed as having a high leaching capacity in relation to non-adsorbed pesticides.

Ground hazards

11.4.141 A GIS mapping dataset (developed by BGS for the Options Phase PSSR) has been used to highlight potential hazard areas where there are potential risks from movement or subsidence. This dataset covers the main spectrum of geotechnical and land stability problems that may be encountered from the naturally varying geology. The intention is to identify formations that have encountered such issues in the past allowing problems to be pre-empted during design.

11.4.142 A summary of the main hazards and where they are present within the study area are detailed in Table 11.10 below and presented in Figures 11.10 to 11.14 in Volume 3.

Table 11.10 Ground hazards

Hazard	Presence of hazard within study area
Compressible ground (Figure 11.9 in Volume 3)	**South of River Thames** – Not thought to occur. **Tunnel** – Compressibility and uneven settlement may be present either side of the River Thames (Alluvium with multiple peat layers) **North of River Thames** – The majority of the route is an area where compressible strata are not likely to occur. However, compressibility and uneven settlement hazards may be present in several places such as from the northern portal to Tilbury junction and to the north of the A13 which is associated with Alluvium in the Mardyke River Valley.
Slope instability (Figure 11.10 in Volume 3)	**South of River Thames** – Not likely to occur **Tunnel** – Not likely to occur over most of the Development Boundary, apart from a small area on the northern bank of the Thames in the Eastern Part of Goshems Farm. Soliflucted materials may be present in Chalk valleys, especially around the Southern Portal. **North of River Thames** - Not likely to occur over most of the Development Boundary, apart from small areas around the A13 and Ockendon Landfills. Known slope failures have occurred within the excavated quarry at the Area II Ockendon Landfill (Cleanaway Limited, 1996). Slope stability may occur where Made Ground, backfilled quarries/landfills are present, have steep slopes and/or are cut/loaded.

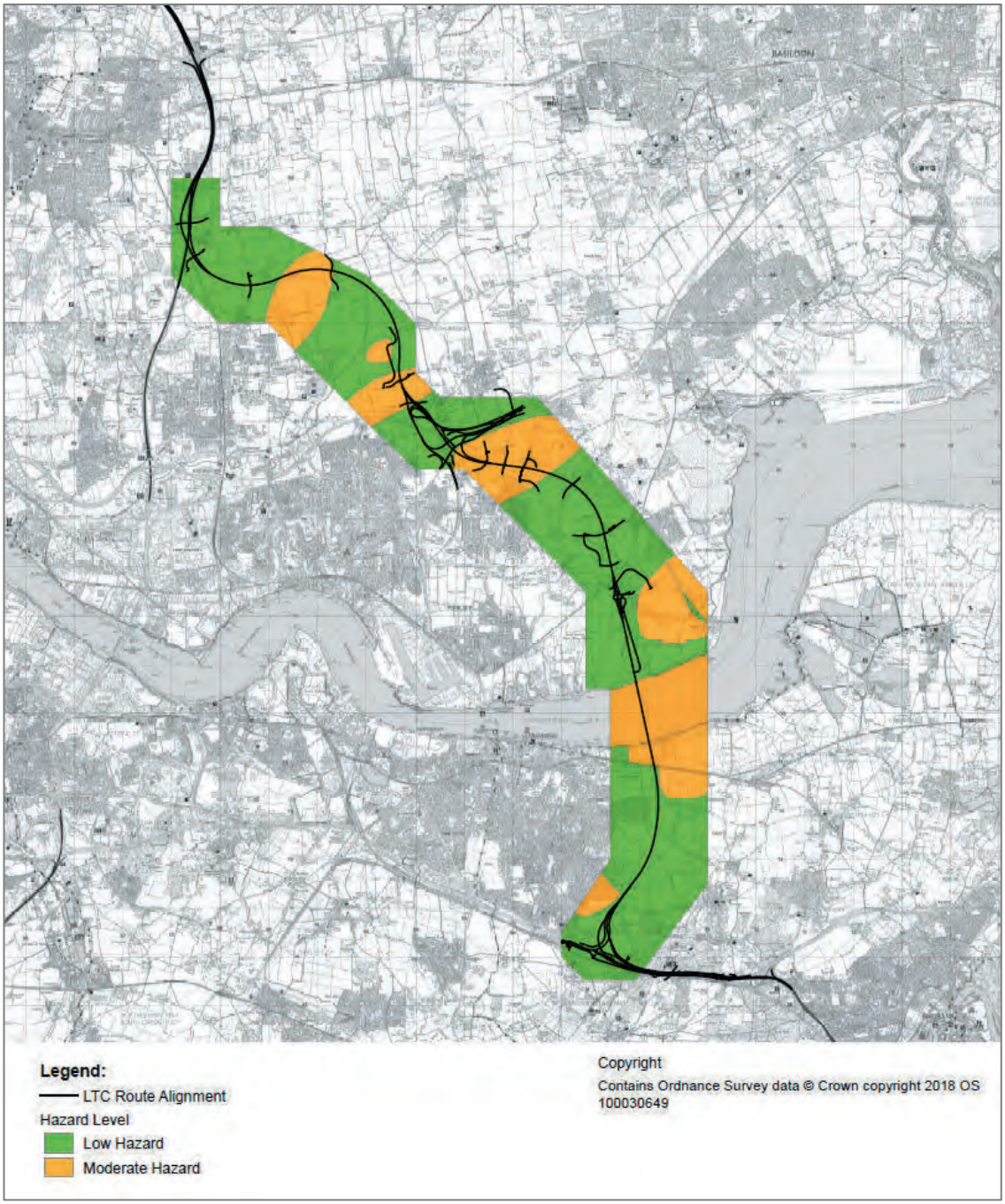
Hazard	Presence of hazard within study area
Running Sand (Figure 11.11 in Volume 3)	**South of River Thames** – Unlikely to be present for most of the Development Boundary, however running sand could be present at the eastern extent of the Gravesend link near the A2 junction. **Tunnel** – Unlikely to be present for most of the Development Boundary, however small areas could be present to the south of Lower Higham Road and on the northern and southern banks of the River Thames. **North of River Thames** – Unlikely to be present for most of this part of the route, however may be associated with the Alluvium deposits around the Mardyke River and between Tilbury and the A13. Constraints may apply to land uses involving excavation or the addition or removal of water.
Shrink-Swell (Figure 11.12 in Volume 3)	**South of River Thames** – Predominantly non-plastic soil in this section with areas of low plasticity associated with the Alluvium. **Tunnel** – Soils of medium plasticity are likely to be present. **North of River Thames** – Between Tilbury and Chadwell St Mary and around North Ockendon the soils are generally of non-plastic or low plasticity. From the A13 to Ockendon the soils have high plasticity. From North Ockendon to the M25 junction soils of very high plasticity are likely to be present.
Soluble Rocks (Figure 11.13 in Volume 3)	**South of River Thames** – Between the A2 and Thong soluble rock (chalk) is likely to be present. From Thong to the southern portal a lower risk is identified but soluble rocks (few dissolution features) are still present in this area. **Tunnel** – Soluble rocks (few dissolution features) are present near to the southern portal. As moving northwards this changes to soluble rocks either not thought to be present within the ground or not prone to dissolution. **North of River Thames** – Across most of the route, soluble rocks are either not thought to be present or not prone to dissolution. There is an area around Tilbury junction that soluble rocks with few dissolution features are likely to be present.

Unexploded ordnance

11.4.143 A UXO desk-based study has been carried out by Zetica for the Project's preferred route alignment (Zetica UXO, 2017). Several potential sources of UXO hazard have been identified relating to WW2 bombing, including Milton Rifle Range, the River Thames and the former RAF Gravesend. The historical maps indicate that East Tilbury Marshes were used for anti-aircraft defences which may have been a target.

11.4.144 Plate 11.5 shows the UXO hazard along the Project and associated risk rating.

Plate 11.5 UXO hazard plan of the Project



11.4.145 The UXO report will be reviewed in more detail during the preparation of the ES.

Future baseline

11.4.146 Future baseline will be assessed by considering the existing site conditions at the time of the start of construction. If any significant changes in ground conditions has occurred since the ground investigation has taken place for example, potential contaminative uses on or near to the route, landslides/stability issues, then additional investigation will be carried out to confirm the current conditions.

11.4.147 The baseline conditions with regards to geology and soils are not anticipated to alter significantly prior to commencement of the construction of the Project as much of the soil and groundwater contamination is historical.

11.5 Further baseline information and surveys required

11.5.1 Information regarding geology, soils and contaminated land has been requested from the EA and local authorities to gain local knowledge of the study area to strengthen the baseline. This information will be reviewed once received and relevant information included within the ES. Relevant information in other chapters will be cross referenced where applicable.

11.5.2 As further historical mapping becomes available, this will be reviewed to understand historic land uses that could have resulted in ground contamination which may be mobilised by the Project. Mapping will indicate areas of infilling across the Project.

11.5.3 Extensive ground investigation will continue to inform the Project design supplemented with remote sensing and geophysics surveys. The results of this investigation will be reviewed to inform the likelihood for disturbance of contaminated materials as well as details about the geology/ground conditions encountered, soil and groundwater quality and groundwater depths.

11.5.4 UXO mitigation will be carried out during the ground investigation based on the findings of the Zetica desk-based study. Any findings will be documented in the ES.

11.5.5 Information from consultees regarding land quality, ground conditions and geological features will be reviewed to gain further understanding about these elements across the Project.

11.5.6 Historical aerial photographs will be interpreted to assess historical activities within the Project.

11.5.7 Other available reports such as the updated PSSR, desk-based study or CSM reports will be reviewed during the preparation of the ES.

11.5.8 Reports prepared by the Geoarchaeologist regarding buried archaeology remains will be reviewed during the preparation of the ES.

11.5.9 Soils surveys, as part of the ALC surveys (see Chapter 14: People and Communities) will be completed to inform the development of a Soil Management Plan.

11.5.10 Site walkovers to supplement those already undertaken, to investigate areas of potential contaminative uses and geological features.

11.6 Potential effects and mitigation measures

11.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. It should be noted that this assessment is ongoing and is subject to change through ongoing development of the Project proposals.

11.6.2 A full detailed assessment will be undertaken before DCO application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the ES.

Construction

Table 11.11 Potential effects and mitigation measures for construction

Item	Description
Receptor	Geology in relation to contaminated land
Potential nature of effect	Spread or mobilisation of pre-existing (historic land use) contamination and creation of contamination during construction eg, within the construction compound areas/general works.
Likely duration	During the construction phase
Potential mitigation	Intrusive ground investigation will be carried out to establish the locations of contaminated soils within the Project. This data will be used to inform a conceptual site model. A*pplying Model Practices for the Management of Land Contamination* CLR 11 (EA, 2004) source-pathway-receptor principles, a quantitative risk assessment would be carried out. Where unacceptable risks are identified, appropriate remedial action will be included within the Project design. Contaminated/unsuitable soils and construction site compounds (eg, chemical storage, waste oils, fuel and refuelling activities) will be managed in line with the Project Code of Construction Practice (CoCP) to prevent areas of soil/geology potentially becoming contaminated and in turn protect surface water and groundwater quality. If contamination occurs during the lifetime of any of the construction compounds, remediation would be carried out to return the land to its previous land quality state. Environmental design measures to prevent pollution incidents to receptors during the construction phase would be documented in the CoCP. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Geology
Potential nature of effect	Risk to the Project from ground (geology) instability, area of soft ground, sink holes and other geohazards.
Likely duration	During the construction phase
Potential mitigation	An intrusive investigation will be undertaken which will investigate potential areas of ground instability, soft ground, sink holes and other geohazards. The design of the route and associated structures (such as embankments and bridges) will consider these findings. Appropriate construction techniques will be used to design the Project to mitigate against geohazards. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Minerals

Item	Description
Potential nature of effect	Loss of mineral resource
Likely duration	During the earthworks phase of construction period
Potential mitigation	A mineral safeguarding assessment report will be prepared to assess the feasibility of using minerals from safeguarded and other suitable areas during the construction of the Project. The Project will incorporate these findings into the design. Further discussions will be requested with the appropriate mineral officers of the local planning authorities to determine a suitable approach. Further discussion regarding the use of materials is detailed in Chapter 12: Materials. If extracted minerals are used within the Project, the impact would be permanent, however assuming the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Human health (construction workers)
Potential nature of effect	Exposure to contaminated soils/groundwater during the construction of the Project.
Likely duration	Mainly during earthworks phase of construction period
Potential mitigation	An intrusive ground investigation will be undertaken to establish the locations of contaminated soils. Appropriate working methods and Personal Protective Equipment (PPE) will be used and good site hygiene adopted by workers to reduce the risk of exposure to contaminated materials. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Human health (residents near to Project)
Potential nature of effect	Fugitive dust (potentially containing contaminants) could be generated by excavation/earth movements during construction of Project. Depending on weather conditions, this could be blown into nearby residential properties.
Likely duration	Mainly during earthworks phase of construction period
Potential mitigation	An intrusive ground investigation will be carried out to establish the locations of contaminated soils. During the construction of the Project and especially during earthworks, excavated soils will be appropriately stored to try and prevent dust generated in dry weather periods being directed towards properties. Exposed contaminated soils will be dampened down and handled in a way to minimise dust generation. Dust levels would be monitored. In addition, other best practice measures such as damping down areas, vehicle wheel washing, covering stockpiles and lorries containing soils would be used to reduce the impacts from dust. Further details regarding air quality is detailed in Chapter 6: Air Quality. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Human health

Item	Description
Potential nature of effect	Potential explosion from unidentified UXO within the Project.
Likely duration	During the construction phase
Potential mitigation	During intrusive ground investigation works mitigation in line with the Zetica report would be carried out eg, use of magnetometers during the drilling of boreholes, to reduce the risk to human health. During construction, a watching brief approach would be adopted in higher risk areas by a UXO specialist. Assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Human health and buildings (near to and within the Project)
Potential nature of effect	Migration of ground gases from landfill sites (and other sources) and build up in confined spaces
Likely duration	During the construction phase
Potential mitigation	An intrusive investigation will be carried out, which will include gas monitoring across the Project but especially in the area near to or on landfill sites such as the northern portal to establish the gas regime. Mitigation measures would be introduced during the construction phase such as use of monitoring equipment/alarms and PPE to reduce the risk. Assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Groundwater in relation to contaminated land
Potential nature of effect	Contaminants being mobilised during construction works and migrating into underlying groundwater and surface water environment.
Likely duration	During the construction phase
Potential mitigation	An intrusive ground investigation will be carried out to establish the locations of contaminated soils and establish existing groundwater quality in the area. To reduce the spread/mobilisation of contaminants, contaminated soils within areas to be excavated would be removed before the main works. Materials would be treated so they can be reused within the Project where appropriate and applicable or, if this is not possible, materials will be disposed of at an appropriate soil treatment centre or waste facility. The design of the Project is yet to be finalised. Band drains or other geotechnical techniques may be used to aid with the consolidation of these features. Piling may be used to construct the structures within the Project. Such techniques (band drains/piling) can introduce pathways for contaminants in pore water to migrate into underlying groundwater. Appropriate techniques would be reviewed, and appropriate design would be included to safeguard the underlying groundwater regime to ensure that groundwater quality is not compromised. Materials used to create the embankments would be analysed to ensure that they are of suitable chemical quality as detailed in the earthworks specification for the Project. Deep excavations are needed in the locations of the tunnel portals which would cause a disturbance of soils. The excavation of the northern portal is through a former landfill site which may contain contaminated soils. During construction of these portals, dewatering will be needed which

Item	Description
	could allow contaminants to flow into these areas (especially the north portal) via groundwater. Dewatered groundwater would be treated before discharge and will be disposed of appropriately. The dewatering is considered in more detail in Chapter 15: Road Drainage and Water Environment. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Surface water in relation to contaminated land
Potential nature of effect	Contaminants being mobilised during construction works and migrating into surface water and wider water environment via surface water runoff.
Likely duration	Mainly during earthworks phase of construction period
Potential mitigation	Excavated materials will be appropriately stockpiled/stored to ensure that water runoff from (possibly contaminated) stockpiles does not enter surface water. Pollution prevention best practice protocols would be documented in the CoCP and adopted to ensure that contamination does not enter surface water. Soils would also be stored in accordance with the *Code of Practice for the Sustainable Use of Soils on Construction Sites* (Defra, 2011). The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Buried archaeological remains
Potential nature of effect	Mobilisation of contaminants and the creation of new pollutant pathways which could affect the preservation and recovery of buried archaeology remains.
Likely duration	During the construction phase
Potential mitigation	An intrusive ground investigation will be carried out to establish the locations of contaminated soils and establish existing groundwater quality in the area. During the investigation a Geoarchaeologist would review the soil samples taken at appropriate depths to determine the likely presence of remains. To reduce the risk of mobilising contaminants, contaminated soils would be removed before further investigation of the archaeology remains. Appropriate drilling and techniques would be adopted (eg, environmental seals) to reduce the risk of creating pollutant pathways. During construction, if piling techniques are needed in sensitive geo-archaeological areas, appropriate techniques would be adopted to reduce the risk of pathway creation. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.

Operation

Table 11.12 Potential effects and mitigation measures for operation

Item	Description
Receptor	Human health (road users and maintenance workers)
Potential nature of effect	Exposure of contaminated soils in landscaped areas on roadside and in rest and service area.
Likely duration	The lifetime of the Project
Potential mitigation	The road itself will reduce the risk of road users being exposed to soils. This will take account of both road users, drivers temporarily at the roadside or in the service area, or maintenance workers. Design of landscaped areas would ensure that unacceptable materials are not present at the surface. Information would be available in the Health and Safety file about quality and location of soils used within the Project. Maintenance workers would wear appropriate PPE to reduce the exposure risk when undertaking work within designated areas of the Project. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Human health and buildings (near to Project)
Potential nature of effect	Migration of ground gases from landfill sites (and other sources) and build-up in confined spaces of buildings/structures within or near to the Project.
Likely duration	The lifetime of the Project
Potential mitigation	An intrusive investigation will be carried out. This will include gas monitoring across the Project but especially in the area near to or on landfill sites such as the north portal to establish the gas regime. Appropriate mitigation measures will be introduced into the design of confined spaces (eg, service ducts/boxes) within the Project to reduce the risk to human health (asphyxiation) and buildings/structures (explosion). Assuming the potential mitigation is implemented, the impact of this effect is not likely to be significant.
Receptor	Minerals (safeguarded areas)
Potential nature of effect	Sterilisation of minerals within safeguarded areas.
Likely duration	Lifetime of the Project
Potential mitigation	A mineral safeguarding assessment report will be prepared before construction works to assess the impact on the safeguarded minerals. Further discussions would be sought with the appropriate local authority mineral officers to determine a suitable way forward. The impact of this effect would be permanent and could potentially be a significant impact as minerals could become sterilized and therefore not available for use in the future. However, with appropriate assessment and discussions, the overall impact can be controlled.

Item	Description
Receptor	Buildings/underground structures
Potential nature of effect	Ingress of contaminants into foundations of buildings/structures within the Project. Aggressive conditions for concrete.
Likely duration	Lifetime of the Project
Potential mitigation	Intrusive ground investigation will be carried out to establish the ground conditions and locations of contaminated soils within the Project. The design of the Project will take into consideration these conditions and be adapted to safeguard the Project eg, correct concrete class based on pH/sulphate of soils. The impact of this effect would be permanent, however assuming that the potential mitigation is implemented, the impact is not likely to be significant.
Receptor	Buildings/underground structures/Project
Potential nature of effect	Potential for settlement/land instability of structures over time which could affect the integrity of the Project.
Likely duration	Lifetime of the Project
Potential mitigation	The ground investigation data will be used to design the Project. Settlement and land instability issues will be assessed as part of the design process and mitigation incorporated into the design to reduce the risk of significant settlement. The impact of this effect could be permanent, however assuming that the potential mitigation is implemented, the impact is not likely to be significant.
Receptor	Shallow geology (soils) and water environment (surface and groundwater)
Potential nature of effect	Potential contamination from road spray, pollution incidents associated with road usage (eg, fuel/oil spillages), traffic accidents and within the rest and service area.
Likely duration	The lifetime of the Project
Potential mitigation	Appropriate drainage systems will be designed to reduce the risk to water receptors (see Chapter 15: Road Drainage and Water Environment). If any incident were to occur which did result in localised contamination, soils which had become significantly affected would be assessed and if necessary removed to reduce the risk of contamination migrating across a wider area and/or entering controlled waters. The impacts are likely to be temporary and assuming that the potential mitigation is implemented, the impact of this effect is not likely to be significant.

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Chapter 12.

Materials

12 Materials

12.1 Introduction

12.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on materials related to the construction and operation of the Project.

12.1.2 It does not refer to impacts associated with the off-site manufacture of products or the offsite extraction of primary materials. These stages of the products' or material resources' life cycles are outside the scope of this assessment due to the range of unknown variables associated with the extraction and manufacturing processes.

12.1.3 The term 'materials' was introduced within the *Design Manual for Roads and Bridges* (*DMRB*) Volume 11 (Department for Transport (DfT), 2009) in August 2009 and embraces the main material resources required to construct the Project and construction-related wastes. The consumption of material resources and the management of waste give rise to environmental impacts that need to be managed and mitigated.

12.1.4 The intent of the Materials chapter is to demonstrate how the design and proposed construction methodology can be influenced through the application of sustainability principles and the waste hierarchy to manage and mitigate potential impacts. The initial information presented in this *Preliminary Environmental Information Report* (*PEIR*) will be built on and expanded in the full assessment of the Environmental Statement (ES).

12.1.5 Throughout this chapter, 'material resources' will be addressed first, followed by 'waste'.

12.1.6 The aims of this chapter are to, in relation to material resources and waste:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to material assets

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies or surveys

e. describe the potential effects of the Project on materials (and how these have been assessed for the purpose of this *PEIR*)

f. describe potential mitigation measures

12.1.7 There are expected to be interrelationships between the potential effects on materials and most of the other disciplines reported on in the *PEIR*. The most significant are:

a. Chapter 6: Air Quality – resultant effects relating to transport

b. Chapter 11: Geology and Soils – source of information on anticipated excavated materials and minerals

c. Chapter 13: Noise and Vibration – resultant effects relating to transport

d. Chapter 15: Road Drainage and Water Environment – source of information on sources of anticipated excavated materials and constraints on reuse within the Development Boundary

e. Chapter 16: Climate – carbon impacts from bulk materials movements

12.2 Planning policy and legislative requirements

Legislative requirements

12.2.1 The relevant legislation applicable to the materials assessment of the Project is presented below:

Table 12.1 Legislative requirements

Legislation name	Summary of requirements
EU Landfill Directive (Directive 1999/31/EC on the landfill of waste)	Establishes a framework for the management of waste across the European Community. It also defines certain terms, such as 'waste', 'recovery' and 'disposal', to ensure that a uniform approach is taken across the European Union (EU).
EU Directive on Waste (Waste Framework Directive) (Directive 2008/98/EC on waste)	The Waste Framework Directive (WFD; Directive 2008/98/EC on waste) contains the EC's legal definition of waste, which is adopted by Member States. This definition is used to establish whether a material is a waste or not. It sets targets for recycling non-hazardous construction and demolition waste (70% by weight by 2020: Article 10).
The Clean Neighbourhoods and Environment Act 2005	It is the responsibility of everyone working in the construction industry to ensure that all waste is disposed of properly. All employees need to be made aware that, if they are tasked with waste disposal, it must be carried out in accordance with the law or they risk being fined.
Environmental Permitting (England and Wales) Regulations 2016 (as amended)	The Environmental Permitting (England and Wales) Regulations (EPR) were created to standardise environmental permitting and compliance in England and Wales to protect human health and the environment. This includes permitting waste and recovery operations within the Development Boundary and at off-site thirdparty facilities receiving waste.
Waste (England and Wales) Regulations 2011 (as amended)	The Waste Regulations transpose the Waste Framework Directive into English law. The regulations require businesses to confirm that they have applied the waste management

Legislation name	Summary of requirements
	hierarchy as well as introduce a new waste hierarchy permit condition and a two-tier system for waste carrier and broker registration.
Environmental Protection Act 1990 (Part II)	The Act outlines the basic provisions for the management of all waste, which includes details on the definition of waste and outlines Duty of Care placed on those involved in managing wastes.
The Town and Country Planning (Environmental Impact Assessment) Regulations 2017	To adequately describe and assess the likely significant effects of the proposed development on material assets, including effects from construction and operation.

National Policy Statement for National Networks

12.2.2 The relevant NPSNN for the waste assessment of the Project is presented below. There are no specific requirements for materials in the NPSNN; aspects pertaining to minerals are addressed in Chapter 11: Geology and Soils.

Table 12.2 NPSNN requirements and Project response

Requirement	Project response
Paragraph 5.42 "The applicant should set out the arrangements that are proposed for managing any waste produced. The arrangements described should include information on the proposed waste recovery and disposal system for all waste generated by the development. The applicant should seek to minimise the volume of waste produced and the volume of waste sent for disposal unless it can be demonstrated that the alternative is the best overall environmental outcome."	The Materials chapter of the *PEIR* sets out arrangements proposed for construction and operation, including the description of proposed mitigation measures such as minimising the volume of waste produced and the volume of waste sent for disposal. It also details where further information will be provided in the ES. In accordance with the requirements of the NPSNN, material resources used and waste arisings from the Project will be managed in line with a materials management strategy. The intention will be that the contractors will be required to produce a Site Waste Management Plan (SWMP), Materials Management Plan (MMP) and Construction Traffic Management Plan (CTMP). This will be outlined in the Code of Construction Practice (CoCP) that will be submitted as part of the Development Consent Order (DCO) application.

Requirement	Project response
Paragraph 5.43 "The Secretary of State should consider the extent to which the applicant has proposed an effective process that will be followed to ensure effective management of hazardous and non-hazardous waste arising from the construction and operation of the proposed development. The Secretary of State should be satisfied that the process sets out: • any such waste will be properly managed, both on-site and off-site; • the waste from the proposed facility can be dealt with appropriately by the waste infrastructure which is, or is likely to be, available. Such waste arisings should not have an adverse effect on the capacity of existing waste management facilities to deal with other waste arisings in the area; and • adequate steps have been taken to minimise the volume of waste arisings, and of the volume of waste arisings sent to disposal, except where an alternative is the most sustainable outcome overall."	The volume of hazardous and non-hazardous waste arising from construction and operation will be forecast, within the Materials chapter of the ES, based on available data from ground investigation and detailed in a forecast SWMP. An assessment will be made of existing off-site waste infrastructure capacity in the study area. Where an adverse impact is anticipated, mitigation will be proposed.

Planning policy requirements

12.2.3 The relevant planning policy applicable to the materials and waste assessment of the Project is presented below:

Table 12.3 Planning policy requirements

Policy name	Summary of requirements
National Planning Policy Framework, 2018	The National Planning Policy Framework (NPPF) does not contain specific waste policies as this is communicated in the *Waste Management Plan for England* (*WMPE*), 2013. However, section 17 contains several provisions for ensuring a sufficient supply of minerals including defining Mineral Safeguarding Areas, encouraging the reuse of secondary and recycled aggregates and new primary mineral sites as well as setting out criteria for associated planning permissions. The framework also makes provision for local authorities to undertake Aggregate Assessments to measure and provide adequate mineral landbanks. Authorities are encouraged to ensure adequate restoration of associated mineral workings.

Policy name	Summary of requirements
Waste Management Plan for England, 2013	The *WMPE* provides an analysis of the current waste management situation in England and fulfils the mandatory requirements of article 28 of the Waste Framework Directive (WFD). The plan does not introduce new policies or change the landscape of how waste is managed in England. Its core aim is to bring current waste management policies under the umbrella of a single national plan. The document states that the construction, demolition and excavation sector is the largest contributing sector to total waste generation.
National Planning Policy for Waste, Department for Communities and Local Government, 2014	This document sets out detailed waste planning policies, specifically providing guidance on the processes to be considered to ensure adequate provision of waste management facilities.
Brentwood Council (adopted *Essex and Southend-on-Sea: Waste Local Plan*, July 2017)	The Local Plan for Brentwood adopts the Essex and Southend-on-Sea: Waste Local Plan. No additional objectives are required by Brentwood Council.
Dartford Council (adopted *Kent Minerals and Waste Local Plan*, July 2016)	The Local Plan for Dartford adopts the Kent Minerals and Waste Local Plan. There are therefore no additional objectives required by Medway Council
Essex and Southend-on-Sea: Waste Local Plan, July 2017	The plan contains several strategic objectives to promote waste recovery and reuse, minimise the need for landfill, and achieve self-sufficiency in the local area through the provision of adequate capacity. The plan does not cover Thurrock.
Gravesham Council (*adopted Kent Minerals and Waste Local Plan*, July 2016)	The Local Plan for Gravesham adopts the Kent Minerals and Waste Local Plan. There are therefore no additional objectives required by Gravesham Council.
Havering Council *Joint Waste Development Plan for the East London Waste Authority Boroughs*, February 2012	The Joint Waste Development Plan covers Havering and has a number of waste objectives focused on reducing the volume of waste generated and moving waste management up the waste hierarchy away from landfill. The plan outlines where capacity is required to be improved to achieve self-sufficiency.
Kent Minerals and Waste Local Plan, July 2016	The Local Plan contains several strategic objectives to ensure Kent has sufficient capacity of minerals and aggregate (including secondary and recycled aggregate). The plan objectives encourage the delivery of minerals through sustainable modes of transport. The plan objectives also encourage the proximity principle to promote waste recovery and reuse, minimise the need for landfill, and achieve self-sufficiency in the local area through the provision of adequate capacity. Objectives also focus on

Policy name	Summary of requirements
	sustainable restoration of mineral extraction sites and waste facilities.
Medway Council (adopted Kent Minerals and Waste Local Plan, July 2016)	The Local Plan for Medway also adopts the Kent Minerals and Waste Local Plan. There are therefore no additional objectives required by Medway Council.
Thurrock Council N/A (in development)	Work on the Minerals and Waste Local Plan has now been suspended indefinitely. The new Local Plan will include content on waste and minerals strategy and is due for adoption in 2020.

12.3 Methodology

Approach

12.3.1 There is currently no definitive methodology for assessing the value of material receptors, so assessment of significance will be undertaken using guidance in Highways England Interim Advisory Note 153/11 and the *Design Manual for Roads and Bridges*. Criteria for evaluating the sensitivity of potential receptors will be outlined in the ES.

12.3.2 As per NPSNN requirements, the Project will seek to manage impacts in accordance with the waste hierarchy, moving waste management practices as far up the hierarchy as practicable.

12.3.3 Design data will be used in the ES to calculate where waste volumes have been minimised through the application of the five key principles of waste minimisation (design for: Reuse and Recovery, Off-Site Construction, Materials Optimisation, Waste Efficient Procurement and Deconstruction and Flexibility) in all design phases.

12.3.4 Where possible, waste materials will be reused (as permitted by the design and technical constraints) within the Development Boundary to minimise off-site haulage movements. Where reuse of waste arisings is not possible onsite, alternative off-site projects will be identified that could potentially beneficially reuse the waste materials and therefore divert waste from landfill disposal. For the purposes of comparison, a quantitative assessment will also be made in the ES against the local waste infrastructure capacity.

Study area

12.3.5 For the purposes of materials and waste assessment it is necessary to use different study areas due to the need to use materials from across the UK which are not available locally and the uneven distribution of waste facilities, particularly those accepting hazardous waste. Different study areas are therefore proposed for material resources, non-hazardous waste (including inert) and hazardous waste:

a. **Material resources** – these will be required to construct the Project, and the assessment will consider the effect of the Project on the availability of natural resources. It is intended that material resources such as aggregate

will be sourced either locally or regionally, wherever possible. However, as some material resources may have to be sourced from other regions, the study area has been extended to the whole UK.

b. **Non-hazardous waste** – the study area comprises a 20km radius from the Development Boundary, as this will equate to a travel time of approximately 1 hour and is considered a reasonable financial and logistical assumption for the construction phase to make the Project viable.

c. **Hazardous waste** – due to the limited presence of hazardous waste landfill sites within the above non-hazardous waste study area, the South East region of the UK will be used to inform the hazardous waste assessment. It is noted that treatment and transfer facilities can often accept both hazardous and non-hazardous waste streams but this cannot be distinguished in the Environment Agency (EA) datasets.

Baseline

Materials

12.3.6 The baseline conditions for material resources have been established through desk-based research, engagement with local authorities and the following documents:

a. Greater London Authority (GLA) (2016) *Local Aggregate Assessment for London*

b. Department for Business, Energy & Industrial Strategy (2017) *Future Capacities and Capabilities of The UK Steel Industry*, BEIS Research Paper Number 26

c. Essex Council (2017) *Greater Essex Local Aggregate Assessment* (which includes Essex and Thurrock)

d. International Steel Statistics Bureau (2016) http://www.issb.co.uk/news/news/uk.html [accessed April 2018]

e. Kent County Council (2016) *Kent Local Aggregate Assessment*

f. Medway Council (2017) *Medway Local Aggregate Assessment*

g. Mineral Products Industry (2016) *Mineral Products Industry at a Glance*

12.3.7 This information has been used to determine the current landbank of available resources and the anticipated availability in the future, when the Project is due to commence construction.

Waste

12.3.8 Baseline conditions have been established to support the assessment of waste arisings, through desk-based research. This includes a review of the following key data sources:

a. Environment Agency (2016) Waste Data Tables [accessed February 2017]

b. Environment Agency (2016) Environmental Permitting Regulations (EPR) database [accessed February 2017]

c. Environment Agency (2016) Waste Data Interrogator [accessed February 2017]

d. Essex County Council (2015) *Essex & Southend on Sea Waste Local Plan*, Topic Paper 1: Waste Capacity Gap Update

e. Government Statistical Service (2016) *UK Statistics on Waste*

f. Kent County Council (2011) *Evidence Base for the Minerals and Waste Core Strategy*, Waste Topic Report 4: Construction, Demolition & Excavation (CDE) Waste

g. Medway Council (2009) *State of Medway Report: Waste*

h. Thurrock Council (2010) *Thurrock Waste Management Capacity Needs Assessment* – 2010 Update

12.3.9 The information has been used to determine the current capacity of the local waste infrastructure and anticipate future capacity, when the Project is due to start construction

12.3.10 Waste can be classed as hazardous, non-hazardous and inert depending on its chemical and physical properties. The assessment will reference all types of waste and explore the anticipated waste types and quantities in the ES.

12.4 Existing environmental conditions

Material resources

12.4.1 Material resources include primary raw materials, such as aggregates and minerals, and manufactured construction products which include recycled and secondary aggregates. The term ‘aggregate’ is an umbrella term for bulk raw materials used in infrastructure construction. These materials are further defined as primary, secondary or recycled aggregate (see *EIA Scoping Report*, para 11.4.1-11.4.3).

12.4.2 The materials required for construction of the Project include metals, aggregate, pavement, concrete and soils. The volume and sources of these materials will be developed through the design stage of the Project. Many of these material resources will originate off-site, purchased as construction products, and some will arise onsite such as excavated soils or recycled road planings. The Project will seek to utilise as much soil sourced from within the Development Boundary

as possible. It is considered that minimal bulk materials will be required for operational purposes.

UK demand

12.4.3 A non-exhaustive list of key material resources likely to be used in the Project is presented in Table 12.4. The values show the UK demand for aggregates, pavement and concrete in 2015 (Mineral Products Industry 2016) and for steel in 2016 (International Steel Statistics Bureau, 2016). This demonstrates the available supply of significant quantities of the key materials likely to be used by the Project.

Table 12.4 UK demand of key material resources likely to be used in the Project

Key material resource	Quantity demand (tonnes)
Aggregates	225,000,000
Pavement	24,000,000
Concrete (including ready mix concrete and concrete products)	81,000,000
Steel	7,800,000

Current local aggregate reserves

12.4.4 Although the study area for materials is the UK, it is not considered useful to map all material resource facilities across the country. To demonstrate the proximity and potential for use of local aggregate sources, local mineral sites within a 20km radius (including aggregate wharves) of the Development Boundary have been presented in Figure 12.1 in Volume 3. The type and location of these facilities is presented in Table J.1 in Appendix J in Volume 2.

12.4.5 With reference to Chapter 11: Geology and Soils, the Development Boundary crosses areas of land where the geology could potentially be considered as mineral assets. A specific Mineral Safeguarding Area Study will be prepared for the ES and will show the locations of key operational and non-operational local aggregate reserves in relation to the Project.

12.4.6 The tonnage of local aggregate reserves available (including sand and gravel, crushed rock and recycled aggregates) is identified by the individual Local Aggregate Assessments outlined in the methodology section of this report (see section 12.3).

12.4.7 In addition, the Crown Estate in the Kent County Council Assessment (Kent County Council 2017) and the GLA Assessment (GLA, 2016) provides data on marine aggregate reserves. This is summarised in Table 12.5.

12.4.8 The GLA Assessment (GLA, 2016) states that in 2015, the Greater London landbank for sands and gravels was in Hillingdon, Havering, Bromley and Redbridge. However, these permitted reserves were calculated as having only two years' capacity remaining. The majority of aggregate need in Greater London is met from the import of marine and land sources outside the city and reuse of construction, demolition and excavation (CD&E) waste recovered as

recycled aggregate. Havering is not therefore considered a significant potential source of aggregate materials for the Project.

Table 12.5 Current aggregate reserves available in Kent, Essex and Medway

		Greater Essex (including Essex and Thurrock)	Kent	Medway
Sharp sand and gravel	Permitted reserves (tonnes)	35,570,000	3,790,000	1,310,000
	Landbank (years)	7.95	6.16	218
	10-year sale average (tonnes per annum)	3,270,000	610,000	6,000
	3-year sales average (tonnes)	3,740,000	-	3,000
Soft sand	Permitted reserves (tonnes)	-	8,180,000	-
	Landbank (years)		13.77	-
	10-year sale average (tonnes per annum)	-	594,000	-
	3-year sales average (tonnes)	-	-	-
Crushed rock	Permitted reserves (tonnes)	-	47,000,000-48,000,000	-
	Landbank (years)		61	
	10-year sale average (tonnes per annum)	-	780,000	-
	3-year sale average (tonnes)	-	-	-
Secondary/ recycled aggregate capacity	Sales/capacity (tonnes per annum)	3,900,000	1,900,000	60,000
Marine	994,000,000 tonnes (reserve) 31,250,000 tonnes per annum permitted extraction across region			

Waste

12.4.9 The Project will result in the production of waste arising from several activities, including damage to materials and goods, offcuts, excavation of soils, tunnelling and packaging.

12.4.10 At present the UK is committed to recovering (diverting from disposal) at least 70% of non-hazardous construction waste by 2020 as required by the European

Union Waste Framework Directive. The latest data from 2014 indicated that the UK achieved a recovery rate of 91.4% (Government Statistical Service, 2016).

12.4.11 The current CD&E waste arisings generated locally for Essex, Thurrock, Kent and Medway have been reported in their individual reported waste capacity assessments (see section 12.3). The values summarised in Table 12.6 provide an indication of scale of generation.

Table 12.6 Local CD&E waste arisings generated

Local authority	Annual tonnage
Essex	3,310,420
Thurrock	345,000
Kent	2,600,000
Medway	300,000

12.4.12 Figure 12.2 in Volume 3 shows the location of waste facilities within 20km of the Project. More detail on these facilities is presented in Table I.1 in Appendix I in Volume 2. As stated in paragraph 12.3.4, it is not possible to differentiate transfer and treatment facilities into those that accept hazardous or non-hazardous waste. This can only be done by landfill type. The closest hazardous waste landfill is approximately 100 miles to the north of the Project.

12.4.13 The EA Waste Data Interrogator Tool was used to evaluate the volumes and methods of recovery/disposal of CD&E waste arisings (those with a European Waste Catalogue Chapter 17 waste code) received by different waste facility type. Table 12.7 shows Thurrock and Essex aggregated into Greater Essex, and Medway into Kent. The majority of CD&E waste in 2016 was received at landfill, but this may include reuse, for example as capping or restoration.

Table 12.7 Receipt of CD&E waste by facility type in 2016

Local authority	Site category	Tonnage received 2016	% of total
Greater Essex, including Essex and Thurrock	Landfill	2,778,723.96	48.1
	Recycled	103,186.25	1.8
	On/In Land	1,225,041.93	21.2
	Transfer	702,819.42	12.2
	Treatment	943,481.97	16.3
	Use of Waste	22,898.00	0.4
	TOTAL	5,776,151.53	100
Kent and Medway	Landfill	1,192,892.39	35.9
	Recycled	161,309.88	4.8
	On/In Land	450,370.80	13.5
	Transfer	772,916.96	23.2
	Treatment	749,073.15	22.5
	Use of Waste	0	0

Local authority	Site category	Tonnage received 2016	% of total
	TOTAL	3,326,563.18	100.00

12.4.14 To provide clarity of landfill type and capacity in the vicinity, the breakdown of receipt of CD&E waste by landfill type is also provided in Table 12.8. Facilities are predominantly focused on accepting inert and non-hazardous waste streams. There is some limited capacity to receive Stable Non-Reactive Hazardous Waste (SNRHW) but there is no hazardous landfill capacity in Kent and Essex.

