Road Investment Strategy
M25 Junction 28 Improvements
Environmental Study Report
October 2016

V 3.0, October 2016

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Document control

The Project Manager is responsible for production of this document, based on the contributions made by his/her team existing at each Stage.

Document Title	M25 Junction 28 Improvements Environmental Study Report
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Distribution	HE Reviewers, Atkins Team
Document Status	Final

Revision History

This document is updated at least every stage.

Version	Date	Description	Author	Checked by	Reviewed by	Authorised by
1.0	22/07/16	First draft	Env Team	SLW	VA & NW	PG
2.0	10/10/2016	Revised draft with Noise & Air Quality and addressing comments from Highways England	Env Team	SLW	NW	PG
3.0	26/10/2016	Final	Env Team	SLW	NW	PG

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Glossary

AADT	Annual Average Daily Traffic
AAWT	Annual Average Weekly Traffic
ALC	Agricultural Land Classification
AOD	Above Ordnance Datum
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
ARN	Affected Road Network
ASR	Appraisal Specification Report
BAP	Biodiversity Action Plan
BBC	Brentwood Borough Council
BCR	Benefit to Cost Ratio
BGS	British Geological Society
BNL	Basic Noise Level
BS	British Standard
CEMP	Construction Environmental Management Plan
CO_2	Carbon Dioxide
CMS	Continuous Monitoring Stations
CSR	Client Scheme Requirements
CRTN	Calculation of Road Traffic Noise
dB	Decibel
DCO	Development Consent Order
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
DM	Do Minimum
DS	Do Something
EA	Environment Agency
EAST	Early Assessment Sifting Tool
ELC	European Landscape Convention
ECI	Early Contractor Involvement
EFT	Emission Factor Toolkit
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIS	Environmental Impact Statement
ESR	Environmental Study Report
EQS	Environmental Quality Standards

FRA	Flood Risk Assessment
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GEML	Great Eastern Mainline
HE	Historic England
HER	Historic Environment Records
HDV	Heavy Delivery Vehicle / Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IAN	Interim Advice Note
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IPC	Infrastructure Planning Commission
LAQMA.TG	Local Air Quality Management Technical Guidance
LBAP	Local Biodiversity Action Plan
LBH	London Borough of Havering
LCA	Landscape Character Assessment
LEP	Local Enterprise Partnership
LDF	Local Development Framework
LPA	Local Planning Authority
LNR	Local Nature Reserve
LVIA	Landscape and Visual Impact Assessment
MAGIC	Multi-Agency Geographic Information for the Countryside
MMP	Materials Management Plan
Mph	Miles per hour
NCAP	National Character Area Profile
NE	Natural England
NPPF	National Planning Policy Framework
NMR	National Monuments Record
NMU	Non-Motorised User
NCRN	National Cycle Route Network
NN NPS	National Networks National Policy Statement
NNR	National Nature Reserve
NO_2	Nitrogen Dioxide
NOEL	No Observed Effect Level
NPSE	Noise Policy Statement for England
NSIP	Nationally Significant Infrastructure Project
NVZ	Nitrate Vulnerable Zone
OAR	Options Appraisal Report
PCF	Project Control Framework

PCM	Pollution Climate Model
PINS	Planning Inspectorate
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometres or less
PM_{10}	Particulate Matter with a diameter of 10 micrometres or less
PPGs	Pollution Prevention Guidelines
PPG	Planning Policy Guidance
PRoW	Public Right of Way
RBMP	River Basin Management Plan
RIGS	Regionally Important Geological / Geomorphological Site
RIP	Regional Investment Programme
RIS	Regional Investment Scheme
SAC	Special Area of Conservation
SNCI	Site of Nature Conservation Importance
SOAEL	Significant Observed Adverse Effect Level
SPA	Special Protection Areas
SPZ	Source Protection Zone
SRN	Strategic Road Network
SSSI	Site of Special Scientific Interest
SUP	Shared Use Paths
SWMP	Site Waste Management Plan
TAME	Traffic Appraisal Modelling and Economics
TAG	Transport Appraisal Guidance
TPO	Tree Preservation Order
TRA	Traffic Reliability Area
UKBAP	UK Biodiversity Action Plan
VISSMM	Verkehr In Städten - SIMulationsmodell" (German for "Traffic in cities - simulation model").
WFD	Water Framework Directive
ZVI	Zone of Visual Influence

1 Introduction and Context

1.1 Background

In December 2014 the Department for Transport (DfT) published the Road Investment Strategy (RIS) for 2015-2020. The RIS sets out the list of schemes that are to be developed by Highways England over the period covered by the RIS (2015 – 2020). A number of schemes have been identified to be constructed within the plan period including improvements to M25 Junction 28.

Atkins Ltd have been commissioned to undertake the Project Control Framework (PCF) Stages 0 and 1 to identify and assess proposed scheme options for improvements to M25 Junction 28. PCF Stage 0 analysed the problems and developed possible solutions The project is currently at PCF Stage 1: Option Identification which entails the identification of options from the solutions developed in PCF Stage 0 to be taken to public consultation, the assessment of those options in terms of environmental impact, traffic forecasts and economic benefits and the refinement of the cost estimate for the options (including an allowance for risk).

This Environmental Study Report (ESR) has been prepared to help inform the identification / selection process for the proposed options for the M25 Junction 28. It forms part of the requirements of the Project Control Framework (PCF) Stage 1.

1.2 Location of project

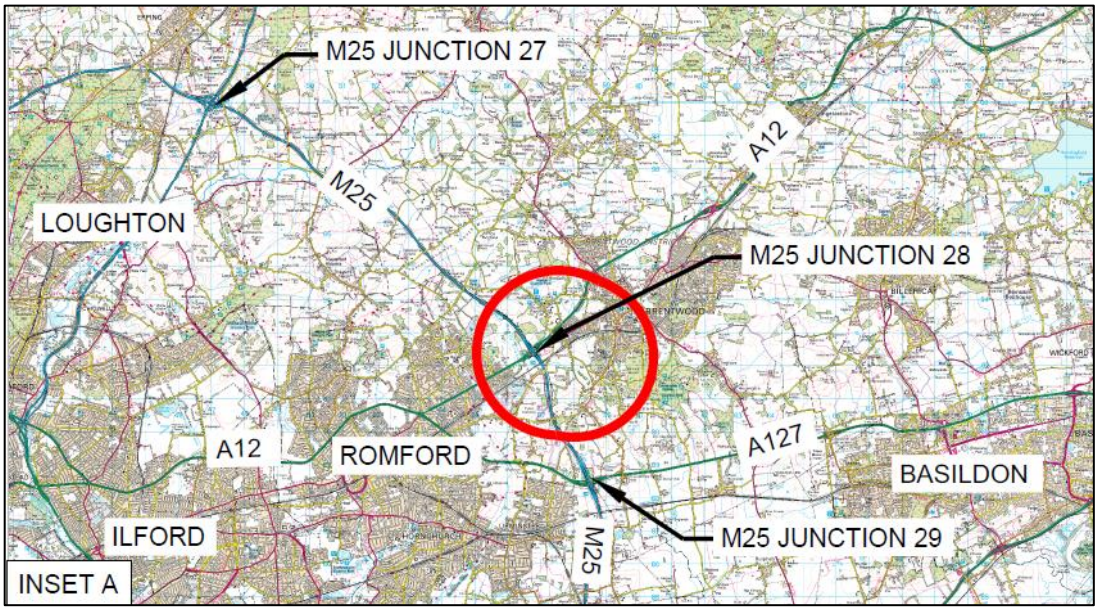
The location of the junction is shown in Figure 1.1 below and in Appendix A. The north-east quadrant of the M25, where Junction 28 is located, is one of the busiest sections of the M25 motorway and often experiences severe congestion. M25 Junction 28 plays a critical role providing access between the M25 and the A12, particularly the A12 towards Essex.