Table 12.8 CD&E waste capacity by facility type in 2016

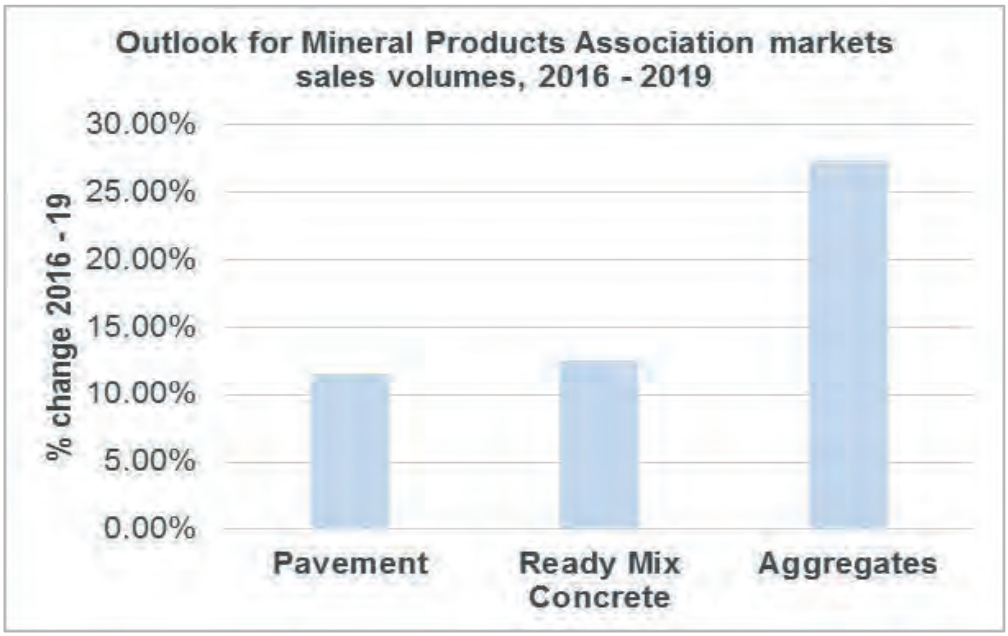
Facility type	Area		Total (tonnes received)	% of the total
	Essex and Thurrock (tonnes received)	Medway and Kent (tonnes received)		
Hazardous merchant/restricted	0	0	0	0
Non-hazardous with SNRHW	0	49,486	49,486	1.25
Non-hazardous	1,747,377	66,885	1,814,262	45.84
Hazardous	0	0	0	0
Inert	1,031,347	1,062,983	2,094,330	52.91
Total	2,778,724	1,179,354	3,958,078	100.00

Future baseline

Material resources

12.4.15 The Mineral Product Association expects a cumulative demand for aggregates of between 3.2 and 3.8 billion tonnes over the next 15 years. Key aggregate material resources likely to be used in the Project and the projected market sales volumes within the UK are presented in Plate 12.1 (Mineral Products Association, 2016).

Plate 12.1 UK projected markets sales volumes for key material resources 2016 – 2019



12.4.16 Due to recent changes in the UK steel market, a reliable forecast of sales is not available. A recent study by the UK Government has indicated there is the potential to grow the market by 150% by 2030, provided some barriers to capacity are addressed (Department for Business, Energy & Industrial Strategy, 2017).

12.4.17 As the Project will seek to use local materials where possible, the future baseline data has been collated from Greater Essex, Medway Council, Kent and their Local Aggregate Assessments. These local authorities have not estimated the possible future demand for the same periods, so the future baseline dates differ.

12.4.18 Greater Essex and Thurrock, *Local Aggregate Assessment* (Essex County Council, 2017) currently has sufficient permitted reserves and allocations to satisfy the assessed sand and gravel mineral requirement over the period of the current Minerals Local Plan (until 2032). The local authority has stated that it cannot rely on marine aggregate, due to an inability to influence supply and a limited number of local wharves. The *Local Aggregate Assessment* also states that there is insufficient permitted capacity of recycled aggregate sites for current CD&E waste arisings, which is partly fuelled by waste import from London.

12.4.19 Medway Council has analysed several external sources to envisage any trends that may be emerging and will influence demand for aggregates in its *Local Aggregate Assessment* (Medway Council, 2017). The population of Medway is predicted to increase by 22% to 2037. In addition, house builders are reporting increased workloads and a higher number of planning permissions granted nationally. This indicates a potential increase in aggregate demand over the coming years, but this does not yet appear to have significantly affected the market, as the 10-year and 3-year sales averages (presented within Table 12.5) remain low. The Medway Local Aggregate Assessment also indicates that both of the aggregate quarries are currently non-operational.

12.4.20 In Kent, the *Local Aggregate Assessment* (Kent County Council, 2016) has analysed past and likely future use of aggregates, evaluating likely demand from a variety of sectors, although the Project was excluded from this assessment due to uncertainty over its implementation. The assessment has acknowledged that the landbank reserves of sharp sands and gravels were insufficient to meet the projected needs of the *Kent Minerals and Waste Local Plan 2013-30*. Soft sands and hard rock reserves meet the NPPF requirements of a minimum landbank of seven years. Kent has stated an intent to substitute shortfalls in land-won aggregate with secondary aggregate and marine sources.

Waste

12.4.21 *The Essex County Council Capacity Waste Gap Report* (Essex County Council 2015) shows the forecast CD&E waste arisings for the Plan Area to 2032, based on the construction sector forecasts from their East of England Economic Forecasting Model. CD&E arisings are forecast to increase from 3,350,000 tonnes per annum in 2013 to 3,910,000 tonnes per annum in 2032. If no further permissions are granted by the end of the plan period (2032), it is anticipated that there will be a shortfall in CD&E recycling capacity of 1,500,000 tonnes per annum. This shortfall in capacity may grow over time as time-limited planning consents expire, requiring the closure of facilities.

12.4.22 Regarding landfill capacity, the collated EA data indicates that, in 2016, Greater Essex had a remaining inert landfill capacity of 4,500,000 tonnes and non-hazardous landfill capacity of 12,700,000 tonnes. Based on the input trend average from 2002 to 2016, this is anticipated to have fallen to 3,300,000 tonnes and 4,100,000 tonnes respectively when project construction starts in 2021.

12.4.23 The *Thurrock Waste Management Capacity Needs Assessment* (Thurrock Council, 2010) identified five CD&E recycling sites but anticipated a shortfall in treatment capacity by 2015/16 of between 195,000 tonnes and 255,000 tonnes due to facility closure. The report anticipated that this will be addressed using mobile crushers and screeners.

12.4.24 The *Kent Waste Capacity Assessment* (Kent County Council, 2011) determined that there is a surplus of inert CD&E waste recycling and landfill capacity within Kent to the end of the plan period (2030), although it acknowledged there is regional disparity due to the uneven distribution of facilities.

12.4.25 Regarding landfill capacity, the collated EA data indicates that, in 2016, Kent (including Medway) had remaining inert landfill capacity of 10,300,000 tonnes and non-hazardous landfill capacity of 2,600,000 tonnes. Based on the input trend average from 2002 to 2016, this is anticipated to have fallen to 6,200,000 tonnes and 310,000 tonnes respectively by the point construction of the Project starts in 2021.

12.4.26 There is no quantification of Medway's CD&E waste treatment capacity in its Waste Assessment (Medway Council, 2009). The assessment notes that much of the CD&E infrastructure is located in 1 area and has temporary planning permission; plant is mobile, often associated with specific redevelopment sites and the long-term retention at these sites is described as "unlikely to be compatible with the areas regeneration". The assessment also says that the remaining capacity of inert landfill is stated as "not recognised as significant".

12.5 Further baseline information and surveys required

12.5.1 The assessment baseline acquired will be updated as and when new sources of information are published by Essex and Kent County Councils. If available, additional information from Gravesham, Medway and Thurrock Councils will also inform the ES.

12.5.2 During the preparation of the ES, it is intended that the above will continue to be engaged, in addition to the following stakeholders:

a. The EA

b. East London Waste Authority

c. Surrounding third party land owners

d. Operators of potential off-site locations for reuse of excavated materials

e. Relevant landfill, waste transfer and treatment station operators

f. Port of London Authority

g. Marine Management Organisation (MMO)

h. Third party riverside operators (eg, Port of Tilbury)

12.5.3 Further information regarding the estimated quantities of key material resources required, and the likely waste arisings anticipated during the construction and operation phases of the Project, will also be generated as the Project design evolves. This information will be used to inform the ES.

12.5.4 The baseline data for material resources and waste will be updated in the ES as new data sets are released or provided through engagement by the Mineral Products Association, International Steel Statistics Bureau, the EA and local authorities.

12.5.5 A Mineral Safeguarding Area Assessment will be produced, but further study is required to evaluate the viability of using borrow pits as part of the construction works. Work is required to establish if site sands and gravels are appropriate for use in the design of the Project. The outcome of this assessment will inform the ES.

12.5.6 Further study is required to ensure that any reuse on site is appropriate for the Project's design and landscaped levels, and that it does not conflict with any other environmental risks, such as flood zones or contaminated land.

12.5.7 A programme of site investigation is being carried out and will be used to inform the assessment in the ES. Chemical and geotechnical data will continue to be collected and the classification of excavated materials will be presented within the ES. This will allow a robust quantitative assessment of arisings that could, potentially, be reused by the Project.

12.5.8 A feasibility assessment will be completed to inform the ES to determine the appropriateness and viability of using river transport. This will support the import

and export of materials (including waste) and the findings used to outline the proposed materials movements strategy in the ES.

12.6 Potential effects and mitigation measures

12.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. It should be noted that this assessment is ongoing and is subject to change through ongoing development of the Project proposals.

12.6.2 A full detailed assessment will be undertaken before DCO application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully included in the ES.

Construction

Table 12.9 Potential effects and mitigation measures during construction

Item	Description
Receptor	Material reserves
Potential nature of effect	The Project is expected to require a significant quantity of materials during construction including concrete (both ready mix and concrete products), aggregates, pavement and steel. Given the quantity of these materials currently on the market and projected increases in production, it is not expected that the material demand of the Project would outstrip the supply chain. A negative impact is not expected on the UK materials supply. There is good availability of sand, gravel and recycled aggregate in Essex and Kent. Due to the geology, and the high specification of tunnel design, some materials eg, cement, are not available locally from source, but may be available from local distributors.
Likely duration	Permanent
Potential mitigation	• Reuse of site excavated material where possible, to minimise the amount needed to be imported to site • Use of secondary and recycled aggregate where possible • Assess whether required materials available from local suppliers are sufficient in quantity and/or suitable for use in the Project design • Potential use of borrow pits onsite to reclaim sand and gravel beneath the Project footprint (within Development Boundary) • Wherever possible and where specification allows, construction material resources would include a measurable recycled content in their manufacture • Contractors will be encouraged to apply good practice to source construction materials from suppliers with responsible sourcing certification (as far as practicable) • Timber will be obtained from recycled and/or reclaimed sources or be accredited to meet sustainable forestry standards such as the Forestry Stewardship Council. Any remaining timber not sourced through the above would target a known temperate source using the Department for

Item	Description
	Environmenta, Food and Rural Affairs (Defra) Central Point of Expertise in Timber • Work with designers and contractors to embed commitments around material and waste management in methodology and contracts.
Receptor	Local waste infrastructure capacity
Potential nature of effect	The Project is anticipated to result in large quantities of excavation of soils and tunnelling waste; encompassing natural soils and Made Ground. Waste such as metal, timber and concrete would result from the demolition of structures located within the Development Boundary. Other wastes are anticipated in smaller quantities eg, vegetation. If all Project waste arisings were to be sent off-site for disposal and/or recovery, there would likely be a negative impact on the local waste management infrastructure capacity.
Likely duration	Permanent
Potential mitigation	• The design and construction approach would apply the waste hierarchy (see section 12.3) and the five key principles of waste minimisation (design for: Reuse and Recovery, Off-Site Construction, Materials Optimisation, Waste Efficient Procurement and Deconstruction and Flexibility) in all design phases. • Where possible, waste and materials would be reused within the Development Boundary to minimise off-site haulage movements. Opportunities will be explored to integrate materials reuse into the Project landscape features, including potential landscape enhancement measures at suitable locations. This is subject to further feasibility studies in relation to the suitability of the excavated material and the potential community benefits of such measures. • Where reuse of waste arisings is not possible onsite, alternative off-site projects will be identified that could potentially beneficially reuse the waste materials and therefore divert waste from landfill disposal. • Excavated materials, including top soils, would be carefully stored in segregated piles for subsequent reuse on the development site, where possible. This would be managed through an MMP or appropriate Environmental Permit. If the excavated materials are geotechnically unsuitable or contaminated, they would be kept separate from usable materials and sent for treatment, recycling or recovery, where appropriate, or disposal at appropriately permitted facilities. • Waste management compounds would be established within the Development Boundary to handle incoming waste from construction activities. These would be designed to facilitate the segregation of key waste streams to maximise the opportunity to reuse, recycle and return waste generated onsite. Materials unsuitable for use onsite (eg, timber offcuts that cannot be used onsite) would be collected for subsequent segregation and considered for recycling at an off-site waste facility. • Agreements would be explored with suppliers to reduce the amount of packaging used to protect materials or to participate in a ‘packaging take back’ scheme. • A SWMP would be produced to promote and track the reuse and recovery of construction waste. The contractor would be encouraged to

Item	Description
	have a Waste Champion to supervise the segregation of waste streams and to enhance recovery. • Where waste management commitments are made, these would be embedded in contractor contracts along with the methodology to be used for monitoring and reporting (eg, percentage diversion from landfill).
Receptor	Transport infrastructure and local residents
Potential nature of effect	Haulage movements associated with the import of material resources and export of waste arisings could lead to congestion on the road network, and impacts on local noise and air quality
Likely duration	Temporary during construction phase
Potential mitigation	• Where possible, suitable excavation, tunnelling and demolition materials would be reused within the Development Boundary to minimise off-site haulage movements. • Temporary haul roads would be established at key access points to mitigate impact on the local road network. • A CTMP would be implemented by the contractors to minimise haulage movements and manage their impacts. • A CoCP will be submitted with the DCO application. This will outline measures to be taken by the contractor to reduce the impact of construction vehicle movements on local residents (eg, site hours). • Further study work will be undertaken, and the output detailed in the ES to determine the feasibility of using river transport for the import/export of material resources and waste. • Waste management options would be supported by the identification of appropriately permitted waste management and recycling facilities near the site compounds.

Operation

12.6.3 It is anticipated that, during the lifetime operation of the Project, relatively minor quantities of materials will be used during maintenance activities such as resurfacing works and asset upgrades. In addition, relatively minor quantities of waste will be generated during operation by site staff in offices associated with the portal structures and from maintenance repairs over the operational lifetime of the asset.

12.6.4 Potential impacts would be mitigated by developing materials management requirements and targets/objectives in contractual documentation and Works Information Packages for the future operators in compliance with UK legislation.

12.6.5 Volumes of materials and waste are, therefore, not expected to be significant, compared to that involved in the construction phase and no additional measures to manage impacts from materials or waste are expected to be required.

Chapter 13.

Noise and Vibration

13 Noise and Vibration

13.1 Introduction

13.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on noise and vibration related to the construction and operation of the Project.

13.1.2 The study and assessment of noise and vibration associated with large scale infrastructure projects and the resultant effects upon communities and the surrounding environment is an important issue. Exposure to prolonged or excessive levels of noise and vibration has been demonstrated through epidemiological studies to cause a range of psychological and physiological effects to those living near the source of noise and vibration.

13.1.3 National planning policy seeks to define potential impacts relative to these health-based effects and calls for their minimisation. The consideration of noise and vibration impacts and their effects on the community and environment is, therefore, a key issue in understanding the overall impacts of the Project.

13.1.4 The aims of this chapter are to:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to noise and vibration

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, using the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies or surveys

e. describe the potential effects of the Project on noise and vibration (and how these have been assessed for the purpose of this *Preliminary Environmental Information Report* (*PEIR*)

f. describe potential mitigation measures

13.1.5 There are expected to be interrelationships between the potential effects on noise and vibration and other disciplines reported on in the *PEIR*. These include assessment and consideration of ecological receptors, designated areas and consideration of tranquillity. See:

a. Chapter 8: Landscape

b. Chapter 9: Terrestrial Biodiversity

c. Chapter 10: Marine Biodiversity

13.1.6 Consideration of other interrelationships with noise are described in Chapter 14: People and Communities.

13.2 Planning policy and legislative requirements

Legislative requirements

13.2.1 The legislation applicable to the noise and vibration assessment of the Project is presented below. Consideration of how this will be addressed within the scope of the Project with regard to noise and vibration will be covered in the Environmental Statement (ES).

Table 13.1 Legislative requirements applicable to noise and vibration

Legislation name	Summary of requirements
Noise Insulation Regulations (NIR) 1975 (amended 1988)	The NIR provide criteria for assessing the eligibility for noise mitigation for properties based on variations in traffic noise due to a new or improved road project.
Control of Pollution Act 1974	Under Section 60 of the Act, local authorities have powers to attach conditions to limit or qualify any consent to allow for changes and limit the duration of any consents. It is noted that although it is generally for those undertaking the works (construction contractors in this case) to decide whether to seek such consent, this is also dependent on the custom and practice of the local authority. Some local authorities request demonstration of best practicable means rather than formal 'Prior Consent' applications. Section 61 of the Act sets out procedures for those undertaking works to obtain 'Prior Consent' from the local authority for construction works within agreed noise limits and parameters. Applications for such consent are made by the construction contractor to the relevant local authority and generally contain a method statement of the works and the steps to be taken to minimise noise.
Environmental Protection Act 1990	Under Part III of the Environmental Protection Act 1990, local authorities have a duty to investigate noise complaints from premises (land and buildings) and vehicles, machinery or equipment in the street. It does not apply to road traffic noise but is applicable to some construction activities. The Noise and Statutory Nuisance Act 1993 amended Part III of the Environmental Protection Act 1990 by placing additional definitions in the list of statutory nuisances in Section 79 of the Environmental Protection Act. The definitions relate to nuisance caused by vehicles, machinery and equipment in the road. If a local authority's Environmental Health Officer is satisfied that a complaint amounts to a statutory nuisance, then the authority must serve an abatement notice on the person responsible or in certain cases the Noise Making Authority or occupier of the property. The notice could require that the noise or nuisance must be stopped altogether or limited to certain times of the day.
The Environmental Noise (England) Regulations 2006	The Environmental Noise Regulations have been introduced in England to implement the assessment and management of the Environmental Noise Directive 2002/49/EC. This Directive relates to the assessment and management of environmental noise in EU member states.

Legislation name	Summary of requirements
(as amended 2008, 2009)	In accordance with European legislation, these Regulations need noise action plans to be developed on a five-year rolling programme. Specifically, part (e) of Regulation 15 sets the general requirements for action plans, identifying that any action plan must "apply in particular to the most important areas as established by strategic noise maps". Under this legislation, "Noise Important Areas" have been defined in England where the top 1% of the population that are affected by the highest noise levels are located according to the results of the strategic noise mapping undertaken by Defra. The purpose of the Action Plan, and the defined Noise Important Areas is to manage environmental noise and its effects, including where necessary the implementation of noise reduction. While not a specific requirement of the Project the consideration of noise impacts on defined Noise Important Areas within the study area is required to be assessed in accordance with the NPSNN.
Land Compensation Act, 1973	Part 1 of the Land Compensation Act provides a means by which compensation can be paid by Noise Making Authorities to owners of land or property which has experienced a loss in value caused by the use of public works, such as new or improved roads. Noise and vibration are two of the factors which would be considered for any claims for compensation, but the claim must consider all changes and effects, including betterment.
The Highways Noise Payments and Movable Homes Regulations, 2000	The Highways Noise Payments and Movable Homes Regulations, 2000 provide highways authorities with a discretionary power to provide a noise payment where new roads are to be constructed or existing ones altered. The Regulations only apply to caravans and houseboats which have been lawfully stationed and are within 300m of the new or altered carriageway.

National Policy Statement for National Networks

13.2.2 The elements of the NPSNN relevant to the noise and vibration assessment of the Project are presented below:

Table 13.2 NPSNN requirements and Project response

Requirement (including paragraph number)	Project response
5.188 "factors that will determine the likely noise impact include: • construction noise and the inherent operational noise from the proposed development and its characteristics; • the proximity of the proposed development to noise sensitive premises (including residential properties, schools and hospitals) and noise sensitive areas (including certain parks and open spaces); • the proximity of the proposed development to quiet places and other areas that are particularly valued for	The Project will be demonstrated to conform with the principles of paragraph 5.188 of the NPSNN based on providing the following within the ES. The assessment and consideration of noise and vibration relative to: • Construction noise and vibration • Operational road traffic noise and vibration • Operational ventilation plant noise and vibration These assessments will be undertaken and provided in the ES based on human receptors,

Requirement (including paragraph number)	Project response
their tranquillity, acoustic environment or landscape quality such as National Parks, the Broads or Areas of Outstanding Natural Beauty; and • the proximity of the proposed development to designated sites where noise may have an adverse impact on the special features of interest, protected species or other wildlife."	ecological receptors and tranquillity within the following chapters: • Chapter 8: Landscape • Chapter 9: Terrestrial biodiversity • Chapter 10: Marine ecology • Chapter 13: Noise and vibration.
5.189 "Where a development is subject to Environmental Impact Assessment (EIA) and significant noise impacts are likely to arise from the proposed development, the applicant should include the following in the noise assessment, which should form part of the environment statement:	An explanation of how the Project conforms with the principles of the NPSNN will be provided in the ES. The operational road traffic noise assessment will be based upon the most likely mix of light vehicles and heavy vehicles over an 18-hour period during the daytime and an 8-hour period during the night as defined within the Lower Thames Area Traffic Model. A construction noise assessment will describe likely noise sources and effects associated with all the construction activities associated with the development of the Project including specialist activities including tunnelling works. A tunnel ventilation noise assessment will describe the noise associated with the operation of the tunnel. The assessment will appropriately consider tonal or impulsive characteristics from the tunnel ventilation in accordance with appropriate Standards and Guidance.
• a description of the noise sources including likely usage in terms of number of movements, fleet mix and diurnal pattern. For any associated fixed structures, such as ventilation fans for tunnels, information about the noise sources including the identification of any distinctive tonal, impulsive or low frequency characteristics of the noise.	
• identification of noise sensitive premises and noise sensitive areas that may be affected.	Noise sensitive receptors and areas will be defined in accordance with the *Design Manual for Roads and Bridges* (*DMRB*) and contained within the detailed study area for the Project. These receptors will be presented graphically within figures supporting the ES.
• the characteristics of the existing noise environment.	Noise surveys will be undertaken at locations within the detailed noise and vibration study area during both the daytime and night-time, as well as over weekday and weekend periods to characterise the existing noise climate of the area surrounding the Project. The monitored levels from these noise surveys will be presented within the Noise and Vibration chapter of the ES.

Requirement (including paragraph number)	Project response
• a prediction on how the noise environment will change with the proposed development:	
○ In the shorter term such as during the construction period;	Short-term noise impacts from the construction phase will be considered in accordance with British Standard 5228 :2009+A1:2014 "*Code of practice for noise and vibration control on construction and open sites*" Part 1; Noise (BS5228-1). The assessment will also consider short-term road traffic noise impacts from the operation of the Project in the opening year.
○ in the longer term during the operating life of the infrastructure;	The assessment will consider long-term operational road traffic noise impacts by considering future road traffic noise levels 15 years after opening of the Project. In addition, long-term operational impacts associated with tunnel ventilation plant will also be considered and mitigated where necessary.
○ at particular times of the day, evening and night as appropriate.	Noise impacts during the daytime and night-time periods will be assessed for construction, operational road traffic noise and tunnel ventilation noise as defined within the relevant guidance methodologies.
• an assessment of the effect of predicted changes in the noise environment on any noise sensitive premises and noise sensitive areas.	As part of the *DMRB* assessment methodology the change in road traffic noise level, its magnitude and the effect will be assessed within the Noise and Vibration chapter of the ES at identified sensitive receptors within the detailed study area.
• measures to be employed in mitigating the effects of noise; and	Mitigation methods will be implemented into the Project design to mitigate adverse construction noise and road traffic noise levels to a minimum, in accordance with Noise Policy Statement for England (NPSE).
• the nature and extent of the noise assessment should be proportionate to the likely noise impact	The assessment will be undertaken using *DMRB* and relevant British Standards and is considered proportionate to the likely noise impacts of the Project. Proportionate assessment of potential impacts will be undertaken across the Lower Thames Area Traffic Model coverage.

Requirement (including paragraph number)	Project response
• Applicants should consider using best available techniques to reduce noise impacts."	The use of Best Available Techniques to reduce noise and vibration impacts to a minimum will be implemented into the Project using a Construction Environmental Management Plan (CEMP) during the construction phase and through design measures relating to operational phase impacts.
5.190 "The potential noise impact elsewhere that is directly associated with the development, such as changes in road and rail traffic movements elsewhere on the national networks, should be considered as appropriate."	Indirect impacts resulting from changes in road traffic noise level on the existing road network will be assessed in accordance with the methodology detailed within the *DMRB*. The noise and vibration assessment will be based upon the traffic flow and composition outputs of the traffic model. It will consider the potential for noise impacts elsewhere within the traffic model area outside of the immediate Project. Specific receptors will be considered within the *DMRB*-defined detailed study area; outside of this, impacts upon key link roads will be considered within the overall traffic model area. Material transportation within the construction phase will use road, rail and water-based transportation systems where appropriate. Temporary impacts associated with these would be considered within the construction phase assessment presented within the Noise and Vibration chapter of the ES.
5.191 "Operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. The prediction of road traffic noise should be based on the method described in Calculation of Road Traffic Noise. The prediction of noise from new railways should be based on the method described in Calculation of Railway Noise. For the prediction, assessment and management of construction noise, reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies"	Construction noise and vibration impacts will be predicted and assessed in accordance with BS5228-1 and BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites (BS5228). Where necessary in the construction phase assessment, based upon final transportation options for materials, reference will be made to *Calculation of Road Traffic Noise* (*CRTN*). Mitigation will be specified within the scope of the CEMP and secured within the Development Consent Order (DCO). Operational road traffic noise levels will be predicted in accordance with the methodology of the *CRTN*. Operational noise from the tunnel ventilation will be assessed in accordance with British Standard 4142 'Methods for rating and assessing industrial and commercial sound' (BS4142).

Requirement (including paragraph number)	Project response
5.192 "The applicant should consult Natural England with regard to assessment of noise on designated nature conservation sites, protected landscapes, protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially affected species in nearby sites may also need to be taken into account."	The potential effects of noise and vibration on ecological receptors and other identified sensitive receptors will be considered within the scope of the ES, within the following chapters: • Chapter 8: Landscape • Chapter 9: Terrestrial biodiversity • Chapter 14: People and communities

Planning policy requirements

13.2.3 The planning policy applicable to the noise and vibration assessment of the Project is presented below:

Table 13.3 Planning policy

Policy name	Summary of requirements
National Planning Policy Framework (NPPF)	Within paragraph 170 of Section 15 of the July 2018 revision of the NPPF it is stated that "Planning policies and decisions should contribute to and enhance the natural and local environment by: e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans." Furthermore, with regard to noise, paragraph 180 of the NPPF states that: "Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should: a) mitigate, and reduce to a minimum, potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life; b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."
Noise Policy Statement for England (NPSE)	The NPSE vision is to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development. To achieve this vision, the NPSE sets out the following aims for the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development: • avoid significant adverse impacts on health and quality of life

Policy name	Summary of requirements
	• mitigate and minimise adverse impacts on health and quality of life • where possible, contribute to improvement of health and quality of life
Havering Local Plan - Policy 34 Managing Pollution	The Council will support development proposals that: • do not unduly impact upon amenity, human health and safety and the natural environment by noise, dust, odour and light pollution, vibration and land contamination • do not pose an unacceptable risk to the quality of the water catchment, groundwater or surface water • optimise the design, layout and orientation of buildings and the use of green infrastructure to minimise exposure to the above pollutants
Gravesham Local Plan Core Strategy - Policy CS19: Development and Design Principles	New development will be located, designed and constructed to avoid adverse environmental impacts from pollution, including noise, air, odour and light pollution, and land contamination.
Thurrock Core Strategy and Policies for Management of Development (as amended) - PMD1 – Minimising Pollution and Impacts on Amenity, Health, Safety and The Natural Environment	The Council will require assessments to accompany planning applications where it has reasonable grounds to believe that a development may suffer from, or cause: • air pollution • noise pollution • contaminated land/soil • odour • light pollution and shadow flicker • water pollution • invasion of privacy • visual intrusion • loss of light • ground instability • vibration
Brentwood Replacement Local Plan (Aug 2005) Saved Policies (Aug 2008) - PC6 Transport Pollution	All new transport proposals and improvements to existing transport infrastructure and services will be assessed against their impact on air quality, noise levels and visual amenity, and will need to be designed to minimise any negative impacts and, where necessary, incorporate reasonable and appropriate mitigation measures
Medway Council Local Plan (Adopted 2003) Policy BNE2: Amenity Protection	All development should secure the amenities of its future occupants, and protect those amenities enjoyed by nearby and adjacent properties. The design of development should have regard to: (i) privacy, daylight and sunlight (ii) noise, vibration, light, heat, smell and airborne emissions consisting of fumes, smoke, soot, ash, dust and grit (iii) activity levels and traffic generation

Policy name	Summary of requirements
Dartford Development Policies Plan, Policy DP5: Environmental and Amenity Protection	Development will only be permitted where it does not result in unacceptable material impacts, individually or cumulatively, on neighbouring uses, the Borough's environment or public health. Consideration must be given to Policies Map designations, areas of sensitivity highlighted in other policies in this Plan, and other potential amenity/safety factors such as: a) air and water quality, including groundwater source protection zones b) intensity of use, including hours of operation c) anti-social behaviour and littering d) traffic, access, and parking e) noise disturbance or vibration f) odour g) light pollution h) overshadowing, overlooking and privacy i) electrical and telecommunication interference j) HSE land use consultation zones

13.3 Methodology

13.3.1 This section presents the noise and vibration assessment methodologies which have been used to date in the consideration of potential construction and operational impacts associated with the Project. Data has been collected at identified dwellings and sensitive receptors, drawing on the methodologies outlined within the *Scoping Report* (Highways England, 2017).

Study area

Construction

13.3.2 The study area for the construction noise assessment will comprise an area up to 300m from the Development Boundary. This will be determined in accordance with guidance provided in BS5228-1, which considers that, at distances greater than 300m, noise predictions should be treated with caution because of the increasing importance of meteorological effects including wind speed and direction, atmospheric pressures and temperature inversions. As such the prediction of construction noise levels presented within the ES will initially be undertaken to identified receptors within 300m, as the potential for significant impacts at residential receptors would be unlikely beyond this distance. However, to provide a robust assessment of the potential for effects from construction noise activities within the area, receptors outside of 300m will be considered where required. This approach will be consulted with the relevant local authorities.

13.3.3 The study area for the construction vehicle assessment for the ES will consider any road/route identified within the Transport Assessment as experiencing temporary increases in heavy vehicle movements accounting for a predicted increase in road traffic noise of greater than 1dB during the construction phase. The study area will consider the effects resulting from temporary road closures and diversions where appropriate.

Operation

13.3.4 The operational noise study area has been derived from the requirements of the *DMRB* but reflects the preliminary stage of assessment.

13.3.5 The study area, in accordance with the *DMRB,* is defined by the following process.

Table 13.4 Study area process

Step	Process
A	Identify the start and end points of the physical works associated with the road project.
B	Identify the existing routes that are being bypassed or improved, and any proposed new routes, between the start and end points.
C	Define a boundary one kilometre from the carriageway edge of the routes identified in (B) above.
D	Define a boundary 600m from the carriageway edge around each of the routes identified in (B) above and 600m from any other affected routes* within the boundary defined in (C) above. The total area within these 600m boundaries is termed the 'calculation area'.

** An affected route is one where there is the possibility of a change of 1dB(A) or more between the Do-Minimum and Do-Something scenarios in the short-term or 3dB(A) or more in the long-term.*

13.3.6 The operational noise and vibration road traffic noise study area focuses on existing routes that are being bypassed or improved, and any proposed new routes, as set out in the process above, and is presented in Figure 13.1 in Volume 3.

13.3.7 The study area for the ES will be expanded to additionally consider other affected routes as defined above. The ES will also consider potential significant effects beyond the defined 600m corridor where appropriate.

13.3.8 Within the study area for the noise assessment, sensitive receptors are classified as "dwellings" and "Other Sensitive Receptors (OSR)". OSRs are defined in *DMRB* as including "hospitals, schools, community facilities, designated areas (eg, Areas of Natural Beauty, National Park, Special Areas of Conservation, Special Protection Areas, Sites of Special Scientific Interest (SSSI), Scheduled Ancient Monuments), and Public Rights of Way", although not all of these occur within the Project study area.

Baseline

13.3.9 Within the scope of this chapter, information relating to the existing environmental conditions has been based upon commercial mapping information, aerial photography, site visits and baseline/ambient noise monitoring. The information quantified through the noise surveys will be used to validate the operational road traffic noise model, inform the ventilation plant assessment and inform the construction noise assessment.

13.3.10 In addition to quantifying the current baseline and ambient noise climate through surveys, a predictive quantification of the prevailing baseline road traffic noise climate will be undertaken, within the scope of the EIA, to inform the operational road traffic noise assessment. This will be quantified for all assessment locations within the study area based upon the supplied traffic information for both the opening and future assessment years.

Noise monitoring

13.3.11 Existing ambient/baseline noise measurements have been taken at 16 monitoring locations positioned within the noise and vibration study area and are considered to be representative of the general noise climate along the length of the Project.

13.3.12 These locations are presented on Figure 13.2 in Volume 3. All monitoring locations and durations were notified to the appropriate local authority Environmental Health department before the surveys were taken and their comments have been included in the surveys. Surveys were carried out in accordance with the *CRTN* shortened method measurement protocol (three consecutive hours between 10:00 and 17:00 on a typical weekday).

13.3.13 The surveys were undertaken between June and July 2018 and were carried out in accordance with BS 7445-1:2003 *Description and measurement of environmental noise. Guide to quantities and procedures* (BS7445).

13.3.14 The noise monitoring equipment that was used corresponded to that specified in BS-EN 61672-1 *Electro-acoustics, Sound Level Meters, Specifications* (2013). The equipment was calibrated in accordance with the manufacturers' specifications within the previous two years and was validated by a localised calibration to a known reference tone prior to the start and upon completion of the surveys. No drift was observed.

13.3.15 During the surveys the meteorological conditions were considered acceptable for noise surveys, with no rain and wind speeds below 5m/s.

Construction

13.3.16 At this stage of the Project, preliminary construction information is used to support the consideration of construction noise and vibration. This centres around high level construction methodology and has been used in a qualitative manner to identify the potential for adverse construction noise and vibration impacts associated with the Project. Further information will become available through the design process which will be incorporated and considered fully within the ES.

Operation

Operational road traffic noise

13.3.17 As part of the *DMRB* assessment, it is necessary to consider road traffic noise changes within the study area because of the Project during both the short and long term. The operational road traffic noise assessment methodology for the *PEIR* has been derived from the requirements of the *DMRB* but reflects the preliminary stage of assessment. The full scope of the detailed assessment will be presented in the ES.

13.3.18 Within the scope of this document the following comparisons of predicted road traffic noise are presented to consider the potential impacts of the Project:

a. Opening Year "Do Minimum" (without Project) against Opening Year "Do Something" (with Project)

b. Opening Year “Do Minimum” against Future Assessment Year “Do Something”

13.3.19 To allow these comparisons to be made, road traffic noise calculations have been undertaken in accordance with the *CRTN* prediction methodology. This allows the calculation of dB $L_{A10,18\text{-hour}}$ values for road traffic noise contribution at identified sensitive receptors within the study area to be derived from supplied traffic data.

13.3.20 Calculations have been made using the commercially available noise modelling software, IMMI, which has been validated to follow the prediction procedures set out in the *CRTN*.

13.3.21 Traffic data information has been provided for both the assumed Opening Year (2026) and Future Assessment Year (15 years after opening; 2041) “Do Minimum” and “Do Something” scenarios based on the following:

a. 18-hour Annual Average Weekday Traffic (AAWT) flow

b. 18-hour average speed (km/h)

c. Percentage heavy goods vehicle content of total 18-hour AAWT flow

13.3.22 An assessment of potential road traffic noise impacts has been presented based upon perceptibility, and the beneficial or adverse nature of the potential change in noise level. *DMRB* provides classification for the magnitude of change in road traffic noise. A change in road traffic noise of 1dB(A) in the short term (“Do Minimum” to “Do Something” in the opening year) is the smallest that is considered perceptible. In the long term (“Do Minimum” in the opening year to “Do Something” in the future assessment year), a 3dB(A) change is the smallest that is perceptible.

13.3.23 Measurements of traffic-induced vibration undertaken by the Transport Research Laboratory and presented within Supplementary Report 218UC *Traffic Induced Ground Vibration in The Vicinity of Road Tunnels* indicate that levels of vibration generated by road traffic travelling through a tunnel are below the level of perception. As such, no assessment of potential ground-borne operational vibration impacts from road traffic using the proposed tunnel has been undertaken.

Operational tunnel ventilation

13.3.24 At this stage of the Project, design only preliminary information is available to support the consideration of operational tunnel ventilation. Further information will become available through the design process which will be incorporated and considered fully within the ES.

13.3.25 Within the scope of the chapter, consideration of the operational tunnel ventilation focuses on high level specification of appropriate operational noise limits specific to static plant provision. Regarding noise, this will be with reference to BS 4142:2014 *Methods for rating and assessing industrial and commercial sound*. This document quantifies noise impacts through a comparison of predicted plant noise against existing measured background noise levels.

13.3.26 Typically, plant and equipment used to ventilate road traffic tunnels is designed and specified so that it does not inherently generate discernible levels of vibration outside of the immediate vicinity. Control of vibration levels is an integral part of the design of operational plant. Unmitigated vibration has the potential to fatigue structural elements, shorten the lifespan of operational equipment and increase maintenance costs. Therefore, the control of operational vibration for these reasons will ensure that vibration generated by the tunnel ventilation plant is not discernible outside of the immediate vicinity of the plant. Operational vibration will be controlled and mitigated through design.

13.4 Existing environmental conditions

13.4.1 The following sections discuss areas with the potential for road traffic noise to change because of the Project. This could be due to the Project itself or changes in traffic flow patterns on the existing network attributable to it.

Between south shore of the River Thames and A2 junction

13.4.2 There are dwellings between the south shore of the River Thames and the Project junction with the A2 that fall within the operational noise and vibration study area. These are primarily at the eastern extent of Gravesend, within the areas of Chalk, Singlewell, Riverview Park and Thong. In addition to these main residential areas there are also several outlying dwellings.

13.4.3 The following OSRs (as defined in paragraph 13.3.8) have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Gravesend Crematorium and Cemetery

b. Michael Gardens Park

c. St Mary's Church

d. Thames Estuary & Marshes Ramsar

e. South Thames Estuary and Marshes SSSI

13.4.4 There are no identified Noise-important Area(s) (NIAs), as defined within Table 13.1 under The Environmental Noise (England) Regulations 2006 (as amended 2008, 2009) identified within this area.

13.4.5 A summary of the monitored noise survey data is presented in Table 13.5.

Table 13.5 Summary of monitored noise survey data collected to date - south of the River Thames between south tunnel portal and A2 junction

Noise monitoring location (see Figure 13.2 in Volume 3)	dB $L_{A10,}$ 3 hour	dB $L_{Aeq,}$ 3 hour	dB $L_{A90,}$ 3 hour	Calculated dB $L_{A10,}$ 18 hour*
ST05	54.4	54.6	43.3	53.4
ST34	62.3	58.8	48.8	61.3

** Calculated in accordance with CRTN Shortened Measurement Procedure*

13.4.6 It can be concluded that the dominant source of noise in the study area is attributable to road traffic noise contributions from the existing A226 and the A2. Rail noise from the commuter line between Higham and Gravesend through Hoo Junction is also a contributing factor towards the north near Chalk.

Between north shore of the River Thames and A13

13.4.7 Between the north shore of the River Thames and the Project junction with the A13 within the operational noise and vibration study area there are existing noise sensitive dwellings located in Tilbury, Linford, Chadwell St Mary and Grays. In addition to these main residential areas there are several outlying dwellings.

13.4.8 The following OSRs have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Emmanuel Church

b. Wickham Fields (nature reserve)

c. Ron Evans Memorial Park

d. Willow Garden Day Nursery

e. Beacon Hill School

f. Treetops School

g. Linford Village Hall

h. The Whitecroft (residential nursing home)

13.4.9 There are also six NIAs which are likely to be within the final noise assessment calculation area. The locations of the six NIAs identified by Defra identification number and Noise Making Authority are presented in Figure 13.1 in Volume 3 and within Table 13.6.

Table 13.6 NIAs located between the north shore of the River Thames and the Project junction with the A13

NIA Ref. No	Noise Making Authority	Location
5693	Highways England	Located along the A1089
5694	Thurrock Council	Located along the A1013
5695	Highways England	Located along the B188
5696	Thurrock Council	Located along the A1013
5697		
5698		

13.4.10 A summary of the monitored noise survey data is presented in Table 13.7.

Table 13.7 Summary of monitored noise survey data collected to date - between north tunnel portal and A13

Noise monitoring location (see Figure 13.2 in Volume 3)	dB $L_{A10,}$ 3 hour	dB $L_{Aeq,}$ 3 hour	dB $L_{A90,}$ 3 hour	Calculated dB $L_{A10,}$ 18 hour*
ST9	48.8	47.1	37.8	47.8
ST12	46.9	47.1	34.8	45.9
ST15	52.4	51.1	40.4	51.4
ST18	54.2	52.2	48.7	53.2
ST19	56.9	55.3	52.8	55.9
ST20	62.0	59.8	56.3	61.0
ST36	50.3	53.9	43.3	49.3
ST 37	44.1	43.5	37.4	43.1

** Calculated in accordance with CRTN Shortened Measurement Procedure*

13.4.11 The area is predominantly rural with road traffic noise contribution from the A13 towards the north, and rail noise contribution from the rail line which runs from Tilbury to Stanford-le-Hope. The existing ambient noise levels for most of this area would be considered to be low.

Between A13 and the northern junction with M25

13.4.12 Between the A13 and the northern junction with the M25 within the operational noise and vibration study area there are existing noise sensitive dwellings located in Orsett, South Ockendon and North Ockendon. In addition to these main residential areas there are several outlying dwellings.

13.4.13 The following OSRs have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Orsett Recreation Ground

b. Chapel Farm (youth hostel)

c. Orsett Church of England Primary School

d. Hobletts Nursery

13.4.14 There are no identified NIAs identified within this area.

13.4.15 A summary of the monitored noise survey data is presented in Table 13.8.

Table 13.8 Summary of monitored noise survey data collected to date - between A13 and the northern tie-in with M25

Noise monitoring location (see Figure 13.2 in Volume 3)	dB $L_{A10,}$ 3 hour	dB $L_{Aeq,}$ 3 hour	dB $L_{A90,}$ 3 hour	Calculated dB $L_{A10,\ 18\ hour}$*
ST28	50.9	48.6	43.1	48.9

** Calculated in accordance with CRTN Shortened Measurement Procedure*

13.4.16 The area is predominantly rural with some road traffic noise contribution from the A13 towards the south and from the M25 towards the west. The existing ambient noise levels from most of this area would be considered to be low.

Along existing A13 between Project and M25 at junction 30

13.4.17 Along the existing A13, between the site of the proposed new junction with the Project and the M25 at junction 30 within the operational noise and vibration study area, there are existing noise sensitive dwellings located in Chafford Hundred, North Stifford and Stifford Clays.

13.4.18 The following OSRs have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Community facilities

   i. Long Lane Recreation Ground

   ii. North Stifford Recreation Ground

   iii. Brannetts Wood Play Area

   iv. Chafford Hundred Medical Centre

   v. Essex Wildlife Trust Visitors Centre

   vi. Grays Jean Hall (village hall)

b. Education

   i. William Edwards School

   ii. Tudor Court Primary School

   iii. Leapfrog Day Nurseries

   iv. Warren Primary School

c. Hotels

   i. Stifford Clays Farm House (youth hostel)

   ii. Park Inn (hotel)

   iii. Premier Inn (hotel)

d. Place of worship

   i. St Mary's Church

13.4.19 There are also four NIAs which are likely to be within the final noise assessment calculation area. The locations of the four NIAs identified by Defra identification number and Noise Making Authority, are presented in Figure 13.1 in Volume 3 and within Table 13.9.

Table 13.9 NIAs located along existing A13 between Project and M25 at junction 30

NIA ref no	Noise Making Authority	Location
5565	Highways England	Along the A13
5566		
5700		
5699		

13.4.20 At this stage of the Project's design no ambient/baseline noise surveys have been undertaken within this area.

13.4.21 The dominant source of noise in this area is attributable to road traffic noise from the A13, A1012, A1306 and A126.

Along the existing M25 between junction 28 and the Dartford Crossing

13.4.22 Along the existing M25 between junction 28 and the Dartford Crossing within the operational noise and vibration study area, there are existing noise sensitive dwellings located in: Upminster, Great Warley, Hornchurch, Little Warley, Aveley, South Ockendon, West Thurrock, Purfleet, Thurrock and Grays. In addition to these main residential areas there are several outlying dwellings.

13.4.23 The following OSRs have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Community facility
    i. Belhus Park
b. Education
    i. Dilkes Academy
c. Hotels
    i. Premier Inn
    ii. Ibis Thurrock
    iii. Hotel Formula One
d. Places of worship
    i. All Saints Church
e. Residential homes
    i. Aveley House
    ii. Larwood

13.4.24 There are also three NIAs which are likely to be within the final noise assessment calculation area. The locations of the 3 NIAs identified by Defra identification number and Noise Making Authority, are presented in Figure 13.1 in Volume 3 and within Table 13.10.

Table 13.10 Noise Important Areas along the existing M25 between junction 28 and the Dartford Crossing

NIA Ref No	Noise Making Authority	Location
5567	Highways England	Located along the M25
5570		
5571		Located along the B1421

13.4.25 A summary of the monitored noise survey data is presented in Table 13.11.

Table 13.11 Summary of monitored noise survey data collected to date - Between A13 and the northern tie-in with M25

Noise monitoring location (see Figure 13.2 in Volume 3)	dB $L_{A10,\ 3\ hour}$	dB $L_{Aeq,\ 3\ hour}$	dB $L_{A90,\ 3\ hour}$	Calculated dB $L_{A10,\ 18\ hour}$*
ST43	66.6	64.9	62.2	65.6
ST48	63.1	62.8	57.4	62.1

** Calculated in accordance with CRTN Shortened Measurement Procedure*

13.4.26 The dominant source of noise in this part of the study area is attributable to road traffic noise contributions from the M25, A13, A282 and A1306. Towards the south of this area, noise from rail movements is also a contributing factor.

13.4.27 At this stage of the Project's design no ambient/baseline noise surveys have been undertaken within this area.

Along the existing A282 between Dartford Crossing and the M25/A2 junction

13.4.28 Along the existing A282 between the Dartford Crossing and the M25/A2 junction within the operational noise and vibration study area there are existing noise sensitive dwellings located in Dartford, Stone, Southfleet, Darenth and Greenhithe.

13.4.29 The following OSRs have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Community Facilities

   i. Temple Hill County Youth Club

   ii. Watling Street Cemetery

   iii. East Hill Burial Ground

   iv. Bow Arrow Cemetery

v. Hesketh Park

vi. Stone Lodge Complex

b. Education

i. The Brent County Primary Junior and Infant School

ii. Leigh Technology Academy

iii. Fleetdown School

iv. St Anselms Roman Catholic Primary School

v. Temple Hill County Primary Infants School

vi. Temple Hill Children Centre

vii. The Gateway Primary School

viii. Windmill Nursery

c. Hotel

i. Holiday Inn Express

ii. Double Tree by Hilton

iii. Premier inn

iv. Campanile Hotel

d. Place of Worship

i. Methodist Church

ii. Rehoboth House

iii. Temple Hill Baptist Church

iv. St Albans Church

v. St Andrews United Reform Church

vi. Winners Chapel

e. Residential homes

i. Littlebrook Hospital

ii. Tarentforte Centre

iii. Dartford East Health Centre

iv. Elizabeth Raybould Centre

v. Priory Mews

vi. Gardenia House

vii. Rosewood Lodge

viii. Tree Tops

ix. Archery House

13.4.30 There are also two NIAs which are likely to be within the final noise assessment calculation area. The locations of the two NIAs, identified by Defra identification number and Noise Making Authority, are presented in Figure 13.1 in Volume 3 and within Table 13.12.

Table 13.12 Noise Important Areas along the existing A282 between Dartford Crossing and the M25/A2 junction

NIA Ref No	Noise Making Authority	Location
1121	Highways England and Kent	Along the A2
927	Kent County Council	Along the A206

13.4.31 The dominant source of noise in this area is attributable to road traffic noise contributions from the A282, A206, A225 and B260. Towards the north of this area, noise from rail movements is also a contributing factor.

13.4.32 At this stage of the Project's design no ambient/baseline noise surveys have been undertaken within this area.

Along the existing A2 between A282/M25 junction and M2

13.4.33 Along the existing A2, between A282/M25 junction and M2 within the operational noise and vibration study area, there are existing noise sensitive dwellings in: Gravesend, Higham, Cobham, Rochester, Gravesham, Shorne, Northfleet, Ebbsfleet Valley, Swanscombe, Bean, Dartford, Greenhithe, Southfleet and Longfield. In addition to these main residential areas, there are several outlying dwellings.

13.4.34 The following OSRs have also been identified within 600m of the Development Boundary and are presented on Figure 13.1 in Volume 3:

a. Community facility

i. Shorne Woods Country Park

ii. Waller Park

iii. The Gerald Miskin Memorial Hall

b. Education

i. Singlewell County Primary School

ii. Dimples Day Nursery

iii. Springhead House (children's nursery)

iv. Painters Ash County Primary School

c. Hotels

i. Premier Inn

ii. Manor Hotel

iii. Inn on the Lake

iv. Tollgate Hotel

d. Place of worship

i. Dene Holm Methodist Church

e. Residential homes/medical facility

i. Peter Gidney Neurodisability Centre

ii. Beechcare Residential Home

iii. Kentwood House Nursing Home

13.4.35 There are also 11 NIAs which are likely to be within the final noise assessment calculation area. The locations of the 11 NIAs, identified by Defra identification number and Noise Making Authority, are presented in Figure 13.1 in Volume 3 and within Table 13.13.

Table 13.13 NIAs along the existing A282 between Dartford Crossing and the M25/A2 junction

NIA Ref No	Noise Making Authority	Location
1219	Highways England	Located along the A2
1220		
6265		
5955		Located along the A225
5957		Located along the A282
5958		Located along the A2
5959		
5960		
846		
921		
924	Kent County Council	Located along the B262

13.4.36 A summary of the monitored noise survey data is presented in Table 13.14.

Table 13.14 Summary of monitored noise survey data collected to date - Along the existing A2 between A282/M25 junction and M2

Noise monitoring location (see Figure 13.2 in Volume 3)	dB $L_{A10,}$ 3 hour	dB $L_{Aeq,}$ 3 hour	dB $L_{A90,}$ 3 hour	Calculated dB $L_{A10, 18 hour}$*
ST02	69.7	68.4	66	68.7
ST41	65.1	63.7	61.4	64.1
ST51	61.9	60.4	57.7	60.9

** Calculated in accordance with CRTN Shortened Measurement Procedure*

13.4.37 The dominant source of noise in this area is attributable to road traffic noise contributions from the A2, A296, A227, B260 and B255. Towards the east of this area, noise from rail movements is also a contributing factor.

13.5 Further baseline information and surveys required

13.5.1 Additional baseline/ambient noise surveys will be undertaken within the scope of the ES, covering both the weekday and weekend periods to gain an understanding of the local diurnal noise variations. Both daytime and night-time noise levels at identified sensitive receptors within the study area will be quantified.

13.5.2 The specifics of the survey locations and durations have been consulted upon with: the London Borough of Havering, Gravesham Borough Council, Thurrock Council, Brentwood Borough Council and Medway Borough Council prior to monitoring being undertaken. Currently, the following responses have been received:

a. London Borough of Havering, acknowledgement of receipt and agreement with methodology proposed

b. Gravesham Borough Council, acknowledgement of receipt and agreement with methodology proposed, subject to the potential for reconsideration following the release of finalised A2 junction plans

c. Thurrock Council, acknowledgement of receipt and agreement with methodology proposed subject to changes to certain monitoring locations

d. Brentwood Borough Council, no response to correspondence to date

e. Medway Borough Council, no response to correspondence to date

13.5.3 As part of the ES assessment, a prediction of existing and future baseline road traffic noise contribution to the area in the absence of the Project will be made. This will be done in accordance with the methodology of *CRTN* and is required as part of *DMRB* detailed assessment methodology. Additionally, noise surveys will be taken around the existing road network, specifically the M25, A282, A13 and A2 to assist in validating the baseline model.

13.6 Potential effects and mitigation measures

13.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. Note that this assessment is ongoing and is subject to change as the Project proposals are developed.

13.6.2 A detailed assessment will be made before DCO application to identify the mitigation required. The results of this assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the ES.

Construction – entire Project route

Table 13.15 Effects and mitigation during construction

Item	Description
Receptor	Dwellings and other sensitive receptors within 300m of Development Boundary
Potential nature of effect	There is potential for temporary adverse noise and vibration effects during the Project's construction phase. **Construction noise** It is anticipated that construction noise effects could occur due to the following aspects of the Project: • Adverse noise impacts from the operation of construction plant within the Development Boundary. While most of the construction works activities will be completed within standard daytime working hours, certain activities (including connecting the Project into the existing road network) will require either extended standard hours or night-time operations, so there would be a potential for both daytime and night-time construction noise impacts. • Methods of transport of excavated material and deliveries are still under consideration but may involve both road and river, which would result in changes to noise levels along these routes. There is also the potential for temporary changes in noise levels around areas identified for the potential jetty which will be considered. • During the construction phase of the Project there may be a requirement for road closures and temporary diversions to be implemented. • Main tunnel drive site – tunnel construction will be on a continuous working hour basis of 24/7. Therefore, there would be a potential for both daytime and night-time construction noise impacts from the operation of the tunnel-boring machine. The location of the main tunnel drive site is still under consideration and could be positioned either on the north or south of the River

Item	Description
	Thames. The location of surface-based support plant and equipment is also to be confirmed. • Tunnel segment production facility – due to the nature of producing precast concrete, this facility will need to operate on a continuous basis 24/7. Therefore, there would be a potential for both daytime and night-time construction noise impacts from this activity. **Construction vibration** It is anticipated that potential construction vibration effects during the daytime and night-time could occur due to the following activities: • Percussive piling • Vibratory piling • Tunnel boring Rotary-bored piling operations have inherently low vibration levels and are unlikely to have any discernible effects outside the immediate vicinity.
Likely duration	Temporary, during the construction of the Project. Because of the linear nature of the Project, very few locations will experience construction noise and vibration impacts for the entire construction period. Construction works will be transient for most of the Project. Exceptions to this are the tunnel drive and reception sites and construction compounds, where impacts over a longer duration will be expected.
Potential mitigation	Measures to minimise noise and vibration impacts from the construction phase would involve adopting 'Best Practicable Means' (as outlined in section 72 of the Control of Pollution Act 1974) and the recommendations of good practice presented in BS 5228-1:2009+A1:2014 Parts 1 and 2. As part of the ES a detailed predictive construction noise and vibration assessment will be undertaken, based on Project specific construction information and in accordance with BS5228: 2009+A1:2014 Parts 1 and 2. The assessment will consider appropriate construction noise and vibration limits, potential construction noise and vibration generation and specific mitigation measures where necessary. To set a framework of how noise and vibration impacts will be managed during the construction phase, a Code of Construction Practice (CoCP) will be developed. The CoCP will provide provisions to minimise noise and vibration impacts. In addition, these methods for mitigating construction noise and vibration would be implemented through a CEMP and secured within the DCO. The provisions of the CoCP will be based on the findings of the environmental impact assessment for the Project and will be submitted to support the DCO application.

Item	Description
	The appointed construction contractors will be required to prepare their own CEMP, which will include clear references to the provisions of the CoCP and incorporate the appropriate mitigation measures identified in the ES which will include, but not be limited to, the following: • providing contact details for a site representative in the event that disturbance due to noise or vibration from the construction works occurs • ensuring that any complaints are dealt with proactively and that subsequent resolutions are communicated to the complainant • installing appropriate fencing/temporary barriers around the construction areas likely to generate noise • keeping site access routes in good condition and well maintained with no potholes or other significant surface irregularities • turning off plant machinery when not in use • maintaining all vehicles and mobile plant so that loose body fittings or exhausts do not rattle or vibrate • using silenced equipment where possible, particularly power generators and pumps • using the most modern equipment available where possible and maintaining and operating equipment properly by trained staff • locating static noisy plant, including generators, as far away from noise sensitive receptors as is possible for the activity • ensuring that the quietest plant and equipment, techniques and working practices available are selected and used • ensuring no music or radios are played on site

Operation

13.6.3 The information in the following tables is derived from the potential road traffic noise change contour plots in Figure 13.3 and Figure 13.4 in Volume 3. The noise change contours are presented at 4m above ground level as required by *DMRB*. Information on predicted noise changes is limited to areas within the study area for the *PEIR*. Effects outside of this study area will be presented within the ES.

13.6.4 Due to the size of the Project, the discussion of the potential operational noise impacts has been separated into the following sections:

a. Between south shore of the River Thames and A2 junction

b. Between north shore of the River Thames and A13

c. Between A13 and the northern junction with M25

d. Along existing A13 between Project and M25 at junction 30

e. Along the existing M25 between junction 28 and the Dartford Crossing

f. Along the existing A282 between Dartford Crossing and the M25/A2 junction

g. Along the existing A2 between A282/M25 junction and the M2

Table 13.16 Potential noise impacts between south shore of the River Thames and A2 junction

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	The Project route will run from the south tunnel portal down to the new junction with the A2 through this area. There is potential for direct road traffic noise impacts at noise sensitive receptors within this area due to the introduction of the new road through an area of existing lower road traffic noise levels. With reference to Figures 13.3 and 13.4 presented in Volume 3 the following is concluded regarding potential short-term and long-term impacts based upon the perceptibility criteria outlined in paragraph 13.3.22: • Short-term perceptible adverse changes of greater than 1dB(A) in road traffic noise contribution are predicted to occur at dwellings and other sensitive receptors located at the eastern extent of Gravesend, within the areas of Chalk, Singlewell, Riverview Park and Thong, along with the other outlying dwellings in this area. • Long-term perceptible adverse changes of greater than 3dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors located at the eastern extent of Gravesend, within the areas of Chalk, Singlewell, Riverview Park and Thong, along with the other outlying dwellings in this area. At this stage of the Project design, the location of any mechanical ventilation systems required by the Project has not been identified. Should the final design of the Project incorporate a tunnel ventilation system within this location on the south of the River Thames, there is potential for operational system noise to adversely affect noise sensitive receptors if not suitably controlled. Subject to appropriate control measures, including noise limits and mitigation, operational tunnel ventilation system noise would not be anticipated to be an issue outside of the immediate vicinity of any associated plant and equipment. The control of noise emissions from plant and equipment similar to that necessary for tunnel ventilation is well understood and exists in numerous places around the UK, and is controlled, managed and mitigated through the use of intelligent design and implementation of modern technology.
Likely duration	Permanent.
Potential mitigation	Through the EIA process, the following mitigation measures will be investigated and incorporated into the Project design where required: • Environmental barriers – these can be earth mounding or acoustic fencing of various types, or a combination of the two. Conventional environmental barriers are not effective in reducing ground-borne vibration and may be only partially effective against airborne vibration. They should, therefore, be ignored in assessing vibration nuisance

Item	Description
	unless tests show benefits from the design proposed. The use of reflective and absorptive barriers could also be considered • Low-noise road surfaces – the principal benefit of low-noise surfaces is the reduction in mid and higher frequencies of noise generated by tyres/surface interaction, at speeds over 75km/h. They are less effective in reducing noise at low speeds where engine noise, particularly, from heavy vehicles is more dominant. The potential benefits of mitigation measures vary widely according to circumstances. For example, environmental barriers can provide reductions of 10dB or more for well-screened locations relatively close to the source. But at greater distances, and especially where the barrier provides only a small deflection of the transmitted sound waves, noise reductions may only be 1 or 2dB. Beyond 200-300m from a road traffic source, the effects of barriers are often negligible, as ground attenuation becomes the most significant factor. Mitigation measures cannot be considered in isolation and reducing the noise and vibration impact from the Project is just one of the factors that needs to be considered in the design process. Consideration will need to be given to cost and benefit, and other environmental and engineering topics through the EIA process, including instances where conflicts may exist, eg, an acoustic barrier would help to reduce noise pollution but may introduce unacceptable visual intrusion or safety implications. In addition, qualification under the terms of the NIR will be considered as part of the operational road traffic noise assessment as required by NPSNN, with any qualifying residential dwellings identified. Operational tunnel ventilation noise impacts will be controlled through the DCO and set in accordance with BS4142, and mitigation will be incorporated into the design of the tunnel ventilation system to minimise impacts. Mitigation would be concluded through the design process but is likely to include intelligent design, acoustic screening, selection of low noise equipment options and installation of silencer units.

Table 13.17 Potential noise impacts between north shore of the River Thames and A13

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	The Project route will run from the north tunnel portal up to the new junction with the A13 through this area. There is potential for direct road traffic noise impacts at noise sensitive receptors located within this area due to the introduction of the new road through an area of existing lower road traffic noise levels. With reference to Figures 13.3 and 13.4 in Volume 3 the following is concluded regarding potential short-term and long-term impacts based upon the perceptibility criteria outlined in paragraph 13.3.22: • Generally, short-term perceptible adverse changes of greater than 1dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors located in Tilbury, Linford, Chadwell St Mary and Grays, along with the other outlying dwellings in this area. • Generally, long-term perceptible adverse changes of greater than 3dB(A) in road traffic noise are predicted to occur at dwellings and

Item	Description
	other sensitive receptors located in Tilbury, Linford, Chadwell St Mary and Grays, along with the other outlying dwellings in this area. At this stage of the Project design, the location of any mechanical ventilation systems required by the Project has not been identified. Should the final design of the Project incorporate a tunnel ventilation system within this location on the south of the River Thames, there is potential for operational system noise to adversely affect noise sensitive receptors if not suitably controlled. Subject to appropriate control measures including noise limits and mitigation, operational tunnel ventilation system noise would not be anticipated to be an issue outside of the immediate vicinity of any associated plant and equipment. The control of noise emissions from plant and equipment similar to that necessary for tunnel ventilation is well understood and exists in numerous places around the UK, and is controlled, managed and mitigated through the use of intelligent design and implementation of modern technology.
Likely duration	Permanent.
Potential mitigation	Through the EIA process, the following mitigation measures will be investigated and incorporated into the Project design where required: • Environmental barriers – these can be earth mounding or acoustic fencing of various types, or a combination of the two. Conventional environmental barriers are not effective in reducing ground-borne vibration and may only be partially effective against airborne vibration. They should, therefore, be ignored in assessing vibration nuisance unless tests show benefits from the design proposed. The use of reflective and absorptive barriers could also be considered. • Low-noise road surfaces – the principal benefit of low-noise surfaces is the reduction in mid and higher frequencies of noise generated by tyres/surface interaction at speeds over 75km/h. They are less effective in reducing noise at low speeds where engine noise, particularly from heavy vehicles, is more dominant. The potential benefits of mitigation measures vary widely according to circumstances. For example, environmental barriers can provide reductions of 10dB or more for well-screened locations relatively close to the source. But at greater distances, and especially where the barrier provides only a small deflection of the transmitted sound waves, noise reductions may only be 1 or 2dB. Beyond 200-300m, the effects are often negligible as ground attenuation becomes the most significant factor. Mitigation measures cannot be considered in isolation and reducing the noise and vibration impact from the Project is just one of the factors that needs to be considered in the design process. Consideration will need to be given to other environmental and engineering topics through the environmental impact assessment process and where conflicts may exist, eg, an acoustic barrier may introduce unacceptable visual intrusion or safety implications. In addition, qualification under the terms of the NIR will be considered as part of the operational road traffic noise assessment as required by NPSNN, with any qualifying residential dwellings identified. Operational tunnel ventilation noise impacts will be controlled through appropriate planning conditions set in accordance with BS4142, and mitigation will be incorporated into the design of the tunnel ventilation system to minimise impacts. Mitigation would be concluded through the design

Item	Description
	process but is likely to include intelligent design, acoustic screening, selection of low-noise equipment options and installation of silencer units.

Table 13.18 Potential noise impacts between A13 and the northern junction with M25

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	The Project route will run from the junction at the A13 north to the tie-in with the M25 through this area. There is potential for direct road traffic noise impacts at noise sensitive receptors located within this area due to the introduction of the new road through an area of existing lower road traffic noise levels. With reference to Figures 13.3 and 13.4 in Volume 3 the following is concluded regarding potential short-term and long-term impacts based upon the perceptibility criteria outlined in paragraph 13.3.22: • Short-term perceptible adverse changes of greater than 1dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors in: South Ockendon, Orsett, Grays and Upminster, along with the other outlying dwellings in this area. • Long-term perceptible adverse changes of greater than 3dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors in: South Ockendon, Orsett, Grays and Upminster, along with the other outlying dwellings in this area.
Likely duration	Permanent
Potential mitigation	Through the EIA process, the following mitigation measures will be investigated and incorporated into the Project design where required: • Environmental barriers – these can be earth mounding or acoustic fencing of various types, or a combination of the two. Conventional environmental barriers are not effective in reducing ground-borne vibration and may only be partially effective against airborne vibration. They should, therefore, be ignored in assessing vibration nuisance unless tests show benefits from the design proposed. The use of reflective and absorptive barriers could also be considered. • Low-noise road surfaces – the principal benefit of low-noise surfaces is the reduction in mid and higher frequencies of noise generated by tyres/surface interaction, at speeds over 75km/h. They are less effective in reducing noise at low speeds where engine noise particularly from heavy vehicles is more dominant. The potential benefits of mitigation measures vary widely according to circumstances. For example, environmental barriers can provide reductions of 10dB or more for well-screened locations relatively close to the source. But at greater distances, and especially where the barrier provides only a small deflection of the transmitted sound waves, noise reductions may only be 1 or 2dB. Beyond 200-300m, the effects are often negligible as ground attenuation becomes the most significant factor. Mitigation measures cannot be considered in isolation and reducing the noise and vibration impact from the Project is just one of the factors that needs to be considered in the design process. Consideration will need to be given to other

Item	Description
	environmental and engineering topics through the environmental impact assessment process and where conflicts may exist, eg, an acoustic barrier may introduce unacceptable visual intrusion or safety implications. In addition, qualification under the terms of the NIR will be considered as part of the operational road traffic noise assessment as required by NPSNN, with any qualifying residential dwellings identified.

Table 13.19 Potential noise impacts along existing A13 between Project and M25 at junction 30

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	There is potential for direct road traffic noise impacts at noise sensitive receptors located within this area due to the new Project route and the alteration of the existing A13/A1089 junction to accommodate the new road. Additionally, there is also potential for road traffic noise levels to be affected along the existing A13 carriageway because of the Project altering existing traffic flow, speed and composition. With reference to Figures 13.3 and 13.4 presented in Volume 3 the following is concluded regarding potential short-term and long-term impacts based upon the perceptibility criteria outlined in paragraph 13.3.22: • Short-term perceptible adverse changes of greater than 1dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors located north of the A13 junction in Orsett and south of the A13 junction in Grays near to the Project's route. • Long-term perceptible adverse changes of greater than 3dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors located north of the A13 junction in Orsett and south of the A13 junction in Grays near to the Project's route. • Negligible changes in both short-term and long-term road traffic noise levels are precited to occur at dwellings and other sensitive receptors located along the existing A13 corridor in Chafford Hundred, North Stifford and Stifford Clays.
Likely duration	Permanent
Potential mitigation	There are no changes in road traffic noise levels predicted along the existing A13 that would be perceptible in either the short term or long term and, as such, road traffic noise mitigation measures would not be required. However, with regard to the new junction between the Project and the A13, the following mitigation measures will be investigated through the EIA process, and incorporated into the Project design where required: • Environmental barriers – these can be earth mounding or acoustic fencing of various types, or a combination of the two. Conventional environmental barriers are not effective in reducing ground-borne vibration and may only be partially effective against airborne vibration. They should, therefore, be ignored in assessing vibration nuisance unless tests show benefits from the design proposed. The use of reflective and absorptive barriers could also be considered. • Low-noise road surfaces – the principal benefit of low-noise surfaces is the reduction in mid and higher frequencies of noise generated by

Item	Description
	tyres/surface interaction at speeds over 75km/h. They are less effective in reducing noise at low speeds where engine noise particularly from heavy vehicles is more dominant. The potential benefits of mitigation measures vary widely according to circumstances. For example, environmental barriers can provide reductions of 10dB or more for well-screened locations relatively close to the source. But at greater distances, and especially where the barrier provides only a small deflection of the transmitted sound waves, noise reductions may only be 1 or 2dB. Beyond 200-300m, the effects are often negligible as ground attenuation becomes the most significant factor. Mitigation measures cannot be considered in isolation and reducing the noise and vibration impact from the Project is just one of the factors that needs to be considered in the design process. Consideration will need to be given to other environmental and engineering topics through the EIA process and where conflicts may exist, eg, an acoustic barrier may introduce unacceptable visual intrusion or safety implications. In addition, qualification under the terms of the NIR will be considered as part of the operational road traffic noise assessment as required by NPSNN, with any qualifying residential dwellings identified.

Table 13.20 Potential noise impacts along the existing M25 between junction 28 and the Dartford Crossing

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	Through this area, the Project will form a new junction to tie in with the M25 but not alter the current alignment of the M25 or the existing A13/M25 at junction 30. There is potential for direct road traffic noise impacts at noise sensitive receptors around this new junction around the new slip roads. Additionally, there is also potential for road traffic noise levels to be affected along the existing M25 because of the Project altering existing traffic flow, speed and composition. With reference to Figures 13.3 and 13.4 presented in Volume 3 the following is concluded regarding potential short-term and long-term impacts based upon the perceptibility criteria outlined in paragraph 13.3.22: • Negligible changes in road traffic noise levels, in both the short term and long term, at dwellings and other sensitive receptors located in Upminster, Great Warley and Hornchurch north of junction 29 on the M25. • Short-term perceptible adverse changes of greater than 1dB(A) in road traffic noise are predicted to occur at dwellings and other sensitive receptors in Upminster located to the west of junction 29 as a result of new slip road provision. In the long term these impacts would be negligible (less than 3dB(A)) due to the road traffic noise level contribution from the existing M25. • Short-term perceptible beneficial changes of greater than 1dB(A) in road traffic noise levels are predicted to occur at dwellings and other sensitive receptors located in South Ockendon, Upminster, Thurrock and Aveley south of junction 29 due to reductions in traffic flow along

Item	Description
	the M25 as a direct result of the Project. In the long term these impacts would be negligible (less than 3dB(A)). • Negligible changes in road traffic noise levels in both the short term and long term at dwellings and other sensitive receptors located in West Thurrock, Purfleet, Aveley and South Ockendon south of junction 30 of the M25 to the Dartford Crossing.
Likely duration	Permanent
Potential mitigation	There are no changes in road traffic noise levels predicted along the existing M25 that would be perceptible in either the short term and long term and, as such, road traffic noise mitigation measures are unlikely to be required in this area. However, with regard to the new junction between the Project and the M25, the following mitigation measures will be investigated through the EIA process and incorporated into the Project design where required: • Environmental barriers – these can be earth mounding or acoustic fencing of various types, or a combination of the two. Conventional environmental barriers are not effective in reducing ground-borne vibration and may only be partially effective against airborne vibration. They should, therefore, be ignored in assessing vibration nuisance unless tests show benefits from the design proposed. The use of reflective and absorptive barriers could also be considered. • Low-noise road surfaces – the principal benefit of low-noise surfaces is the reduction in mid and higher frequencies of noise generated by tyres/surface interaction at speeds in excess of 75km/h. They are less effective in reducing noise at low speeds where engine noise particularly from heavy vehicles is more dominant. The potential benefits of mitigation measures vary widely according to circumstances. For example, environmental barriers can provide reductions of 10dB or more for well-screened locations relatively close to the source. But at greater distances, and especially where the barrier provides only a small deflection of the transmitted sound waves, noise reductions may only be 1 or 2dB. Beyond 200-300m, the effects are often negligible as ground attenuation becomes the most significant factor. Mitigation measures cannot be considered in isolation and reducing the noise and vibration impact from the Project is just one of the factors that needs to be considered in the design process. Consideration will need to be given to other environmental and engineering topics through the environmental impact assessment process and where conflicts may exist, eg, an acoustic barrier may introduce unacceptable visual intrusion or safety implications. In addition, qualification under the terms of the NIR will be considered as part of the operational road traffic noise assessment as required by NPSNN, with any qualifying residential dwellings identified.

Table 13.21 Potential noise impacts along the existing A282 between Dartford Crossing and the M25/A2 junction

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	There is potential for road traffic noise levels to be affected because of the Project altering existing traffic flow, speed and composition along the A282. With reference to Figures 13.3 and 13.4 in Volume 3 it is concluded in accordance with the perceptibility criteria outlined in paragraph 13.3.22 that negligible changes in road traffic noise levels are predicted to occur in both the short term and long term at dwellings and other sensitive receptors in Dartford, Stone, Southfleet, Darenth and Greenhithe between the Dartford Crossing and the A2.
Likely duration	Permanent
Potential mitigation	There are no changes in road traffic noise levels predicted that would be perceptible in either the short term and long term and, as such, road traffic noise mitigation measures would not be required in this area.

Table 13.22 Potential noise impacts along the existing A2 between A282/M25 junction and M2

Item	Description
Receptor	Dwellings and other sensitive receptors
Potential nature of effect	There is potential for road traffic noise levels to be affected because of the Project altering existing traffic flow, speed and composition along the existing A2 alignment. With reference to Figures 13.3 and 13.4 in Volume 3 it is concluded in accordance with the perceptibility criteria outlined in paragraph 13.3.22 that negligible changes in road traffic noise levels are predicted to occur in both the short term and long term at dwellings and other sensitive receptors in Gravesend, Higham, Cobham, Rochester, Gravesham, Shorne, Northfleet, Ebbsfleet Valley, Swanscombe, Darenth, Bean, Dartford, Greenhithe, Hawley, Sevenoaks, Southfleet and Longfield.
Likely duration	Permanent
Potential mitigation	There are no changes in road traffic noise levels predicted that would be perceptible in either the short term or long term and, as such, road traffic noise mitigation measures would not be required in this area.

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Chapter 14.

People and Communities

14 People and Communities

14.1 Introduction

14.1.1 This chapter explores how the Project potentially affects people in their daily lives – for example where they live, work, the services they may use and places they may visit and value. The chapter includes information about:

a. the local and wider economy

b. residential and commercial property that may potentially be impacted by the Project (including infrastructure, marine assets and development land)

c. community infrastructure, including education and healthcare services, sport and recreation facilities (leisure centres, play areas, green spaces) and community services (community centres, places of worship, post offices, libraries)

d. walking, cycling and equestrian use, to identify what connections there may be between services, green spaces and communities

e. human health and wellbeing

14.1.2 This chapter also covers agriculture and the soils that support agriculture in relation to both the productivity of the land (which is dependent on the characteristics of the soils present) and the way land is farmed. Understanding the characteristics of soils and associated land management practices enables appropriate soil restoration measures to be identified, potential impacts on farm practices to be minimised and land to be returned to productive agriculture where possible.

14.1.3 The aims of this chapter are to, in relation to people and communities:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies or surveys

e. describe the potential effects of the Project on people and communities (and how these have been assessed for this *Preliminary Environmental Information Report (PEIR)*)

f. describe potential mitigation measures

14.1.4 There are expected to be interrelationships between the potential effects on people and communities and other disciplines reported on in the *PEIR*. See:

a. Chapter 6: Air Quality

b. Chapter 8: Landscape

c. Chapter 11: Geology and Soils

d. Chapter 13: Noise and Vibration

14.2 Planning policy and legislative requirements

Legislative requirements

14.2.1 There are no legislative requirements associated with the people and communities assessment.

National Policy Statement for National Networks

14.2.2 The relevant NPSNN requirements for the people and communities assessment of the Project is presented in Table 14.1.

Table 14.1 NPSNN requirements and Project response

Requirement	Project response
The Government's vision and strategic objectives for national networks includes "supporting a prosperous and competitive economy", specifically: • Networks with the capacity and connectivity to support national and local economic activity and facilitate growth and create jobs, and • Networks which join up our communities and effectively link to each other. Paragraph 2.27 states: "in some cases…it will not be sufficient to simply expand capacity on the existing network. In those circumstances new road alignments and corresponding links, including alignments which cross a river or estuary, may be needed to support increased capacity and connectivity."	The assessment has considered existing and proposed land uses near the Project, and identified communities found adjacent to the Project on both the north and south side of the River Thames. The assessment has, among other matters, considered changes to journey times and accessibility, including changes in cross-river connectivity which will support economic growth in the area.

Requirement	Project response
Paragraph 3.3 requires that "reasonable opportunities to deliver environmental and social benefits as part of schemes" should be considered and that environmental and social impacts should be mitigated in line with the principles set out in the National Planning Policy Framework (NPPF) and the Government's planning guidance.	Opportunities for delivering environmental and social benefits continue to be explored as part of the Project. Appropriate mitigation for relevant environmental effects in relation to people and communities is described in section 14.5of this chapter and in other relevant chapters including Chapter 6: Air Quality, Chapter 8: Landscape, Chapter 11: Geology and Soils and Chapter 13: Noise and Vibration.
Paragraph 4.15 of the NPSNN requires the assessment "to describe and assess the effects on … soil". Paragraph 5.168 requires "Applicants to take into account the economic and other benefits of the best and most versatile agricultural land (defined as land in grades 1, 2 and 3a of the Agricultural Land Classification)." Paragraph 5.179 notes that protecting soils during construction can minimise the direct effects of a project.	Soils are assessed, including the grade of the land, according to the Agricultural Land Classification (ALC) system. Appropriate mitigation in relation to soil handling is presented.
Paragraph 5.89 of the NPSNN discusses what considerations may need to be given to a scheme of management and mitigation to reduce any loss of amenity because of emissions of odour, dust, steam, smoke or artificial light from the Project.	Mitigation for relevant environmental effects in relation to people and communities has been identified in section 14.6 of this chapter. Impacts on residential amenity (for example from noise, air quality or visual impacts) are described within relevant chapters. Further mitigation measures will be set out in further detail in the Code of Construction Practice (CoCP).
Paragraphs 5.165 and 5.166 state that the applicant should identify existing and proposed land uses near the Project, any effects of replacing an existing development or use of the site with the proposed Project, or the effects of preventing a development or use in a neighbouring site from continuing.	Proposed land uses found near the Project, in addition to relevant catchment areas for specific land uses, are identified within the description of existing conditions. Proposed land uses near the Project are also identified. The effects of the Project on existing developments and future land uses are considered within the assessment of land-take for the Project and impacts on development land.

Requirement	Project response
Paragraph 5.162 highlights the importance of high quality open spaces and the countryside and opportunities for sport and recreation as a means for providing necessary mitigation and/or compensation requirements. In addition, green infrastructure can also enable developments to provide positive environmental and economic benefits. Paragraph 5.166 states that existing open space, sports and recreational buildings and land should not be developed unless the land is surplus to requirements, or the loss would be replaced by equivalent or better provision in terms of quantity and quality in a suitable location.	Existing areas of green space used for formal or informal recreation near the Project are identified. These may include sports provision, play areas, and more informal areas of green space that may have recreational value. An Open Space Assessment will be undertaken as part of the Development Consent Order (DCO) submission. The effects of the Project on these uses are considered within the assessment and mitigation measures identified as appropriate.
The NPSNN identifies key considerations and requirements in relation to accessibility, severance and non-motorised users (NMUs), requiring projects to minimise adverse impacts. It advises that all reasonable opportunities to deliver improvements in accessibility on and to the existing network should also be taken. Applicants are advised to seek to deliver improvements that reduce community severance and improve accessibility. The NPSNN recognises the importance of Public Rights of Way (PRoW), National Trails and other rights of access to land for walkers, cyclists and equestrians. Where severance occurs, mitigation measures are required to address adverse effects. Where possible, access should be improved. The character, use and attractiveness of the area needs to be taken into consideration.	The needs of NMUs including pedestrians, cyclists and equestrians have been taken into account through the identification of existing routes and networks, a commitment to reinstate routes that have been severed as a result of the Project, and the identification of mitigation measures for NMUs as appropriate.
The NPSNN also sets out requirements in relation to the impacts of projects on health, particularly if they affect access to key public services, local transport, opportunities for cycling and walking or the use of open space for recreation and physical activity. Paragraph 4.81 of the NPSNN states: “where the Project has likely significant environmental impacts that would have an effect on human beings, Environmental Statements are required to identify and set out the assessment of any likely significant adverse health impacts.”	Data relating to the existing health and wellbeing of residents has been collected, particularly as it may relate to transport projects (for example walking and cycling, the use of open space or changes in access to health facilities). An initial assessment has been made of where any significant adverse health impact may occur because of the Project.

Planning policy requirements

14.2.3 The relevant planning policy applicable to the people and communities assessment of the Project is presented in Table 14.2.

Table 14.2 Planning policy requirements and Project compliance

Policy name	Summary of requirements
National Planning Policy Framework (2018)	The Government updated the NPPF in July 2018. The NPPF sets out the Government's planning policies for England and how these should be applied, providing a framework within which locally-prepared plans for housing and other developments can be produced, which are underlined by core planning principles. Paragraph 7 highlights that the purpose of the planning system is to contribute to the achievement of sustainable development. Paragraph 8 states: "achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways." These include: • an economic objective • a social objective • an environmental objective Paragraph 9 states that these objectives should be delivered through the preparation and implementation of plans and the application of the policies in this Framework; they are not criteria against which every decision can or should be judged. Planning policies and decisions should play an active role in guiding development towards sustainable solutions but in doing so should take local circumstances into account, to reflect the character, needs and opportunities in each area. Paragraph 170 states that the economic and other benefits of the best and most versatile agricultural land should be recognised.
Gravesham Local Plan Core Strategy (adopted September 2014)	Strategic objectives include community wellbeing, economic development and regeneration. Key policies relate to the Gravesend Riverside East and North East Gravesend Opportunity Area (Policy CS04), the protection of physical and social infrastructure (Policy CS10) and the green infrastructure network (Policy CS12). Paragraph 4.2.22 highlights the importance of agriculture in the Borough and the role the Green Belt has had in protecting the best and most versatile agricultural land. The *Gravesham Local Plan* Reg 18 Stage 1 Consultation Part 2: Development Management Policies Document (April 2018), states that development on the best and most versatile land will not be allowed unless the site is allocated; there is no alternative; the development is not inappropriate in the Green Belt; and there is avoidance of fragmentation of remaining high-quality land.