The M25 Junction 28 is located between Brentwood and Romford. To the east of the junction is the London Borough of Havering, with Brentwood Borough Council immediately to the west.

The junction provides the intersection between the M25 motorway, the key trunk route of the A12 and the A1023, providing connectivity between London and Chelmsford, Ipswich and Brentwood and other key destinations across the South East of England.

The junction caters for several dominant movements particularly between the M25 motorway and the A12 towards Essex. One of these, the M25 clockwise to A12 east movement was improved in 2008 with the introduction of a dedicated free flow left turn link. However, the M25 Junction 28 gyratory continues to operate at or over capacity during both AM and PM peak periods. Motorists regularly experience queueing and delays in peak travel periods, particularly on the A12 (east) and M25 (north) approaches, as well as on A1023 Brook Street approach.

Figure 1-1 Scheme Location



1.3 Environmental overview

M25 Junction 28 is within a predominantly rural setting in within designated Green Belt between the edge of the settlement of Brentwood just to the east and Romford further to the west. Brentwood Borough Council have declared two Air Quality Management Areas (AQMAs); for the eastern half of the junction and for the area near Nags Head Lane to the south. London Borough of Havering has declared a borough wide AQMA which covers much of the area to the west. DEFRA has recorded elevated NO_2 concentrations on the A12. There are a number of Noise Important Areas within the area. The traffic levels on the M25 and A12 give rise to noise and air quality problems in the area. Changes to flows brought about by the scheme could affect noise or air pollution levels.

There is a Grade II Listed Building, The Nags Head just to the east of the junction on Brook Street and two Registered Park and Gardens at Warley Place to the south and Weald Park to the north. There are no designations for landscape quality but there are a number of Ancient Woodlands around the junction. There are two Local Nature Reserves (LNR) to the north west of the junction but no national or internally designated ecological sites. The area surrounding the junction is Grade 3 Agricultural Land Classification (ALC) and there is a former landfill site immediately to the north west. Two waterbodies cross the site, the Ingrebourne and the Weald Brook which both have associated fluvial flood plains. These environmental constraints are shown on the environmental constraints drawings in Appendix B.

1.4 Purpose of the environmental study report

As a Major Project for Highways England, this Environmental Study Report (non-statutory) (ESR) forms part of the Project Control Framework's (PCF) Stage1: Options Identification (Options Phase). This report follows on from and is underpinned by the Stage 1: Environmental Study Scoping Report (April 2016).

The ESR has been prepared to provide a broad overview of the environmental constraints on the project, and the relative environmental benefits and potential adverse effects associated with the proposed options. It also identifies likely further

assessment and mitigation requirements. The purpose of this document is to provide decision makers with an accessible document.

The preferred option will be selected during PCF Stage 2, and if the selected option requires a statutory Environmental Impact Assessment (EIA), it will be prepared during PCF Stage 3.

1.5 Scope and Content

This ESR considers the five proposed options (including sub options) that have been identified to date. These are detailed in in Chapter 3, and the proposed scheme option plans are provided in Appendix C. The baseline information has primarily been obtained through desk studies from readily available information sources. Site visits have also been undertaken to obtain some further information. Further monitoring and survey work will be required at a later stage in the design process, in order to close data gaps, and the requirements for this are set out in the topic sections of this ESR. It is anticipated that the recommended further survey information will be incorporated into a revised version of the ESR at PCF Stage 2, once the number of options has been reduced and more detailed information is available on the option designs.

This ESR covers the following Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3 topics:

- Landscape
- Cultural Heritage
- Nature Conservation
- Air Quality
- Noise and Vibration
- Road Drainage and the Water Environment
- Geology and Soils
- Materials and Waste
- People and Communities

1.6 Structure of the environmental study report

Section 2 of the Report describes the background to the current situation at Junction 28 including the current problems experienced leading to the set of scheme objectives.

Section 3 describes the proposed options being considered.

Section 4 describes the alternatives considered.

Sections 6 to 14 considers each of the environmental topics, identifies the baseline conditions, potential effects, scope and level of assessment and presents the assessment of potential effects in the ESR.

Section 15 outlines the cumulative effects of the scheme

Section 16 gives initial details of the Environmental Management Plan

Section 17 provides conclusions and a summary table comparing the options considered in the environmental assessment.

Figures that support the environmental assessments are saved in named appendices and within the text of this report.

2 Background to the Project

2.1 Existing junction characteristics

Junction description

M25 Junction 28 comprises a 3 tier grade separated junction, with the gyratory operating at grade and the main A12 and M25 carriageways run below grade and above grade respectively. The gyratory section comprises a five arm signalised gyratory connecting the M25 and A12, as well as the A1023 Brook Street which gives access to Brentwood. The junction between the gyratory and the A1023 Brook Street is currently uncontrolled, and operates as a priority intersection.

M25 JUNCTION 28 strategic and local function

The north-east quadrant of the M25, where Junction 28 is located, is a very busy section of the M25 motorway network and often experiences severe congestion. Junction 28 plays a critical role providing access between the M25 and the A12, particularly the A12 towards Essex.

In their Route Strategy for the London Orbital and M23 to Gatwick corridors (April 2014) Highways England set out their priorities for the first road period (2015/16 to 2019/20. It identified Junction 28 of the M25 as a key junction with capacity issues as it caters for high levels of demand between the M25 and A12 routes.

Average speeds at peak times on the adjacent M25 links can be as low as 51-60 mph north of Junction 28 and 61-70 mph to the south. The sections of the M25 in this quadrant feature in the top 10 percentile in terms of vehicle hour delay.

The capacity issues at M25 Junction 28 can be attributed to:

- High volumes of traffic on several movements between the M25 (anti-clockwise and clockwise) and the A12 towards Essex, with most of this traffic passing through the gyratory section.
- The relatively high volumes of traffic to and from Brentwood via the A1023 Brook Street which is also accessed from the gyratory via an uncontrolled intersection.
- Limited capacity on the gyratory section due to the high traffic levels and the capacity of the signalised intersections.

Accidents

M25 Junction 28 also experiences a high number of accidents and incidents. While the majority of these accidents involve damage and slight injuries only, in many cases these result in significant disruption to traffic and unreliable journey times. This is compounded with the junction operating at capacity during peak times, and hence limited ability to remain open and available in the event of an accident or incident on the gyratory.

2.2 Current problems

Based on the evidence review undertaken at PCF Stage 0 a number of key problems were identified as below:

- Problem 1 - Congestion and delay on Junction 28 disrupts journeys on the strategic road network and local roads.

- Problem 2 - Actual and significant perceived safety concerns associated with driver movements on the Junction 28 gyratory.
- Problem 3 - Poor resilience to incidents or accidents resulting in significant disruption and unreliable journey times.
- Problem 4 - Air quality issues at the junction where there are two AQMA's designated by the local authorities.

Non-motorised user provisions

Footways exist on the A12 and A1023. On the northern side of the A12, west of the M25 Junction 28 roundabout, a footway provides access to the vicinity of the roundabout and then to the southern side of the A12 via an uncontrolled crossing of the A12 entry slip and exit slip road. This then connects with a shared use path (SUP) to the southern side of the A12 / A1023.

Shared Use Paths (SUPs) exist on the A1023 immediately east of the M25 Junction 28 roundabout junction, through the southern side of the junction via one uncontrolled and one controlled crossing point. This SUP then continues along the southern side of the A12 west of the roundabout towards Harold Wood providing a connection to National Cycle Network Route (NCNR) 136.