Policy name	Summary of requirements
Thurrock Core Strategy Local Plan (adopted January 2015)	The Core Strategy contains policies relating to housing, jobs and the safeguarding of community facilities, sports and leisure provision and open space. CSTP21 Productive Land recognises the importance of food security and will ensure the protection, conservation and enhancement of agriculture, productive land and soil in the Borough. CSSP5 Sustainable Green Grid promotes productive land and natural system opportunities, which includes agricultural land.
London Borough of Havering Core Strategy and Development Control Policies Development Plan (adopted 2008)	The objectives of the Core Strategy include creating a thriving, successful and healthy community for all, as well as a dynamic and prosperous economy. Core policies relate to the retention and increased access to recreation and leisure opportunities (Policy CP7); the retention of a suitable range of community facilities (Policy CP8) and reducing the need to travel through the provision of opportunities for informal recreation in the Havering countryside (Policy CP9). Policy DC47 – Agriculture states: "the Council will not grant planning permission where the proposal would result in the loss of high quality agricultural land (Grades 1, 2 and 3a) unless it can be shown that there is an overriding sustainability benefit, or the development is unavoidable and no lesser quality land is available."
Brentwood Local Plan (adopted 2005)	IR3 Protecting The Best and Most Versatile Agricultural Land states: "Development of the best and most versatile agricultural land will only be permitted where it can be shown that no alternative development site exists within existing settlement boundaries or on other previously developed land. Where development of agricultural land is required, such development should seek to use agricultural land of the least value unless sustainability or other considerations suggest otherwise."
Medway Local Plan (adopted 2003)	Policy BNE48 – Agricultural Land states: "Development that would cause a loss of the best and most versatile agricultural land (MAFF grades 1, 2 and 3a) will not be permitted. Exceptionally, development will be permitted when: (i) there exists an overriding need for the development that is of more significance than the considerable weight to be afforded to protecting the best and most versatile agricultural land; and (ii) there exists a lack of suitable development opportunities on previously developed sites and land within the boundaries of existing developed areas; or (iii) either sufficient land in lower grades is unavailable, or available lower grade land has statutory landscape, wildlife, historic or archaeological designation which outweigh agricultural considerations; and (iv) where grade 1, 2 or 3a land needs to be developed and there is a choice between sites in different grades the development is proposed on land of the lowest grade."

Policy name	Summary of requirements
London Plan 2016 (2011 plan consolidated with alterations since 2011)	The *London Plan* is the overall strategic plan for London up to 2036. It incorporates various alterations. Policies of relevance to the Project include the protection of London's network of green infrastructure (Policy 2.18); the need to protect and enhance facilities and services that meet the needs of particular groups and communities (Policy 3.1) and the protection and enhancement of social infrastructure (Policy 3.16).

14.3 Methodology

14.3.1 There is no detailed guidance which provides a specific methodology for the assessment of effects on people and communities. As such, the assessment has drawn on guidance provided in the *Design Manual for Roads and Bridges* (*DMRB*) Volume 11, Section 3, Part 6 ('Land Use'), Part 8 ('Pedestrians, Cyclists and Equestrians and Community Effects'), and Part 9 ('Vehicle Travellers').

14.3.2 Baseline data in relation to agricultural land has been limited to within the Development Boundary. For agricultural viability the assessment has included the whole of each land holding, such that impacts on farm viability are assessed in the right context.

14.3.3 To date, the assessment methodology has included the following stages:

a. Data on land use has been collected using a variety of data sources, including online information (for example Ordnance Survey maps, MAGIC online maps, Google maps) and local authority websites.

b. Statistical data has been collected in relation to the local and wider economy, human health and wellbeing topics, using online sources such as Census data 2011; Nomis; Office for National Statistics (ONS); the Ministry of Housing, Communities and Local Government (MHCLG); and Public Health England.

c. Survey work has been undertaken to ascertain the location and condition of PRoW potentially affected by the Project as well as to gain an understanding of the communities and settlements potentially affected by the Project.

d. Baseline data to inform the agricultural land and business assessment has been collected from various currently available sources as follows:

   i. Ordnance Survey mapping and aerial photography to establish land use and settlement patterns

   ii. published ALC mapping for the area, including detailed mapping where available (from the MAGIC website[27])

[27] www.magic.defra.gov.uk

iii. climatic data and LandIS Soil Site Reports, purchased from National Soil Resources Institute

iv. Review of Land Information System Soilscapes database (available on the MAGIC website)

v. *Soils of Kent* (Fordham and Green, 1980)

vi. MAGIC website to ascertain information on agri-environmental schemes

vii. consultation with Natural England to ascertain information on agri-environmental schemes and survey effort required

14.3.4 This data has been assessed through overlaying with the Development Boundary to develop a full understanding of how the Project could potentially affect agricultural land and businesses.

14.3.5 Consultation with stakeholders and interested parties has helped to inform the assessment.

14.3.6 Appropriate study areas have been defined on a topic by topic basis, as set out in Table 14.3. Study areas have been identified using professional judgement unless otherwise stated.

Table 14.3 Study areas

Sub-topic	Study area
Local and wider economy	The local study area encompasses the local authority areas of Thurrock, Havering, Medway, Gravesham, Dartford, Brentford and Basildon. A wider study area encompasses Kent, Essex and the Greater London Authority (GLA).
Commercial and private assets	Assets within the Development Boundary and a 500m corridor either side of it.
Agricultural land and quality	The study area for agricultural land has been limited to within the Development Boundary. For agricultural viability the assessment has included the whole of each land holding so that impacts on farm viability are assessed in the right context.
Community	Community facilities within the Development Boundary and a 500m corridor either side of it.
Non-motorised users	The study area to assess changes to journey length, amenity and severance has been identified using guidance provided within *DMRB* Volume 11 Section 3 Part 9 together with professional judgement. The study area encompasses footpaths, bridleways and cycle routes potentially affected by the Project, in addition to the catchment areas of community facilities where these are considered relevant.
Human health and wellbeing	The study area encompasses the six local authority areas of Thurrock, Havering, Medway, Gravesham, Dartford and Brentford.

14.3.7 Baseline data collected will be used to inform the assessment of impacts of the Project on people and communities. In addition to information set out in this *PEIR*, a wider community impact approach is being followed by Highways England as part of the Project assessment. This approach includes the preparation of separate equalities and health impact assessments, which will assist with determining the effects of the Project on communities and vulnerable populations.

14.4 Existing environmental conditions

14.4.1 Baseline data collated for this chapter is described below and, where relevant, information is presented in Figure 14.1 and Figure 14.2 in Volume 3.

Local and wider economy

14.4.2 This section presents a picture of the current economic profile of the local and wider area, through a review of socio-economic statistics, relevant economic strategies and related documents.

14.4.3 Local authority areas that have been selected for data collection purposes are Gravesham Borough Council, Thurrock Council, The London Borough of Havering, Medway Council, Dartford Borough Council, Basildon Council and Brentwood Borough Council. These are either local authorities through which the Project directly passes or neighbouring authority areas identified as appropriate for inclusion through consultation with stakeholders. Specifically, Dartford Borough Council has been agreed as a host authority following discussions with the Planning Inspectorate, and Basildon Council has been included because of consultation responses highlighting its role within the wider economic region. Comparative data has been collected for a wider geographical area comprising the two counties of Kent and Essex, and for Greater London and England as a whole.

14.4.4 The Project is in one of the UK's most economically active regions. The counties of Kent, Essex, Thurrock, Southend, Medway and East Sussex together comprise the South East Local Enterprise Partnership (SELEP) area. Strengths of this area are highlighted in the *Strategic Economic Plan* (2014) and include the area's ports, road and rail networks; population growth, which has in turn helped drive economic growth; and the relatively high proportion of businesses and self-employment in the area, demonstrating an entrepreneurial business culture. Another key strength is the nine universities across the SELEP area, which offer many opportunities for knowledge creation and innovation. Along with local businesses, they are a driving force behind economic growth.

14.4.5 The *Strategic Economic Plan* highlights the importance of investment in transport growth corridors to the wider economy, namely the A13 corridor – Thurrock – Canvey Island corridor and the A2/M2 – Thames Gateway. The plan identifies the former as the largest single growth opportunity in the SELEP area, linking the container sea port at London Gateway with the UK's trunk road network. The A2/M2 – Thames Gateway potentially unlocks the residential and employment potential of Ebbsfleet and Swanscombe.

14.4.6 Information produced by Kent County Council in 2017 (*Kent Economic Indicators*, 2017) presents a summary of the economy at both county and

district level, looking at factors including unemployment, earnings, overall economic wellbeing and new business survival rates. At district level, Dartford is shown to rank above average in several areas, including an increase in employment rate between 2012 and 2017 from 70.4% to 81.6%. Data for Medway shows that the district has changed very little over the last five years; although it ranks well in terms of qualification levels and workplace earnings, it ranks within the bottom 20% in the country in terms of Gross Value Added per head – an indicator of general economic wellbeing.

14.4.7 Key characteristics of the local economy in Gravesham are set out in an *Economy and Employment Background Paper* (2012), referring to:

a. the very small local economy with a low level of self-containment and significant levels of out-commuting to London and neighbouring authorities

b. manufacturing, finance, IT and other business activities being under-represented in the local economy, with construction now taking a more prominent role. Higher proportions of jobs in public administration expose the local economy to the impact of reductions in public spending

c. sector specialisms in Gravesham that include manufacturing, transport and logistics; future opportunities that include proposals for a major theme park destination near Gravesend

d. skills levels appearing low, with a higher proportion of people with no qualifications when compared with the rest of the Kent Thames Gateway area and the national average. This is attributed, in part, to being one of the legacies of Gravesham's industrial past

14.4.8 The *Economic Plan for Essex* (Essex County Council, 2014) highlights that the county already has a large and productive economy but there are challenges in relation to out-commuting (particularly to London), recruitment of suitably skilled employees and vulnerability within certain sectors of the local economy (for example, as a result of changing global supply chains, or reliance on sectors that are particularly vulnerable to economic changes, such as construction). Opportunities therefore exist to strengthen the resilience of the Essex economy, diversifying the business base and growing high value sectors.

14.4.9 As a unitary authority, Thurrock has developed an *Economic Growth Strategy* (2016–2021) to provide strategic guidance to support the development of the economy, enhance growth potential and shape the future economy.

14.4.10 Thurrock's economy is dominated by the transport, logistics and retail sectors. While these are key strengths for the area, they traditionally deliver large numbers of low wage jobs. As such, there is a focus on bringing more high value jobs to the area, to improve wage levels while also increasing productivity.

14.4.11 Higher skilled sectors, such as advanced manufacturing and environmental technologies, are expected to become more prevalent in the coming years, for example, following the establishment of Thames Enterprise Park. Many companies with offices, plant and premises in the area anticipate significant future growth.

Economic activity

14.4.12 Table 14.4 shows economic activity rates across the local and wider area. The economic activity rates measure the proportion of the working age population (aged between 16–64 years old) who are active or potentially active members of the labour market. A high economic activity rate indicates that a high proportion of people are working or available for work or training.

14.4.13 The table shows that among the local authorities economic activity rates are highest in Dartford, which is higher than for Greater London and England as a whole. Levels of economic inactivity are highest in Basildon (25.1%).

Table 14.4 Economic activity rates July 2016–June 2017

Local authority	Economic activity (%)	Economic inactivity (%)
Gravesham	75.9	24.1
Thurrock	78.7	21.3
Havering	82.0	18.0
Medway	78.9	21.1
Dartford	86.0	14.0
Brentwood	78.2	21.8
Basildon	74.9	25.1
Kent	79.0	21.0
Essex	79.4	20.6
Greater London Authority	78.3*	21.7
England	78.9*	21.1

*Source: ONS annual population survey *August 2017–October 2017*

Unemployment

14.4.14 Table 14.5 shows the proportion of economically active people classified as unemployed for each local authority. Looking in more detail at each of the local authorities, the unemployment rate is highest in Gravesham at 5.5% and lowest in Dartford at 3.2%.

Table 14.5 Unemployment rates July 2016–June 2017

Local authority	Unemployment Rate (%)
Gravesham	5.5
Thurrock	4.6
Havering	4.8
Medway	5.0
Dartford	3.2
Brentwood	3.3

Local authority	Unemployment Rate (%)
Basildon	5.0
Kent	3.6
Essex	3.5
Greater London	4.9*
England	4.3*

*Source: Annual Population Survey, 2017 *August–October 2017*

Socio-economic classification

14.4.15 The socio-economic classification of residents in each area is given in Table 14.6. The table shows that there is a lower proportion of residents in higher managerial and professional occupations in each of the seven local authorities than is the case for Kent and Essex as a whole.

14.4.16 In addition, within the seven local authorities there is a higher proportion of residents working in semi-routine (for example traffic wardens, receptionists, care workers) and routine (for example cleaners, lorry drivers) occupations when compared to the wider region.

Table 14.6 Socio-economic classification (%)

	Gravesham	Thurrock	Havering	Medway	Dartford	Brentwood	Basildon	Kent	Essex	Greater London	England
Higher managerial, administrative and professional occupations	8	7	9	7	9	15	9	10	10	13	10
Lower managerial, administrative and professional occupations	19	19	20	19	22	26	20	22	22	23	21
Intermediate occupations	14	15	19	15	17	17	17	14	15	12	13
Small employers and own account workers	10	9	11	9	10	11	10	11	11	9	9
Lower supervisory and technical occupations	8	9	7	8	8	5	7	7	7	5	7
Semi-routine occupations	16	16	14	15	14	10	15	14	14	10	14
Routine occupations	13	14	9	12	10	6	12	10	10	7	11
Never worked and long-term unemployed	6	6	5	5	4	3	5	4	4	8	6
Not classified	7	6	7	8	6	7	6	8	7	11	9

Source: Office for National Statistics, Census Data 2011

Commercial and private assets

14.4.17 This section identifies commercial and private assets located within 500m of the Development Boundary. Commercial and private assets include commercial properties (for example businesses), residential properties as well as marine and utility infrastructure. Assets are illustrated in Figure 14.2 in Volume 3.

South of the River Thames: Project/A2 junction to Gravesham link

Commercial

14.4.18 There are three commercial properties located within the Development Boundary which may be directly affected by the Project. These are shown in Figure 14.2 in Volume 3.

14.4.19 There are other local businesses near the Project and within nearby settlements which have been identified because of their potential to be impacted (for example in terms of access).

Residential

14.4.20 The Project passes close to several towns and villages, including residential areas on the outskirts of these settlements as well as more isolated rural farms and properties.

14.4.21 There are nine residential properties located within the Development Boundary. These are shown in Figure 14.1 in Volume 3. Not all the properties within the Development Boundary will need to be acquired to construct the Project.

14.4.22 Residential areas within 500m of the Development Boundary broadly include the outskirts of Strood; the villages of Shorne, Thong and Cobham; and eastern suburbs of Gravesend (notably the Singlewell, Riverview Park and Chalk areas).

14.4.23 Other residential communities located near the Project include traveller communities. Within the local authority area of Gravesham, 0.2% of residents identified themselves as Gypsy or Irish Traveller (according to data provided in the Census 2011).

14.4.24 Information relating to traveller sites is collated by relevant local authorities and submitted to the MHCLG on a biennial basis. The last counts were undertaken in July 2017. Gravesham District Council lists one authorised traveller site within proximity of the Project. This is the Denton Caravan Site located off Dering Way on the outskirts of Gravesend, located 1.4km west of the Project.

Infrastructure

14.4.25 Infrastructure crossed by the Project includes the A226 which runs in an east to west direction from Chalk to Rochester; the North Kent Railway Line (connecting London with the towns of Dover and Hastings); and the Thames Medway Canal (also known as the disused Gravesend and Rochester Canal), which runs in an east to west direction, 1.2km to the south of the River Thames.

14.4.26 The Singlewell Infrastructure Maintenance Depot is located between the A2 and High Speed 1 (Channel Tunnel Rail Link) and has fuelling facilities, workshops, storage and office space.

14.4.27 Also at Singlewell, there is an electricity substation. Running north from the substation across the A2 and from west to east across the route at Thong, there are high voltage overhead pylons.

North of the River Thames: Tilbury junction to M25 junction 29

Commercial

14.4.28 There are 13 commercial properties located within the Development Boundary which may be directly affected by the Project. These are shown in Figure 14.2 in Volume 3.

14.4.29 There are other local businesses near the Project and within nearby settlements which have been identified because of their potential to be impacted (for example in terms of access).

Residential

14.4.30 There are 221 residential properties located within the Development Boundary. These are shown in Figure 14.1 in Volume 3. Not all the properties within the Development Boundary will need to be acquired to construct the Project.

14.4.31 Residential areas within 500m of the Development Boundary broadly include the town of Tilbury; the northern outskirts of Grays (specifically the Stifford Clays area); the villages of West Tilbury and East Tilbury, Linford, Chadwell St Mary, Orsett, North Ockenden and South Ockenden; the hamlet of Baker Street and the eastern outskirts of Upminster (notably the Cranham area).

14.4.32 Other residential communities located near the Project include traveller communities. Within the local authority area of Thurrock, 0.3% of residents identified themselves as Gypsy or Irish Traveller (according to data provided in the Census 2011).

14.4.33 As noted above, information relating to traveller sites is collated by relevant local authorities and submitted to the MHCLG on a biennial basis.

14.4.34 Traveller sites within the Development Boundary include Gammon Field traveller site located on Long Lane. The site is within Thurrock Council and has 22 plots

14.4.35 Traveller sites located near the Development Boundary include:

a. Ship Lane traveller site found to the north west of Grays (21 pitches)

b. Pilgrims Lane traveller site found to the north of Grays (22 pitches)

14.4.36 There are no publicly owned or operated gypsy and traveller sites within the London Borough of Havering. A Gypsy and Traveller Position Statement published by the London Borough of Havering in 2017 confirmed that the Borough is dependent on privately-owned sites to accommodate identified need. A review of such sites identified the Tyas Stud Farm site, located to the north of St Mary's Lane in Upminster. The site (which has an area of approximately 1.6ha) is located within the Development Boundary.

Infrastructure

14.4.37 Transport infrastructure crossed by the Project includes Muckingford Road (Linford to Chadwell St Mary); Brentwood Road (from the A13 towards

Chadwell St Mary); the A13 trunk road; North Road (which links North Ockendon with South Ockendon); and the Tilbury Loop line, which forms part of the wider London, Tilbury and Southend Railway Line, connecting Fenchurch Street Station in Central London with destinations in east London and Essex, including Grays and Tilbury.

14.4.38 Utility infrastructure near the Project to the north of the River Thames includes an electricity substation at Tilbury and several lines of overhead pylons running north alongside and across the route towards Orsett and Ockendon. There is also a sewage treatment works at Tilbury.

Marine assets and infrastructure

14.4.39 The River Thames runs west to east through the Development Boundary. The river is subject to many journeys every year, with passenger vessels on scheduled and charter services, fast ferries, tugs and tows (water transfer of barges delivering aggregates) and service vehicles (for example emergency services and Environment Agency services).

14.4.40 In this area, the River Thames is popular for recreational boating, with sailing clubs at Gravesend, Grays and Cliffe. In addition, the river is used for the Great River Race and the Barge Race, both of which attract many competitors annually.

14.4.41 Marine infrastructure found within the immediate vicinity of the Project (in an area known as Gravesend Reach) includes the following on the southern banks of the River Thames:

a. Port Control Centre, managed by the Port of London Authority and which provides a crossing to the north banks of the River Thames.

b. Gravesend Embankment Marina and Sailing Club, which has a serviced pontoon berth, lock access to the Thames and an established community of residential and leisure berth holders.

c. Gravesend Lifeboat Station which is one of the Royal National Lifeboat Institution's newest lifeboat stations and one of four lifeboat stations operating on the River Thames.

d. Denton Wharf, managed by the Port of London Authority which provides a purpose-built facility to undertake a wide range of marine operations.

e. Town Pier, which is the oldest surviving cast iron pier in the world and is Grade II* listed.

14.4.42 The following marine infrastructure is on the northern banks of the River Thames:

a. The Port of Tilbury is London's major port, providing distribution services for the benefit of the South East of England and beyond.

b. East Tilbury Jetty is a jetty comprising a pontoon and access bridge.

c. London Cruise Terminal (which is Grade II* listed), is London's only deep water purpose-built cruise facility. Over the years, the terminal has become increasingly popular as a turnaround port for Baltic and Northern European destinations but is also well placed for transit calls to visit London, Kent and the South East.

Development land

14.4.43 Proposals for new employment, residential and leisure developments within the local and wider region are described here, highlighting those developments likely to influence future residential and economic growth in the area, as well as changes to communities, travel to work and visitor patterns.

14.4.44 Proposed developments relevant to the Project because of their location, scale or type include:

a. Growth at the Port of Tilbury – government policy explicitly supports new port development at Tilbury to cater for forecast growth in imports and exports. The Tilbury area is seen as a 'growth hub' and plans are underway to guide development for the next 20 years. The closure of Tilbury Power Station has led to part of the site becoming available for redevelopment and the Port of Tilbury has purchased a section, with a view to creating a new port terminal. The application to expand operations at the Port of Tilbury is currently going through a DCO process.

b. Crossrail – Crossrail Limited is building a new railway for London and the South East, running from Reading and Heathrow in the west, through 42km of new tunnels under London to Shenfield and Abbey Wood in the east. The route is expected to be fully operational in December 2019.

c. Tilbury Energy Centre – RWE Power is proposing to submit plans to develop this project at the former Tilbury Power Station site.

14.4.45 Other proposed developments of relevance include:

a. The Thames Gateway, Europe's largest regeneration project stretching 40 miles along the Thames Estuary from Canary Wharf in London to Southend in Essex and Sittingbourne in Kent. The area includes the largest designated brownfield site in the South of England.

b. Ebbsfleet Garden City – a new Development Corporation was established in April 2015 to develop Ebbsfleet Garden City. The development will include a new commercial centre and improved public transport, over the next 15 years, with up to 15,000 homes proposed to be built.

c. London Resort Company Holdings are proposing a theme park and entertainment resort on the Swanscombe Peninsula in Kent, which could become the UK's largest entertainment resort. The project, a Nationally

Significant Infrastructure Project, is predicted to bring up to 50,000 visitors per day and create up to 33,000 jobs.

d. Purfleet Centre Regeneration Limited, in partnership with Thurrock Council, is leading the regeneration of Purfleet Centre, which is found on the northern banks of the River Thames in Tilbury. This project will see around 2,800 new homes built alongside a film and TV complex, an improved train station and bridge crossing, a new primary and secondary school and other vital health and education infrastructure. The aim is to open up Purfleet's river frontage, create employment and educational opportunities and drive growth.

e. Lakeside Shopping Centre opened in 1990 and is the tenth largest shopping centre in the UK (by area). Lakeside has plans to increase development by 33% with a further 2,600 jobs.

f. Bluewater Shopping Centre opened in 1999 and has expansion plans, which will create 2,300 new jobs with five new buildings.

g. The regeneration of Thurrock is a key part of the authority's Local Development Framework, with proposals to create 3,000 additional homes and 9,000 jobs.

h. Gravesend town centre is identified as an Opportunity Area in the *Gravesham Local Plan* Core Strategy, and plans are progressing for town centre-related economic and social activity.

i. Brentwood Enterprise Park is a potential employment allocation in the emerging Local Plan.

Agricultural land quality and use

14.4.46 A range of information on the agricultural land quality is available from published sources. A description of ALC grades and agricultural enterprises is presented below and has been divided into the following sections:

a. South of the River Thames: Project/A2 junction to Gravesend link

b. Tunnel: south portal to north portal

c. North of the River Thames: Tilbury junction to M25 junction 29

14.4.47 A more detailed description of soils can be found in Chapter 11 Geology and Soils. Note that while the baseline conditions immediately adjacent to the River Thames are described here, this includes areas which will not be directly affected by construction activities.

14.4.48 Available soil, ALC and agri-environment and forestry information is presented in Figures 14.3 to 14.6 in Volume 3.

South of the River Thames: Project A2 junction to Gravesend link

14.4.49 To the south of the River Thames the soils are generally described from the sources listed above in the Methodology section as well-drained loamy soils.

14.4.50 Agricultural land in England and Wales is graded between 1 and 5, depending on the extent to which physical or chemical characteristics impose long-term limitations on agricultural use. Grade 1 land is excellent quality agricultural land with very minor or no limitations to agricultural use, and Grade 5 is very poor-quality land, with severe limitations due to adverse soil characteristics, relief, climate or a combination of these. Grade 3 land is subdivided into Subgrade 3a (good quality land) and Subgrade 3b (moderate quality land).

14.4.51 Grades 1, 2 and 3a are defined as the Best and Most Versatile land.

14.4.52 The land between the A2 junction and Gravesend link is classed, based on the provisional mapping, as a mix of Grade 1, 2 and 3a. The Grade 1 land is shown to occur around the A2 junction. Note that the ALC mapping at this scale will provide overall context and an indication of likely grade but is not suitable for detailed land grade assessments.

14.4.53 Some detailed mapping is available for the area north of Thong around the golf course. This confirms the presence of Grade 2 and 3a land, as well as some Grade 3b land.

14.4.54 These grades are expected given the deep, well-drained nature of the soils present, where soil wetness, depth and stoniness are not major limitations to agricultural productivity.

14.4.55 Land in this area is predominantly under arable production, with small areas of pasture. The Southern Valley Golf Course also lies within the Development Boundary.

14.4.56 Some land around the Gravesend link is within Stewardship agreements (Entry Level plus Higher Level Stewardship). Environmental Stewardship is an agri-environmental scheme which aims to secure widespread environmental benefits. Entry Level Stewardship is a ‘whole farm scheme’ open to all farmers and land managers. Higher Level Stewardship aims to deliver significant environmental benefits and concentrates on the more complex types of management and where agreements need to be tailored to local circumstances.

Tunnel: south portal to north portal

14.4.57 Soils adjacent to the River Thames are mapped as belonging to the Wallasea Association, described as deep stoneless, non-calcareous and calcareous clayey soils developed in Marine Alluvium.

14.4.58 The land south of the River Thames is provisionally mapped as Grade 4. Soil wetness is a major limiting factor in ALC grades, and it is likely that in this area the high groundwater levels and seasonal waterlogging restrict the land grade.

14.4.59 This land is under pasture with individual fields bounded by ditches. From aerial photographs there is clear evidence of an historic creek system which would have been present before this land was reclaimed for agriculture. Much of the land is under Entry Level plus Higher Level Stewardship agreements.

14.4.60 North of the North Kent Railway Line is the Metropolitan Police firing range.

14.4.61 On the northern bank of the River Thames the land is provisionally mapped as non-agricultural, reflecting the influence of activity in and around Tilbury Power Station. The soil type is the same as that mapped for similar land adjacent to the southern bank of the River Thames, so it is likely that any agricultural land on the northern bank would be of a low land quality grade.

North of the River Thames: Tilbury junction to M25 junction 29

14.4.62 A range of soil types are present between Tilbury and junction 29 on the M25. Land north of Tilbury to the A13, and the area around Orsett and to the south of the A13, is provisionally mapped as being Grade 2 and 3(Grade 2 land occurring particularly around the A13 junction).

14.4.63 North of the A13 the soil type gives way to slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils along with loamy soils, with naturally high groundwater around junction 29. The area north of the A13 to South Ockendon Hall is provisionally mapped as Grade 3 land.

14.4.64 To the west of South Ockendon Hall, the soils are described as deep fine loamy and fine loamy over sandy soils, variably affected by groundwater. This area is provisionally mapped as Grade 1 land, indicating that the coarser texture facilitates better drainage so has greater productivity potential.

14.4.65 Most of the land north of Tilbury is under arable production, with limited areas of pasture. West and north of South Ockendon Hall, areas of land are within Entry Level Stewardship agreements.

Community

14.4.66 This section describes in more detail information relating to the communities that are present along the route of the Project. Baseline data relates to community facilities, leisure and recreation facilities, community open space (including formally designated open space in addition to areas used more informally for recreation purposes, Open Access Land and common land) and visitor attractions.

Community facilities

14.4.67 Settlements and communities located along the Project's route are identified in Table 14.7. Summary information is provided for each settlement in terms of its population and the social and community infrastructure present. This includes education and healthcare facilities, community centres, places of worship, libraries, residential care homes, post offices, areas of formal and informal open space and their nearest principal centre.

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Table 14.7 Summary of the key features of communities near the Project

Settlement	Population (Census 2011)	Schools	Community facilities	Recreation and access	Presence of shopping facilities	Principal centre
South of the River Thames						
Strood	33,182	Bligh Junior School Strood Academy	GP surgeries Dental practices Places of worship Residential homes Post office Public houses	Rede Common Bligh Way Park Northcote Road Recreation Ground Broomhill Park Leisure centre	Local shops	Rochester
Gravesend	74,000	Primary and secondary schools (eg, Thamesview School, Riverview Infant School)	GP surgeries Dental practices Places of worship Residential homes Post office Public houses	Springhead recreation ground Cascades Leisure Centre Gravesend Rugby Football Club	Local and regional level shopping facilities	Gravesend
Cobham	1,469	Cobham Hall Independent School	St Mary Magdalene Church Public houses	Cobham Village Sports Ground Cobham Cricket and Tennis Clubs Owletts National Trust property	-	Gravesend

Settlement	Population (Census 2011)	Schools	Community facilities	Recreation and access	Presence of shopping facilities	Principal centre
South of the River Thames						
Shorne	2,487 (inc. Thong)	Shorne Church of England Primary School	Downs Way Medical Practice Shorne Village Hall St Peter & St Paul Church Shorne Methodist Church	Shorne Woods Country Park	Limited shopping facilities	Gravesend
Thong	2,487 (inc. Shorne)	-	-	Shorne Wood Country Park Southern Valley Golf Club	-	Gravesend
Chalk	2,163	-	St Mary the Virgin Church, Higham Chalk Parish Hall	Playing field Allotments	Local shops	Gravesend
North of the River Thames						
West Tilbury	<500	-	West Tilbury Village Hall Place of worship	The Green Condovers Scouts Activity Centre	-	Grays/Thurrock
East Tilbury	4,672	East Tilbury Primary School and Nursery	Parish Church of St. Catherine Residential home Post office Public house	Gobions Park Coalhouse Fort	Limited	Grays/Thurrock

Settlement	Population (Census 2011)	Schools	Community facilities	Recreation and access	Presence of shopping facilities	Principal centre
South of the River Thames						
Tilbury	13,055	Tilbury Pioneer Academy St Mary's Roman Catholic Primary School Lansdowne Primary Academy The Gateway Academy	Tilbury Health Centre Commonwealth Health Centre Places of worship Residential homes Post office Dental practice	King George's Field Tilbury Leisure Centre Anchor Fields Park Tilbury Fort	Local shops	Grays/Thurrock
Linford	849	-	Linford Village Hall Linford Methodist Church Public house	Recreation ground	Limited	Grays/Thurrock

Settlement	Population (Census 2011)	Schools	Community facilities	Recreation and access	Presence of shopping facilities	Principal centre
South of the River Thames						
Chadwell St Mary	6,025	Chadwell St Mary Primary School Herringham Primary Academy	Chadwell Medical Centre Chadwell Working Men's Social Club Dilip Sabnis Medical Centre Dental practice Emmanuel Church Parish Church of Chadwell St Mary Community Church Chadwell Post office Residential homes Cemetery	Courtenay Road recreation ground	Local shops	Grays/Thurrock
Orsett	6,115 (ward population)	Orsett Church of England Primary School	Village hall Orsett NHS Hospital Saint Giles and All Saints Church Public house	Orsett Showground Orsett Cricket Club, Bowls Club Orsett Park Rectory Road allotments	Local shops	Grays/Thurrock
North Ockendon	Scattered rural community	-	Church of St Mary Magdalene Residential home	Top Meadow Golf Club	-	Grays/Thurrock

Settlement	Population (Census 2011)	Schools	Community facilities	Recreation and access	Presence of shopping facilities	Principal centre
South of the River Thames						
South Ockendon	18,001	The Ockendon Academy and Studio School Benyon Primary School	Derry Medical Practice South Ockendon Health Centre Places of worship Dental practices Public house Post office Residential homes	Recreation ground South Ockendon Village Social Club Bonnygate Wood Thames RFC Mardyke Valley Golf Club	Local shops	Grays/Thurrock
Grays	9,150	William Edwards Academy School Stifford Clays Primary School Treetops School Woodside Academy	GP Dental practices Public houses Residential homes Post office Civic Hall Arts Venue	Thurrock Rugby Football Club King George's Field	Local and regional shopping facilities	Grays/Thurrock
Upminster	25,361	Coborn School Hall Mead School	Cranham Village Surgery Dental practices Residential homes Post office Public houses Upminster Cemetery	Thames Chase Forest Centre Cranham Golf Course Upminster Hall Playing Field	Local shops	Romford

Leisure and recreation

14.4.68 This section describes existing leisure, recreation and open space facilities found within the vicinity of the Project. They include sports and leisure centres, community open space (such as country parks and community woodlands), visitor attractions and Open Access Land. While a number of these facilities are commercially operated (for example golf courses and sports centres), they are included under the wider heading of community facilities to reflect the role that they play.

Sports and leisure facilities

14.4.69 South of the River Thames, leisure facilities include Cascade's Leisure Centre and Legends Sports Centre in Gravesend, which both offer various sports facilities, including a gym, health suite, pool and tennis courts. Immediately to the south of these sports centres is the Southern Valley Golf Club, an 18-hole golf course which also caters for weddings and events.

14.4.70 Another golf course, the Rochester & Cobham Park Golf Course, is located to the south of the A2 near Cobham Hall.

14.4.71 North of the River Thames, recreational facilities include Orsett Golf Club and Top Meadow Golf Club and Hotel. Both include 18-hole golf courses, with Top Meadow Golf Club also catering for weddings. In addition, Thurrock Rugby Club and Thurrock Athletic Stadium are near the Project, to the east of Thurrock.

14.4.72 Condovers Scout Activity Centre is found to the west of the Project on Station Road. The site covers 3.5 acres and provides pack holiday facilities, toilets, a shower block and space for camping.

14.4.73 Foxhounds Riding School is located immediately to the north of the A13 near Baker Street.

Community open space

14.4.74 Community open space incorporates areas used for more informal recreation purposes, including the various country parks, areas of community woodland, Open Access Land and common land located near the Project. These are identified on Figure 14.1 in Volume 3 and include:

a. Shorne Woods Country Park – located 500 metres to the east of the southern section of the Project. The woods cover nearly 300 acres and include a visitor centre, café, toilets and a gift shop. There are a variety of walking trails in addition to two adventure play areas.

b. Jeskyns Community Woodland and Greenspace – located immediately to the south of the A2. The area comprises woodlands, orchards and a lake. Interpretation boards inform visitors of the wildlife, planting, restoration and archaeology of the area. In addition, the area has several natural play features and sculptures.

c. Thames Chase Community Forest – the forest covers nearly 10,000 hectares, and is located to the south-east of Upminster, immediately to the west of the M25. The community forest was established in 1990 and is

surrounded by meadows, ponds and paths that have been created from disused farmland. The site offers all-weather paths for walking for all abilities, cycling and riding and a visitor centre with a café and gift shop. In addition, the visitor centre can be used to accommodate community groups and societies.

d. Mardyke Country Park – located to the west of the Project and South Ockendon. It has a variety of woodland paths to explore and benefits from two adjacent play areas.

e. The Kent Downs Area of Outstanding Natural Beauty (AONB) is to the south of the Project.

14.4.75 The Countryside and Rights of Way Act 2000 gives a public right of access to land mapped as open country (mountain, moor, heath and down) or registered common land. These areas are known as Open Access Land.

14.4.76 Open Access Land within the Development Boundary comprises:

a. Orsett Fen, located 1.5km to the north-west of Orsett

b. land either side of the M25 forming part of the Thames Chase Community Forest

14.4.77 Other areas of Open Access Land within 500m of the Development Boundary comprises The Green, Hall Hill, Fort Road, Parsonage, Walton and Tilbury Fort Common Land. Tilbury Fort Common Land is located to the north of the Project, immediately to the north of Tilbury Fort and Tilbury Power Station. The proposed route passes 0.4km to the east.

Visitor attractions

14.4.78 To the south of the River Thames, visitor attractions include the Shorne Marshes nature reserve which is run by the Royal Society for the Protection of Birds. The site can be accessed from nearby foot and cycle paths.

14.4.79 Visitor attractions to the north of the River Thames currently near the Project include Tilbury and Coalhouse Forts.

14.4.80 Tilbury Fort is a former artillery fort located immediately to the east of Tilbury Docks on the northern banks of the River Thames and managed by English Heritage. The site serves as a significant tourist attraction to thousands of visitors a year. The site is listed as a scheduled monument, with the officers' barracks a Grade II* listed building.

14.4.81 Coalhouse Fort is located 4km to the east of Tilbury Fort. Built in 1867–1874, the fort was part of the defence against the potential threat of French invasion. It is listed as a scheduled monument and is owned by Thurrock Council.

14.4.82 In 1983, the Coalhouse Fort Project was set up by a team of volunteers to run and manage the attraction, welcoming many visitors per year on guided tours. The fort has been used as a set location for films.

14.4.83 Further to the north, the Orsett Showground is near the Development Boundary. The showground is located on land bounded by Rectory Road to the west and

the A13 to the south. The Orsett Show is held annually every September and attracted over 10,000 people in 2016.

Non-motorised users

14.4.84 This section describes baseline data relating to NMUs. These are defined as pedestrians, cyclists and horse riders. Baseline data relates to PRoW, cycle routes, bridleways and National Trails likely to be either directly or indirectly affected by the Project.

PRoW and bridleways

14.4.85 PRoW and bridleways located near the Project, with either the potential to experience direct effects (ie, severance) or indirect effects (ie, loss of amenity for users) have been identified from definitive PRoW mapping accessed via local authority websites. PRoW and bridleways are illustrated in Figure 14.1 in Volume 3. Each of the PRoW or bridleways that may be directly affected by the Project has been subject to a walkover survey, to identify the potential level of use from the condition of the route (for example an overgrown/inaccessible route would suggest it was rarely used) in addition to identifying what facilities or areas the routes connect.

14.4.86 Table 14.8 and Table 14.9 detail PRoW which may be directly affected by the Project (ie, those which are within the Development Boundary), with Table 14.10 and Table 14.11 identifying PRoW found in close proximity to the Project, where the amenity of users of these routes may potentially be affected. The tables give a brief description of usage levels identified by the walkover surveys.

Cycle routes

14.4.87 There are several cycle routes near the Project that are part of the Sustrans Cycle Network. These are shown in Figure 14.1 in Volume 3:

a. Route 177 runs from Northfleet in Kent towards the south coast. The route runs east to west immediately to the south of the Project, adjacent to the A2.

b. Route 1 is a long-distance route connecting Dover and the Shetland Islands. The route runs from Gravesend in an easterly direction along the towpath of the disused Thames Medway Canal. The Dover to London section forms part of the international EuroVelo 5 cycle route.

c. To the north of the River Thames, Route 13 of the National Cycle Network will connect Tower Bridge in London with Fakenham in Norwich. The route is currently under development by Sustrans, with open sections alongside the River Thames at Grays and Tilbury. Section 2 of the route, from Tilbury to Colchester, heads north from Coalhouse Fort.

14.4.88 Cross-river cycle provision is currently available at the Dartford Crossing and the Tilbury to Gravesend Ferry. Although cyclists are not permitted to cycle over the Dartford Bridge or through the Dartford Tunnel, a special pick-up service is available to take cyclists and their bicycles across the river at this point using a dedicated Highways England vehicle.

14.4.89 The Tilbury to Gravesend Ferry operates between Monday and Saturday and is a foot passenger service that accepts bicycles.

Table 14.8 PRoW and bridleways with potential to be directly affected by the Project – south of the River Thames

PRoW reference	Description	Linkages
Footpath NG7/1	Located to the south of the southern tunnel portal, the route runs east to west from Thong Lane in the west, linking with NG8/2 in the east.	The footpath does not provide any key linkages but begins off Thong Lane, which has several residential properties. The path appears well used by locals for dog walking.
Footpath NG8/2	Runs south west to north east from Thong Lane in the east, linking with Footpath NG&/1 in the north.	The footpath does not provide any key linkages but does appear to be well used by locals for dog walking.
Footpath NS169/2	Runs north west to south-easterly from a housing estate in Gravesham towards Thong Lane.	The footpath does not provide any key linkages but begins near housing to the south of Riverview Park. The path is well used by locals for dog walking and general recreation.
Footpath NS167/8	Links with footpath NS169/2 and runs north east to south west towards the A2.	The footpath provides a linkage from surrounding residential areas to the wider footpath network.

Table 14.9 PRoW and bridleways with potential to be directly affected by the Project – north of the River Thames

PRoW reference	Description	Linkages
Footpath 136	Runs south west to north east from South Ockendon towards Harrow Road in the north east.	The footpath provides a link to South Ockendon which has several community facilities and a train station.
Footpath 79	Runs north to south linking Stanford Road (A013) in the north towards residential areas.	The footpath provides a link from a housing estate located to the north of Chadwell St Mary and the A1013 in the north. There are bus stops and a church near the southern section of the path.
Footpath 61	Located immediately adjacent to Bridleway 63, the footpath runs east to west towards Princess Margaret Road, finishing immediately to the north of East Tilbury train station.	The footpath provides a link to East Tilbury and East Tilbury train station and adjacent residential areas.
Footpath 200	Located to the east of Station Road and ultimately runs south-easterly towards the southern end of Princess Margaret Road, immediately to the north of Coalhouse Fort.	The footpath provides a link to Coalhouse Fort and appears to be well used by locals for dog walking.

PRoW reference	Description	Linkages
Bridleway 219	Runs south west to north east from the south of South Ockendon.	The footpath provides a linkage towards the south of the village of South Ockendon. In addition, the footpath meets with Footpath 136, which provides a direct link to South Ockendon.
Bridleway 161	Runs in a north south/west east direction from Stifford Clays Road near Grays.	The footpath does not appear to provide any key linkages. The survey findings did not consider this route to be well used.
Bridleway 58	Runs in a north west/south east direction and joins Station Road in the south.	The footpath provides a link to footpath 61, which provides a link to East Tilbury and East Tilbury train station.

Table 14.10 PRoW and bridleways with potential to be indirectly affected by the Project – south of the River Thames

PRoW reference	Description	Linkages
NS174/1	Links with footpath NS167/8 and runs north east to south west through some woodland towards the A2.	The footpath provides linkages from the A2 to the wider footpath network. The path is well used by locals for dog walking and general recreation.
NG17/1	Located immediately to the north of the A2, adjacent to NS174/1. The path runs north to south, before changing course running from east to west.	The footpath does not appear to provide key linkages.
NS367/1	Located on the southern side of the A2 it runs west to east before changing course to run in a northerly direction.	The footpath does not appear to provide key linkages.

Table 14.11 PRoW and bridleways with potential to be indirectly affected by the Project – north of the River Thames

PRoW reference	Description	Linkages
Footpath 136	Runs in a south westerly to north easterly direction from South Ockendon towards Harrow Road in the north east.	The footpath provides a link to South Ockendon which has several community facilities and a train station.
Footpath 176	Runs east to west from Fairholme Gardens in the west towards the M25 in the east.	The footpath provides a link from a housing estate in Upminster towards the wider footpath network. The path is well used by locals for dog walking/general recreation.
Footpath 179	Runs east to west from the M25 towards Warley Street in the east.	The footpath does not appear to provide any key linkages.

PRoW reference	Description	Linkages
Bridleway 183	Runs north to south alongside the M25 and finishes at Codham Hall Lane.	The footpath does not appear to provide any key linkages.
Footpath 251	Runs east to west from Church Lane in the east, towards the M25 in the west.	The footpath provides a link to Saint Mary Magdalene, the Parish Church of North Ockendon.
Footpath 252	Runs east to west from the south of Church Lane across a field towards the M25.	The footpath does not appear to provide any key linkages.
Footpath 230	Runs north to south from Ockendon Road (B1521) through Thames Chase Forest towards Cranham Golf Course.	The footpath provides linkages to Thames Chase Forest Centre.
Footpath 96	Runs east to west from Baker Street directly through Foxhound Riding School towards Mill Lane in the east.	The footpath provides a link from Baker Street towards Mill Lane.
Footpath 97	Runs south westerly/north easterly from Long Lane, adjacent to a residential estate in Grays.	The footpath does not provide any key linkages but runs north from a housing estate off Long Lane. The path appears well used by locals for dog walking/general recreation.
Footpath 144	Found to the west of the north portal it runs north to south from Fort Road towards a residential area to the south of Tilbury.	The footpath provides linkages for residential areas found in Tilbury. The path is well used by locals for dog walking and general recreation.
Bridleway 206	Runs north to south along Mill Lane and then east to west, parallel to the A13.	The bridleway does not appear to provide any key linkages.
Bridleway 63	Runs north west to south-easterly from Blue Anchor Lane in the west towards Low Street Lane in the east.	The footpath does not provide any key linkage but does link with the wider footpath network.

National Trails

14.4.90 The English Coastal Path (ECP) is a major project with committed Government funding to define a walkable route around the full coastline of England and is estimated, when complete, to cover 4,500km. The ECP is opening in sections and, when finished (anticipated in 2020), it will be one of the longest coastal walking routes in the world. While sections of the ECP are within the Development Boundary, they are immediately adjacent to the River Thames and pass over the Project's tunnel.

14.4.91 The proposed route of the ECP runs along both the northern and southern banks of the River Thames and is at an early stage of development. The ECP crosses the River Thames further inland at Woolwich. Natural England is in the process of developing the route between Grain and Woolwich (a 78km stretch of coastline to the south of the River Thames) and between Tilbury and

Southend-on-Sea (a 70km stretch of coastline to the north of the River Thames). The two sections are anticipated to be ready in 2019 and 2020 respectively.

14.4.92 The Timeball & Telegraph Trail is a long-distance path which runs from Timeball Tower near Deal in Kent to the Royal Observatory in Greenwich. The route runs in an east to west direction on the southern side of the River Thames. The route passes directly through Shorne Woods Country Park, before running south adjacent to Thong Lane, crossing the A2 and heading east to west, 1.3km to the south of the A2.

Human health and wellbeing

14.4.93 Using Census and other data sources at local authority and comparator levels, information has been collected on the health and wellbeing status of residents living in the local authorities through which the Project passes. The information below provides an overview of health status, followed by a focus on those health factors relevant to the Project.

14.4.94 Table 14.12 shows that the population of Thurrock Council, as a percentage, has the best self-reported health status, with 48.2% of residents stating they had a 'very good health' status. The proportion of residents reporting 'bad health' and 'very bad health' is slightly higher in both Havering (5.2%) and Gravesham (5.1%) compared to England as a whole (5.4%). Each of the local authority areas report slightly lower proportions of bad and very bad health status than is the case for England as a whole (5.4%).

Table 14.12 Health status of residents (%)

Self-reported classification	Gravesham	Thurrock	Havering	England
Very good health	46.5	48.2	46.0	47.2
Good health	35.0	34.7	35.6	34.2
Fair health	13.4	12.3	13.3	13.1
Bad health	4.0	3.7	4.0	4.2
Very bad health	1.1	1.0	1.2	1.2

Source: Census, 2011

14.4.95 Life expectancy at birth (shown in Table 14.13) has risen nationally in recent decades due to improvements in public health. For males, Havering has the highest life expectancy at birth (80.2 years), followed by Gravesham (79.4) and Thurrock (78.9). By means of comparison, in England life expectancy at birth for males is 79.5. For females, Havering has the highest life expectancy at birth (84.4), followed by Gravesham (83.2) and Thurrock (82.6). For England, life expectancy at birth for women is 83.1.

Table 14.13 Life expectancy of residents

	Gravesham		Thurrock		Havering		England	
	Male	Female	Male	Female	Male	Female	Male	Female
Life expectancy at birth	79.4	83.2	78.9	82.6	80.2	84.1	79.5	83.1

Source: Public Health England, 2017, 2013 – 2015

14.4.96 Health profiles are produced for each local authority in England by Public Health England and provide an overview of local health.

14.4.97 Heart disease and respiratory disease are major causes of death in each of the local authority areas through which the Project passes. Public Health England data identifies that, for mortality due to cardiovascular deaths, Thurrock experiences a significantly worse rate than the England average while Gravesham is not significantly different from the England average and Havering is significantly better than the England average.

14.4.98 The health profile for Gravesham for 2017 shows that the health of people within the local authority is generally similar to the England average. For Thurrock the health of local people is varied for different factors, compared with the England average. For the London Borough of Havering, the health of local people is generally better than the England average. However, in respect of child health, childhood obesity (recorded for children in Year 6) is significantly worse than the average for England across all three authorities. The profiles identify excess weight in adults to also be significantly worse than for England in both Gravesham and Thurrock. In addition, under-75 mortality rates for cardiovascular and cancer-related issues are significantly worse in Thurrock compared to England.

Future baseline

14.4.99 In considering proposed developments across the wider area which have been highlighted in preceding sections, there will be a significant increase in the number of jobs and homes in the area, which will have an impact on future traffic growth. Indeed, the SELEP outlines an ambition to spearhead, with Government, a £10 billion investment programme into East Sussex, Essex, Kent, Medway, Southend and Thurrock until 2020. This will create 200,000 private sector jobs and finance 10,000 new homes.

14.4.100 Data has been collected from the Office of National Statistics (ONS) which outlines the projected population increase between 2014 and 2039. Table 14.14 shows that between 2014 and 2039, it is projected that each area within the Study Area is likely to witness an average population growth of 26%. The area with the highest projected population growth is Havering, which is anticipated to have an increase of 32%. The area with the lowest projected population increase is Southend-on-Sea at 20%.

Table 14.14 Forecast growth in population in the study area

Study area	2014	2039	% growth
Kent	1,510,000	1,845,000	22
Essex	1,432,000	1,719,000	20
Gravesham	105,000	130,000	24
Havering	246,000	324,000	32
Medway	274,000	340,000	24
Thurrock	163,000	208,000	28
Southend-on-Sea	178,000	214,000	20
Greater London	8,539,000	10,976,000	29
England	54,317,000	63,282,000	17

Source: ONS, 2014-based National Population Projections

14.4.101 Other changes to the future baseline will arise from the growth in population described above. These will include likely growth in the number of vehicle trips, public transport network users and the number of trips being made by other modes of transport, such as walking and cycling. With increasing demand for travel, it is likely that levels of congestion on the road network will increase (further reducing journey time reliability).

14.4.102 A further effect of increased populations is the increased social infrastructure that may be required to accommodate them, for example education and healthcare facilities.

14.5 Further baseline information and surveys required

14.5.1 Further baseline information will be obtained to develop the assessment for people and communities and demonstrate how the Project will impact on local communities in different ways. The additional information relates to:

a. Identification/confirmation of catchment areas for community facilities (education and healthcare facilities for example). These will be identified through a combination of desk-based research and from outputs of consultations, for example with local schools and healthcare facilities.

b. Identification/confirmation of community networks, how people move around within their local area by car, public transport, walking or cycling. These will be identified through a combination of desk-based research, for example considering where people might travel from and to, as well as specific transport routes, and site visits.

c. User counts for cycle routes likely to be directly affected during construction will be undertaken.

d. Soil and ALC surveys will be undertaken to determine the characteristics of the soils present and the land grades. Soil surveys will be carried out across non-agricultural land where the soils are important in the land use supported. The ALC surveys will follow published guidelines (Ministry of Agriculture, Fisheries and Food (MAFF), 1988).

e. Land owner and land manager interviews will be conducted to gain a full understanding of the nature and function of the agricultural businesses affected.

14.6 Potential effects and mitigation measures

14.6.1 The potential likely significant effects of the Project during construction (see Table 14.155) and operation have been considered based upon available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. Note that this assessment is ongoing and is subject to change through ongoing development of the Project proposals.

14.6.2 A full, detailed assessment will be made before the DCO application and will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will be fully detailed within the Environmental Statement (ES).

Construction

Table 14.15 Effects and mitigation during Project construction

Item	Description
Receptor	Commercial and private assets – south of the River Thames
Potential nature of effect	Although every effort has been made to minimise impacts on private properties through design of the Project, several private assets within the Development Boundary would either be subject to demolition, land-take, or would experience changes to access as part of the Project. To the south of the River Thames, a total of four residential and zero commercial properties are likely to require demolition. A total of 2.32km^2 of temporary land-take and 2.55km^2 of permanent land-take would be required.
Likely duration	For those assets where land-take will be permanent, effects will be experienced for the lifetime of the Project. For other assets, land-take may be temporary and for the construction period only.
Potential mitigation	In the absence of any available mitigation, compensation for the loss of properties and/or land will be provided. Methods and procedures for assessing the appropriate levels of compensation are being followed in accordance with the National Compensation Code. Where appropriate, consultation with landowners, occupiers and agents will continue as the Project develops to manage and reduce impacts on property owners as far as practicably possible. A CoCP will be prepared as part of the DCO application and will outline the measures required to ensure contractors act considerately in relation to residents, particularly for any works that may be programmed to take place at night. Appropriate arrangements will be put in place to ensure that access to residential and commercial properties is retained during the construction period. For example, temporary access to Rochester & Cobham Golf Club will be provided.
Receptor	Commercial and private assets – north of the River Thames
Potential nature of effect	Although every effort has been made to minimise impacts on private properties through design of the Project, several private assets within the Development Boundary would either be subject to demolition, land-take, or would experience changes to access as part of the Project. To the north of the River Thames, a total of 20 residential and zero commercial properties are likely to require demolition. A total of 7.39km^2 of temporary land-take and 7.28km^2 of permanent land-take would be required.
Likely duration	For those assets where land-take will be permanent, effects will be experienced for the lifetime of the Project. For other assets, land-take may be temporary and for the construction period only.
Potential mitigation	In the absence of any available mitigation, compensation for the loss of properties and/or land will be provided. Methods and procedures for assessing the appropriate levels of compensation are being followed in accordance with the National Compensation Code. Where appropriate consultation with landowners, occupiers and agents will continue as the Project develops to manage and reduce impacts on property owners as far as practicably possible.

Item	Description
	A CoCP will be prepared as part of the DCO application and will outline the measures required to ensure contractors act considerately in relation to residents, particularly for any works that may be programmed to take place at night. Appropriate arrangements will be put in place to ensure that access to residential and commercial properties is retained during the construction period.
Receptor	Marine users and infrastructure
Potential nature of effect	There may be potential effects on river usage and navigation because of construction activities and subsequent use of a jetty for the transportation of construction materials and waste. No permanent acquisition of the riverbed will be necessary during the construction period.
Likely duration	During the construction and decommissioning phases.
Potential mitigation	The potential effects on river usage will be mitigated through the careful design of structures, including the location of the jetty, and through careful consideration given to mooring, berthing and manoeuvring arrangements.
Receptor	Utilities
Potential nature of effect	The route would require the diversion or alteration of overhead high voltage electricity transmission and distribution lines, including near the A13 to the north of the River Thames. In addition, there are large high-pressure gas feeder mains potentially affected by the route that would require diversion.
Likely duration	During the construction and decommissioning phases.
Potential mitigation	Discussions are ongoing with utility providers regarding potential diversion routes and further information will be presented in the ES.
Receptor	Development land
Potential nature of effect	Potential effects on development land because of the Project may include land-take near an emerging employment allocation in Brentwood (Brentwood Enterprise Park). Other potential effects on development land during construction are likely to relate to traffic diversions or delays because of construction activities.
Likely duration	During the construction phase.
Potential mitigation	Mitigation includes the implementation of a Transport Management Plan (TMP) and CoCP, both of which would help to minimise potential impacts of construction-related traffic and activities.
Receptor	Agricultural land
Potential nature of effect	Loss of best and most versatile agricultural land
Likely duration	During the construction phase.
Potential mitigation	There is no direct mitigation for the loss of agricultural land. Through an iterative design process, the total area of best and most versatile agricultural land affected or lost will be minimised as far as possible. The implementation of best practice in relation to soil handling, restoration and reuse, in accordance with appropriate guidance such as the *Defra*

Item	Description
	Construction Code (2009), would minimise the removal of soil off-site and ensure land required temporarily for construction is returned to agricultural use in a suitable condition.
Receptor	Agricultural businesses
Potential nature of effect	Loss of land and disruption to business operations affecting viability.
Likely duration	During the construction phase.
Potential mitigation	Potential impacts on farm viability will be discussed with land owners/land managers with the potential for compensation agreements to be reached. A CoCP will outline measures to minimise disruption during the construction phase.
Receptor	Local and wider economy
Potential nature of effect	There is the potential for beneficial effects on the local and wider economy because of Project construction, for example through job creation and training. The number and type of potential jobs that may be created, together with the skills that may be required and training opportunities that may be created will continue to be developed as the Project progresses. Construction activities are also likely to stimulate the local economy through demand for goods and services from local firms and suppliers, as well as spend in the local community by construction workers. The effect on the local and wider economy is likely to be positive.
Likely duration	Effects on the local and wider economy arising from job creation and expenditure of employees will be restricted to the construction phase.
Potential mitigation	Although no mitigation is required, there is potential for the creation of skills and training opportunities.
Receptor	PRoW, bridleways, cycle routes and National Trails
Potential nature of effect	There would be a negative effect on several walking, cycling and equestrian routes near the Project as a result of construction activities. Effects may include routes being temporarily closed for short periods of time, or routes which may need to be temporarily diverted. The impact on journey length on affected routes in the long term is likely to be minimal. Users of routes may also be indirectly affected because of changes in amenity (more information on this is provided in Chapter 8 Landscape). The following routes would be severed during the construction phase (these routes are identified on Figure 14.1 in Volume 3): • Footpath 136 • Bridleway 219 • Bridleway 161 • Footpath 97 • Footpath 96 • Bridleway 206 • Footpath 79 • Bridleway 63 • Footpath 61 • Bridleway 58

Item	Description
	• Footpath 200 • Footpath NG7/1 • Footpath NG8/2 • Footpath NS169/2 • Footpath NS167/8 • Sustrans Route 177 Current cross-river provision for cyclists (a vehicle that drives cyclists across the Dartford Bridge on a limited timetable) would not be impacted by the Project.
Likely duration	During the construction period.
Potential mitigation	To minimise disruption to NMU routes, including PRoW, bridleways, cycle routes and National Trails, temporary diversions will be put in place where necessary, together with appropriate signage. This will be carried out in consultation with the local highways authority and other interested stakeholders. Temporary alternative routes for PRoW that are affected would be required. Information in advance and during closure periods would help to reduce any inconvenience caused to users of the PRoW. Footbridges and underpasses will need to be accessible to all members of the public, including those using wheelchairs and be designed to ensure the safety of vulnerable users. They should, include, for example, appropriate lighting.
Receptor	Community facilities
Potential nature of effect	No direct effects on community facilities (for example education or healthcare facilities) have been identified during the construction phase, for example because of land-take. Effects on community facilities near to the Development Boundary may relate to changes in noise levels, air quality conditions or because of visual impacts. The effect on community facilities because of Project construction is considered to be potentially negative, but short term.
Likely duration	During the construction phase.
Potential mitigation	Further information on specific mitigation measures as they relate to air quality, visual amenity and noise can be found in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration. of this *PEIR*.
Receptor	Sports and leisure facilities
Potential nature of effect	Two golf courses are likely to be directly affected during the construction phase – Southern Valley Golf Course would be affected because of land-take and the Rochester & Cobham Golf Course would be affected because of changes to access. The effect on sports and leisure facilities is therefore considered to be negative.
Likely duration	During the construction phase.
Potential mitigation	Consultations have indicated that the Southern Valley Golf Course will no longer be in use following construction of the Project; methods and procedures for assessing the appropriate levels of compensation are being followed in accordance with the National Compensation Code.

Item	Description
	A temporary access would be provided for the Rochester & Cobham Golf Course during construction works.
Receptor	Community open space
Potential nature of effect	Areas of open space that would be directly affected by the Project because of land-take comprise the Thames Chase Forest and Orsett Fen areas of Open Access Land. There may be an adverse effect on users of areas of open space near the Project (for example Shorne Woods Country Park and the Kent Downs AONB) during construction because of changes in the local amenity due to construction activities. Related effects are described in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration. The effect on community open space because of the Project is considered to be negative and permanent.
Likely duration	Lifetime of the Project.
Potential mitigation	Ongoing liaison with relevant stakeholders to identify exchange land/opportunities for enhancement where necessary (in relation to areas of formally designated open space for example) as well as to confirm specific mitigation measures. Further information on specific mitigation measures as they relate to air quality, visual amenity and noise can be found in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration of this *PEIR*.
Receptor	Visitor attractions
Potential nature of effect	No visitor attractions are directly affected by the Project because of land-take or changes to access. During Project construction, effects are likely to be restricted to disruption because of construction traffic, and changes to amenity for visitors because of construction activities. Related effects are described in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration. The effect on visitor attractions during Project construction may be negative but is likely to be short term.
Likely duration	During the construction phase.
Potential mitigation	Ongoing consultation will take place with relevant stakeholders to ensure access arrangements are appropriate for specific events held locally, for example the annual Orsett Show. Further information on specific mitigation measures as they relate to air quality, visual amenity and noise can be found in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration of this *PEIR*.
Receptor	Community severance
Potential nature of effect	Severance effects would be reduced as far as practicable through the design process. An analysis of community severance for residents and businesses travelling by private vehicle will be made following review/analysis of traffic model data.
Likely duration	During the construction phase.
Potential mitigation	Access between communities on either side of the route will be maintained through the provision of overpasses/underpasses.

Item	Description
Receptor	Human health and wellbeing
Potential nature of effect	Effects on human health and wellbeing because of the Project are primarily likely to relate to environmental change (for example air quality and noise levels); changes in access to employment, leisure and community facilities, including areas of open space; or to changes in the way people walk or cycle near the Project.
Likely duration	During the construction phase.
Potential mitigation	Mitigation will be identified on a topic-by-topic basis (for example in relation to PRoW and cycle routes, access to community facilities, or in relation to air quality and noise (see Chapter 6 Air Quality and Chapter 13 Noise and Vibration in this *PEIR*).
Receptor	Changes in amenity for local residents
Potential nature of effect	There may be a negative impact on people who live, work and use community facilities which are near the Project, because of changes in amenity arising from construction activities. For example, during construction there may be a combination of dust arising from construction activities, changes to how an area looks (its visual amenity) or changes to noise levels. These effects are discussed in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration. With mitigation, the effect is likely to be negative.
Likely duration	During the construction phase.
Potential mitigation	Mitigation includes the implementation of a TMP and CoCP, both of which would help reduce potential impacts of construction traffic and activities. Further information on specific mitigation measures as they relate to air quality, visual amenity and noise can be found in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration of this *PEIR*.
Receptor	Road users (views from the road)
Potential nature of effect	During construction, road users may experience a negative effect in terms of views from the road because of the presence of construction activities. The effect is deemed to be temporary and negative.
Likely duration	During the construction phase.
Potential mitigation	Mitigation includes the implementation of a TMP and CoCP, both of which will help reduce potential impacts of construction traffic and activities.
Receptor	Road users (driver stress)
Potential nature of effect	During the construction of the Project, vehicle travellers could experience delays, either because of reduced speed limits through roadworks, the presence of construction traffic, increased congestion throughout the area or because of drivers re-routing. These factors may result in an increase in driver stress because of driver frustration and uncertainty. Although impacts may be negative, they are likely to be restricted to the construction period and localised.
Likely duration	During the construction phase.
Potential mitigation	During construction, a TMP will be implemented to minimise delays and thereby help reduce driver stress caused by roadworks. This would include

Item	Description
	temporary signage which would be put in place to reduce uncertainty and frustration. In addition, during the construction phase, the transportation of construction equipment and waste materials would require careful planning to minimise the impact on existing road users and local communities.

Operation

14.6.3 Table 14.16 sets out likely effects, together with potential mitigation measures, during the operation phase.

Table 14.16 Effects and mitigation during Project operation

Item	Description
Receptor	Commercial and private assets – south of the River Thames
Potential nature of effect	Although every effort has been made to minimise impacts on private properties through design of the Project, several private assets within the Development Boundary would either be subject to demolition or necessitate permanent land-take or would experience changes to access as part of the Project. To the south of the River Thames, a total of four residential and three commercial properties are likely to require demolition. A total of 2.55km^2 of permanent land-take would be required.
Likely duration	The lifetime of the Project.
Potential mitigation	Land-take requirements for any proposed mitigation will be further optimised through seeking multifunctional environmental solutions to maximise the environmental benefits with minimal impact on land-take. In the absence of any available mitigation, compensation for the loss of properties and/or land will be provided. Methods and procedures for assessing the appropriate levels of compensation are being followed in accordance with the National Compensation Code.
Receptor	Commercial and private assets – north of the River Thames
Potential nature of effect	Although every effort has been made to minimise impacts on private properties through the design of the Project, several private assets within the Development Boundary would either be subject to demolition or necessitate permanent land-take or would experience changes to access as part of the Project. To the north of the River Thames, a total of 20 residential and zero commercial properties are likely to require demolition. A total of 7.28km^2 of permanent land-take would be required.
Likely duration	The lifetime of the Project.
Potential mitigation	In the absence of any available mitigation, compensation for the loss of properties and/or land will be provided. Methods and procedures for assessing the appropriate levels of compensation are being followed in accordance with the National Compensation Code.
Receptor	Development land

Item	Description
Potential nature of effect	Operational impacts on development land, including strategic allocations and planning applications are largely expected to be beneficial due to improved access provided by the Project. Benefits could be extended to development sites within the wider region. Overall, the effect is likely to be positive, long-term and significant.
Likely duration	The lifetime of the Project.
Potential mitigation	As there would be no significant adverse effect on any extant planning permissions or strategic allocations during the operation phase, no specific mitigation is required. Appropriate consultation with landowners, occupiers and agents would continue as the Project develops to manage and reduce the impact on property owners.
Receptor	Local economy
Potential nature of effect	The Project will provide a safer, faster, more reliable road that will improve the resilience of the wider road network and relieve the congested Dartford Crossing and surrounding approach roads. The Project will enable sustainable local development and regional growth, leading to a stronger economy. It will open opportunities for investment in housing and allow businesses to grow, creating more jobs, apprenticeships and training opportunities. The Project will improve access to jobs, housing, leisure and retail facilities on both sides of the River Thames. The effect is likely to be positive and significant.
Likely duration	The lifetime of the Project.
Potential mitigation	Not required.
Receptor	PRoW, bridleways, cycle routes and National Trails
Potential nature of effect	Routes which have been severed by the Project during the construction phase would be reinstated by means of bridges or underpasses as appropriate. Overall, the effect is deemed to be neutral. New structures required for specific routes are summarised as follows: • Public footpath NS167 between Gravesend and Thong – new footbridges and underpasses to cross the Project route to A2/M2 link roads • Public footpath NG7 north of Thong Lane diverted over about 500m to cross the Project route on a new footbridge over approach cutting to south portal • Bridleway BR58 and Coal Road north of Tilbury loop railway diverted over about 900m to pass under the Project embankment north of the Tilbury junction and railway viaduct through a new underpass • Footpath FP79 north of Chadwell St Mary diverted over about 600m to cross the Project route on a new accommodation overbridge which also carries a realigned farm track • Bridleway BR219 adjacent to Mardyke river crossed by Project viaduct over Mardyke flood plain

Item	Description
	• Footpath FP136 east of Ockendon landfill site diverted over about 650m and raised by about 9.5m above existing ground level to cross the Project route on a new footbridge • Footpath FP151 south of North Ockendon diverted over about 650m and raised by about 3m above existing ground level to cross both the the Project route to M25 link roads and the Upminster and Grays branch railway on a new footbridge
Likely duration	The lifetime of the Project.
Potential mitigation	When developing the design, careful consideration has been given to provision of pedestrian, equestrian and cycling access where links are likely to be severed. Where these links are located within or near environmentally sensitive areas, the visual impact on any users will be mitigated through the introduction of green structures as shown in Figure 2.4 Outline Environmental Masterplan in Volume 3 of this *PEIR*. Further consideration will be given when designing footbridges and underpasses for accessibility of all members of the public including the use of wheelchairs, and ensuring safety for vulnerable users, including for example, lighting at night.
Receptor	Changes in amenity for local residents
Potential nature of effect	There may be a negative impact on people who live and work in the immediate vicinity of the Project because of changes to amenity arising during the operation phase. For example, there may be a combination of changes to how an area looks (its visual amenity) or changes to noise levels. These effects are discussed individually in Chapter 8 Landscape and Chapter 13 Noise and Vibration. With mitigation, the effect is likely to be negative or neutral.
Likely duration	The lifetime of the Project.
Potential mitigation	Information on specific mitigation measures as they relate to air quality, visual amenity and noise can be found in Chapter 6: Air Quality, Chapter 8: Landscape and Chapter 13: Noise and Vibration of this *PEIR*.
Receptor	Sports and leisure facilities
Potential nature of effect	The Southern Valley Golf Club would be permanently affected because of land-take for the Project and would no longer be operational. The effect is negative and permanent.
Likely duration	The lifetime of the Project.
Potential mitigation	Methods/procedures for assessing the appropriate levels of compensation would be undertaken in accordance with the National Compensation Code.
Receptor	Community open space
Potential nature of effect	Areas of open space that would be directly affected by the Project because of land-take include the Thames Chase Forest and Orsett Fen areas of Open Access Land. The effect on community open space because of the Project is considered to be negative and permanent.
Likely duration	During the lifetime of the Project.
Potential mitigation	Indicative locations for compensation land for direct loss of community open space are included in the immediate vicinity of the affected

Item	Description
	community assets as shown in Drawing 2.4 Outline Environmental Masterplan. Ongoing liaison with relevant stakeholders will ensure adequate integration with the existing community open space. Potential mitigation measures relating to landscape are discussed further in Chapter 8: Landscape.
Receptor	Visitor attractions
Potential nature of effect	Visitor attractions in the immediate vicinity of the Project (for example Coalhouse Fort and Tilbury Fort) are not likely to experience any change in visitor numbers during the operation phase – for example road access to these attractions by means of the Local Road Network would not be affected. However, visitor attractions in the wider region, particularly those likely to experience high volumes of visitors (for example the Theme Park under development on the Swanscombe Peninsula in Kent, or Lakeside Shopping Centre) may experience a beneficial effect because of improved accessibility. The overall effect on visitor attractions in the local and wider area is likely to be positive and long term.
Likely duration	The lifetime of the Project.
Potential mitigation	No further mitigation required.
Receptor	Human health and wellbeing
Potential nature of effect	Effects on human health and wellbeing as a result of the Project are primarily likely to relate to environmental change (for example air quality and noise levels); changes in access to employment (for example the Project may provide improved accessibility to jobs and training opportunities which would have health and wellbeing benefits), leisure and community facilities, including areas of open space; or to changes in the way people walk or cycle in the vicinity of the Project.
Likely duration	During the lifetime of the Project.
Potential mitigation	Mitigation would be identified on a topic-by-topic basis. For example, in relation to PRoW and cycle routes, access to community facilities, or in relation to air quality and noise. See Chapter 6: Air Quality and Chapter 13: Noise and Vibration. in this *PEIR*. Specific mitigation measures for affected communities would also be identified.
Receptor	Road users (views from the road)
Potential nature of effect	Typically, within the rural landscape south of the River Thames, between the junction with the A2 and the south tunnel portal, views out would be limited as the carriageway would be in a cutting and therefore road users would not easily be able to see beyond this. Along this section it is anticipated that the structures at the proposed junction with the A2, the cutting slopes and potential chalk rock outcrops, and the south tunnel portal would be the main features in the view of vehicle travellers. North of the River Thames where the carriageway emerges on embankment as it crosses the River Thames floodplain, there is potential for views out across the urban fringe landscape of Thurrock, although screening mitigation such as false cuttings, environmental barriers and tree and shrub planting could limit these views. Elsewhere the new carriageway would pass through sections of cutting and embankment with associated mitigation measures. In this section it is anticipated that the north tunnel

Item	Description
	portal and the structures at proposed junctions with the A13 and M25 with their associated tree and shrub planting would form the main features of the view for vehicle travellers north of the River Thames. The effect on vehicle travellers in relation to views from the road during the operation phase is likely to be neutral or positive.
Likely duration	The lifetime of the Project.
Potential mitigation	Road users' views could be improved through keeping roadside barriers low and minimising the use of undercuttings, where this is possible given other mitigation priorities, for example relating to noise management. Where there is no option but to have travellers' views blocked, innovative approaches to creating a positive environment through planting and lighting could be used.
Receptor	Road users (driver stress)
Potential nature of effect	It is expected that during the operation of the Project, there would be a positive effect on driver stress through reductions in congestion at the Dartford Crossing and approach roads, resulting in improved accessibility to employment and other destinations. The overall effect is likely to be positive.
Likely duration	The lifetime of the Project.
Potential mitigation	Safety barriers and planting would help to reduce fear of accidents and stress.

Chapter 15.

Road Drainage and Water Environment

15 Road Drainage and Water Environment

15.1 Introduction

15.1.1 This chapter presents the preliminary environmental information for the assessment of potential effects on road drainage and the water environment related to the construction and operation of the Project.

15.1.2 Water is vital for all living plants and animals. For human beings it is not only essential to life and health, but also of crucial importance in industry and agriculture, for the transport and dilution of waste, as a means of transport and for recreation. The Government is committed to maintaining and, where justified, improving the quality of UK drinking water, surface waters, groundwater and coastal waters. It also attaches great importance to the management of flood risk, taking account of climate change. Contaminants deposited on road surfaces are quickly washed off during rainfall and, where traffic levels are high, there is potential for unacceptable harm being caused to water bodies that receive road drainage. Roads can also impact the existing hydrology and hydrogeology of the catchments and aquifers through which they pass.

15.1.3 The aims of this chapter are to, in relation to road drainage and water environment:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to road drainage and the water environment

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies or surveys

e. describe the potential effects of the Project on road drainage and the water environment and how these have been assessed for the purpose of this *PEIR*

f. describe potential mitigation measures

15.1.4 There are expected to be interrelationships between the potential effects on road drainage and the water environment, and other disciplines reported on in the *PEIR*. Please refer to:

a. Chapter 7: Cultural Heritage

b. Chapter 8: Landscape

c. Chapter 9: Terrestrial Biodiversity

d. Chapter 10: Marine Biodiversity

e. Chapter 11: Geology and Soils

f. Chapter 14: People and Communities

15.2 Planning policy and legislative requirements

Legislative requirements

15.2.1 This assessment has been undertaken in accordance with the requirements of legislation relating to the water environment in the context of the Project, summarised in Table 15.1.

Table 15.1 Summary of legislative requirements

Legislation name	Summary of requirements
The EU Water Framework Directive 2000; Council Directive 2000/60/EC	The Water Framework Directive (WFD) provides a framework for the protection of surface (fresh) water, estuaries, coastal water and groundwater. The objectives of the WFD are to enhance the status, and prevent further deterioration, of aquatic ecosystems, promote the sustainable use of water, reduce pollution of water and ensure progressive reduction of groundwater pollution.
The Flood and Water Management Act 2010	This legislation provides a comprehensive flood risk management framework for people, homes and businesses. The Act encourages the use of sustainable drainage in new developments and redevelopments, with reference to the non-statutory Technical Standards for Sustainable Drainage Systems (SuDS).
The Water Resources Act 1991/2003	The Water Resources Act 1991, as amended in 2003, sets out the regulatory regime under which water abstraction and impounding is licensed by the Environment Agency (EA). It is a criminal offence to knowingly permit any poisonous, noxious or polluting matter or any solid waste matter to enter any controlled waters.
Part 2A of the Environmental Protection Act (1990)	This legislation provides protection to controlled waters from pollution by hazardous substances in, on or under the land.

National Policy Statement for National Networks

15.2.2 The relevant NSPNN requirements for the road drainage and water environment assessment of the Project are presented in Table 15.2.

Table 15.2 NPSNN requirements and Project response

Requirement	Project response
Paragraph 4.48 highlights that discharges from a proposed project that affect water quality and the marine environment may be subject to separate regulation. It sets out that: "Relevant permissions should be obtained for any activities within the development that are subject to regulation under the pollution control framework or other consenting or licensing regimes."	Relevant regulatory authorities are being consulted about consents and licensing for Project activities such as discharges to the water environment, groundwater control and works to, and structures in, on, over or under a controlled water.
Paragraph 5.90 states that: "The applicant should take account of the policy on climate change adaption [detailed in paragraphs 4.36 to 4.47] which states that new development should be planned to avoid increased vulnerability to the range of impacts arising from climate change, incorporating suitable adaption measures, considering the latest UK Climate Projections (currently 2009 (UKCP09)"	The Project design has built-in climate change resilience in several ways. For example, the operational drainage design has included an allowance for the predicted effects on rainfall intensity and the implications for operational road drainage volumes and rates. Through undertaking a detailed Flood Risk Assessment (FRA), the vertical alignment of the carriageway, the design of watercourse crossings and the protection measures for the tunnel portals all include appropriate UKCP09 allowance for climate change effects on river flows and Thames Estuary water levels.
Paragraphs 5.91 to 5.93 state: "Development of essential transport infrastructure is acceptable in areas of high flood risk, subject to the requirements of the Exception Test. Applications for all projects in Flood Zones 2 and 3 should be accompanied by an FRA. The FRA should identify and assess the risks from all forms of flooding to and from the project and demonstrate how these risks will be managed, taking climate change into account."	The Project is subject to a detailed FRA that considers all sources of flood risk. The FRA is being informed by consultation with the EA and relevant Lead Local Flood Authorities and the results of hydrological and hydraulic modelling of the River Mardyke, Tilbury Main and tidal Thames. The FRA will inform the Environmental Statement and will also be submitted as a stand-alone report as part of the Development Consent Order (DCO) application.
Paragraphs 5.105 and 5.108 outline the requirements of two key flood risk and planning policy tests. It is stated that: "Preference should be given to locating projects in Flood Zone 1 in accordance with the Sequential Test, however national networks infrastructure projects can be located in Flood Zone 3 subject to the Exception Test. For the Exception Test to be passed it must be demonstrated that the project provides wider sustainability benefits that outweigh flood risk; and a FRA proves that the project will be safe for its lifetime without increasing flood risk elsewhere and, where possible, will reduce flood risk overall."	As noted above, the Project is subject to a detailed FRA, which will provide the evidence required to satisfy the latter part of the Exception Test. Evidence in support of the first part of the Test regarding the sustainability benefits of the Project is summarised in the *Case for the Project*.

Requirement	Project response
Paragraph 5.221 states: "Where a development is likely to have significant adverse effects on the water environment, the applicant should ascertain the existing status of, and carry out an assessment of the impacts of the proposed project on water quality; water resources and physical characteristics as part of the Environmental Statement."	All the characteristics listed have been included in the scope of the assessment that will be reported in the Environmental Statement.
Paragraph 5.223 states: "The ES should assess any impacts of the proposed project on Source Protection Zones around potable groundwater abstractions."	A hydrogeological risk assessment is being prepared and will describe any potential impacts on Source Protection Zones. Appropriate design and mitigation measures will be incorporated into the Project in consultation with the EA.
Paragraph 5.226 states: "Development proposals should have regard to the relevant River Basin Management Plan (RBMP) and the requirements of the WFD (including Article 4.7) and its daughter directives, including those on priority substances and groundwater in terms of WFD compliance. The overall aim of projects should be no deterioration of the ecological status of water bodies."	A WFD assessment is being prepared and appropriate design and mitigation measures will be incorporated into the Project to facilitate WFD compliance. The WFD assessment will inform the Environmental Statement and will also be submitted as a stand-alone report as part of the DCO application.
Paragraph 5.230 states: "Projects should adhere to any national standards for Sustainable Drainage Systems (SuDS)."	A drainage strategy is being prepared that centres on the application of SuDS, appropriate to local conditions, to manage surface water runoff from the Project.

Planning policy requirements

15.2.3 The water environment planning policy requirements summarised in Table 15.3 have also been considered.

Table 15.3 Summary of planning policy requirements

Policy name	Summary of requirements
National Planning Policy Framework (NPPF) (July 2018)	The NPPF and online 'planning practice guidance' set out the Government's planning policies for England and how these are expected to be applied. The document streamlines national planning policy into a consolidated set of priorities, with the core theme being the delivery of sustainable development and economic growth. Paragraph 149 advocates adoption of proactive strategies to mitigate and adapt to climate change, taking full account of flood risk, coastal change, water supply, biodiversity and landscapes.

Policy name	Summary of requirements
Thames Estuary 2100 Plan (TE2100)	The TE2100 divides the Thames Estuary into action zones and policy units and assigns a flood risk management approach to each unit. The policy applicable to the southern portal of the Project (Action Zone 6) encourages "maintaining flood defences at their current level, accepting the likelihood of a flood will increase because of climate change." The north portal is within Action Zone 5 where taking further action is advocated "to keep up with climate change and land use change so that flood risk does not increase."
Thurrock Core Strategy and *Policies for Management of Development*, as amended January 2015	Sets out policies for the management and reduction of flood risk (CSTP27 Paragraphs 5.161 to 5.177) and for minimising pollution and impacts on the natural environment (PMD1 Paragraphs 6.5 to 6.10). The policy states that any development having the potential to cause water pollution or failing to sustainably manage surface water runoff and flood risk will not be permitted.
Gravesham Local Plan Core Strategy, adopted September 2014	Policy CS18 contains guidance aimed at ensuring appropriate flood risk management (Paragraphs 5.14.5 to 5.14.12); WFD compliance (Paragraph 5.14.13) and the sustainable management of surface water drainage (Paragraphs 5.14.14 to 5.14.16). Sustainable drainage is advocated as the preferred drainage solution for new developments and the policy supports the objectives of the WFD *Thames River Basin Management Plan* and ensures that new developments are 'future-proofed' against flood risk.
Brentwood Replacement Local Plan, adopted August 2005	Two policies, IR7 Development in flood risk areas and IR8 Surface water runoff no longer form part of the Local Plan as their content was considered to repeat National Planning Policy.
Medway Local Plan, adopted May 2003	Sets out policies for the protection of surface and groundwater resources (CF12 Paragraph 9.5.33) and for ensuring sustainable development in areas at risk of tidal flooding (CF13 Paragraphs 9.5.34 to 9.5.37). These policies state that development proposals must ensure that adequate measures are undertaken to protect water resources and to ensure the integrity of existing flood defences.

15.3 Methodology

15.3.1 The assessment methodology comprises data collection, consultation and site surveys to gather data to characterise the existing qualities of the water environment. The potential for the Project to change existing conditions has then been assessed using a methodology drawn from Volume 11, Section 3, Part 10 of the *Design Manual for Roads and Bridges (DMRB*) (HD45/09).

15.3.2 Baseline information has been gathered by:

a. identifying appropriate study areas

b. taking into consideration issues raised through consultation with interested parties

c. carrying out a desk-based study using published data sets defining surface and groundwater quality, water resources, flow regimes, flood risk and

drainage, sourced from the EA, local authorities and British Geological Survey

d. carrying out site walkover surveys

15.3.3 The first phase of a water features survey was conducted in September 2017. The objective of the survey was to identify and characterise the baseline characteristics of surface and groundwater features that may be affected by the construction and operation of the Project. The spatial extent of the survey includes surface water features within 500m of the Development Boundary and groundwater features within 1km of this boundary. The first phase of field survey was limited to features within public spaces and areas where access had been agreed with landowners.

15.3.4 Study areas for both field and desk-based assessments have been defined to reflect the surrounding water environment after considering the distance over which significant effects can reasonably have the potential to occur. This approach is in line with the *DMRB* guidelines and study areas have been agreed in consultation with the EA.