A further SUP exists on the northern side of the A12 in the vicinity of Harold Wood but this is discontinuous and does not provide a direct route to the roundabout junction on the northern side of the A12. Therefore, the only direct SUP access to and from the roundabout is currently via the SUP to the southern side of the A12. A grade separated crossing exists in the vicinity of Harold Wood to facilitate crossing movements of the A12.

Route 136 of the NCRN crosses the A12 approximately 1km west of the junction. It is a largely traffic free route connecting the village of Noak Hill and Dagnam Park north of the A12 south to Upminster and the Thames at Rainham via Harold Hill and Hornchurch and passing through parks and green spaces. It can therefore be assumed that local cyclists from Brentwood, Romford and areas in between will likely travel to and from this route and access it from the vicinity of the A12.

2.3 Regulatory framework

National policy

In December 2014 the Government adopted a National Networks National Policy Statement (NN NPS), which 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. The Secretary of State will use the NN NPS as the primary basis for making decisions on development consent applications for national networks NSIPs in England.

The NN NPS states that improvements on the highways network are vital to alleviate congestion, particularly in the South East. Paragraph 2.17 states that:

"It is estimated that around 16% of all travel time in 2010 was spent delayed in traffic, and that congestion has significant economic costs: in 2010 the direct costs of congestion on the Strategic Road Network in England were estimated at £1.9 billion per annum."

The NN NPS indicates that options testing need not be considered by the examining authority or the decision-maker if projects have been subject to full options appraisal in achieving their status within Road or Rail Investment Strategies, or other appropriate

policies or investment plans. For national road and rail schemes, proportionate consideration of alternatives will have been undertaken as part of the investment decision-making process.

The Department for Transport's (DfT's) Command Paper 'Action for Roads' 2013 sets out its vision for the future of the road network and explains that the Government is making a transformational investment in the road network to support the economy and the environment, and to build a network that is fit for the future.

The proposal to address problems at Junction 28 was announced within the RIS (2015-2020) and the scheme is included in the Highways England Delivery Plan 2015 – 2020. The Delivery Plan indicates that Highways England expects to make a recommendation on the preferred route for this scheme in 2017. The proposed construction year is March 2020 with opening year in 2022.

2.4 Strategic objectives

Through the Roads Investment Strategy, provisional funding has been identified for a longer term solution to address congestion issues and safety at Junction 28 of the M25. The following objectives are specified in the draft Option Assessment Report (OAR) (Jan 2015):

- Support the growth planned in the area;
- Reduce congestion, smooth traffic flow and improve journey time reliability;
- Reduce the number of accidents.

2.5 Scheme objectives

The scheme objectives have been defined in line with addressing problems and they align closely with the business strategies for the Highways England, the Local Enterprise Partnership (LEP) and for Local and Central Government – most obviously in terms of the Government's broad goals for transport.

The desired outcomes from each scheme objective have also been considered

- To cater future traffic demands efficiently with minimal delay and to support future development and economic growth.
- Improve journey time reliability.
- Improve journey times.
- Increase vehicular throughput of the junction.
- Support employment and housing development planned for Brentwood, Essex and Havering.
- To improve the network resilience of Junction 28 and enable smoother flow of traffic and reliable journey times.
- Improve road safety on the approaches to and through Junction 28.
- Reduce the severity and rate of accidents and causalities.
- Minimise the impact of high traffic volumes and stopping traffic on local air quality.
- Minimise the detrimental environmental effects of the scheme and offset by mitigation measures where possible and feasible.

- Incorporate improvements such as biodiversity, where these can be identified and support other objectives.
- Reduce (or at least keep to neutral) carbon dioxide emissions and noise levels.

2.6 Highways England Strategic Performance Indicators / Key Performance Indicators

Highways England has published its Delivery Plan, 2015 -2020 and Strategic Business Plan (SBP). It states that:

"Government has made a strong commitment to an ongoing improvement in environmental outcomes through the operation, maintenance and modernisation of the strategic road network. We are committed to ensuring that all activity on the network is delivered in a manner that does not harm the environment; but instead delivers long term benefits to the natural and built environment, creating a sustainable future for all"

Section 6: Improving the Environment, sets out a number of environmental interventions to meet this commitment which are transpired into Performance Indicators (PIs) and Key Performance Indicators (KPIs) to measure how Highways England are delivering better environmental outcomes across the network over the next five years.

An extract from the Delivery Plan Annex B: Key performance indicators and performance indicators is provided below. Where relevant, the M25 Junction 28 scheme will aim to contribute to meeting these PIs and KPIs.

There is an additional relevant KPI for People and Communities.

"The number of new and upgraded crossings is a KPI in The Highways England Delivery Plan (2015-2020)".

The development of new indicators which demonstrate improved facilities for cyclists, walkers, and other vulnerable users is identified as a requirement in the Delivery Plan. The Delivery Plan sets out Highways England's commitments for improving integration and accessibility through the network including a commitment to work with local communities, to listen to local people to identify how to improve the physical or environmental quality of a place, or the economic or social well-being of a community.

Table 2-1 – Highways England Environmental KPIs

Performance Specification				Delivery Plan		
Topic		Measure	KPI target	Highways England Output	Delivery Date	Section number
Delivery better environmental outcomes	KPI	Noise: Number of Noise Important Areas mitigated	At least 1,150 Noise Important Areas over RP1	1,150 Noise Important Areas mitigated	By 31st March 2020	6.1.1
	KPI	Biodiversity: Delivery of improved biodiversity, as set out in the Company's Biodiversity Action Plan	Publish Biodiversity Action Plan by 30 June 2015 & report annually against the Plan to reduce net biodiversity loss on ongoing annual basis	Biodiversity Action Plan (BAP) to include method for demonstrating impact on biodiversity, and subsequent reporting progress against this plan	Publish BAP by 30 June 2015, report progress annually	6.1.4
	PI	Suite of PIs to provide additional information about environmental performance. These should, at a minimum, include: - Air Quality;	N/A	Undertake 10 Air Quality Pilot Studies to test the feasibility of 'Air Quality Intervention Measures'	Complete all 10 studies by 31 March 2018	6.1.2
	PI	Suite of PIs to provide additional information about environmental performance.'- Carbon dioxide, and other greenhouse gas emissions for the Company and its supply chain that occur as they carry out work on the SRN.	N/A	Monitor carbon dioxide equivalents in tonnes associated with the company's activities, and separately activities associated with the supply chain	Report annually	6.1.3
	Requirement	Demonstrate what activities have been undertaken, and how effective they have been, to improve environmental outcomes	N/A	Produce a programme and monitor progress against it	Programme by 31 March 2016, then annually report progress	6.0
	Requirement	Develop metrics covering broader environmental performance. These should include: - a new or improved biodiversity metric	N/A	Produce a programme, collect data to develop biodiversity baseline and monitor against it; by the end of RP1, develop and a biodiversity metric.	Programme by 31 March 2016, annual progress reports, new 'env capital' metric by 31 March 2020	6.1.4
	Requirement	Develop metrics covering broader environmental performance. These should include: - carbon dioxide, and other greenhouse gas emissions arising from the use of the network.	N/A	Produce a programme, collect data to develop baseline and monitor against it; by the end of RP1, develop a network carbon metric.	Programme by 31 March 2016, annual progress reports, new network carbon metric by 31 March 2020	6.1.3

Source: Highways England Delivery Plan, 2015 -2020 and Strategic Business Plan (SBP)

2.7 Environmental impact assessment

On 12 March 2014, the European Parliament voted to adopt substantive amendments to the Environmental Impact Assessment ("EIA") Directive 2011/92/EU. These amendments made by EIA Directive 2014/52/EU will be transposed into UK legislation in 2017 and therefore will be relevant to this Scheme if it is deemed that the EIA Regulations are applicable.

2.8 Construction, operation and long term management

Construction, operational and long term management arrangements are not known at this stage of the project and will be detailed in PCF Stage 2. Any assessment relating to such are based on assumptions and prior experience.

3 Description of Proposed Options

3.1 Overview

Following the scheme review in PCF Stage 0 the following options are being taken forward for further design and assessment during PCF Stage 1. The scheme options drawings are provided in Appendix C.

3.2 Option 2 - Two lane northern loop

This option comprises a two lane with hardshoulder configuration requiring reconfiguration of Nags Head Lane overbridge, Wigley Bush Lane overbridge, footbridge over the A12 & Weald Park Way with proposed structures under railway, over A12 and over M25.

This option requires a proposed diverge south of Nags Head Lane overbridge, which requires the realignment of Nags Head Lane, the demolition of the existing overbridge and the construction of a new bridge and associated embankment. Travelling north the diverge passes under the railway and requires a significant retaining wall between the M25N and the diverge. North of the railway it passes to the west of the existing junction and crosses the A12 and slip roads on a proposed overbridge. The alignment transverses the adjacent land to the northwest of the junction on an embankment before crossing the M25 on another overbridge.

East of the M25 the alignment transitions into cutting before merging into the A12 east of Wigley Bush Lane overbridge. As consequence of the horizontal geometry, the ancient woodland north of the A12 is severed, Wigley Bush Lane overbridge and the footbridge further east will need to be extended. Furthermore Weald Park Way will be realigned to accommodate the merge.

3.3 Option 4 – Two lane compact northern loop

This option comprises a two lane with hardshoulder configuration requiring reconfiguration of Nags Head Lane overbridge, Wigley Bush Lane overbridge & Weald Park Way with proposed structures under railway, parallel to and then over M25.

For this option it is necessary to alter the M25N/circulatory diverge configuration to facilitate the proposed link diverge and to make space for the proposed parallel structure over the existing junction. As a consequence the reconfigured diverge to the circulatory starts south of the Nags Head Lane overbridge, which requires the realignment of Nags Head Lane, the demolition of the existing overbridge and the construction of a new bridge and associated embankment. Travelling north the realigned diverge passes under the railway and requires a significant retaining wall between the M25N and the diverge before joining the circulatory of the roundabout.

The diverge to the proposed link utilises the existing lane-drop configuration from the M25N but follows the vertical profile of the main carriageway. The alignment then passes over the existing roundabout, M25 and associated slip roads north of the roundabout on a multi-span viaduct. East of the M25 the alignment descends before merging into the A12 east of Wigley Bush Lane overbridge. As consequence of the horizontal geometry, the ancient woodland north of the A12 is severed, Wigley Bush Lane overbridge and the footbridge further east will need to be extended. Furthermore Weald Park Way will be realigned to accommodate the merge.

3.4 Option 5A - Single lane cloverleaf, affecting rail bridge

This option comprises a single lane and hardshoulder configuration requiring reconfiguration of Nags Head Lane overbridge with proposed structure under railway.

For this option it is necessary to alter the M25N/circulatory diverge configuration to facilitate the proposed link diverge and to make space for the proposed parallel structure over the existing junction. As a consequence the reconfigured diverge to the circulatory starts south of the Nags Head Lane overbridge, which requires the realignment of Nags Head Lane, the demolition of the existing overbridge and the construction of a new bridge and associated embankment. Travelling north the realigned diverge passes under the railway and requires a significant retaining wall between the M25N and the diverge before joining the circulatory of the roundabout.

The diverge to the proposed link utilises the existing lane-drop configuration from the M25N but follows the vertical profile of the main carriageway crossing the existing roundabout and the circulatory/M25N merge on a parallel structure. The horizontal alignment continues in a loop while the vertical profile starts to decline from the proposed structure on an embankment following the existing topography downhill towards the A12. Due to the compact nature of the proposed link it directly impacts on buildings associated with the skip/recycling centre in this quadrant of the junction.

The proposed link requires the realignment of the existing A12/circulatory diverge to facilitate the joining of the link to the existing A12 before the existing structure supporting the roundabout circulatory. As a consequence the A12/circulatory diverge requires a structure which facilitates the proposed link running under the realigned A12/circulatory diverge.

It is proposed to extend the existing single lane section of the A12 further west, to the proposed A12/circulatory diverge to enable the link to merge without widening the A12E. This in turn avoids the requirement to widen the supporting structure of the circulatory and M25. The A12 single lane section will be developed by a lane drop configuration at the proposed A12/circulatory diverge. Users traveling east on the A12 wanting to utilise the circulatory are in the near-side lane and users wanting to continue east on the A12 are in the offside lane. Between the diverge and the merge the nearside lane will be hatched so that the traffic on the proposed link can merge to the existing A12E near-side lane in a free flow manner without requiring works to the existing structures supporting the circulatory and M25.

3.5 Option 5B - Single lane cloverleaf, widening M25

This option comprises a single lane and hardshoulder configuration requiring the widening of the M25 viaduct.

The option requires a diverge, immediately after the existing nosing of the M25N/circulatory diverge. An initial length of retaining wall and sequential widening of the existing M25 viaduct is required to facilitate the proposed M25N/proposed link diverge. This configuration does not meet Department for Transport standard for the required distance between successive diverges. Once the proposed alignment has passed the diverge nose it begins to turn into the adjacent land, north-east of the existing junction. Following the required widening of the existing structure an adjoining proposed structure is required to support the proposed link over the existing circulatory and then the existing M25N merge. The horizontal alignment continues in a loop while the vertical profile starts to decline from the proposed structure on an embankment following the existing topography downhill towards the A12. Due to the compact nature

of the proposed link it directly impacts on buildings associated with the skip/recycling centre in this quadrant of the junction.

The proposed link requires the realignment of the existing A12/circulatory diverge to facilitate the joining of the link to the existing A12 before the existing structure supporting the roundabout circulatory. As a consequence the A12/circulatory diverge requires a structure which facilitates the proposed link running under the realigned A12/circulatory diverge.

It is proposed to extend the existing single lane section of the A12 further west, to the proposed A12/circulatory diverge to enable the link to merge without widening the A12E. This in turn avoids the requirement to widen the supporting structure of the circulatory and M25. The A12 single lane section will be developed by a lane drop configuration at the proposed A12/circulatory diverge. Users traveling east on the A12 wanting to utilise the circulatory are in the near-side lane and users wanting to continue east on the A12 are in the offside lane. Between the diverge and the merge the nearside lane will be hatched so that the traffic on the proposed link can merge to the existing A12E near-side lane in a free flow manner without requiring works to the existing structures supporting the circulatory and M25.

3.6 Option 5C - Single lane cloverleaf, no works required to M25

This option comprises a single lane and hardshoulder configuration requiring all lane running on M25 viaduct.

The option converts the use of the existing hardshoulder over the M25 viaduct to the proposed deceleration lane and associated diverge configuration. The diverge commences to the north of the existing structure, consequently requiring no works to the existing railway structure and the existing M25 viaduct. Following the diverge nose it begins to turn into the adjacent land, north-east of the existing junction. The existing circulatory/M25N merge will be realigned to pass under the proposed link. The horizontal alignment continues in a loop while the vertical profile starts to decline from the proposed structure on an embankment following the existing topography downhill towards the A12.

The proposed link requires the realignment of the existing A12/circulatory diverge to facilitate the joining of the link to the existing A12 before the existing structure supporting the roundabout circulatory. As a consequence the A12/circulatory diverge requires a structure which facilitates the proposed link running under the realigned A12/circulatory diverge.