15.4 Existing environmental conditions

15.4.1 This section presents baseline data describing the following features and attributes of the water environment:

a. Main river and ordinary watercourses and designated areas with a water interest

b. Surface water quality and WFD status of surface water bodies

c. Surface water abstractions and discharges

d. Groundwater units and WFD status of groundwater bodies

e. Groundwater levels and quality

f. Groundwater utilisation

g. Flood risk and flood defences

h. Existing land and highway drainage

Surface water features

15.4.2 The study area and surface water features in this area are illustrated in Figure 15.3 in Volume 3.

15.4.3 In the section of the route between the A2 and the south portal of the main tunnel crossing of the River Thames, there are few surface water features, except for some ponds and a stream that flows through Shorne Woods. In this section there are dry valleys, described in paragraph 15.4.25 and the Project crosses the South Thames Estuary and Marshes Site of Special Scientific Interest (SSSI), Shorne Marshes Royal Society for the Protection of Birds

(RSPB) Reserve and the Thames Estuary and Marshes Ramsar, which are drained by a network of main rivers and ordinary watercourses.

15.4.4 From site observation, the watercourses draining through the designated sites, which have a flat topography, are characterised as ranging in width typically between 2m and 4m, having vegetated banks (grass, reeds) and a silty bed load. They are intermittently crossed by access tracks, and water levels and flows in the system are managed. During winter and spring, it is reported by the RSPB that water levels in the ditch network serving the Shorne Marshes Reserve are controlled using an active pumping system to maintain them at a maximum of 2m above Ordnance Datum.

15.4.5 The Project's route crosses beneath the River Thames, which is tidally dominated. Approximately 7.5km upstream of the Project route, a reach of the river is designated in the Swanscombe Recommended Marine Conservation Zone, that aims to protect a geographically restricted but important population of tentacled lagoon-worm. The zone stretches from The Queen Elizabeth II Bridge to Columbia Wharf in Grays. Salinity conditions are such that the water becomes fully marine downstream of Gravesend and within the study area the river constitutes a major shipping route for commercial and leisure craft.

15.4.6 To the north of the main tunnel crossing of the Thames, the primary surface water features are the Mardyke and its tributaries including the Orsett Fen Sewer, Golden Bridge Sewer, Stringcock Sewer and West Mardyke. The Mardyke drains a total catchment area of 90km^2, rising in Holden's Wood between Great Warley and Little Warley and flowing approximately 18km to discharge into the River Thames via a flapped outfall at Purfleet.

15.4.7 Local to the north portal and Tilbury junction, the Tilbury Main and other unnamed main rivers, as well as numerous ordinary watercourses, drain the West and East Tilbury Marshes, both of which lie within the River Thames floodplain. During a site walkover survey conducted in September 2017, several of these drains were observed to be dry (see Appendix M in Volume 2). There is also a groundwater-fed pond, understood to be used by the landowner to provide a storage reservoir for groundwater used in spray irrigation.

Surface water quality and resources

15.4.8 Surface water quality has, to date, been defined using available data records supplied by the EA, in addition to limited field sampling of pH, temperature and electrical conductivity, carried out in September 2017 during the first phase of a water features survey. Requests for water quality data records specific to the watercourses flowing through the Shorne Marshes Reserve and Ramsar/SSSI were also made to the RSPB and Natural England, who confirmed they hold no data records.

15.4.9 Available EA data is summarised in Table 15.4 and Table 15.5 summarises the current (second cycle) Water Framework Directive status of surface water bodies within the study area. The data is also illustrated in Figure 15.6 in Volume 3.

Table 15.4 Existing surface water quality – EA monitoring records

Water body and sampling location	Period of record	Parameters sampled
Mardyke at Stifford Gauging Station	2000 to 2017	Priority substances (judged as presenting a significant risk to the aquatic environment) and certain other pollutants as provided for in Article 16 of the WFD
Mardyke at the A1306 Road Bridge		

Table 15.5 Water Framework Directive data summary – surface water

Water body and WFD ID	2015 Water body classification
Thames Middle GB530603911402	Hydromorphological designation: Heavily modified Overall Status: Moderate Biological Quality Elements: Moderate Hydromorphological Supporting Elements: Not assessed Ecological: Moderate Chemical: Fail
Mardyke GB106037028200	Hydromorphological designation: Heavily modified Overall Status: Moderate Biological Quality Elements: Good Hydromorphological Supporting Elements: Supports good Ecological: Moderate Chemical: Good
Mardyke (East Tributary) GB106037028070	Hydromorphological designation: Heavily modified Overall Status: Moderate Biological Quality Elements: Good Hydromorphological Supporting Elements: Supports good Overall: Moderate Ecological: Moderate Chemical: Good
Mardyke (West Tributary) GB106037028080	Hydromorphological designation: Heavily modified Overall Status: Moderate Biological Quality Elements: Bad Hydromorphological Supporting Elements: Supports good Ecological: Moderate Chemical: Good

15.4.10 The Thames Middle water body has maintained its Cycle 1 status. The chemical status of Fail is attributed to exceedance of target concentrations of Tributyltin compounds (a priority hazardous substance).

15.4.11 The overall status of the Mardyke and Mardyke East tributary have improved from Poor in Cycle 1 (2009) to Moderate in Cycle 2 (2015).

15.4.12 The Mardyke West tributary has maintained its Cycle 1 Moderate status.

15.4.13 The current Moderate status of the Mardyke and its East and West tributaries are limited by physio-chemical quality elements, specifically low dissolved oxygen and elevated phosphate concentrations. These conditions are attributed to point sources of pollution (sewage discharges) and land drainage is also suspected to contribute. The EA is targeting Good status by 2027. However, there are no operational measures currently in place to achieve the improvements in status.

15.4.14 Regarding the field data recorded to date, pH and temperatures ranging from a pH of 7 to 9 and from 14 to 18^{o}C respectively have been recorded from samples of water in the ditch network draining the designated sites to the south of the Thames. Electrical conductivity (EC) was recorded in the range of 990 to 2713 µS/cm. EC in watercourses can naturally range between 100 and 2000 µS/cm, with higher values indicative of increased salinity. It is proposed to collect further measurements of these parameters during a second phase of surveys in summer 2018.

15.4.15 In the north, drains flowing through the west and east Tilbury Marshes have been sampled and pH ranging from 7.6 to 8.4 was recorded, with a typical temperature between 12 and 13^{o}C. In most samples EC was recorded in the range of 2020 to 4555 µS/cm. Two samples recorded EC values exceeding 10,000 µS/cm potentially indicating influence/interaction between some of the drains and the tidal Thames. However, these measurements will be verified by repeat sampling during a second phase of survey and the results reported in the Environmental Statement.

15.4.16 Data collected from the Mardyke and its tributaries indicates a range of pH of 7 to 8 and temperature range of 13^{o}C to 15^{o}C. Recorded EC values ranged between 728 and 1095 µS/cm. The full set of field water quality data is provided in the Water Features Survey Factual Report in Appendix M in Volume 2.

15.4.17 The EA has also supplied information from their Pollution Incident database. Details of incidents within the study area resulting in a major or significant impact on water have been provided. It is summarised that during the period from 2000 to 2016, a total of 35 incidents were recorded. The most common pollutants involved in these incidents were sewage material and oils or fuels.

15.4.18 The surface water bodies within the study area, described above, support several services, including:

a. Abstraction

b. Receipt, dilution and transport of discharges

c. Recreation

d. Biodiversity

15.4.19 The recreational and biodiversity attributes of the surface water environment are described in Chapter 14: People and Communities and Chapter 9: Terrestrial Biodiversity and Chapter 10: Marine Biodiversity.

15.4.20 The EA has supplied records of licensed abstractions and consented discharges to surface water sources in the study area, shown in Figure 15.3 in Volume 3. As illustrated, to the south of the Thames several ditches flowing through the Shorne Marshes RSPB Reserve support abstraction to supply 'top up water' for wetland support. The open water section of the Thames and Medway Canal receives 'top up water' from the adjacent stream, Denton New Cut. On the River Thames intakes supply water for non-evaporative cooling. To the north, the Mardyke and its tributaries, including the Orsett Fen Sewer and Stringcock Sewer, support several abstractions of water for agricultural use (spray irrigation), with a cluster of abstractions at Orsett Fen and North Ockendon. Full details are provided in the table in Appendix L in Volume 2.

15.4.21 Information regarding the presence and usage of unlicensed water supplies supported by surface water has been collected through consultation with local authorities and landowners. The information collected to date is provided in Appendix M in Volume 2. Further information, particularly on small scale agricultural supplies, will be collected during additional surveys and landowner interviews.

15.4.22 EA records show that there are numerous consented discharges to surface waters within the study area. Discharges include effluents from waste water treatment works, domestic properties, trade effluent and aquaculture. Discharges are received by the River Thames, the Mardyke and many of its tributaries. Full details are provided in the table in Appendix L in Volume 2.

Groundwater units

15.4.23 The groundwater (hydrogeological) units and their layout are summarised in Table 15.6 and Table 15.7, for the study areas to the south and north of the Thames respectively. A detailed table is presented in Appendix L in Volume 2. The mapped distribution of these units is shown in Figures 15.1 and 15.2 in Volume 3. See Chapter 11: Geology and Soils for descriptions of the soils and rocks.

Table 15.6 Hydrogeological units summary – southern study area and River Thames

Geological units	Description	Hydrological unit type
Superficial deposits		
Superficial deposits – shallow clays and silts	Alluvium. Generally thick clays in the River Thames floodplain. Head: generally narrow, lenticular shaped outcrop at base of dry valleys. Wide area at proposed Project/A2 junction.	Aquitard. In the River Thames the floodplain acts to confine underlying aquifers. Head deposits likely to be aquitards depending on lithology.

Geological units	Description	Hydrological unit type
Superficial deposits – gravels	River terrace deposits. Gravels and sands occur beneath the River Thames and floodplain alluvium.	Aquifer
Solid geology (rocks)		
London Clay Formation	Mostly stiff silty clay. Limited beside the A2 at Shorne Woods	Aquitard. Acts to confine underlying aquifers.
Lambeth Group and Thanet Formation (soft bedrock)	Layered sands, silts, clays and gravels. Limited outcrop local to the A2, mostly at Shorne Woods.	Aquifer. Local perched water at A2. May be associated with ponds and streams in the A2 area.
Chalk Group	Fractured limestone bedrock. Regional extent. Extensive outcrop. Thick unconfined aquifer on the North Downs.	Aquifer

Table 15.7 Hydrogeological units summary – northern study area

Geological units	Description	Hydrological unit type
Superficial deposits		
Superficial deposits – shallow clays and silts	Alluvium. Generally thick clays in the River Thames floodplain.	Aquitard. In the River Thames the floodplain acts to confine underlying aquifers.
Superficial deposits – gravels	River terrace deposits. Gravels and sands occur beneath the River Thames floodplain alluvium. Gravels and sands also occur as gravel terraces on higher ground. Locally the gravels may form an important local water supply.	Aquifer
Solid geology (rocks)		
London Clay Formation	Mostly stiff silty clay. Extensive outcrop north of the A13.	Aquitard. Acts to confine underlying aquifers.
Lambeth Group and Thanet Formation (soft bedrock)	Wide outcrop north of Tilbury Marshes to the A13.	Hydraulic connection with Chalk aquifer north of Tilbury Marshes.
Chalk Group	Lies beneath younger solid geology and/or superficial deposits. Confined north of the A13.	Aquifer

15.4.24 The Chalk aquifer is the dominant groundwater-bearing strata south of the River Thames. The Chalk is an important aquifer due to significant abstraction for public water supplies. Fracture flow is the dominant groundwater flow mechanism. Fractures are the reason for the generally high but spatially variable transmissivity but low storage capacity.

15.4.25 The Chalk aquifer is unconfined on the North Downs. The upper 50m of the saturated zone (that is the zone below the water table) generally has the highest permeability. Within that top 50m, even higher permeability zones are associated with dry valleys. Most groundwater flow tends to be concentrated in a few large fractures near to the current or historical water table elevation. Enhanced fracture porosity at discrete depths is thought to be caused by groundwater flow at specific depths. Layering in the Chalk and/or past periglacial water table elevations are the most likely causes of the enhanced fracture porosity (British Geological Survey (BGS), 2008).

15.4.26 North of the River Thames, the Chalk aquifer is generally covered by superficial deposits and/or other bedrock. Where confined the Chalk aquifer typically has a lower transmissivity due to fewer fractures and less circulation of groundwater in the geological past.

15.4.27 Other hydrogeological units occur in the study area and are summarised in Appendix M. The mapped distribution of these units is shown in Figures 15.1 and 15.2 in Volume 3.

15.4.28 The WFD designated water bodies and their aquifer designations are summarised in Table 15.8. The table also shows associated man-made uses and baseflow to natural features.

Table 15.8 Water Framework Directive groundwater bodies summary

Water body (groundwater) [geological unit]	**Main uses and baseflow**	**EA aquifer designation**
South of the River Thames		
North Kent Medway Chalk [Chalk Group]	Significant abstraction for public water supply along much of the North Downs where there are extensive overlapping Source Protection Zones. Baseflow to north Kent marshes (including Ramsar) of unknown contribution.	Principal aquifer
North of the River Thames		
Essex Gravels [river terrace gravels and fluvial glacial deposits]	Small domestic water supplies. Local agricultural water supplies. Local baseflow to streams. Local baseflow to pond (“seepage reservoir”) near Low Street, Tilbury.	Secondary A aquifer.

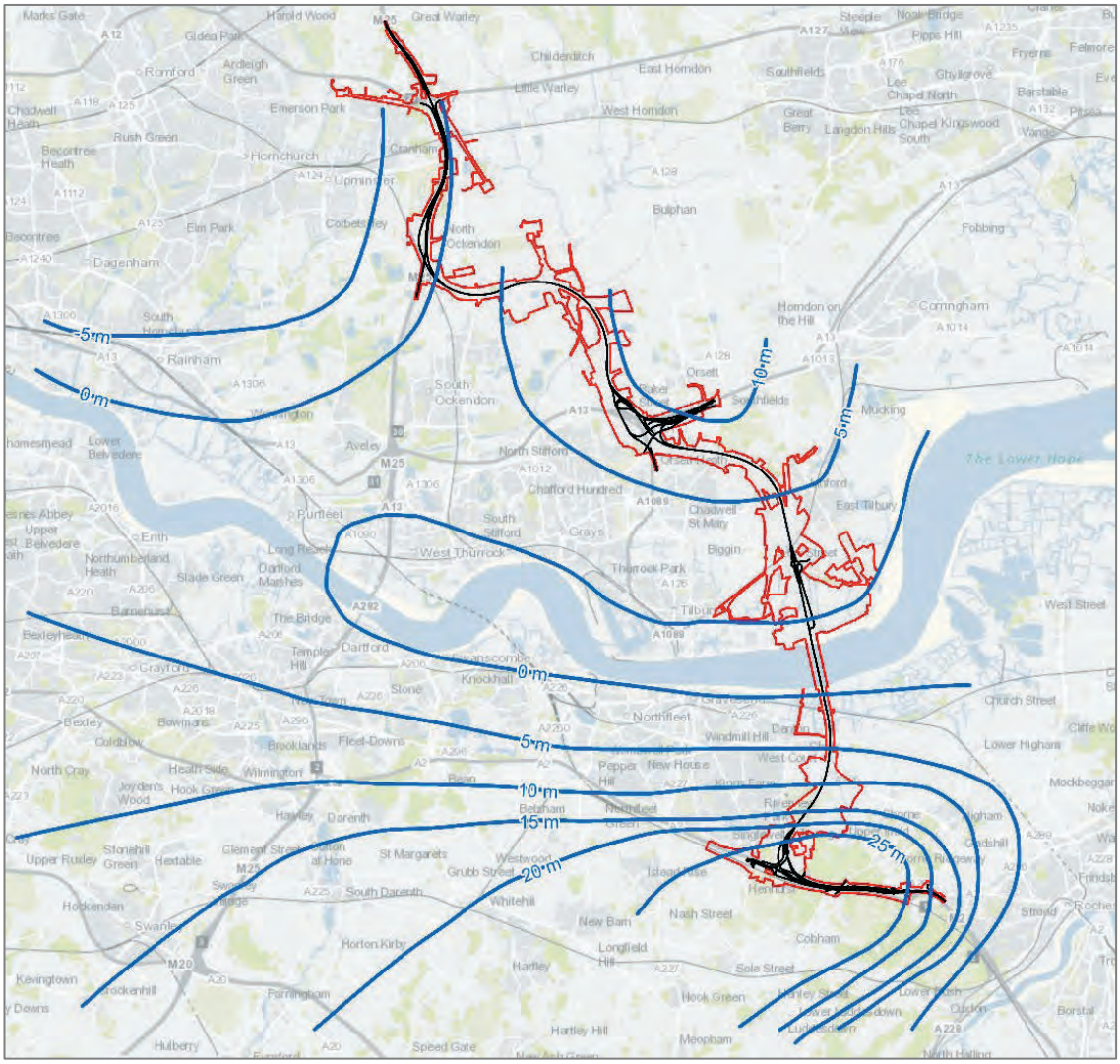
Water body (groundwater) [geological unit]	Main uses and baseflow	EA aquifer designation
Essex South Lower London Tertiaries [Lambeth Group and Thanet Formation]	No abstractions known in study area, but locally small abstractions are possible. Baseflow to unnamed main river near Linford is likely.	Secondary A aquifers.
South Essex Thurrock Chalk [Chalk Group]	Abstraction for public water supply at Linford and Stifford. Possible baseflow to Thames Estuary and Marshes (Ramsar, SSSI) in south Essex. Baseflow to unnamed main river at Linford is likely (via above water body) and to main river at edge of East Tilbury Marshes.	Principal aquifer.

15.4.29 The Thames Estuary and Marshes areas, within the Medway Catchment Abstraction Management Strategy (CAMS) area, are designated as SSSI, Special Protection Area (SPA) and Ramsar sites. They are located along the southern edge of the River Thames above the proposed tunnel of the Project. The EA states that these designations are influenced by freshwater flows and may be vulnerable to groundwater abstraction (Environment Agency, 2013).

Groundwater levels

15.4.30 Groundwater levels within the study area are influenced by geology, topography, natural recharge and man-made groundwater abstractions (present and historical). Figure 15.5 in Volume 3 shows the February 2014 Chalk aquifer water level. Contours have been estimated using EA monitoring data (Appendix K in Volume 2). A study area-wide presentation of the same contours is shown in Plate 15.1. February 2014 represents a generally high groundwater level period associated with prolonged winter rainfall. Pumping at the Linford public water supply well was reduced in 2014 compared to the maximum licensed rate. Rebound has continued in the north end of the Project since 2014 (see below).

Plate 15.1 Chalk aquifer groundwater level contours, February 2014



Note: contours are at 5m intervals

15.4.31 Appendix K in Volume 2 summarises the EA monitoring locations and recorded maximum and minimum groundwater levels. Summary charts of water levels with time are shown for the boreholes.

15.4.32 Groundwater levels in the study area are characterised as follows:

a. The North Downs Chalk aquifer water table is deep (approximately 40m below ground level)

b. The North Downs water table is influenced by the effect of public water supply wells

c. Springs occur where the water table meets geological contacts or intersects the land surface

d. Springs or diffuse leakage (depending on groundwater levels and overlying superficial geology) are likely to occur along the southern edge of the north Kent marshes (eg, at the Ramsar site). The water balance of these

wetlands is likely to be dominated by rainfall, runoff and local man-made controls on surface water, but the importance of groundwater inflow is not well understood (Soley *et al*, 2012).

e. South Essex Chalk water levels are influenced by local public water supply wells

f. Ceased chalk quarry dewatering at Thurrock is causing local groundwater rebound (Thurrock Council, 2010)

g. Ceased 1900s industrial pumping in London is causing widespread groundwater rebound (Environment Agency, 2017)

h. Rebound in the north part of study area is approximately 0.3m per year in the confined Chalk (Appendix K in Volume 2)

i. Local perched groundwater may occur where there are layered sands and clays

j. Perched water may be locally important for baseflow to small streams or ponds

k. Perched water levels may exist in the shallow layered sands and clays beside the A2

l. Perched water may be locally important in the Essex Gravels

Aquifer vulnerability to pollution

15.4.33 Figure 15.4 in Volume 3 summarises aquifer vulnerability to pollution across the study area. Vulnerability to aquifer pollution from point contaminative sources is discussed in Chapter 11: Geology and Soils. Vulnerability to diffuse contaminative sources such as agricultural fertiliser application is discussed below.

15.4.34 Areas of highest vulnerability to principal aquifers comprise areas where there is unconfined Chalk aquifer which has no or permeable soil cover. Shallow water increases vulnerability as does fracture flow since pollution can potentially enter the water table more rapidly. Areas of highest aquifer vulnerability in the study area comprise the unconfined Chalk aquifer of the North Downs. Confined Chalk beneath tens of metres of London Clay Formation, in the north of the study area, has a low vulnerability to pollution.

Groundwater quality

15.4.35 The groundwater bodies that are defined and classified by the EA are listed in Table 15.9.

Table 15.9 Water framework directive – classification of groundwater bodies

Water body (WFD ID)	2015 Water body classification
Kent North Medway Chalk (GB40601G500300)	Overall status: Poor Quantitative: Poor Chemical: Poor
Essex Gravels (GB40503G000400)	Overall Status: Poor Quantitative: Good Chemical: Poor
Essex South Lower London Tertiaries (GB40602G401000)	Overall status: Good Quantitative: Good Chemical: Good
South Essex Thurrock Chalk (GB40601G401100)	Overall status: Good Quantitative: Good Chemical: Good

15.4.36 Potential point sources of pollution including petrol filling stations, landfills and historical contaminative land uses are presented in Chapter 11: Geology and Soils. Regional contamination issues including salinity and widespread agricultural practices are discussed below.

15.4.37 Saline intrusion of the Chalk aquifer has historically been caused by water from the tidal River Thames entering the aquifer. Low groundwater levels worsened by man-made abstraction enhanced the phenomenon around the river in the past. Figure 15.5 in Volume 3 shows the historical (1965) mapped extent of saline intrusion indicated by the 150mg/l chloride contour. Saline intrusion on the south side of the River Thames is shown as close to the river boundary. However, saline intrusion is shown as extending beneath most of the Tilbury Marshes north of the river. Licensed abstraction restrictions are required in some areas due to the potential of saline intrusion (Environment Agency, 2013).

15.4.38 Natural Chalk aquifer groundwater quality is good where the aquifer is unconfined such as beneath the North Downs. Here groundwater is replenished by rainfall recharge. However, the unconfined aquifer is vulnerable to man-made pollution. Past widespread agricultural application of fertilisers has contributed to high nitrate concentrations in groundwater (BGS, Environment Agency, 2003). Nitrate vulnerable zones (Figure 15.7 in Volume 3) have been established by the EA on the North Downs, including within the study area.

15.4.39 The Essex Gravels water body is confirmed as not achieving ‘Good’ status. Land use pressures and permeable soils have resulted in leaching of agricultural nitrate to the groundwater. This has resulted in a ‘Poor’ chemical status. Measures proposed are to ensure there is no deterioration from the current status and for protected area compliance only. The EA recommendation is that improvement is not cost beneficial (Environment Agency, 2014).

Groundwater utilisation

15.4.40 The EA has supplied records of licensed abstractions and consented discharges to groundwater in the study area, shown in Figure 15.5 in Volume 3.

A full list of abstraction licences in presented in Appendix L in Volume 2. Abstractions support public water supply, industrial and agricultural uses.

15.4.41 Groundwater, mostly from the Chalk aquifer of the North Downs, provides 80% of Kent's water supply (public water supplies, industry and agriculture) (BGS and EA 2003). More than 50% of an average year's effective rainfall is abstracted for public water supply and other uses (British Geological S, 2008). The CAMS for the Medway area study states a 'presumption against' the granting of licences for abstraction from the Chalk for unconstrained consumptive use. Any new or varied licence will most likely have a 'Groundwater Level Condition' (EA, 2013). Southern Water uses groundwater resources from the Kent North Medway Chalk aquifer.

15.4.42 North of the River Thames there is less public water supply utilisation of groundwater. The Thurrock area is reliant for its water supply on sources outside the area as around 3% of public water supply comes from groundwater supply (Chalk aquifer) (Thurrock Council, 2010). The Essex and Suffolk Water Company (part of Northumbrian Water Ltd) uses groundwater resources from the South Essex Thurrock Chalk aquifer in the study area.

15.4.43 Public water supply wells (potable water) have published source protection zones (Figure 15.5 in Volume 3). The Project does not cross the inner protection zone (Source Protection Zone 1 (SPZ1)) of any of the public water supply wells. The Project does cross the outer protection zone (SPZ2) at some locations beside the A2 and in the Linford area.

15.4.44 Licensed groundwater abstractions, which are not for public supply, comprise mostly agricultural or mixed use. Mineral washing is the most common industrial use. On the North Downs the only abstractions are for public water supply (see above). Beside the River Thames, southern side, the non-public supply wells are abstractions for mineral washing. North of the River Thames, near Low Street, there are three groundwater abstractions for agricultural use and general use including for drinking. Near Orsett Fen there are four general farm and domestic abstractions.

15.4.45 Unlicensed groundwater abstractions, for abstractions less than 20m^3 per day, also exist in the study area. Local authorities regulate drinking water consumption of unlicensed groundwater supply. The local authorities have stated that they hold no records for unlicensed supplies within the study area. The phase 1 water features survey has recorded one unlicensed groundwater abstraction. This is located at Southern Valley Golf Course on the North Downs. One other well has been identified at a private property on Thong Lane, Thong. Details of abstractions are shown in Appendix L in Volume 2. Other small groundwater abstractions are possible and will be the subject of further water feature survey investigation.

Flood risk and flood defences

15.4.46 Fluvial and tidal flood risk zones and flood defence assets are illustrated in Figure 15.3 in Volume 3.

South of the Thames

15.4.47 To the south of the Thames, the Project traverses undulating ground that generally falls towards the Thames Estuary, with the Thames floodplain

extending approximately 1.4km south of the Thames shoreline. The floodplain is classified as Flood Zone 3, but benefits from the protection of the Thames tidal flood defences.

15.4.48 These defences comprise raised embankments and walls that are managed and maintained by the EA. The defences provide protection against tidal flooding from the Thames during storm events with a 0.1% chance of happening each year (to the year 2030) as reported in the London Regional Flood Risk Appraisal (Greater London Authority, 2014). The future policy direction for flood risk management in this location, described in the Thames Estuary 2100 Plan (Environment Agency, 2012) is to maintain defence standards at the current level. This means that there is a likely consequence of flood risk increasing in the future due to the predicted effects of climate change.

North of the Thames

15.4.49 Immediately to the north of the Thames the Project traverses land that has a flat topography, which gives way to undulating ground that generally rises as the Development Boundary extends northwards. The Project crosses the River Thames tidal floodplain in one location and the fluvial floodplain of the Mardyke in two locations. These areas are defined as Flood Zone 3 and, in some locations are protected by flood defences.

15.4.50 Defences comprise raised river walls and embankments alongside the Thames frontage. There are also several flood management assets on the Tilbury Marshes. These include the Bowaters Sluice at the outfall of the Tilbury Main, the Star Dam and the Tilbury Flood Storage Area. Defences protect against tidal flooding from the Thames during storm events with a 0.1% chance of happening each year. This is reported in the London Regional Flood Risk Appraisal (Greater London Authority, 2014). Future policy direction for flood risk management in this location, described in the Thames Estuary 2100 Plan, is to take further action to keep pace with climate and land use change such that flood risk does not increase in the future.

Study area wide

15.4.51 Regarding other sources of flood risk, lands behind the Thames defences are at risk of rapid inundation in the unlikely scenario of defence overtopping or breach. There is also localised risk of flooding from surface water, with overland flow routes and areas vulnerable to surface water ponding shown on the Long-Term Flood Risk Information Map (Environment Agency, 2018).

15.4.52 Groundwater flooding risk mapping by British Geological Survey (BGS, 2017) is available for the whole study area and is presented in Figure 15.5 in Volume 3. The BGS mapping is based on rock type and estimated groundwater level after extended rainfall and is indicative of relative risk at a resolution of greater than a few hundred metres (BGS 2017). Areas of potential risk generally comprise low-lying areas where aquifers are present at outcrop.

15.4.53 Groundwater flooding risk is presented by London Borough of Havering in their Strategic Flood Risk Assessment (SFRA) (Havering London Borough, 2016). In the Borough superficial deposits (the Essex Gravels) are the source of potential flooding. A 75% proportion of each 1km^2 grid square of the area from Orsett Fen to just south of the A127 is calculated as having a risk of groundwater

flooding. Flooding incident reports are mapped at Great Hall east of M25 junction 29 and in the Cranham area of Upminster to the west of the M25.

15.4.54 The SFRAs prepared by Thurrock Council (Thurrock Council, 2009 and 2010) contain no reports of historical groundwater flooding incidents within the borough. The Kent County Council Preliminary Flood Risk Assessment (Kent County Council, 2011) refers to reports of high groundwater levels in the Chalk aquifers during winter 2013 and spring 2014 which caused groundwater flooding in the Nailbourne and Darent valleys and in villages along the south-western edge of the North Downs. There are no reports of lands within the study area having a history of groundwater flooding.

Existing drainage

15.4.55 Within the study area, land to the south of the Thames is primarily in agricultural use and the Project also crosses through an existing golf course. Most rainfall runoff drains to the underlying permeable chalk geology, with the remainder flowing into the marsh areas fringing the Thames. Existing development to the south of the crossing is thought to be served by foul sewer networks, and runoff from local roads is understood to drain over the edge onto the verge and to ground via infiltration.

15.4.56 Information on the existing drainage arrangements of the A2 has been collected from Highways England's drainage database. The road is served by kerbs and gullies or combined kerb and drain connected to pipe networks that outfall into several infiltration basins (soakaways to ground) along the route of the road, as illustrated in Figure 15.3 in Volume 3.

15.4.57 To the north, land is primarily in agricultural use and rainfall runoff mostly drains to field drainage systems and watercourses. Areas of built development are served by the public surface water and combined sewer network, maintained by Thames Water, and highway drainage systems.

15.4.58 Information on the existing drainage arrangements of the A13 and M25 has been collected from Highways England's drainage database and as-built records held by Highways England's maintaining agent for Area 5. The M25 drains via a series of outfalls into balancing ponds before discharging to the Mardyke which crosses the M25 in the study area. These features are dry, grassed basins. The four basins, illustrated in Figure 15.3 in Volume 3 provide storage volumes ranging between approximately 650m^3 and 3,400m^3. Very little information has been sourced to date to describe the existing drainage arrangements of the A13. It is known that the A13, west of the Project, is drained by kerbs and gullies into a piped drainage network that ultimately discharges, via a deep public sewer, into the Mardyke about 200m north of the A13/A1012 junction. East of the Project the A13 is again drained by a system of kerbs and gullies connected to a piped network, but the eventual outfall is currently unknown.

Future baseline

15.4.59 The existing environmental conditions described are expected to be subject to change in future years. For example, the current cycle of WFD management planning ends in 2021. The implementation of specific measures detailed in the *Thames River Basin Management Plan* (Environment Agency, 2015) is likely to

enhance the ecological and chemical quality of surface and groundwater water bodies in the study area. Also upgrades and investment in wastewater treatment infrastructure will contribute to water quality improvements in the Thames and Mardyke catchments.

15.4.60 Government guidelines (Environment Agency, 2017) predict the likely impacts of climate change on river flows, rainfall intensities and groundwater levels. Predictions include an increase in the frequency of intense rainstorms, a rise in tide levels and storminess and an increase in peak river floods. To the north of the River Thames continued investment in flood defence infrastructure is expected to keep pace with climate change, as driven by the policies set out in TE2100. However, to the south, the policy is such that the likelihood of a flood from the tidal River Thames will increase in the future because of climate change.

15.4.61 Groundwater levels are likely to be susceptible to periods of sustained weather type. Dry weather, especially dry winters, could cause groundwater lowering in the Chalk aquifer. Where spring flow or diffuse discharge occurs then flows may be reduced. Intense wet weather periods could cause local groundwater flooding in areas of shallow superficial aquifers and such flooding could be relatively short term but potentially also add to surface water flooding. Long periods of wet winter weather have the capacity to cause local longer-term flooding from the Chalk aquifer although the wet weather period of 2013/2014 did not record such flooding in vicinity of the Project (see paragraph 15.4.54).

15.5 Further baseline information and surveys required

Water features survey

15.5.1 As described in paragraph 15.3.3 the first phase of a water features survey was completed in September 2017. A second phase of the survey is currently underway. This phase has a focus on gathering data to help understand surface and groundwater interactions in the Ramsar site. Drains and ditches within the site are being sampled along south to north transects to record pH, temperature and conductivity. Additional water features that are now accessible are also being surveyed. The specification for the survey has been agreed in consultation with the EA.

Flood risk assessment

15.5.2 An FRA will be prepared in line with the requirements of the NPSNN and the National Planning Policy Framework Flood Risk and Coastal Change Planning Practice Guidance (Ministry of Housing, Communities and Local Government, 2014). The assessment is currently being scoped in consultation with the EA and will be informed by hydrological and hydraulic modelling of key river systems including the Tilbury Main, the Mardyke and its tributaries (the Orsett Fen Sewer and the Golden Bridge Sewer). In addition, breach of the Thames' defences will be modelled and the subsequent flood risk to the Project assessed. A topographical survey will be undertaken, and the data used to develop models of these watercourses and their floodplains. The findings of the modelling studies will be reported in an FRA that defines baseline flood risk and informs the design of any flood risk management measures that may be

necessary. These findings will also inform the Road Drainage and Water Environment Chapter of the Environmental Statement.

Hydrogeological risk assessment

15.5.3 A hydrogeological risk assessment will be prepared. The assessment scope has been discussed with the EA and will be refined following completion of the water features survey. This will include assessment of the risk associated with both construction and operation of the Project and will define baseline monitoring requirements during the construction period, to determine the efficacy of mitigation measures.

Drainage strategy

15.5.4 A surface water drainage strategy is being developed. The strategy will describe the measures embedded into the Project design to attenuate and treat runoff before it is discharged into the water environment. Measures to isolate accidental spills on the road surface and prevent pollution will also be described.

15.5.5 Dialogue with the EA, Lead Local Flood Authorities and Highways England drainage maintenance agents is ongoing, and will continue to develop and agree surface water drainage concepts and treatment trains at road drainage outfalls.

15.5.6 Due to the contrasting nature of the ground conditions and topography, described in paragraphs 15.4.55 to 15.4.58, drainage concepts for the Project differ to the south and north of the River Thames. The strategy in the south for surface water drainage is to use soakaways in the form of infiltration basins. These will comprise large open basins with a series of shallow, gravel-filled trenches across their base. North of the Thames the strategy for surface water drainage is primarily to use piped drainage systems that flow through attenuation basins before discharge to surface watercourses.

15.5.7 When the strategy is suitably mature, a quantitative appraisal of the effects of road drainage discharges on the quality of receiving water bodies will be carried out using the Highways Agency Water Risk Assessment Tool. The results will inform the design of discharge treatment measures.

Ground investigation and monitoring and groundwater levels and quality

15.5.8 The first phases of ground investigation have included drilling boreholes near the proposed main crossing including the northern edge of the North Downs, Shorne Marshes and Tilbury Marshes. Future ground investigation will include drilling along the rest of the Project's route, including beneath the River Thames. Pumping tests are also proposed. These are a field experiment in which a well is pumped at a controlled rate and water level response (drawdown) is measured in one or more surrounding observation boreholes.

15.5.9 Assessment of ground investigation data is proposed to assess the:

a. groundwater levels and seasonal variation of the different aquifers along the route

b. extent of baseline saline intrusion using groundwater quality data

c. predicted groundwater drawdown from the main crossing and tunnel portal construction

d. groundwater flow into (or out of) designated wetland areas (for example the Ramsar site) by examination of groundwater levels in underlying strata

e. infiltration rates for proposed SuDS features using permeability test results of soils

Water Framework Directive

15.5.10 The findings from all the above surveys and assessments will be used to inform a stand-alone Water Framework Directive Compliance Assessment, which is being scoped in consultation with the EA.

15.6 Potential effects and mitigation measures

15.6.1 The potential likely significant effects of the Project during construction and operation have been considered based upon currently available data relating to both the construction and operation phases of the Project. The potential effects and potential mitigation measures to manage them are outlined below. It should be noted that this assessment is ongoing and is subject to change through ongoing development of the Project proposals.

15.6.2 A full detailed assessment will be undertaken before DCO application, which will identify the mitigation required. The results of this detailed assessment, and the mechanism by which mitigation measures will be secured and delivered, will both be fully detailed within the Environmental Statement.

15.6.3 All of the receptors discussed are illustrated in Figures 15.1 to 15.8 in Volume 3.

Construction south of the River Thames

Table 15.10 Potential construction effects and mitigation south of the Thames

Item	Description
Receptor	Surface and groundwater resources
Potential nature of effect	Negative impact. Construction of the Project will have a significant consumptive water use need. At this stage it is unknown which water resources would be used to meet this demand. Effects on water resources will be assessed in detail in the Environmental Statement.
Likely duration	Temporary during the construction period.
Potential mitigation	Maximise water use efficiencies and water reuse on site. Measures detailed in the Code of Construction Practice (CoCP) to include leakage prevention and where practicable, rainwater harvesting to supply welfare facilities and for use in dust suppression and collection of greywater for use in wheel washing facilities.

Item	Description
Receptor	Surface or groundwater dependent designated sites: Thames Estuary and Marshes Ramsar and South Thames Estuary and Marshes SSSI.
Potential nature of effect	Negative impact. The design is such that the Project is below ground as it crosses these designated sites, so there would be no direct impact on the surface watercourses that contribute to supporting designated interests. However, there is potential for construction groundwater control (including dewatering), at the south portal and tunnel cross-passages, which could cause temporary groundwater lowering (drawdown) of the Chalk aquifer. This could reduce the quantity of groundwater inflow which may currently enter the designated areas as springs or diffuse leakage. The water balance of these wetlands is likely to be dominated by rainfall, runoff and local man-made controls on surface water, but the importance of groundwater inflow is not well understood. Therefore, local drawdown of the Chalk aquifer water level could result in reduced baseflow in the network of surface water drains that flow through the designated sites, increasing their vulnerability to drying out and changing surface water quality characteristics. Construction groundwater control (including dewatering) at the south portal and tunnel cross-passages could lower groundwater levels and increase the extent of saline intrusion of deep groundwater beneath the marshes. If this water does seep into the designated sites as springs and diffuse leakage, then surface water quality characteristics may be vulnerable to change. The south portal structures and cut and cover tunnels will be constructed predominantly in Chalk, largely above the groundwater table. Any pollution incidents in the excavations could cause seepage of contaminants to the water table which could then seep towards the designated sites.
Likely duration	Temporary during construction period of the south portal.
Potential mitigation	Effect avoided through implementation of best practice groundwater control management (including minimising groundwater drawdown outside of the Development Boundary) and implementation of best practice CoCP to avoid accidental spillages and safely manage drainage.
Receptor	Ramsar (Thames and Medway Canal).
Potential nature of effect	Negative impact. The canal is located beside the Thames Estuary and Marshes Ramsar on embankment. The canal open water section is approximately 1,700m long near the Project and is partially infilled beyond. During tunnel boring there is a risk from increased leakage of water from the canal due to settlement. Leakages would flow into the Ramsar ditch network with potential to change the existing surface water chemistry and the nature/quality of wetland habitats supported by the ditches.
Likely duration	Temporary during the construction period, particularly during tunnel boring.
Potential mitigation	Further water features survey to include water quality monitoring of the canal to check whether it is a potential source of contamination to the Ramsar. Carry out construction phase monitoring of the canal embankments and put in place any necessary remedial action to safeguard the integrity of the canal to prevent additional leakage.

Item	Description
Receptor	WFD Water body: Thames Middle (ID GB530603911402) and estuarine flood defence assets.
Potential nature of effect	Negative impact. The option to transport excavated materials by river barge would require construction of a new temporary jetty in the River Thames and potential scour protection for the tunnel would also require works to the bed of the river. Piling and dredging linked to these activities could cause localised effects on the existing sediment transport/deposition and hydrodynamics regime of the Thames. There is also a risk of the above activities disturbing legacy contaminated bed sediments, causing mobilisation of pollution into the water column. These effects have the potential to cause WFD non-compliance. Tunnelling activity has the potential to cause settlement and vibration, reducing the integrity of Thames flood defences and making them more vulnerable to failure, putting construction workers and residents at increased risk. Construction phase groundwater control measures at main crossing tunnel portals and tunnel-boring activities could generate surplus water which could be discharged to the River Thames, changing its existing water quality.
Likely duration	Temporary during the construction period.
Potential mitigation	Studies to quantify the effects of jetty construction and usage and scour protection measures. Mitigate any effects by selecting appropriate techniques and carrying out works in line with EA, Marine Management Organisation and Port of London Authority protocols and licence conditions. Minimise generation of surplus water during construction by using appropriate groundwater inflow reduction and tunnelling methods. Where possible reuse water. CoCP to include appropriate water treatment and best practice methods for environmental permitted discharge(s). Carry out geotechnical assessment of the Thames flood defences to inform construction phase monitoring of existing flood defences and put in place any necessary remedial action to safeguard the integrity of the defences. Put in place construction flood risk management protocols, documented in the CoCP, to safeguard workers and residents.
Receptor	Discharge to ground, permit locations adjacent or within the Development Boundary (eg, in the Shorne area).
Potential nature of effect	Potential need to demolish the discharge works or temporarily interrupt use.
Likely duration	Permanent or temporary during construction period depending on location.
Potential mitigation	Receptor to be removed and alternative provision to be provided.
Potential for a positive impact	As removal of the discharges (sewage) to ground to an alternative piped sewerage system may result in improved groundwater quality.

Item	Description
Receptor	Perched groundwater fed lakes and springs (eg, in Shorne Woods Country Park and Cobham Wood).
Potential nature of effect	Negative impact. Temporary construction excavations and cutting excavation could lower or change groundwater flow paths of perched groundwater causing drying or lowering of water levels in lakes and springs.
Likely duration	Temporary during the construction period.
Potential mitigation	Ground investigation and hydrogeological risk assessment to determine risk to water features and construction groundwater control measures to be designed to minimise change of perched groundwater level.