It is proposed to extend the existing single lane section of the A12 further west, to the proposed A12/circulatory diverge to enable the link to merge without widening the A12E. This in turn avoids the requirement to widen the supporting structure of the circulatory and M25. The A12 single lane section will be developed by a lane drop configuration at the proposed A12/circulatory diverge. Users traveling east on the A12 wanting to utilise the circulatory are in the near-side lane and users wanting to continue east on the A12 are in the offside lane. Between the diverge and the merge the nearside lane will be hatched so that the traffic on the proposed link can merge to the existing A12E near-side lane in a free flow manner without requiring works to the existing structures supporting the circulatory and M25.

3.7 Option 5D - Two lane cloverleaf with structure over the M25

This option comprises a two lane and hardshoulder configuration requiring proposed structure over M25 and dedicated M25S/A12 link for merge rationalisation.

The diverge commences to the north of the existing M25 viaduct, with the widening of the M25N carriageway. The hardshoulder over the existing viaduct between the two successive diverges will be discontinued to avoid potential ambiguity. Following the diverge nose the proposed link begins to turn into the adjacent land, north-east of the existing junction. The existing circulatory/M25N merge will be realigned to pass under the proposed link. The horizontal alignment continues in a loop while the vertical profile starts to rise before passing over the M25 and associated slip roads. East of the M25 the alignment is on embankment which reduces in height to merge to the A12 east of Wigley Bush Lane overbridge.

To standardise the merge configuration to the A12 east of the M25 a proposed dedicated slip will be constructed joining the M25S to the proposed link road before merging to the A12. In addition the existing dedicated lane from M25S bypassing the circulatory to A12 east will be closed and the exit from the circulatory will be reduced to one lane. To facilitate the merge to A12 east it will be necessary to extend Wigley Bush Lane overbridge.

3.8 Option 5E - Two lane cloverleaf with structure under M25.

This option comprises a two lane and hardshoulder configuration requiring proposed structure under M25 and dedicated M25S/A12 link for merge rationalisation.

The diverge commences to the north of the existing M25 viaduct, with the widening of the M25N carriageway. The hardshoulder over the existing viaduct between the two successive diverges will be discontinued to avoid potential ambiguity. Following the diverge nose the proposed link begins to turn into the adjacent land, north-east of the existing junction. The existing circulatory/M25N merge will be realigned to pass under the proposed link. The horizontal alignment continues in a loop while the vertical profile starts to drop before passing under the M25 and associated slip roads. Furthermore the M25S/circulatory diverge will be realigned to enable the proposed link to pass under it. East of the M25 the alignment is in cutting before rising up to merge to the A12 east of Wigley Bush Lane overbridge.

To standardise the merge configuration to the A12 east of the M25 a proposed dedicated slip will be constructed joining the M25S to the proposed link road before merging to the A12. In addition the existing dedicated lane from M25S bypassing the circulatory to A12 east will be closed and the exit from the circulatory will be reduced to one lane. To facilitate the merge to A12 east it will be necessary to extend Wigley Bush Lane overbridge.

3.9 Option 5F – Two lane cloverleaf

This is a variant of Option 5C comprising two lane cloverleaf, no works required to M25 but reconfiguration of A12 required to accommodate 2 lane cloverleaf merge. The assessment findings in this ESR for Option 5C are the same as for 5F and not repeated in the ESR.

3.10 Option 6 – Two lane southern link

This option comprises a two lane with hardshoulder configuration including various multi-span viaducts' and reconfiguration of Weald Park Way.

This option requires a proposed diverge south of Nags Head Lane overbridge, before climbing over Nags Head Lane, M25 and the existing railway on a multi-span viaduct. To the south-east of the existing junction the alignment is on a short length of embankment before crossing over Brook Street, Brentwood Garden Centre, the A12

and Wigley Bush Lane overbridge on another multi-span viaduct before merging to the A12. As consequence it will be necessary to realign Weald Park Way and the existing footbridge further east will need to be extended.

4 Alternatives Considered

4.1 Option development

PCF Stage 0 was completed in September 2015 which confirmed and prioritised the problems associated with Junction 28 by reviewing available evidence, and examining the suitability and viability of a range of alternative solutions to address these. In doing so it also confirmed and scoped an appropriate improvement scheme for addressing the problems and achieving Highways England's strategic outcomes and KPIs. Stage 0 culminated with the identification of a number of alternative options for Junction 28 to be considered further in PCF Stage 1.

The approach adopted in PCF Stage 0 to develop and assess strategic options and scheme options comprises several key steps including *Identification and assessment of high level Strategic Options* and *Initial development and assessment of Project Options.*

Identification and assessment of high level Strategic Options – a range of strategic options were identified which could potentially be considered to address the key problems at Junction 28. These strategic options give high level consideration to a range of alternatives dealing with supply and demand, and include options for different modes as appropriate (e.g. including a Do-maximum highway option, local access and demand management, enhanced public transport and reviewing the SRN classification). Based on this assessment a strategic option focussing on localised highway improvements at Junction 28 was confirmed as the preferred solution. The key factors in selecting this strategic option include:

- The highway proposal is strongly aligned to addressing the local problems identified for Junction 28
- It can be delivered within the RIS1 period
- The timescales for other options would extend beyond RIS1
- While the Do-maximum junction improvements would perform strongly in terms of impacts against addressing the problems, it will not address short term problems and the cost would significantly exceed the RIS1 budget
- Based on the foregoing, it was also considered that a highway improvement option offered good flexibility and scalability, in that it could be designed to allow incremental improvements to the junction in the future, thus forming the basis of a Do-maximum as and when required.

Initial development and assessment of Project Options – based on the preferred Strategic Option a range of detailed project options were identified as concepts. Seven project options were identified:

- A hamburger through-about
- A northern loop
- A compact northern loop
- A satellite roundabout
- A single cloverleaf
- A southern link
- A Do-maximum (for example a double cloverleaf).

These options were assessed based on the expected impacts of achieving the identified transport objectives, indicative cost ranges, and key issues and risks relating to scheme delivery. This assessment was aligned with the principles of the Department for Transport's (DfT's) Early Assessment Sifting Tool (EAST) approach. In this way the key elements of the five case business case model were included in the assessment as appropriate at this early stage (Strategy, Economy, Managerial, Financial and Commercial) and enabled the assessment to consider deliverability issues.

The key findings of this initial assessment of the scheme options are summarised in Table 4.1.

Table 4-1 PCF Stage 0 initial assessment and short listing of scheme options

Scheme Option	Hamburger Through-about	Northern Loop	Satellite Roundabout	Compact Northern Loop	Single Cloverleaf	Southern Link (Announced RIS1Scheme)	Do Maximum – Options
A) Impact on problems (Impact scores from 0 – neutral, 1 Very low to 5 Very high)							
Congestion and delay on the Junction 28 disrupts journeys on the strategic road network and local roads	1	3	1	3	3	3	5
Actual and significant perceived safety concerns associated with driver movements on the Junction 28 gyratory	3	4	2	3	4	4	4+
Resilience to incidents or accidents is poor, resulting in significant disruption and unreliable journey times	1	3	2	3	3	3	4-5
Air quality is an issue at the junction, with Air Quality Management areas immediately adjacent	0	3	0	3	3	3	4-5
Overall impact against problems	1	3	1	3	3+	3+	4
B) Timescales (years)	3	5+	3-5	5	3-5	5-10	5-7
C) Indicative cost range (£ million)	20-30	60-100	10-20	50-70	50-70	100-150	150-250
D) DCO Issues?	No	Yes	Maybe	Yes	Yes	Yes	Yes
E) Deliverability issues and risks (■ = Low risk, ■ = Medium risk, ■ = High risk)							
Scale of investment (affordability)							
Cost exceeds RIS1 budget						■	■
Funding availability		■					■
Maintenance - access & increased costs	■	■	■	■	■	■	■
Impacts Area 6 maintenance activities/costs			■				
Statutory undertakings – location and cost	■	■	■	■	■	■	■
Practical feasibility / deliverability							

Scheme Option	Hamburger Through-about	Northern Loop	Satellite Roundabout	Compact Northern Loop	Single Cloverleaf	Southern Link (Announced RIS1Scheme)	Do Maximum – Options
A) Impact on problems (Impact scores from 0 – neutral, 1 Very low to 5 Very high)							
Overall technical feasibility		■		■	■	■	■
Disruption to local & SRN traffic during construction	■	■	■	■	■	■	■
Ambiguity to A12 through traffic over which roundabout to use			■				
Public / stakeholder acceptability							
Reputation – not being seen to fixing the problems fully	■	■	■	■	■	■	■
Reputation – scheme benefits SRN users at expense to local communities						■	
Acceptance by LAs/LEP	■		■			■	■
Implementation timescales							
Timescales extend beyond RIS1 period		■				■	
Timing with A12 improvements to east		■	■	■	■	■	■
Network Rail issues and protracted process		■	■	■	■	■	■
Legal / planning issues							
Land take required		■	■	■	■	■	■
Environmental issues – ancient woodland; visual intrusion; landfill site; ecology impacts		■	■	■	■	■	■
Potentially impacts on a listed building (farm)						■	
E) Initial Rank as RIS1 scheme		=2		=2	1	4	

Based on this initial assessment, the single cloverleaf option was highlighted as the best performing option. The key factors drawn out from the assessments include:

- The single cloverleaf option best addresses the local problems at Junction 28.
- It was considered that the single cloverleaf option could be implemented within the RIS1 timescale
- While the Do-maximum double cloverleaf option offers a better solution for addressing the problems, it would extend beyond the RIS1 timescale and the cost would exceed the RIS1 budget
- The single cloverleaf option offers flexibility and scalability, and importantly could form the first phase of a longer term scheme similar to the Do-maximum
- The single cloverleaf option also presents fewer delivery risks and issues; those that exist are considered to be largely manageable through the design and implementation phases

- The alignment for the single cloverleaf is both technically feasible and minimises issues/risks relating to land-take, disruption to local communities, acceptance by the public and local authorities, network rail issues and processes, and environmental impacts.

Based on the assessment, the hamburger through-about and the satellite roundabout options were discarded and not taken forward to Stage 1. The assessment indicated that the hamburger through-about option would have very little effect on achieving the project objectives, and that any noticeable improvements would only be short term. Also it was felt that there would be severe disruption to local and strategic traffic during the construction of this option. Similarly, it was considered that the satellite roundabout option would have little effect on meeting the objectives; in particular, the improvements would be at the expense of the free movement of traffic on the A12.

Based on the option assessment the following options were recommended to be taken forward for further consideration under PCF Stage 1:

- Northern loop
- Compact northern loop
- Single cloverleaf
- Southern link.

Full details of the Stage 0 findings are set out in the PCF Stage 0 Final Report (September 2015).

5 Environmental Assessment Methodology

5.1 General approach

This section sets out the approach taken to the ESR. Although there are methods and requirements specific to each assessment topic, the approach set out below is common to all topics and is in accordance with relevant guidance and best practice.

The ESR follows the assessment approach in the DMRB Volume 11 (Highways Agency, 2009). Sections 1 and 2 of DMRB Volume 11 were updated in August 2009 to describe the approach to Scoping, Simple and Detailed Environmental Assessment. Section 3 of DMRB Volume 11 provides guidance on topic specific assessment. Guidance on four topics (Air Quality, Cultural Heritage, Noise and Vibration, and Road Drainage and the Water Environment) in Volume 11, Section 3 has been updated. In addition, Interim Advice Notes (IANs) have been produced providing guidance on the assessment of Landscape and Visual Effects, Ecology and Nature Conservation and Materials. This guidance was followed in the assessment of the relevant environmental topics in the ESR.

The environmental topic headings described in Section 3 of Volume 11 of the DMRB were amended most recently in 2015 by IAN 125/15 (Table 5-1). Highways England has not yet issued environmental topic advice notes to reflect all the new topic headings. For those topics that have not been updated, DMRB guidance as published in Section 3 will be used as relevant. Where this is no longer considered appropriate, the methodology has been set out in the topic chapter.

Table 5-1 Comparison of environmental topics between the revised version of the DMRB Volume 11 (October 2015), Section 3 and the previous version

PREVIOUS ENVIRONMENTAL TOPIC HEADING	REVISED ENVIRONMENTAL TOPIC HEADING (OCTOBER 2015)	CHANGES TO THE CONTENT OF EACH TOPIC AT THE TIME OF WRITING
Air Quality	Air Quality	Individual Policies and Plans and Disruption due to Construction sections required as part of each topic.
Cultural Heritage	Cultural Heritage	
Landscape Effects	Landscape	
Ecology and Nature Conservation	Nature Conservation	
Geology and Soils	Geology and Soils	
	Materials (to include waste)	
Noise and Vibration	Noise and Vibration	
Vehicle Travellers	People and Communities	Vehicle travellers, Pedestrians, Cyclists, Equestrians, Land Use and Community Effects assessments have been merged to become “People and Communities”. Individual Policies and Plans and Disruption due to Construction sections required.
Pedestrians, Cyclists, Equestrians and Community Effects		
Land Use		

PREVIOUS ENVIRONMENTAL TOPIC HEADING	REVISED ENVIRONMENTAL TOPIC HEADING (OCTOBER 2015)	CHANGES TO THE CONTENT OF EACH TOPIC AT THE TIME OF WRITING
Road Drainage and the Water Environment	Road Drainage and the Water Environment	Individual Policies and Plans and Disruption due to Construction sections required as part of each topic
Policies and Plans	N/A	To be included in every topic.
Disruption due to Construction	N/A	To be included in every topic.

5.2 Scoping

A scoping exercise was undertaken as part of PCF Stage1 to determine the level of assessment that was appropriate at this early stage in the design process, and consider whether any topics could be scoped out in accordance with DMRB. This ESR has been undertaken to support early design work and therefore all topics have been scoped into this assessment at PCF Stage 1. The findings of this assessment will therefore be used to scope out topics at a future assessment stage at PCF Stage 2. This is discussed further within Chapter 17 Conclusions of this ESR.

The level of assessment and proposed approach for each topic is summarised in Table 5-2.

Table 5-2 Findings from Scoping Exercise

Topic	Proposed level of assessment	Comments	Summary of proposed methodology
Cultural Heritage	Simple	A simple assessment to determine whether the proposed scheme options would be likely to be granted Scheduled Monument Consent (SMC) given the anticipated significant effects on scheduled sites.	The Simple Assessment will follow the guidelines set out in DMRB Volume 11, Section 3, Chapter 5, and Annex 5 and 6 in relation to archaeological remains and built heritage, respectively.
Landscape character	Simple	Effects on character at local level only	Assessment in accordance with IAN135/10 and reference to GLVIA 3
Visual impact	Simple	Visual effects constrained by woodland	Assessment in accordance with IAN135/10 and reference to GLVIA 3
Water quality and drainage	Simple	A site walkover is proposed for the ESR, no water quality tests to be undertaken at this stage.	The assessment will be based on guidance contained in the DMRB Volume 11, Section 3, Part 10 HD45/09 - Road Drainage and the Water Environment (November 2009).
Noise – construction	Qualitative	As baseline noise monitoring will be undertaken at a future design stage, a full construction noise assessment using BS5228-1:2009+A1:2014 will be	The assessment at this design phase will be qualitative.