Construction north of the River Thames

Table 15.11 Potential construction effects and mitigation north of the Thames

Item	Description
Receptor	Surface and groundwater resources
Potential nature of effect	Negative impact. Construction of the Project will have a significant consumptive water use need. At this stage it is unknown which water resources would be used to meet this demand. Effects on water resources will be assessed in detail in the Environmental Statement.
Likely duration	Temporary during the construction period.
Potential mitigation	Maximise water use efficiencies and water reuse on site. Measures detailed in the CoCP to include leakage prevention and, where practicable, rainwater harvesting to supply welfare facilities and for use in dust suppression and collection of greywater for use in wheel washing facilities.
Receptor	Tilbury Main system (main rivers and ordinary watercourses).
Potential nature of effect	Negative impact. Culverting of reaches of watercourses in the Tilbury Main system to facilitate construction activities. Diversion of reaches of a main river in the Tilbury Main system. The works necessitate infilling and loss of these channel reaches, and risks of polluting reaches downstream. Works in proximity to several ordinary watercourses are also required. A large construction compound and the tunnel-boring machine launch chambers are proposed in this part of the study area. There would be a need for large scale spoil storage and materials handling/storage. There is also land that has been contaminated through historical and current land uses. Water bodies would be at risk of pollution, particularly where activities such as excavation and earthworks cause mobilisation of contaminated land leachates or other polluting materials. There is also potential for exposure of construction workers to these contaminants to the detriment of their health. Temporary loss of floodplain storage during construction.
Likely duration	Temporary during the construction period.
Potential mitigation	Measures to be documented in the CoCP include: Returning culverted watercourses to open channel where possible.

Item	Description
	Diversion channels designed to replicate or improve upon the channel reaches that are lost, in terms of flow conveyance and river habitat quality/quantity. Where possible, create the new river channels in dry working conditions to minimise pollution risks. Where crossings of ordinary watercourses are required, design to mitigate effects by maintaining natural channel bed widths and slopes and retaining or reinstating bed materials and bankside vegetation. Ensure crossings do not pose a barrier to the movement of fish or mammals. Adopt best practice measures for the storage and handling of spoil and other construction materials. Undertake any necessary land remediation to minimise the risk of water environment pollution and employ best practice measures to prevent exposure of construction workers to contaminated soils or water. Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment.
Receptor	Orsett Fen, including the Orsett Fen Sewer and several unnamed ordinary watercourses.
Potential nature of effect	Negative impact. One new crossing of the Orsett Fen Sewer and several ordinary watercourses that drain the Orsett Fen. These works carry risks of pollution and degradation of downstream water and river habitat quality, as well as the potential to restrict the flow regime of these watercourses. Temporary loss of floodplain storage during construction.
Likely duration	Temporary during the construction period.
Potential mitigation	Viaduct crossing of the Orsett Fen Sewer to avoid direct impacts on the channel and its flow conveyance properties and design of ordinary watercourse crossings as detailed for the Tilbury Main system. Create the new river crossing structures in dry working conditions where possible, and employ best practice pollution control measures, described in several Construction Industry Research and Information Association publications (CIRIA, 2006, 2015a and 2015b) to minimise risks of water quality degradation. Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment.
Receptor	WFD Water body: Mardyke (ID GB106037028200) and Golden Bridge Sewer.
Potential nature of effect	Negative impact. The Project requires construction of a new crossing of these watercourses. Construction works near these receptors have associated risks of pollution and degradation of river habitat quality.
Likely duration	Temporary during the construction period.
Potential mitigation	Design of clear span crossings (viaducts) to minimise effects by allowing river channel bed and banks to be retained with less disturbance. Design also reduces the footprint of above ground development in the floodplain. Pollution avoided or contained for rapid clean up through implementation of best practice pollution prevention measures in line with CIRIA guidance. Examples include: use of silt fences, keeping stocks of oil absorbent materials on site and managing work site runoff to prevent discharge of untreated runoff to surface water bodies.

Item	Description
Receptor	WFD Water body: Mardyke West tributary (ID GB106037028080) and its floodplain.
Potential nature of effect	Negative impact. The Project requires extension of an existing culvert on the watercourse, necessitating in-channel works with the associated risks of pollution and degradation of downstream water and river habitat quality. There is also the potential to restrict the flow regime of the watercourse. Temporary loss of floodplain storage during construction.
Likely duration	Temporary during the construction period.
Potential mitigation	Pollution avoided or contained for rapid clean up through implementation of best practice pollution prevention measures in line with CIRIA guidance. Examples include: keeping the works area dry where possible, using appropriate isolation techniques such as coffer dams, deploying silt fences and keeping stocks of oil absorbent materials on site. Flow regime effects avoided through appropriate culvert design (eg, sizing, gradient) and undertaking works in accordance with relevant environmental permit requirements. Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment.
Receptor	Surface water abstractions (licensed and unlicensed).
Potential nature of effect	Negative impact. Several abstractions in the Mardyke catchment supply spray irrigation activities may be negatively impacted. There are risks of loss of the integrity of a source of water supply due to pollution of the source water body, resulting in additional treatment burden before use, or total loss of a source of supply due to more severe pollution or loss of access to the abstraction location. Also, there is potential for reduced reliability of a supply (in terms of quantity) should there be a change to groundwater levels/flows local to the sources, impacting on surface water baseflows.
Likely duration	Temporary during the construction period.
Potential mitigation	Pollution control measures to prevent water quality detriment to water supplies. Where an abstraction is located within the footprint of the Project or is otherwise derogated, provide an alternative source of supply.
Receptor	South Essex Thurrock Chalk aquifer.
Potential nature of effect	Negative impact. The construction of the north portal and tunnel cross-passages may require construction phase groundwater control (including dewatering). This could lower the Chalk aquifer groundwater level (drawdown) causing increased saline intrusion of the aquifer where there is hydraulic connection with the tidal River Thames.
Likely duration	Temporary during the construction period (main crossing tunnel and portal construction).
Potential mitigation	Effect avoided through implementation of best practice groundwater control management (including minimising groundwater drawdown outside of the Development Boundary).

Item	Description
Receptor	Essex Gravels aquifer and small-scale private abstractions, agriculture abstractions (general farming and irrigation), licensed and unlicensed groundwater abstractions from the Essex Gravels, buried archaeological remains. Groundwater wells and baseflow to ponds and streams from the Essex Gravels superficial aquifer.
Potential nature of effect	Negative impact. Construction of flood compensation areas causing removal of gravels could potentially cause permanent change of groundwater flow paths and groundwater levels. When the strategy for these is mature then an appraisal of the impacts and any necessary mitigation would be conducted. The changes could cause a change of pumped water levels at existing wells, change of baseflow to existing ponds and streams, change of groundwater quality and detriment to the integrity of buried archaeology. Construction of road cuttings could be below the water table in the superficial aquifer and could require groundwater control measures including pumping and drainage. This could locally cause drawdown of the water table in the Essex Gravels aquifer and reduce groundwater levels or cause drying out of local wells and groundwater fed streams and ponds.
Likely duration	Permanent
Potential mitigation	Hydrogeological risk assessments of proposed borrow pits and flood compensation areas. These are to be used to inform the design of the construction of the borrow pits and flood compensation areas in consultation with the EA. Mitigation measures may include maximum excavation depth down to the water table and/or restrictions of excavations in the vicinity of groundwater supplies (protected rights). Hydrogeological risk assessment of proposed large cuttings. Assessment to be used for construction phase groundwater control design. Construction phase groundwater level monitoring.
Receptor	Public water supply well at Linford, abstracting from the South Essex Thurrock Chalk.
Potential nature of effect	Negative impact. North portal groundwater control (dewatering) in combination with maximum licence yield at Linford could cause widespread Chalk aquifer groundwater level lowering (drawdown). Combined drawdown effects may increase saline intrusion effects. Excavation of flood compensation areas or borrow pits could change the effective rainfall recharge in the well catchment area. Any pollution spillage in the base of the excavation could be close to the water table and pollution could be rapidly transported to the well. Piling that penetrates the Chalk aquifer could produce suspended solids which could travel by fracture flow and temporarily clog submersible pumps and cause reduction in supply water quality in the well causing temporary disruption of water supply.
Likely duration	Temporary during the construction period.
Potential mitigation	Hydrogeological risk assessments of construction work that could affect the Linford well in consultation with the EA. Groundwater level and groundwater quality monitoring during construction for early identification of impacts. Best

Item	Description
	practice groundwater control management (including minimising groundwater drawdown outside of the Development Boundary). Implementation of CoCP to avoid accidental spillages. Foundations risk assessment to identify best piling methods and soil improvement measures to avoid sedimentation of the Chalk aquifer and reduction in quality and/or disruption of supply. Further details are provided in Chapter 11: Geology and Soils.
Receptor	Discharge to ground locations including those with environmental permits for discharge. Locations within the Development Boundary.
Potential nature of effect	Potential need to demolish the discharge works or temporarily interrupt use.
Likely duration	Permanent or temporary during construction period depending on location.
Potential mitigation	Alternative discharge location to be provided or compensation may be required depending on location and discharge details.
Potential for positive impact	Removal of the discharges (sewage) to ground to an alternative piped sewerage system may result in improved groundwater quality.
Receptor	Structures, railway, utility infrastructure (underground pipes)
Potential nature of effect	Potential ground settlement caused by construction phase groundwater control (dewatering) causing local groundwater level drawdown.
Likely duration	Temporary during the construction period.
Likely mitigation	Effect avoided through hydrogeological risk assessment and geotechnical risk assessments. Implementation of best practice construction site drainage management informed by construction phase monitoring of groundwater levels and ground settlement where appropriate.

Operation south of the River Thames

Table 15.12 Potential operational effects and mitigation south of the Thames

Item	Description
Receptor	Surface or groundwater dependent designated sites: Thames Estuary and Marshes Ramsar and South Thames Estuary and Marshes SSSI.
Potential nature of effect	Groundwater pollution from highway drainage soakaways seeping into surface water of designated sites. Long-term effects on groundwater levels and surface water baseflows
Likely duration	Lifetime of the Project.
Potential mitigation	Use of wide, shallow infiltration basins at locations high above a deep-water table and at large distances from the designated areas, to promote diffuse seepage into the ground. Provision of appropriate spillage containment and pollution control measures. Measures to maximise diffuse seepage into ground. Design of highway drainage to prevent direct discharge of highway drainage to surface water bodies in the designated areas to safeguard surface water quality within these designated sites. Emergency spillage containment provision also to be included.

Item	Description
Receptor	Water Framework Directive feature ID: Kent north Medway Chalk (GB4061G500300) and Southern Water Services Ltd public water supply wells abstracting from the Kent North Medway Chalk.
Potential nature of effect	Groundwater pollution from highway drainage soakaways contaminating public water supply wells and Chalk aquifer groundwater quality.
Likely duration	Lifetime of the Project.
Potential mitigation	Use of wide, shallow infiltration basins at locations high above a deep-water table and outside of SPZ1 areas where possible or subject to a detailed hydrogeological risk assessment in consultation with the EA. Measures to promote diffuse seepage into the ground.
Receptor	Properties and local roads
Potential nature of effect	Local land collapse in Chalk areas from activation of natural solution features activated by increased surface water runoff (man-made drainage or adverse weather conditions) or increased water infiltration into the ground.
Likely duration	Lifetime of the Project.
Potential mitigation	Ground investigation and geotechnical assessment to assess the risk of solution features. Use of wide, shallow infiltration basins, for highway drainage, at large distances from housing. Drainage design to promote diffuse seepage into the ground.
Receptor	Tilbury Main system (main rivers and ordinary watercourses).
Potential nature of effect	Permanent loss of floodplain storage and receipt of highway drainage discharges.
Likely duration	Lifetime of the Project.
Potential mitigation	Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment (the compensation areas created during construction will form all, or part of, the compensation areas required for operation). Drainage design includes SuDS measures, eg, storm water wetlands, to attenuate rates of runoff and to treat highways discharges to safeguard the water quality of these watercourses.
Receptor	Orsett Fen, including the Orsett Fen Sewer and several unnamed ordinary watercourses.
Potential nature of effect	Clear span crossing of the Orsett Fen Sewer causing reduced habitat quality due to shading, and there would be some severance of floodplain connectivity and permanent loss of floodplain storage on the Fen, potentially with detriment to baseline flood risk. Several ordinary watercourses would be crossed by culverting. In addition, some watercourses in this area will receive operational discharges of highway runoff containing road salts, hydrocarbons and other pollutants, with potential for an impact on existing water quality and flow regimes. Land that is currently undeveloped (permeable) would be converted to impermeable land cover, affecting the current rainfall runoff and land drainage regimes. Effects include reduced infiltration of rainfall to ground and increased rates and volumes of surface water runoff, and the potential for blockage of existing overland flow paths/surface water runoff routes. This would be likely to change the flow regimes and water balance of the Fen and its watercourses.

Item	Description
	This type of effect is also applicable to other parts of the study area and the other surface water receptors tabled (except for the Thames Estuary).
Likely duration	Lifetime of the Project.
Potential mitigation	Offsetting the effects of habitat degradation on the Orsett Fen Sewer by enhancing habitat quality upstream and downstream of the new crossing. Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment (the compensation areas created during construction will form all, or part of, the compensation areas required for operation). Comprehensive drainage design, using SuDs suitable to local conditions, to limit post-development rates of rainfall runoff to greenfield (existing) rates; to treat routine highway runoff and capture/contain accidental spills of pollutants; to avoid water transfer between catchments, and to maintain the connectivity of key flood cells.
Receptor	WFD Water body: Mardyke (ID GB106037028200) and Golden Bridge Sewer and their floodplains.
Potential nature of effect	Although the crossings of these watercourses are designed as clear span (viaducts), some loss of habitat quality would result due to shading, and there would be some severance of floodplain connectivity and permanent loss of floodplain storage, potentially with detriment to baseline flood risk. In addition, these watercourses would also receive operational discharges of highway runoff, with potential for an impact on existing water quality and flow regimes.
Likely duration	Lifetime of the Project.
Potential mitigation	Offsetting the effects of habitat degradation by enhancing habitat quality upstream and downstream of the crossings and provision of floodplain compensation, by lowering areas of land that are currently connected to, but outside of, the floodplain. Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment (the compensation areas created during construction will form all, or part of, the compensation areas required for operation). Drainage design includes SuDS measures, eg, storm water wetlands, to attenuate rates of runoff and to treat highways discharges to safeguard the water quality of these watercourses.
Receptor	WFD Water body: Mardyke West tributary (ID GB106037028080) and its floodplain.
Potential nature of effect	An extended culvert could potentially impede fish and mammal passage along the watercourse and result in poorer habitat quality due to shading. Hydraulically, a longer culvert introduces an increased risk of blockages and a permanent loss of floodplain storage, with potential for local increases in flood risk. In addition, this watercourse would receive discharges of operational highway runoff from the Project, with the potential for an impact on existing water quality and its flow regime.
Likely duration	Lifetime of the Project.

Item	Description
Potential mitigation	Design of the culvert extension in line with best practice to minimise effects on flow conveyance, sediment transport, barrier effects and habitat quality. Examples of good design include maintaining the natural channel bed width and slope and oversizing to allow for burying the culvert invert. Offsetting the effects of habitat degradation by enhancing habitat quality at the culvert inlet and outlet and providing ledges or tunnels to allow for mammal passage. Drainage design includes measures to attenuate rates of runoff and to treat highways discharges to safeguard the water quality of the West Mardyke. Flood compensation areas to be created in consultation with the EA to ensure no flood risk detriment (the compensation areas created during construction will form all, or part of, the compensation areas required for operation).
Receptor	Water Framework Directive feature ID: South Essex Thurrock Chalk (GB4061G401100).
Potential nature of effect	Groundwater pollution from highway drainage swales and other discharges to ground contaminating public water supply wells and Chalk aquifer groundwater quality.
Likely duration	Lifetime of the Project.
Potential mitigation	Use of wide, shallow infiltration soakaways (eg, swales) above the water table to promote diffuse seepage into the ground. Pollution interceptors to be used as appropriate. No soakaways within SPZ1 areas.
Receptor	Essex Gravels aquifer Small_scale private abstractions, agriculture abstractions (general farming and irrigation), licensed and unlicensed groundwater abstractions from the Essex Gravels. Baseflow to local ponds and streams from the Essex Gravels.
Potential nature of effect	Negative impact. Permanent change of groundwater flow direction and levels due to flood compensation areas and borrow pits. Large cuttings, for example the M25 junction, requiring permanent drainage and permanent lowering of groundwater level (drawdown) causing drying or reduced yields of local wells or reduced baseflow or drying of groundwater fed streams. Groundwater pollution from highway drainage swales and other discharges to ground contaminating public water supply wells and Chalk aquifer groundwater quality.
Likely duration	Lifetime of the Project.
Potential mitigation	Use of wide, shallow infiltration soakaways (eg, swales) above the water table to promote diffuse seepage into the ground. Pollution interceptors to be used as appropriate. No soakaways within SPZ1 areas.

Chapter 16.

Climate

16 Climate

16.1 Introduction

16.1.1 This chapter presents the preliminary environmental information relating to climate for the Project. The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 were brought into force in May 2017, aligning the new requirements set under the EIA Directive (as amended 2014/52/EU). This introduced a requirement for projects to consider climate. To align with the requirements of the EIA Regulations 2017 and the National Policy Statement for National Networks (NPSNN) 2014, the Climate chapter of the *PEIR* has been divided into two subsections:

a. Effects on climate (Greenhouse Gas (GHG) emissions) – the effects on the climate of GHG emissions arising from the Project, including how the Project will affect the ability of Government to meet its carbon reduction plan targets (in accordance with NPSNN paragraph 5.17).

b. Vulnerability of the Project to climate (and impacts relevant to adaptation) – the resilience of the Project to impacts resulting from a changing climate, including how the Project design will take account of the projected impacts of climate change (in accordance with NPSNN paragraph 4.40 and the EIA Regulations 2017).

16.1.2 The aims of this chapter are to, in relation to climate:

a. detail the requirements of the National Policy Statement for National Networks (NPSNN) and other key legislative and policy requirements and describe how the Project will respond to them with regard to climate

b. explain how information on the existing and future environment has been collected (for example through desk-based studies, survey work and consultation)

c. describe the understanding of the existing and future environment, based on the baseline information collected to date

d. explain any further information to be obtained through further consultation, desk-based studies, or surveys

e. describe the potential effects of the Project on climate from its GHG emissions

f. describe the potential effects on the Project due to climate change (and how these have been assessed for the purpose of this *PEIR*)

g. describe potential mitigation measures

16.1.3 There are expected to be interrelationships between the potential effects on the Project and other disciplines reported on in the *PEIR*. See:

a. Chapter 6: Air Quality

b. Chapter 7: Cultural Heritage

c. Chapter 8: Landscape

d. Chapter 9: Terrestrial Biodiversity

e. Chapter 11: Geology and Soils

f. Chapter 12: Materials

g. Chapter 13: Noise and Vibration

h. Chapter 14: People and Communities

i. Chapter 15: Road Drainage and Water Environment

16.2 Planning policy and legislative requirements

Legislative requirements

16.2.1 The relevant legislation applicable to the climate assessment of the Project is presented in Table 16.1.

Table 16.1 Legislative requirements and Project compliance

Legislation name	Summary of requirements
The Climate Change Act 2008	The Act sets the framework for the UK to achieve its long-term goals of reducing GHG emissions by 34% (from the 1990 baseline) by 2020 and 80% by 2050, while ensuring that steps are taken towards adapting to the impact of climate change. The Act introduces a system of carbon budgeting which constrains the total amount of emissions in a given period. The Act also sets out a procedure for assessing the risks of the impact of climate change for the UK and a requirement on the Government to develop an adaptation programme.

Planning policy requirements

16.2.2 The planning policies applicable to the climate assessment of the Project are presented in Table 16.2. This includes policies adopted by the host local authorities of Medway, Gravesham, Thurrock, Havering and Brentwood as well as the County Councils of Kent and Essex. Table 16.2 also includes relevant strategy documents and guidance plans.

Table 16.2 Planning policy requirements and Project compliance

Policy name	Summary of requirements
National Planning Policy Framework (NPPF) 2018	The NPPF 2018 describes ways in which the challenge of climate change can be met. Chapter 14 of the NPPF highlights that planning plays a key role in mitigation against climate change. The policy also states that new development should be planned for in ways that: "Avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure. "Can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards."
The Carbon Plan 2011	*The Carbon Plan* 2011 sets out the Government's plans for achieving the emission reductions committed to in the Climate Change Act, on a pathway consistent with meeting the 2050 target of an 80% reduction from the 1990 baseline. The publication brings together the Government's strategy to curb greenhouse gas emissions and deliver climate change targets, as well as an updated version of actions and milestones for the next 5 years.
Highways England Delivery Plan, 2015	The *Highways England Delivery Plan* states that, in complying with Section 4.2 (g) and its general duty under Section 5(2) of the Infrastructure Act 2015, to have regard for the environment, the licence holder must: • Adapt its network to operate in a changing climate, including assessing, managing, and mitigating the potential risks posed by climate change to the operation, maintenance and improvement of the network • Develop approaches to the construction, maintenance and operation of the Licence holder's network that are consistent with the government's plans for a low carbon future • Take opportunities to influence road users to reduce the GHG emissions from their journey choices
Kent Environment Strategy: A Strategy for Environment, Health and Economy 2016	The *Kent Environment Strategy* identifies climate change and energy consumption and generation as key challenges for the future. Kent has developed key themes and priorities for the county to achieve by 2030. Priorities include understanding risks and opportunities, energy use and emissions, building resilience to the impacts of environmental change and focusing on low carbon, environmental services and rural sectors. The key climate and carbon indicators and targets developed for the county are: • reduce emissions across the county by 34% by 2020 from a 2012 baseline • more than 15% of energy generated in Kent to be from renewable sources by 2020 from a 2012 baseline • reduce the number of properties at risk from flooding • to develop climate action plans by 2018

Policy name	Summary of requirements
Kent Adaptation Action Plan 2011-2013	The *Kent Adaptation Action Plan* takes a risk-based approach to the identification of appropriate and proportionate responses to the threats and opportunities of climate change. The plan informs (and is informed by) the wider strategies and business plans for Kent. In particular, the plan responds to the Kent environment strategy target to help the public sector, the business community and Kent residents to manage both positive and negative impacts of climate change, including extreme weather events. The plan ranks the roads and highways in Kent as one of the highest priorities and includes the following commitments for highway services: • "KHS1: We will develop and maintain a climate change risk register for our services, with risks incorporated into our standard risk management processes as appropriate. Business, Performance & Communication. • KHS2: We will review our current materials and processes for all our assets taking into consideration the implications of climate change and identify replacements where necessary. Technical Services & Asset Management. • KHS3: We will monitor the impacts of severe weather events on our assets and use this information to inform assessments of maintenance and repair priorities. Business, Performance & Communication."
Essex County Council *Adapting to Climate Change Action Plan* – Summary, 2015	Essex County Council has acknowledged the influence and pressure that climate change will have on the continued running of its services. The adaptation action plan provides a means of planning and preparing for extreme weather by building resilience and reducing the potential damage and costs that would result. Resilience will be built through changing systems and behaviours appropriate for a changing climate.
Medway Council Local Plan 2012-2035 Development Strategy Regulation 18 Consultation Report	Policy NE5 is proposed to secure strong green infrastructure, giving a high level of protection to sensitive features. The council will expect development proposals to demonstrate resilience and to adapt to the future impacts of climate change, in strengthening ecological networks. Policy NE7 states that development should be designed to be resilient to, and adapt to, the future impacts of climate change through the inclusion of adaptation measures including (but not limited to) water efficiency measures, minimising vulnerability to flood risk and optimising the use of multi-functional green infrastructure.
Gravesham Local Plan Core Strategy, adopted 2014	The council's approach to flood risk and carbon is addressed in policy CS18. This provides guidance on how developments should assess the risk of flooding as well as setting out how they should achieve carbon reductions in the context of national policy.
Thurrock Core Strategy, adopted 2015	Policy CSTP25 gives guidance on developments' approach to addressing climate change. The policy adds requirements for climate change adaptation measures and mitigation measures to be considered from the outset in development proposals. • Policy CSTP26 promotes a shift to a low-carbon future with the council encouraging opportunities to generate energy from non-fossil fuel and low-carbon alternatives. • The management and reduction of flood risk is addressed in policy CSTP27 providing guidance on effective land use planning and the use of sustainable drainage.

Policy name	Summary of requirements
	• Policy CSTP20 gives guidance on the identification, planning and design of open spaces to be multi-functional with climate change mitigation and adaptation given weighting. • Policy PMD14 requires developers to minimise emissions by demonstrating that all viable energy efficiency measures and renewable or low-carbon technology opportunities have been utilised.
Brentwood Replacement Local Plan, adopted 2008	Policy IR5 provides guidance on energy and water conservation and the use of renewable source of energy in new developments. This states that new development, improvements in energy efficiency and development of combined heat and power will make a vital contribution to cutting carbon dioxide emissions by 60% by 2050. The policy advises that new development should: • Incorporate the principles of energy conservation and efficiency in the design, massing, sitting, orientation, layout and use of materials; • Encourage the use of renewable sources of energy; and • Encourage water conservation. Policy IR6 states that renewable energy schemes will be permitted provided there is no detrimental impact on a number of aspects including but not limited to: • Health, the environment or amenity; • Visual amenity and character of the area; • Statutory protected nature conservation sites, historic settlements or buildings/areas; and • Existing infrastructure.
Havering Core Strategy and Development Control Policies Development Plan Document, adopted 2008	Policy CP15 relates to climate change adaptation and to the requirements, for developments, to consider the effects of climate change in their location. Policy DC48 relates specifically to the potential risk of flooding that is associated with climate change, through the control of surface waters, the application of the drainage hierarchy and appropriate attenuation. A flood risk assessment must be submitted for all major developments in Flood Zone 1, in areas at risk from surface water, sewer, groundwater and lake flooding and where drainage problems have been identified by the Environment Agency (EA). DC50 indicates that all applications for major developments should include a formal energy assessment and include provision of on-site renewable energy equipment to reduce predicted CO^2 emissions, unless it can be fully demonstrated that such provision is not feasible.

NPSNN requirements

Table 16.3 NPSNN requirements and Project response

Requirement	Project response
Paragraph 4.40 "The applicant must consider the impacts of climate change when planning location, design, build and operation. Any accompanying environment statement should	This sets out how the applicant has considered the impacts of climate change when planning location, design, build and operation. In accordance with the requirements of the NPSNN, the ES will set out how the proposal will

Requirement	Project response
set out how the proposal will take account of the projected impacts of climate change."	take account of the projected effects of climate change. For example, the Road Drainage and Water Environment chapter of the ES will detail the flood risk impacts taking climate change into account.
Paragraph 4.41 "Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the United Kingdom Climate Projections 2009 (UKCP09) high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level."	This chapter has applied the UKCP09 high emissions scenario against the 2080 projections at the 50% probability level. The United Kingdom Climate Projections 2018 (UKCP18) data interface and support products are scheduled to be released in late 2018. If available, these will be applied in the Climate chapter of the ES.
Paragraph 4.42 "The applicant should take into account the potential impacts of climate change using the latest UK Climate Projections available at the time and ensure any environment statement that is prepared identifies appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure. Should a new set of UK Climate Projections become available after the preparation of any environment statement, the Examining Authority should consider whether they need to request additional information from the applicant."	This chapter considers the potential impacts of climate change using UKCP09 high emissions scenario against the 2080 projections at the 50% probability level and begins to identify appropriate mitigation or adaptation measures to be considered. In accordance with the requirements of the NPSNN, the ES will apply the latest UKCP18 and will cover the estimated lifetime of the Project.
Paragraph 4.43 "The applicant should demonstrate that there are no critical features of the design of new national networks infrastructure which may be seriously affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections. Any potential critical features should be assessed taking account of the latest credible scientific evidence on, for example, sea level rise (eg, by referring to additional maximum credible scenarios such as from the Intergovernmental Panel on Climate Change or Environment Agency) and on the basis that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime through potential further mitigation or adaptation."	In accordance with the requirements of the NPSNN, the ES will demonstrate that there are no critical features of the design of the Project which may be seriously affected by more radical changes to the climate beyond that projected in UKCP18. This will be assessed taking account of the latest scientific evidence. Mitigation and adaptation measures will be integrated within the Project's design to be assessed in the ES. These will be presented as part of the Project Description within the ES. Topic assessments when identifying mitigation will also take account of climate change and its effects to ensure any mitigation is future-proofed.
Paragraph 4.44 "Any adaptation measures should be based on the latest set of UK Climate Projections, the Government's national Climate Change	This chapter has applied the UKCP09 high emissions scenario against the 2080 projections at the 50% probability level.

Requirement	Project response
Risk Assessment and consultation with statutory consultation bodies. Any adaptation measures must themselves also be assessed as part of any environmental impact assessment and included in the environment statement, which should set out how and where such measures are proposed to be secured.”	The core raw data products of UKCP18, full UKCP18 data interface and support products are scheduled to be released in late 2018. If available, these will be applied in the Climate chapter of the ES. In addition, adaptation measures in the design will be based on the UK Climate Change Risk Assessment. Statutory consultation bodies will be consulted regarding these measures, as set out in Chapter 4. In accordance with the requirements of the NPSNN, the ES will assess any climate adaptation measures as part of the developed design.
Paragraph 4.47 “Where adaptation measures are necessary to deal with the impact of climate change, and that measure would have an adverse effect on other aspects of the project and/or surrounding environment (eg, coastal processes), the Secretary of State may consider requiring the applicant to ensure that the adaptation measure could be implemented should the need arise, rather than at the outset of the development (eg, reserving land for future extension, increasing the height of an existing sea wall, or requiring a new sea wall).”	Adaptation measures will be based on the UK Climate Change Risk Assessment and in consultation with the relevant bodies presented within Chapter 4. Where appropriate, measures agreed with the relevant consultation bodies will be embedded within the Project’s design. Adaptation measures will be implemented when necessary rather than only at the outset of the Project.
Paragraph 5.17 “Carbon impacts will be considered as part of the appraisal of Project options (in the business case), prior to the submission of an application for the Development Consent Order. Where the development is subject to Environmental Impact Assessment (EIA), any Environmental Statement will need to describe an assessment of any likely significant climate factors in accordance with the requirements in the EIA Directive. It is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets. However, for road projects applicants should provide evidence of the carbon impact of the project and an assessment against the Government’s carbon budgets.”	The carbon impacts have been considered as part of the appraisal of the Project options and will continue to be assessed throughout the development of the design. Where relevant, these will be reported within the ‘Reasonable Alternatives’ chapter of the ES. The Climate chapter of the ES will include a presentation of the carbon emissions from the construction and operational phases and will consider these against the appropriate carbon budget. The Climate chapter of the ES will summarise the likely significant changes in climate parameters, identifying the potential resultant effects on the Project design and assess their significance. The design will continue to develop taking into account allowances for climate change. This will be assessed as part of the specialist topic chapters of the ES and will include any adaptation and mitigation measures embedded within the design.
Paragraph 5.24	The design assessed as part of the ES will include embedded adaptation measures. This

Requirement	Project response
The biodiversity and ecological conservation presented in paragraph 5.24 “needs to be viewed in the context of the challenge of climate change.”	will form the basis of the Project assessed by each topic chapter. Where significant impacts remain, the topic chapters will present any additional measures taking account of climate. These will be based on the UK Climate Change Risk Assessment and in consultation with the relevant consultation bodies presented within Chapter 4.
Paragraph 5.78 “The applicant must demonstrate that full account has been taken of the policy on assessment and mitigation in paragraphs 5.91- 5.114 of the NPSNN, taking account of the potential effects of climate change on these risks.”	The climate chapter of the ES will demonstrate that a full account of the climate change policy on assessment and mitigation in paragraphs 5.91 – 5.114 of the NPSNN has been considered by the Project and its design.
Paragraph 5.93 The Flood Risk Assessment (FRA) “should identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed, taking climate change into account.”	The FRA will identify and assess the risks of all forms of flooding to and from the Project and demonstrate how these risks will be managed, taking climate change into account.
Paragraph 5.94 “In preparing the FRA the applicant should take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made.”	The FRA will include allowances for climate change. It will also state the development lifetime over which the assessment has been made.

16.3 Existing environmental conditions

16.3.1 In accordance with the NPSNN, where the Project is subject to EIA, the applicant should provide evidence of the carbon impact of the Project and an assessment against the Government’s budgets. The ES must describe an assessment of any likely significant climate factors in accordance with the EIA Directive. The following two sub-sections provide evidence, obtained to date, of the existing carbon emissions within the UK and south east region and describe the recent changes in climate experienced in the UK and the south east of England.

Effects on climate (from GHG emissions)

Existing baseline

16.3.2 Across the UK, the total GHG emissions from transport are presented as carbon dioxide equivalents (CO_2e). CO_2e is a quantity that describes, for a given amount of GHG emissions, the amount of CO_2 that would have the same global warming potential (GWP), when measured over a timescale of 100 years. Data, obtained from the Department for Business, Energy and Industrial Strategy, show the emissions produced by vehicles across the UK and within the south

east region. These are presented within Table 16.4. They do not include the emissions created in the production of the fuels used.

Table 16.4 CO_2 emissions from all transport modes in UK

Year	CO_2 emissions all modes in UK (tonnes)	CO_2 emissions all modes in the South East (tonnes)
2010	182,732,453	35,124,551
2011	179,817,439	34,708,183
2012	177,910,402	34,364,532
2013	176,639,469	33,891,695
2014	178,891,663	34,366,851
2015	183,294,454	35,474,505
2016	187,130,986	36,276,612

Vulnerability of the Project to climate change

16.3.3 In accordance with the NPSNN, new infrastructure must be designed taking into account predicted changes in climate over the lifetime of the Project to ensure its continued operation. This section describes recent changes in climate in the Project area, and future predictions published within the UKCP09 and funded by the Department for Environment, Food and Rural Affairs (Defra).

Existing baseline

16.3.4 Local Climate Impact Profiles (LCLIP) have been developed to assess the vulnerability of council services to severe weather events for Kent County Council, Essex County Council, Thurrock Council and the London Borough of Havering. Medway, Gravesham and Brentwood local authorities have not produced separate LCLIPs, however, have contributed towards their respective county profiles.

16.3.5 The LCLIP for Kent was developed through a review of media stories in the local press over a 14-year period between 1996 and 2010. The LCLIP review found that Kent is already experiencing major weather events and that 52 highly significant events occurred over the 14-year LCLIP period. The most frequent impacts of these events were heavy rain and resultant flood events, heatwaves, droughts, freezing temperatures and snow as well as multiple storms.

16.3.6 Through the LCLIP, Kent has learnt that adequate data and information had not been collected to record the true impacts. Consequently, and since 2012, Kent County Council is utilising the Severe Weather Impacts Monitoring System (SWIMS). This is a decision-support tool enabling partners across Kent to record how they have been impacted by, and are responding to, severe weather events, as and when they occur.

16.3.7 The LCLIP for Essex, Thurrock and Havering also assessed the vulnerability of council services to severe events. The LCLIP for Essex is based on a review of media stories in the local press over a six year period between January 2004 and December 2009. The LCLIP from Thurrock Council is based on the period

from 1959 to 2007 and the LCLIP from London Borough of Havering is based on a five year period between 2005 and 2009.

16.3.8 All four LCLIPs show a pattern with regards to frequency and severity of extreme weather events and highlight the impacts these have on services, including spending pressures, across the counties. A summary of the key findings from the LCLIPs for Kent, Essex, Thurrock and Havering is provided in Table 16.5.

Table 16.5 Summary of the Kent and Essex County Council, Thurrock Council and London Borough of Havering LCLIP

Weather event	Kent County Council	Essex County Council	Thurrock Council	London Borough of Havering
Heavy rainfall and flooding	A total of 22 heavy rain and flooding events were reported over the 14-year study period.	Over 160 incidents caused by heavy rain and flooding were reported from January 2004 to December 2009.	Approximately 11,000 properties are at risk of flooding within the unitary authority. Frequency of major flooding events is likely to increase.	A total of five significant events of heavy rainfall during the study period. Two of the events took place over the winter months of November and February while the other three took place over June to July.
Storms (increase in wind speed for worst gales)	Kent experienced 10 severe storms. Impacts due to storms included, loss of power for thousands of homes.	The LCLIP does not present the number of severe storms. However, the annual frequency of strong winds has increased during the six year study period.	The annual frequency of strong winds has increased over the 10-year study period. This increased frequency and intensity has caused greater damage, transport disruption, tree falls and power cuts.	Havering reported 4 significant high wind events (storms and gales). These events saw winds of up to 90 miles per hour and lightning
Extreme winter temperatures and precipitation	A total of 12 freezing events were noted. Impacts included 583	The LCLIP does not present the number of freezing	Thurrock reports that maximum temperatures have	Snowfall and low temperatures were noted to severely impact

Weather event	Kent County Council	Essex County Council	Thurrock Council	London Borough of Havering
	closures over three events, full rail service suspensions and shortages in county grit levels.	events. However, it notes that extreme winter temperatures are a major impact on Essex's roads and transport system.	remained consistent. However, minimum temperature rates have risen by 1% over the period 1959-2007.	the borough. The winter of 2009 was particularly significant with respect to disruption to local services.
Extreme summer temperatures and precipitation	Over seven heatwave events were reported over the study period. Impacts reported included a 20-year low in the River Stour's levels and road surfaces melting.	The LCLIP does not present the number of heatwave events. However, it notes that extreme summer events had impacts on health, agricultural difficulties as well as the long- term effects on Essex's buildings and infrastructure.	The east of England is the driest region in England. Predicted scenarios for climate change show more frequent drought conditions are expected.	A total of 3 periods of high temperatures, severe dry weather and heatwaves were reported during the study period for the LCLIP.

16.3.9 There has been a significant human influence on the observed warming in England's annual temperature since 1950. Statistical results from extreme value analysis suggest that the UK daily maximum and minimum temperature extremes have increased by just over 1°C since the 1950s, and that heavy seasonal and annual rainfall events have also increased. Across England, land temperature in the decade 2005-2014 was 1°C warmer than 1961-1990.

16.3.10 There has been a small observed increase in mean annual rainfall in recent decades. Between 1961-1990 and 1991-2010 mean annual rainfall increased by 3.2%. However, this change is not statistically significant in the context of rainfall totals over the last century.

16.3.11 UK climate projection data is published by Defra via the UKCP09 data tool kit. The UKCP09 tool provides projections for a number of parameters from the 1990 baseline values. The 1990 baseline values for the key climate change adaptation parameters are presented in Table 16.6. As a result of the format of the data obtained from the UKCP09 tool, climate data is presented as three climate 'areas' across the Project. The areas are as follows:

a. A2 to A13

b. Ockendon link

c. M25 junction 29

Table 16.6 Average climate change adaptation parameters in 1990 for the Development Boundary

Parameters	A2 to A13	Ockendon link	M25 junction 29
Mean air temperature at 1.5m (°C)	9.938	9.938	9.938
Mean maximum air temperature at 1.5m (°C)	13.848	13.880	13.911
Mean minimum air temperature at 1.5m (°C)	6.027	5.996	5.965
Temperature of the coolest day (°C)	-4.496	-4.566	-4.617
Temperature of the warmest day (°C)	30.701	30.810	30.919
Precipitation rate (mm/day)	1.664	1.630	1.596

Predicted changes in climate

16.3.12 It is predicted that climate change will increase the frequency and severity of some types of extreme weather events in England. The climate projections published by Defra (UKCP09) generally show that warmer, drier summers will become more likely with warmer, wetter winters. The projections for the Project areas in the 2080s under a high emissions scenario (50% probability level change in line with Paragraph 4.41 of the NPSNN requirements) are presented in Table 16.7.

Table 16.7 Predicted average changes in climate (from 1990 baseline) in the 2080s

Parameters	A2 to A13	Ockendon link	M25 junction 29
Mean air temperature change at 1.5m (°C)	4.382	4.391	4.400
Maximum air temperature change at 1.5m (°C)	4.477	4.480	4.484
Minimum air temperature change at 1.5m (°C)	4.087		
Temperature change of the coolest day (°C)	2.772	2.758	2.744
Temperature change of the warmest day (°C)	4.385	4.392	4.399
Temperature change of the coldest night (°C)	3.605	3.564	3.523
Temperature change of the warmest night (°C)	4.890	4.857	4.823
Change in precipitation rate (%)	1.163	1.680	2.197
Wind	There is considerable uncertainty in projections for changes in wind speed and wind direction. However, overall an increase in extreme weather including wind is		

Parameters	A2 to A13	Ockendon link	M25 junction 29
	projected (Committee on Climate Change, 2017)		

16.4 Further baseline information and surveys required

Effects on climate (GHG emissions)

16.4.1 Given the continued development of the Project and design, preliminary carbon calculations have been presented within this *PEIR* chapter, however further calculations to determine carbon emissions during both the construction and operational phase of the Project will be assessed and reported within the ES. In line with the NPSNN, the significance of the carbon emissions during the Project phases will be referenced against the relevant UK Government carbon budget period.

Vulnerability of the Project to climate change

16.4.2 A review of UKCP18 will be carried out when it becomes available. This will provide the latest information on the future climate and will build upon the current set of projections provided through the UKCP09 data set. The core raw data products of UKCP18, full UKCP18 data interface and support products are expected to be released in winter 2018.

16.4.3 Requests for baseline information have been issued to several stakeholders, including the Environment Agency, Essex County Council, Kent County Council, Thurrock Borough Council and Medway Council. Information requested from the stakeholders included:

a. Climate change targets, aims and commitments, if they are available

b. Details of future plans and policy emerging that would impact climate change requirements and baseline

c. GHG emissions, including estimates of road emissions

16.4.4 Consultation will continue during the development of the ES chapter. Additional requests will be issued to the remaining host boroughs.

16.5 Potential effects and mitigation measures

16.5.1 The potential climate effects associated with the Project during design, construction and operation are outlined below.

16.5.2 Carbon emissions from the Project were calculated by using the emissions factors published in Interim Advice Note 185/15 (Speed banding). The total emissions in the Opening Year (2026), both with and without the Project, were calculated as a worst-case representation.

16.5.3 A full assessment of the significance of effects will be completed and reported as part of the ES.

Construction – effects on climate (GHG emissions)

Table 16.8 Construction – effects on climate (GHG emissions)

Item	Description
Receptor	Climate
Potential nature of effect	To construct the Project, the use of natural resources, for example, raw materials and energy, will be required, which will contribute towards GHG emissions and, therefore, climate change. The construction phase of the Project will also have the potential to increase GHG emissions due to: • embodied carbon within construction materials such as concrete • emissions from construction plant onsite (for example excavation plant, concrete casting facilities and tunnel support facilities) • emissions from water consumption • exhaust emissions from construction phase road traffic and movements It is estimated that if excavated materials must be transported off-site, a substantial percentage of the total construction emissions will come from the additional vehicle movements required.
Likely duration	Permanent

Potential mitigation	Key mitigation measures which would be considered are:
	• Implementation of the Highways England Sustainable Development Strategy, in which carbon management is one of five themes. The strategy states that Highways England will "aim to reduce the carbon footprint and work closely with suppliers to reduce emissions from network related activity". This could be achieved by applying the following high-level options when seeking to reduce GHG emissions:
	  ○ Avoid and prevent: maximise potential for reusing or refurbishing existing assets to reduce the extent of new construction required
	  ○ Reduce: apply low carbon solutions (including technologies, materials and products) to minimise resource consumption during construction. Construct efficiently, using techniques that reduce resource consumption over the construction phase of the Project
	  ○ Remediate: after addressing steps 1 and 2, the Project will identify, assess and integrate measures to further reduce carbon through on or off-site offsetting or sequestration
	• Considering the specification of materials with an optimum design life and less embodied carbon. This could include using recycled materials or materials sourced from nearer to site to minimise transportation movements.
	• Where possible, maximising the reuse of materials from demolition and excavation works both onsite and off-site.
	• Minimising water use during construction and encouraging reuse.
	• The contractor will be required to monitor carbon emissions during construction to encourage good practices and continued savings onsite.

Construction – vulnerability of the Project to climate

Table 16.9 Construction – vulnerability of the Project to climate

Item	Description
Receptor	Material supply, transport, manufacturing and construction process
Potential nature of effect	Due to the short-term nature of the construction phase it is considered unlikely that there will be significant changes to the climate during this period. There may be vulnerabilities associated with flooding which will be assessed within the Road Drainage and Water Environment chapter of the ES. Vulnerability of the Project to climate change, during the construction phase, will be scoped out. However, as the design evolves between now and the DCO submission, the vulnerability of the Project will be considered to ensure that the construction design of the Project is sufficiently resilient to climate change vulnerability. If necessary, a risk assessment would be undertaken.

Operation – effects on climate (GHG emissions)

Table 16.10 Operation – effects on climate (GHG emissions)

Item	Description
Receptor	Climate
Potential nature of effect	Because of the operation of the Project, GHG emissions would mainly result from vehicular movements along the route. Preliminary modelling suggests that the Project would result in an increase of around 62,587 tonnes of carbon dioxide equivalent emissions in the opening year from vehicle emissions. In the context of the total UK emissions from transport modes presented in Table 16.4, and the UK carbon budget, it is considered unlikely that the Project alone would have a significant adverse effect on climate change. However further calculations to determine carbon emissions during the operational phase of the Project, including cumulative effects, will be undertaken and reported within the ES. Additional emissions are likely to arise as a result of the operation of highways lighting, operation of the rest and service area and activities such as tunnel operations and maintenance. However, these are likely to be minimal in comparison to road user traffic emissions.
Likely duration	Permanent.
Potential mitigation	Key mitigation measures which would be considered are: • The impacts of carbon throughout the design process of the Project. This will have the potential to reduce the emissions from road users during the operation of the Project through the consideration of road gradients, junction layouts, structure designs and future maintenance strategies, pavement design and speed limits. • Implementation of the Highways England Sustainable Development Strategy with respect to long term maintenance strategies and operation of assets. The approach to carbon management is to "aim to reduce the carbon footprint and work closely with suppliers to reduce emissions from network related activity". Operations and maintenance strategies will take into account the value of lower carbon solutions through

Item	Description
	reducing fuel, energy and raw material consumption and all waste generation.

Operation

Table 16.11 Operation – vulnerability of the Project to climate

Item	Description
Receptor	Pavements, structures (including gantries), drainage, geotechnics, signs and signals, soft estate, vehicle restraint systems and end-users.
Potential nature of effect	During the Project's 120-year design life, changes in climate (temperature, precipitation and wind) will be experienced in the south east of England. Table 16.12 presents the potential effects to the Project's receptors. These have been devised in line with the areas presented within the Highways England Climate Adaptation Risk Assessment Progress Update, 2016.
Likely duration	Permanent.
Potential mitigation	Key mitigation measures which would be considered are: • The Project design will consider the effects of climate for a range of design fluvial and tidal flood events up to and including the 1% (1 in 100) annual probability river flood and 0.5% (1 in 200) annual probability of tidal flood, including the addition of the relevant climate change allowance and in defended and undefended (breach/failure) scenarios. • While the risk of drought occurring in the future is likely to increase due to climate change, leading to lower than normal river flows, the Project incorporates sustainable drainage systems (SuDS) measures. This will encourage infiltration of storm runoff promoting groundwater recharge at source, wherever this is reasonably practicable. • The landscaping strategy, including plant species chosen and their location, will take account of their ability to adapt to climate change and ability to cope with changes in soil moisture conditions to minimise the impact of drought. It is unlikely that hotter, drier or drought conditions would cause stress to these plants. • The use of integral structures to avoid the need for joins would reduce the risk of accelerated wear caused by increases in temperature, have been considered within the design. • Although mitigation and adaptation measures will be embedded within the Project design, any further additional mitigation measures identified by the topic chapters will take account of the vulnerability of the Project to the climate change effects, presented in Table 16.12. Additional mitigation will be presented within the following chapters: o Chapter 7: Cultural Heritage o Chapter 8: Landscape o Chapter 9: Terrestrial Biodiversity o Chapter 11: Geology and Soils o Chapter 12: Materials o Chapter 14: People and Communities o Chapter 15: Road Drainage and Water Environment

Item	Description
	• Further assessment on the resilience of the Project to future climate effects will continue as the Project's design evolves and as further assessment is undertaken for other applicable EIA topic chapters. The most appropriate mitigation measures (relevant to the identified potential effects) will be identified in the climate chapter of the ES and will be embedded within the Project. For example, the following aspects would be further investigated for the ES to reduce the Project's vulnerability to climate change: ○ foundation type to reduce the risk of failure caused by increased precipitation. ○ pavements designed to reduce the risk of heaving through pavement expansion due to heavy rainfall or shrinking due to high temperatures.

Table 16.12 Operation – vulnerability of the Project to climate – potential effects on the Project

Receptor	Aspect	Potential effect on the Project (impact)
Pavement	Foundation	Pavement has a typical design life of 40 years and so could be affected by changes in climate. An increase in mean daily rainfall rates has the potential to alter the moisture content of soils. This could lead to ground movements, soil settlement as well as expansion and contraction. This could also cause the Project's pavements and foundations to heave.
		For concrete pavements, thermal gradients have the potential to create uneven internal stresses which could then give rise to curling or warping, sometimes called hogging, of the slabs. These could be compounded by loading from passing traffic.
	Surface	Large changes in temperature have the potential to generate thermal contraction and expansion of the slabs which, if not taken into consideration at the design stage, could generate unacceptably large longitudinal internal stresses and excessive movements at joints.
Structures	Superstructure	Increases in temperature have the potential risk of thermal actions (loads) being applied to structures and this can lead to joint and bearing failure. Some structures have the potential to fail to operate within original design parameters. This could induce failures meaning additional works would then be required to strengthen them.
		Increases in temperature can increase the risk of joint and bearing failure associated with project structures.
		Increases in precipitation rates could lead to premature deterioration rates for joints, bearings and surfaces. This would lead to increased traffic disruption.
		An increase in the frequency and intensity of storms has the potential to cause impacts to the operation of structures, overhead lines and other road assets.
		An increase in wind speed has the potential to cause overhead line collapse.
		Increased precipitation has the potential to lead to tunnel flooding, preventing or deterring travellers from using the tunnel.
	Foundations and substructure	Changes in groundwater levels because of an increase in precipitation rates could lead to ground movements and soil settlement.

Receptor	Aspect	Potential effect on the Project (impact)
		An increase in the frequency and intensity of storm events could reduce the design life of several key assets such as signage, lighting, road surface and road markings. This could increase maintenance costs over the lifespan of the road.
Drainage	Drainage	An increase in the frequency and intensity of rainfall could lead to localised flooding events, increased maintenance and increased land take for additional drainage assets and storm events could lead to an increase in particulates entering the drainage system.
		An increase in the mean daily rainfall could lead to an increased risk of pollution mobilisation from accidental spillages associated with the Project. This would increase the risk of releasing contaminants into the water environment.
Geotechnics	Earthworks	An increase in frequency and intensity of heavy rainfall and flooding events could cause collapse of embankments.
		Changes in mean temperatures and rainfall rates may impact soils reinstated for agricultural use. This has the potential to alter the productivity of the land.
Signs and signals	Signs	An increase in wind speed and in frequency of extreme wind events has the potential to affect the stability of the signs, which have a design life of 25 years (*Design Manual for Roads and Bridges* Standard BD 94/07).
	Lighting columns and fencing	An increase in wind speed and in frequency of extreme wind events has the potential to affect the stability of the lighting columns as well as highway signs and fencing.
	Road markings	Increase in precipitation and temperature have the potential to weather road markings and change performance.
Soft estate	Landscape design	A decrease in mean rainfall may lead to drought-tolerant trees becoming more prevalent. This may cause a change in the landscape character of the area.
		An increase in mean temperature and precipitation may alter the growing characteristics such as soil properties and length of growing season. This may impact the species identified as part of the landscape strategy and thus alter the character of the landscape.
		An increase in precipitation and flooding has the potential to destroy plants in higher flood risk areas.
		Increased wind speed could lead to the loss of valued landscape features, opening up new views of the Project that were previously shielded.

Receptor	Aspect	Potential effect on the Project (impact)
		An increase in frequency of drier and drought conditions could lead to an increased risk of wildfire occurring, potentially destroying Project landscape planting.
	Built heritage	Drier and drought conditions, along with a change in the existing noise and vibration environment resulting from the Project, has the potential to exacerbate the risks of ground settlement.
		An increase in wind speed has the potential to temporarily and permanently disrupt the setting of built heritage assets due to tree loss.
		An increase in extreme precipitation and/or temperature has the potential to disrupt the setting of built heritage assets due to an increase in growing season and an increased rate of growth of vegetation.
	Habitats and wildlife species	An increase in mean temperatures may exceed thresholds for certain habitats and species identified for relocation and enhancement as part of the environmental masterplan.
		An increase in frequency of drier and drought conditions could lead to an increased risk of wildfire occurring, potentially destroying habitat created as mitigation.
		Increased tree loss, habitat loss and/or fragmentation and reduction in woodland blocks may be associated with increased wind speeds.
Vehicle restraint systems	Safety barriers	Steel safety barriers have a design life of approximately 25 years. More frequent extreme weather and changes in temperature and precipitation may result in an increase in rate of deterioration of vehicle restraint systems.
End-users	Pedestrians, cyclists and horse riders	An increase in the rate of deterioration of assets due to extreme weather events could lead to an increase in the requirements for construction and maintenance workers as well as traffic officers working within the carriageway. Workforce may also have to work in dangerous conditions.
		An increase in the frequency and intensity of storm events may discourage pedestrians, cyclists and horse riders from taking journeys. This may lead to more users on the Project's roads.
		An increase in temperatures and occurrence of heatwaves has the potential to increase the volatility of organic compounds causing unpleasant odours locally.
		An increase in heavy rain could potentially lead to flooding and closures and diversions of footpaths.

Receptor	Aspect	Potential effect on the Project (impact)
	Motorised users	Changes in the volume, composition and distribution of traffic in the area could occur as people change the way they travel. Hotter, drier or drought conditions could increase concentrations of certain air pollutants such as ozone and $PM_{2.5/10}$.
		Changes in humidity and an increase in temperature would lead to a greater number of people sleeping with windows open. This may alter propagation characteristics of sound through air increasing disturbance of noise sensitive receptors.
		An increase in the frequency and intensity of storm winds may increase the mobilisation of air pollutants.
		An increase in frequency and intensity of heavy rainfall events and flooding could decrease concentration of air pollutants such as ozone and $PM_{2.5/10}$.
		Hotter, drier and drought conditions might affect the effectiveness of the landscape strategy in shielding the Project.
		An increase in frequency and intensity of heavy rainfall, flooding and storm events could lead to a higher rate of vehicle collisions causing severe disruption to the highway. Major accidents will cause harm to highways, users and adjacent receptors.
		An increase in temperature has the potential to increase the risk of more incidents due to: • vehicles breaking down or overheating • a higher frequency of vehicle fires • smoke drifting across carriageways from wildfires • Heavy Good Vehicles blow-overs and flying debris

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Glossary

Glossary

Term	Explanation
AADT	Annual Average Daily Traffic
AAWT	Annual Average Weekday Traffic
ADMS	Atmospheric Dispersion Modelling System
Agri-environment scheme	Agri-environment schemes provide funding to farmers and land managers to farm in a way that supports biodiversity, enhances the landscape and improves the quality of water, air and soil.
ALC (grades)	Agricultural Land Classification: provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use. The limitations can operate in one or more of four principal ways: they may affect the range of crops which can be grown, the level of yield, the consistency of yield and the cost of obtaining it. The classification system gives considerable weight to flexibility of cropping, whether actual or potential, but the ability of some land to produce consistently high yields of a somewhat narrower range of crops is also taken into account.
Ambient Noise	The total sound in a given situation at a given time. It is usually composed of sound from many sources, near and far.
AONB	Area of Outstanding Natural Beauty: statutory designation intended to conserve and enhance the ecology, natural heritage and landscape value of an area of countryside.
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area: an area, declared by a local authority, where air quality does not meet national Air Quality Strategy objectives.
AQS	Air Quality Strategy
Aquitard	An aquitard is a zone within the earth that restricts the flow of groundwater from one aquifer to another.
ARG	Amphibian and Reptile Group of the United Kingdom
ARN	Affected Road Network
AURN	Defra's Automatic Urban and Rural Network: the UK's largest automatic monitoring network and the main network used for compliance reporting against the Ambient Air Quality Directives.
A-weighting	In addition to its non-linear amplitude response, the human ear has a non-linear frequency response; it is less sensitive at low and high frequencies and most sensitive in the range 1 kHz to 4 kHz (cycles per second). The A-weighting is applied to measured sound pressure levels so that these levels correspond more closely to the subjective response. A-weighted noise levels are often expressed in dB(A).
BAP	Biodiversity Action Plan: national, local and sector-specific plans established under the UK's Biodiversity Action Plan, intended to secure the conservation and sustainable use of biodiversity. See UK BAP.
Baseline year	For an assessment of noise and vibration, the baseline year is taken as the opening year of the road Project.
BCT	Bat Conservation Trust
Benthic	Benthic animals are organisms that live at the lowest level of a body of water.

Term	Explanation
BGS	British Geological Survey: a partly publicly funded body which aims to advance geoscientific knowledge of the United Kingdom landmass and its continental shelf by means of systematic surveying, monitoring and research.
BoCC	Birds of Conservation Concern
Borrow pits	A pit resulting from the excavation of minerals and clay such that they can be reused as part of a scheme. The pit is often backfilled to achieve design levels.
BPM	Best Practicable Means
CAMS	Catchment Abstraction Management Strategy: this strategy sets out how the Environment Agency will manage the water resources of a catchment and contribute to implementing the Water Framework Directive.
CCMA	Coastal Change Management Area
CD&E waste	Waste that results from construction, demolition and excavation activities.
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
Cetaceans	Whales, dolphins and porpoises
CIEEM	Chartered Institute of Ecology and Environmental Management
CIRIA	Construction Industry Research and Information Association
CO_2e	Carbon dioxide equivalents: a standard unit for measuring carbon footprints. It is a quantity that describes, for a given amount of Greenhouse Gas emissions, the amount of CO_2 that would have the same Global Warming Potential (GWP), when measured over a timescale of 100 years.
CoCP	The Code of Construction Practice sets the framework to control possible impacts arising from the construction of a project. The CoCP covers environmental, public health and safety aspects of the project that may affect the interests of local residents, businesses, the general public and the surrounding area in the vicinity of the project.
Construction phase	A defined period of construction works.
Cross-passage	A small tunnel usually linking two larger tunnels.
CRTN	Calculation of Road Traffic Noise
CSEMP	Clean Safe Seas Environmental Monitoring Programme
CSM	Conceptual Site Model: the CSM describes the environmental setting and identifies contaminant sources (potential areas of concern and associated contaminants), modes of contaminant movement (migration pathways), the person/ecosystem and components/environmental values potentially affected by the contamination (potential receptors) and how exposure may occur (exposure routes).
CSO	Combined sewer overflow
CTMP	Construction Traffic Management Plan: establishes vehicle routing and tests whether vehicles can access and egress the site safely during the construction phase. This is typically in the form of routing plans, restrictions to timing of vehicle movements, temporary enabling works and parking suspensions.
Cut-and-cover	A form of construction usually involving in situ reinforced concrete, where a tunnel is built within an excavation which is undertaken from the ground surface.

Term	Explanation
Dartford Crossing	The Dartford Crossing – known as the Dartford tunnel until 1991 – is a major road crossing of the River Thames. It carries the A282 between Dartford to the south and Thurrock in the north.
dB(Decibel)	This is the unit of measurement used for sound pressure levels and noise levels and usually quoted in decibels (dB). The decibel scale is logarithmic rather than linear. The threshold of hearing is zero decibels while, at the other extreme, the threshold of pain is about 130 decibels. In practice these limits are seldom experienced and typical levels lie within the range of 30 dB(A) (a quiet night-time level in a bedroom) to 90 dB(A) (at the kerbside of a busy street).
DBA	Desk-based assessment: a document produced to assess the overall heritage resources of a defined area. These are primarily performed without the aid of archaeological field investigations through the use of HERs and archive materials.
DCO	Development Consent Order: this is a statutory order which provides consent for a project and means that a range of other consents, such as planning permission and listed building consent, will not be required. A DCO can also include provisions authorising the compulsory acquisition of land or of interests in or rights over land which is the subject of an application.
Defra	Department for Environment, Food and Rural Affairs: the Government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the UK.
DMRB	Design Manual for Roads and Bridges: a comprehensive manual (of 15 volumes) which contains requirements, advice and other published documents relating to works on motorways and all-purpose trunk roads for which one of the Overseeing Organisations (Highways England, Transport Scotland, The Welsh Government or the Department for Regional Development (Northern Ireland)) is highway authority. The DMRB has been developed as a series of documents published by the Overseeing Organisations of England, Scotland, Wales and Northern Ireland. For the Lower Thames Crossing the Overseeing Organisation is Highways England.
Design Year	Term used to describe the situation 15 years after project opening.
Dewatering	The process of removing groundwater from an aquifer.
DfT	Department for Transport: the Government department responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved.
Disbenefit/benefit	A negative or positive effect of an outcome.
DM scenario	Do-Minimum scenario (without Project scenario)
Drawdown	Drawdown is the change in head or water level relative to background condition, indicating the difference in head which has occurred at a given location relative to an initial time at the same location.
DS scenario	Do-Something scenario (with Project scenario)
Dwelling	A building used for living purposes. A mobile home used for permanent living should be included in an assessment. If calculations are being conducted for compensation purposes, then some mobile homes are dealt with under the Highways Noise Payments and Moveable Homes Regulations.
EA	Environment Agency: established under the Environment Act 1995, it is a Non-Departmental Public Body of Defra. The EA is the leading public body for protecting and improving the environment in England and Wales. It is responsible for wide-ranging matters, including the management of all forms of flood risk, water resources, water quality, waste regulation, pollution control, inland fisheries, recreation, conservation and navigation of inland waterways.
Earthworks	Engineering works created through the processing of parts of the earth's surface involving quantities of soil or unformed rock.

Term	Explanation
EC	Electrical Conductivity
ECP	English Coastal Path
eDNA	environmental DNA
EIA	Environmental Impact Assessment: an analytical process that systematically examines the likely significant environmental effects of a project.
EIA Regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017
ELC	European Landscape Convention: the ELC is the first international treaty dedicated to the protection, management and planning of all landscapes in Europe.
EMP	Environmental Masterplan: a drawing setting out all the proposed elements of environmental design, together with their function(s).
Entry Level Stewardship	An agri-environment scheme that provides funding to farmers and other land managers in England in return for delivering environmental management on their land.
Environmental Permit	A consent granted and audited by the Environment Agency to provide permission for activities listed in the Environmental Permitting Regulations (England and Wales) 2016.
EPA	Environmental Protection Act: The Environmental Protection Act 1990 is an Act of the Parliament of the United Kingdom that as of 2008 defines, within England and Wales and Scotland, the fundamental structure and authority for waste management and control of emissions into the environment.
Epidemiological	The study of how often diseases occur in different groups of people and why. Epidemiological information is used to plan and evaluate strategies to prevent illness.
EPR	Environmental Permitting (England and Wales) Regulations
ES	Environmental Statement: a document which sets out the findings of the EIA process, and particularly a description of the likely significant effects of the proposed development on the environment and a description of any measures envisaged in order to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment.
EU	European Union: a politico-economic union of 28 member states that are located primarily in Europe.
EWTBRC	Essex Wildlife Trust Biological Records Centre
Excavated material	Ground or other material removed during a construction process, usually by mechanical means.
False cuttings	A means of screening the road from properties in the surrounding landscape. It is particularly appropriate in gently-undulating ground where a natural cutting cannot be achieved. It has the added benefit of reducing the impact of noise.
FRA	Flood Risk Assessment
Future Assessment Year	The year between baseline and the 15th year where the maximum impact from the road Project would occur.
GES	Good Environmental Status: the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive.
GHG	Greenhouse Gas
GIS	Geographic Information System: an integrated collection of computer software and data used to view and manage information about geographic places, analyse spatial relationships and model spatial processes.
GLA	Greater London Authority

Term	Explanation
Good design	The 10 principles of good road design are set out in Highways England's "The road to good design" document. Good design: 1 – makes roads safe and useful 2 – is inclusive 3 – makes roads understandable 4 – fits in context 5 – is restrained 6 – is environmentally sustainable 7 – is thorough 8 – is innovative 9 – is collaborative 10 – is long-lasting
Greater Essex	The county of Essex with Thurrock
Green belt	A green belt (or greenbelt) is a policy and land use zone designation used in land use planning to retain areas of largely undeveloped, wild, or agricultural land surrounding or neighbouring urban areas.
Groundwater	Water below ground level
GWP	Global Warming Potential
Habs Regs	Conservation of Habitats and Species Regulations 2010
Hazardous waste	Waste which displays one or more of the hazardous properties listed in Annex III of the Waste Framework Directive.
HDV	Heavy Duty Vehicle. This includes Heavy Goods Vehicles and buses.
HER	Historic Environment Record(s): information services that seek to provide access to comprehensive and dynamic resources relating to the historic environment of a defined geographic area for public benefit and use.
Higher Level Stewardship	An agri-environment scheme that provides funding to farmers and other land managers in England in return for delivering environmental management on their land.
Historic England Archive	One of the largest publicly accessible archives in the UK. It holds over 12 million photographs, drawings and reports relating to the archaeology and architecture of England.
Historic England's National Heritage List for England	This draws together all scheduled monuments, listed buildings, registered landscapes and battlefields, and protected wrecks and can be viewed in an online map viewer. The List now holds almost 400,000 entries. Historic England continuously updates The List, which is curated for the Department for Digital, Culture, Media and Sport.
HLC	Historic Landscape Characterisation: a formal process of the study of the historic landscape, using an array of sources including historic maps, archaeological data and aerial photographs. HLC identifies and describes the essential characteristics of the land being studied. The studied areas are recorded chiefly in GIS format as polygons.
HRA	Habitats Regulations Assessment: a tool developed by the European Commission to help competent authorities (as defined in the Habitats Regulations) to carry out assessment to ensure that a project, plan or policy will not have an adverse effect on the integrity of any Natura 2000 or European sites (Special Areas of Conservation, Special Protection Areas and Ramsar sites), (either in isolation or in combination with other plans and projects), and to begin to identify appropriate mitigation strategies where such effects were identified.
HS1	High Speed 1 rail line (formerly Channel Tunnel Rail Link (CTRL))
HSI	Habitat Suitability Index

Term	Explanation
IAN	Interim Advice Notes: issued by Highways England from time to time. They contain specific guidance, which should only be used in connection with works on motorways and trunk roads in England.
INNS	Invasive non-native species
IUCN	International Union for the Conservation of Nature
Jetty	A structure that projects from land out into water for the purposes of marine logistics.
JNCC	Joint Nature Conservation Committee: the statutory adviser to the Government and devolved administrations on UK and international nature conservation. Its work contributes to maintaining and enriching biological diversity, conserving geological features and sustaining natural systems.
KMBRC	Kent and Medway Biological Records Centre
LA10 index	LA10 is the A-weighted sound level in dB that is exceeded during 10% of the measurement period. This is the standard index used within the UK to describe traffic noise.
LA10,18hour index	The LA10,18hour noise level is the arithmetic mean of all the levels of LA10 during the period from 06:00 to 24:00. From research it has been found that subjective response to road traffic noise is closely linked to higher noise levels experienced and is correlated well with the LA10,18hour index.
LA90 index	The background noise level is commonly quoted using the LA90 index. This is the A-weighted sound level in dB that is exceeded during 90% of the measurement period.
LAeq index	The equivalent continuous sound level LAeq is the level of a notional steady sound, which at a given position and over a defined period would have the same A-weighted acoustic energy as the fluctuating noise.
Landbanks	An estimation of resource availability in order for each mineral planning authority to manage supply of aggregate and ensure a suitable supply.
LAQM	Local Air Quality Management
LAQM.TG	Local Air Quality Management Technical Guidance
LCA	Landscape Character Areas: geographically unique areas of the country. They are areas where a combination of factors such as topography, vegetation pattern, land use and cultural associations combine to create an area with a distinct, recognisable character.
LCLIP	Local Climate Impact Profile
LDP	London Distribution Park: offers 70 acres (28Ha) of land for industrial and logistics development 6.5 miles from the M25, adjacent to Port of Tilbury, London.
LiDAR	LiDAR (light detection and ranging): a surveying method that measures distance to a target by illuminating the target with pulsed laser light and measuring the reflected pulses with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3D representations of the target. LiDAR has considerable potential for archaeological investigation through examining topography, land-use interpretation and the palaeoenvironment.
LLFAs	Lead Local Flood Authorities: unitary authorities or county councils responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets.
LNR	Local Nature Reserves

Term	Explanation
LTAM	Lower Thames Area Model: a strategic highway model produced by Highways England to assess the impact of the Project on the highway network. It also provides traffic data for use in the environmental, social and economic assessment of the Project.
LWS	Local wildlife site
M25	Orbital motorway that encircles most of Greater London.
Made Ground	An artificial fill is present consisting of natural materials, refuse, brick, concrete etc. Alternatively, man-made deposits such as embankments and spoil heaps on the natural ground surface.
Made Ground (landfill)	Made Ground associated with landfill which is a site for the disposal of waste materials by burial.
MAFF	Ministry of Agriculture, Fisheries and Food: it was merged into Department for Environment, Food and Rural Affairs (Defra) in 2001.
MAGIC	Multi-Agency Geographic Information for the Countryside
Mardyke	A small river, mainly in Thurrock, that flows into the River Thames at Purfleet, close to the QEII Bridge.
Marine aggregate	Aggregate, usually sand and gravel recovered from the sea floor via dredging, for sale and use on the land.
MCZ	Marine Conservation Zone
MHCLG	Ministry of Housing, Communities and Local Government: the UK Government department for housing, communities and local government in England.
Mitigation	Measures including any process, activity or design to avoid, reduce, remedy or compensate for negative environmental impact or effects of a development.
MMO	Marine Management Organisation: an executive, non-departmental public body in the UK established under the Marine and Coastal Access Act 2009. The MMO exists to make a significant contribution to sustainable development in the marine area, and to promote the UK Government's vision for clean, healthy, safe, productive and biologically diverse oceans and seas.
MMP	Materials Management Plan: a document to enable the reuse of excavated materials in construction projects when produced in line with the Definition of Waste: Development Industry Code of Practice, CLAIRE 2011, version 2.
MoU	Measure of Uncertainty
MSA	Mineral safeguarding area: these are areas of mineral resources of economic importance safeguarded from sterilisation by incompatible non-mineral development. Development of a significant nature within an MSA will have to demonstrate that the sterilisation of proven mineral resources of economic importance will not occur as a result of the development and that the development would not pose a serious hindrance to future extraction in the vicinity. If this cannot be demonstrated, prior extraction will be sought where practical.
MSFD	Marine Strategy Framework Directive
National Compensation Code	A collective term used for the principles set out in Acts of Parliament, principally the Land Compensation Act 1961, the Compulsory Purchase Act 1965, the Land Compensation Act 1973, the Planning & Compulsory Purchase Act 1991 and the Planning & Compulsory Purchase Act 2004. This is supplemented by case law, relating to compensation for compulsory acquisition.
Natural England	A non-departmental public body and the Government's adviser for the natural environment in England. It helps to protect England's nature and landscapes for people to enjoy and for the services they provide.

Term	Explanation
NCA	National Character Area: England is divided into 159 NCAs, each defined by a unique combination of landscape, biodiversity, geodiversity, history, and cultural and economic activity. Their boundaries follow natural lines in the landscape rather than administrative boundaries.
NCR	National Cycle Route
NE	See: Natural England
NERC Act 2006	The Natural Environment and Rural Communities Act 2006
NIA	Noise Important Area(s): Defra published noise maps for England's roads in 2008, with the noise action plans following two years later in 2010. The action plans set out a framework for managing noise, rather than propose specific mitigation measures. They were designed to identify 'Important Areas' that are impacted by noise from major sources and therefore must be investigated. NIAs are where the 1% of the population that are affected by the highest noise levels from major roads are located, according to the results of Defra's strategic noise maps.
NIR	Noise Insulation Regulations 1975 (amended 1988)
NMU	Non-motorised users: includes pedestrians, cyclists and horse-riders.
Noise Making Authority	An authority that designates Noise Important Areas, for example Highways England or Kent County Council.
NPPF	National Planning Policy Framework: published in March 2012 by the UK's Department for Communities and Local Government, it consolidates over two dozen previously issued documents called Planning Policy Statements and Planning Policy Guidance Notes for use in England.
NPSE	Noise Policy Statement for England
NPSNN	National Policy Statement for National Networks: the NPSNN sets out the need for, and Government's policies to deliver, development of Nationally Significant Infrastructure Projects on the national road and rail networks in England. It also provides planning guidance for promoters of Nationally Significant Infrastructure Projects on the road and rail networks and is the basis for the examination by the Examining Authority and decisions by the Secretary of State.
NRMM	Non-Road Mobile Machinery
NSIP	Nationally Significant Infrastructure Project: major infrastructure developments in England and Wales. Includes proposals for power plants, large renewable energy projects, new airports and airport extensions and major road projects needing a DCO granted by the relevant Secretary of State.
NVC	National Vegetation Classification
OMH	Open Mosaic Habitat
ONS	Office for National Statistics: the executive office of the UK Statistics Authority, a non-ministerial department which reports directly to the UK Parliament.
Open Access Land	Land designated by the Countryside and Rights of Way Act 2000, to which the public has a right of access.
Opening Year	In the case of this Project, this is the modelled opening year in the traffic forecasts, which is 2026.
Order Limits	The spatial boundaries of the Project.
OSR	Other Sensitive Receptors
Palaeochannels	Relict river courses within the buried environment, representing the former course of brooks, streams and rivers.

Term	Explanation
PCM	Defra's Pollution Climate Mapping model
PEI	Preliminary Environmental Information
PEIR	Information referred to in Part 1 of Schedule 4 (information for inclusion in environmental statements) which: a) has been complied by the applicant; and b) is reasonably required to assess the environmental effects of the development (and of any associated development). The focus of the PEIR is to enable the local community to understand the environmental effects of the proposed development so as to inform their responses regarding the proposed development. Provision of a PEIR may assist in the identification of potential issues, enabling these to be addressed at an earlier stage in the preapplication consultation.
PFA	Pulverised Fuel Ash: a by-product of pulverised fuel-fired power stations. The fuel is crushed into a fine powder before being mixed with heated air and burned. PFA is used as engineering fill and as a component for concrete. Blocks made using PFA are lightweight with good thermal insulation properties.
Pinnipeds	Seals and their relatives
PINS	Planning Inspectorate
PLA	Port of London Authority: a self-funding public trust established by The Port of London Act 1908 to govern the Port of London. Its responsibility extends over the Tideway of the River Thames and its continuation (the Kent/Essex strait). It maintains and supervises navigation and protects the river's environment.
PPE	Personal Protective Equipment: clothing or accessories designed to protect people in the workplace. It can include fluorescent clothing, gloves, boots and hard hats.
PRA	Preferred Route Announcement
Protected lane	Lanes designated by a local authority as protected, for example, due to their historic or ecological importance.
PRoW	Public Right of Way: a right possessed by the public to pass along routes over land at all times. Although the land may be owned by a private individual, the public may still gain access across that land along a specific route. The mode of transport allowed differs according to the type of Public Right of Way, which consists of footpaths, bridleways and open and restricted byways.
pSPA	potential Special Protection Area: sites which are approved by Government that are in the process of being classified as Special Protection Areas.
Ramsar	A wetland of international importance, designated under the Ramsar convention.
RaSA	Rest and service area
RDB	Red Data Book
rMCZ	recommended Marine Conservation Zone: a site put forward for designation under the Marine and Coastal Access Act 2009 to conserve the diversity of nationally rare, threatened and representative habitats and species.
Road planings	Aggregate of different size, often coated in bitumen, recovered from a road surface when it is taken up.
RSPB	Royal Society for the Protection of Birds: a charitable organisation that works to promote conservation and protection of birds and the wider environment through public awareness campaigns, petitions and the operation of nature reserves throughout the United Kingdom.
RWE	npower: a leading integrated UK energy company.

Term	Explanation
SAC	Special Area of Conservation: defined in the European Union's Habitats Directive (92/43/EEC), also known as the Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora. SACs are to protect the 220 habitats and approximately 1000 species listed in annex I and II of the directive which are of European interest following criteria given in the directive.
SAQAP	Scheme Air Quality Action Plan
SEB	Statutory Environmental Body(ies): any principal council as defined in subsection (1) of section 270 of the Local Government Act 1982 for the area where the land is situated. Where the land is situated in England, Natural England, Historic England, the Environment Agency; Natural Resources Wales and the National Assembly for Wales where, in the opinion of the Secretary of State, the land is sufficiently near to Wales to be of interest to them and any other public authority which has environmental responsibilities and which the Secretary of State considers likely to have an interest in the project.
SELEP	South East Local Enterprise Partnership: the business-led, public/private body established to drive economic growth across East Sussex, Essex, Kent, Medway, Southend and Thurrock.
Sensitive receptor	Receptors which are potentially sensitive to noise and vibration. Examples include dwellings, hospitals, schools, community facilities and designated areas.
SEO	Statements of Environmental Opportunity: these statements identify opportunities for positive environmental change relating to NCAs.
Service building	The building housing all control, power supply and other essential equipment for the operation of the tunnel. Also houses firefighting control and ventilation equipment. Serves as a maintenance base and has the facility to become a standby operations room.
SFRA	Strategic Flood Risk Assessment
Slurry	A suspension of water, a clay mineral (called bentonite) and other additives which is used in a variety of ground-related construction purposes including ground support for bored pile and TBM tunnel construction.
SNRHW	Stable Non-Reactive Hazardous Waste: a class of landfill waste material which, when tested, demonstrates a specific class of leachate behaviour. These wastes are hazardous but not readily biodegradable/reactive and are therefore subject to different disposal constraints.
Soil Management Plan	Provides procedures for the effective handling of soil during site excavation and backfilling activities.
SoS	Secretary of State
SPA	Special Protection Area: a designation under the European Union Directive on the Conservation of Wild Birds.
SPZ	Source protection zone: EA-defined groundwater sources (2000) such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area.
SSSI	Site of Special Scientific Interest: a conservation designation denoting an area of particular ecological or geological importance.
SuDS	A sustainable drainage system designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges.
SWMP	Site Waste Management Plan: sets out how resources will be managed and waste controlled at all stages during a construction project.
Taxa	A taxon (plural taxa) is a group of one or more populations of an organism or organisms seen by taxonomists to form a unit.
TBM	Tunnel boring machine: a machine used to excavate tunnels with a circular cross-section.

Term	Explanation
TE2100	EA's Thames Estuary 2100 project (formed November 2012) to develop a comprehensive action plan to manage flood risk for the Tidal Thames from Teddington in West London, through to Sheerness and Shoeburyness in Kent and Essex.
TEBP	Thames Estuary Benthic Programme
TEP	Thames Estuary Partnership
Thames Crossing area	Section of the development area around the River Thames for the preliminary baseline study of marine habitats and sessile species.
The Project	The Lower Thames Crossing project is a proposed tunnel, associated structures and connecting roads, which crosses the River Thames linking Essex, Thurrock and Kent.
TMP	Transport Management Plan: details the management and control strategy related to pedestrian and vehicular movements, both on and off site, to ensure the safety of all members of the general public and workforce at all times. It applies throughout the construction period in accordance with all requisite Acts and Regulations.
TDSCG	Tunnel Design and Safety Consultation Group: a formal group of stakeholders including emergency services, police, the tunnel promoter, the highway authorities, the tunnel and highway operator and maintainer and the tunnel designer. It meets regularly through the planning and detailed engineering design phases to consider and agree matters of safety provision in the proposed tunnels.
Tunnel portal	A structure which defines the end of a section of tunnel.
UK BAP	The UK BAP was a national Biodiversity Action Plan for the UK which was published in 1994 in response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992. The UK BAP described the biological resources of the UK and provided detailed plans for conservation of these resources. Action plans for the most threatened species and habitats were set out to aid recovery and national reports were produced every three to five years to show the UK's progress towards significant reduction of biodiversity loss as required by the CBD. http://jncc.defra.gov.uk/ukbap
UKCP09	United Kingdom Climate Projections 2009
UKCP18	United Kingdom Climate Projections 2018
Un-bunded	A constructed retaining wall around storage where potentially polluting substances are handled, processed or stored. Its purpose is to contain any unintended escape of material from that area.
Unconformably	An unconformity is a contact between two rock units in which the upper unit is usually much younger than the lower unit. Unconformities are typically buried erosional surfaces that can represent a break in the geologic record of hundreds of millions of years or more.
Undercutting	An undercutting is when the road is at a lower level to enable another road to cross it at the existing ground level.
UXO	Unexploded Ordnance: these could be unexploded bombs, grenades or bullets that did not explode when they were employed, and which still pose a risk of detonation and so a threat to members of the public and workers on site.
VP	Vantage Point (used for surveys)

Term	Explanation
Waste	Waste is defined in Article 1(a) of the European Waste Framework Directive 2008/98/EC (Ref 13-3) as 'any substance or object in the categories set out in Annex I which the holder discards or intends to discard or is required to discard'. The term 'holder' is defined as the producer of the waste or the person who is in possession of it and 'producer' is defined as anyone whose activities produce waste. Waste can be further classified as hazardous, non-hazardous or inert.
Waste Champion	A person appointed by a contractor to take responsibility for waste management during a project. They ensure management is legally compliant and increases the recovery and recycling of waste, diverting it from landfill disposal.
WCA	Wildlife and Countryside Act
WebTAG	A Transport Analysis Guidance system, it is DfT's web-based multi-modal guidance on appraising transport projects and proposals.
WES	William Edwards School
Western Southern Link	The Western Southern Link is an alternative for shortlist Routes 2, 3 and 4 to the south of the River Thames. The route would connect into the A2 to the east of Gravesend and would go to the west of Thong and Shorne and east of Chalk towards Church Lane and Lower Higham Road. This route could connect into any of the Routes 2, 3 and 4 north of the river using all the crossing options for these route options.
WFD	Water Framework Directive: a European Community Directive (2000/60/EC) of the European Parliament and council designed to integrate the way water bodies are managed across Europe.
WFS	Water Features Survey: identifies, records and characterises all surface and groundwater bodies and dependent uses within a defined radius of a proposed activity that may be affected by this activity.
WSL	See: Western Southern Link
WW2	World War Two
ZSL	Zoological Society of London
ZTV	Zone of Theoretical Visibility: a computer-generated model to identify the likely (or theoretical) extent of visibility of a development. The elevation (or a set of elevations) of the development is tested against a 3D terrain model. The terrain model is usually, but not always, a bare-earth model; it does not feature buildings, vegetation or other boundaries which may have a significant effect on the visibility of a development. This is the principal reason it refers to theoretical visibility. Neither does the ZTV, by itself, take account of the effects of distance in reducing the visibility of a development.
ZVI	Zone of Visual Influence: the visual 'line of sight' or catchment area having the potential to be visually affected by a development.