Topic	Proposed level of assessment	Comments	Summary of proposed methodology
		deferred until baseline noise monitoring data is available.	
Noise - operation	Proportionate / basic	The assessment will not provide detailed noise level predictions required for a WebTAG assessment or to meet the requirements of a 'Simple' or 'Detailed' level assessment described in DMRB. Noise level predictions at individual noise sensitive receptors will be deferred to a future design stage. A basic quantitative noise assessment will be undertaken to identify areas that may exceed DMRB's threshold levels and trigger the need for a detailed assessment in a future design stage.	To provide a proportionate level of assessment for PCF Stage 1, an operational noise assessment will be undertaken generally in line with the guidance in DMRB 11:3:7.
Air quality - construction	Simple	A simple assessment approach will be undertaken for the air quality assessment at PCF Stage 1 using a proportionate risk assessment approach	Construction impacts will be assessed qualitatively in accordance with relevant guidance given in DMRB HA207/07.
Air quality - operation	Simple	A simple assessment approach will be undertaken for the air quality assessment at PCF Stage 1 using a proportionate risk assessment approach. Limitations in the availability of traffic data preclude completion of any quantitative assessment of potential air quality effects associated with each option.	Further air quality assessment will be undertaken in accordance with HA207/07 DMRB Volume 11, Section 3, Part 1, IAN 170/12 v3, IAN 174/13, IAN 175/13, and Defra's Local Air Quality Management Technical Guidance (LAQM.TG (09)), where appropriate.
Nature conservation: Designated sites	Simple	Potential for significant effects.	Breeding bird survey and consultation with Natural England.
Nature conservation: Notable habitats and protected species	Simple	Potential for significant effects.	A targeted Extended Phase 1 Habitat survey will inform the scope for further habitat and protected species survey work. Habitats with greater botanical interest will be subject to NVC surveys. A search for evidence of invasive species subject to legal control will also be

Topic	Proposed level of assessment	Comments	Summary of proposed methodology
			undertaken to inform plans for site clearance. Field surveys will be carried out for legally protected species where there is potential that a licence could be required and/ or the presence of a species could have a substantial effect on the design, planning or programming of site works. An ecological assessment will be undertaken to determine the value of receptors, characterise potential impacts and determine the significance of effects that may arise from the construction and operation phases of the M25 Junction 28 Improvements.
Geology, Soils and Materials	Simple	No comment	In accordance with DMRB Volume 11, Section 3, Chapter 11
People and Communities	Simple	No significant effects are considered likely so simple assessment level selected.	The assessment will use published guidance provided in DMRB Volume 11 – combining the NMU component of DMRB 11.3.8 - Pedestrians, Cyclists, Equestrians and Community Effects, and DMRB 11.3.9 - Vehicle Travellers, DMRB 11.3.6 for Land Use (DMRB 11.3.6) and the Community Effects component of DMRB 11.3.8 (Pedestrians, Cyclists, Equestrians and Community Effects) as set out in IAN 125/15.

5.3 Value / sensitivity, magnitude and significance criteria

The assessment will identify the potential impacts that might occur due to the construction and operation of the M25 Junction 28 scheme. Impacts may be adverse/negative or beneficial/positive, direct, indirect, secondary or cumulative, temporary or permanent, short, medium or long term. The proposed scheme options can affect the environment in a variety of ways. The differing parts of the environment affected by a proposed scheme option are known as receptors (i.e. those things that receive an impact from a scheme). Receptors can range from individual plants, animals or human beings living in or passing through the area, through to the landscape as a whole and the physical, ecological and cultural elements within it.

Chapter 2 of DMRB Volume 11 Section 2 Part 5 introduces the general principle underlying the assessment process, which can be summarised generally, although not necessarily for every topic, as a three-step process:

- the evaluation of the value, importance or sensitivity of the receptors;
- assessment of the magnitude of the impact of the scheme on the receptor, be it adverse or beneficial; and
- determination of the significance of the effect resulting from combining the impact (of a certain magnitude) on a receptor (of a particular value).

Significance criteria are set out for each assessment topic following this three step approach. Table 5-3 sets out an assessment matrix to determine the value or sensitivity of receptor and the magnitude of impact to determine the significance of effect. Moderate and major effects are considered 'significant' for the purposes of EIA regulations and might indicate the need for a statutory Environmental Impact Assessment Report (EIAR) later in the project lifecycle.

Table 5-3 Arriving at the Significance of Effects

		MAGNITUDE OF IMPACT (DEGREE OF CHANGE)				
		No change	Negligible	Minor	Moderate	Major
ENVIRONMENTAL VALUE (SENSITIVITY)	Very High	Neutral	Slight	Moderate or Large	Large or Very Large	Very Large
	High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very Large
	Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
	Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
	Negligible	Neutral	Neutral	Neutral or Slight	Neutral or Slight	Slight

5.4 Mitigation design, enhancement and monitoring measures

Mitigation is defined as 'measures intended to avoid, reduce and, where possible, remedy significant adverse environmental effects' (DMRB Volume 11, Section 1, Part 7 (HA 218/08)). Enhancement measures are defined as 'measures over and above normal mitigation' (IAN 125/15).

Some initial mitigation and enhancement measures have been identified in the topic chapters. However, further measures will be considered at a later stage in the design process, once further design information is available. As the project develops, the mitigation and enhancement will be developed in consideration of all topic requirements.

Prior to construction, a Construction Environmental Management Plan (CEMP) would be compiled to provide guidance on specific areas during the construction process. This would detail both generic and specifically targeted instructions to enable construction to be undertaken with minimal impact on the environment.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

6 Landscape

6.1 Introduction

This chapter describes and evaluates the existing landscape resource and visual receptors in the vicinity of the proposed options for M25 JUNCTION 28. It identifies the likelihood of potential significant effects on high sensitivity landscape and visual receptors associated with each of the proposed options described in Chapter 3 of this ESR. At this stage the assessment is based on 2D design for all options. The findings of the assessment are intended to inform the selection of options and whether appropriate design and mitigation can reduce significant landscape and visual impacts.

6.2 Assessment methodology

The assessment of landscape and visual effects was preceded by a review of baseline information to inform the landscape and visual context. This included analysis of the planning framework as applied to this project, and desktop data gathering including information on statutory designations from the DEFRA website magic.defra.gov.uk and relevant local planning authority documents.

The Guidelines for Landscape and Visual Impact Assessment 3rd edition (GLVIA) state that:

"LVIA must address both effects on landscape as a resource in its own right and effects on views and visual amenity...An assessment of landscape effects should consider how the proposal will affect the elements that make up the landscape, its aesthetic and perceptual aspects, its distinctive character and the key characteristics that contribute to this....An assessment of visual effects deals with the effects of change and development on the views available to the people and their visual amenity."

The Simple Assessment approach has been informed by the Interim Advice Note 135/10 Landscape and Visual Effects Assessment that replaced existing guidance in DMRB Volume 11 Section 3 Part 5 Landscape Effects. The Third Edition of Guidelines for Landscape and Visual Impact Assessment published by Landscape Institute and Institute of Environmental Management & Assessment, 2013 was also used to guide the assessment process. The assessment has been informed by desk study information and initial site visits. The approach has also been informed by the Guidelines for Landscape and Visual Impact Assessment, Third Edition, Landscape Institute and Institute of Environmental Management & Assessment, 2013 (GLVIA3).

A desktop study was undertaken to identify landscape and visual receptors. This included a review of aerial imagery, OS maps and other public sources of information to define the potential study area and establish a range of possible landscape and visual effects. An initial site visit was undertaken (27 and 28/04/2016) to gain an understanding of the context and potential inter-visibility of features.

A preliminary desk study and site analysis of the physical landscape (e.g. landform, vegetation) and spatial components (e.g. scale, key views) was undertaken to identify key landscape characteristics and features, key visual receptors, site constraints and opportunities to be considered in the selection of the proposed options.

Preliminary baseline information was based on a combination of field survey and desk study, which was obtained from:

- Published landscape character assessment at local level prepared jointly for the Braintree District Council, Brentwood Borough Council, Chelmsford Borough Council, Maldon District Council and Uttlesford District Council, produced by Chris Blandford Associates (2006);
- 1:25,000 Ordnance Survey Explorer maps;
- Government and local authority planning documents;
- Google Earth Pro; and
- National, county and local landscape designations.

The approach to the assessment is outlined below, the full methodology and associated criteria are provided in Appendix D.

Landscape sensitivity

The sensitivity of landscape resources/receptors combines judgements of their susceptibility to the type of change or development proposed with the value attached to the landscape, (as per GLVIA3).

The GLVIA notes that:

"The determination of the sensitivity of the landscape resource is based upon an evaluation of each key element or characteristic of the landscape likely to be affected. The evaluation will reflect such factors as its quality, value, contribution to landscape character, and the degree to which the particular element or characteristic can be replaced or substituted"

Visual sensitivity

Visual receptors are the people who live in or visit the landscape, and who will experience views of the proposed scheme options.

The sensitivity of the visual receptors (people) combines judgements of their susceptibility to the type of change in views and visual amenity with the value attached to particular views (as per GLVIA3).

The following five groups of people are considered to be visual receptors:

- Local communities (e.g. villages and settlements) and isolated residential properties.
- People in their places of work.
- People using nationally designated or regionally promoted footpaths, cycle routes, bridleways, the local rights of way network and areas of open access land.
- Visitors at publicly accessible sites including for example registered park and gardens, historic sites, and other visitor attractions.
- Road users.

Magnitude of landscape impact

The magnitude of landscape impact is determined by taking into consideration size, scale, geographical extent, duration and reversibility of the improvement's works on the landscape resource.

Magnitude of visual impact

The magnitude of visual impact, whether adverse or beneficial, has been assessed taking into consideration the changes in the composition of the view in comparison to the baseline view. In determining the magnitude of visual impact, the following has been considered; scale of change, nature of change, duration of change, distance, screening, direction of the view, removal of vegetation, whether the receptor is static or moving, and the numbers and type of receptor. The likely environmental design measures or mitigation measures have also been considered in assessing the magnitude of impact.

Significance of effects

The significance of landscape or visual effects has been determined by taking into consideration both the magnitude and sensitivity of landscape resource or visual receptors. The effects can be both adverse, neutral and beneficial. The assessment is determined using professional judgement, which relies on a consistent reasoning based on the current guidance including IAN 135/10 and GLVIA3.

Landscape or visual effect are considered as significant when moderate or higher level adverse effects have been identified.

6.3 Study area

Landscape and visual effects have been considered within the area from which the proposed options would be visible, i.e. the Zone of Visual Influence (ZVI). The desk top study informed the extent of the study area for both landscape and visual effects. It is expected that potentially significant effects may occur within 1.5km radius from the centre of the junction or within 1000m buffer both side of the proposed scheme options. Any effects beyond that considered area are unlikely to be significant and are not considered further in this report.

6.4 Baseline conditions

Landscape

The identification of landscape receptors was preceded by analysis of the existing landscape character and identification of elements and features of landscape character that may be affected. Key characteristics and values attached to landscape and landscape designations, along with identification of interactions with the proposed scheme options were also considered to inform identification of receptors.

The proposed scheme options are located between Brentwood and Romford to the north east of London and are centred on the M25 Junction 28. With the exception of Vicarage Wood Ancient and Semi-Natural Woodland, there are no designated landscapes that could potentially be directly and indirectly affected by the proposed scheme options.

Landscape character

This area is located within National Character Area Profile (NCAP) No.111 Northern Thames Basin. Due to the nature and scale of the proposals an assessment against the NCAP will not be undertaken and this report will focus on local landscape character which is described below.

The proposed scheme options are located at the border of Brentwood Borough Council and Havering London Borough Council.

The landscape character of Brentwood Borough Council is described in Braintree, Brentwood, Chelmsford, Maldon and Uttlesford Landscape Character Assessments prepared by Chris Blandford Associates in September 2006. Majority of the landscape surrounding M25 Junction 28 is located within Wooded Farmland Landscape Character Type. This includes areas to the south, east and north east of the junction. This landscape type is subdivided into two landscape character areas, F13 Great Warley Wooded Farmland Landscape Character Area located to the south and south east and F15 Weald Wooded Farmlands to the north east of the M25 Junction 28.

There are no published landscape character assessments within Havering London Borough Council. Therefore a brief description of key characteristic and attributes of the landscape within the London Borough of Havering has been presented in the table below. The extent of this characteristic is restricted to the study area. The key attributes of landscape character surrounding M25 Junction 28 are presented in the Table 6.1.

Table 6-1 Summary of relevant attributes of relevant landscape character areas

Key characteristics of relevant landscape character areas		
Brentwood Borough Council		Havering London Borough Council
F13 Great Warley Wooded Farmland	F15 Weald Wooded Farmlands	Urban character of Havering
•Strongly undulating wooded farmland/wooded hills; •Extensive patches of woodland; •Small-scale field pattern with mature treed field boundaries; • Small-scale settlement pattern comprising small historic farmsteads and hamlets; • Narrow, quiet sinuous rural lanes; • Noise and movement associated with the M25 and A127 road corridors; and • Strong sense of place and orientation provided by views across Thames Chase to the west towards London and North Kent.	• Swathe of relatively open commons; • Wooded rolling hills and slopes; • Narrow, tree-lined roads; • Intricate network of woodland and grassland within Weald Country Park; and • Sense of tranquillity away from main road corridors.	• Raised landform of Maylands Golf Course to the west of Weald Brook; • Presence of sports club and Dagnam Park as well as Mayland Golf Course create recreational character of urban fringe; • Large woodland blocks are present between the M25 and residential edge of Havering Borough Council; • Proximity of the M25 and the A12 results in noise intrusion; • The M25 creates natural boundary for the urban character of Havering. • Predominantly inter war semi-detached and terraced houses; and • Materials: red brick, pebbledash, white render to walls.

The M25 Junction 28 is partially surrounded by belts of woodland. The majority of the inner perimeter of the Junction 28 roundabout is filled with the existing mature woodland with some scrub vegetation present close to its verge. Woodland belts are largely present along the on and off slip roads as well as along the A12. Worth noting

is that although belt of trees dominate, some longer gaps occur where instead a belt of tree there would be a hedgerow or hedgerow with trees.

Designations

Ancient and semi natural woodland

It is expected that sections of woodland would be lost from Lower Vicarage Wood (designated as Ancient and semi-natural woodland). The location of ancient woodland has been shown on the Environmental Constraints Plan in Figure B and Figures 8.1 in Appendix F. The importance of ancient woodlands as an irreplaceable habitat is set out in paragraph 118 of the NPPF, which states: 'planning permission should be refused for development resulting in the loss or deterioration of irreplaceable habitats, including ancient woodland and the loss of aged or veteran trees found outside ancient woodland, unless the need for, and benefits of, the development in that location clearly outweigh the loss.'

Green Belt

The majority of proposed scheme options run through the Green Belt area, which is defined by the Brentwood Replacement Local Plan. The area designated as a Greenbelt is shown on Figure 6.1 in Appendix D.

Visual

The main receptors in this area include some of the residential properties at the edges of Romford and Brentwood as well as isolated properties and some sections of the Public Rights of Way (PRoW's). Most of the identified receptors will be of high sensitivity. There are a number of woodlands adjacent to Junction 28 and along the road corridors that fully or partially screen views of the junction.

The key views have been identified below:

Receptor 1: Views from open access land including Tyler's Common to the south of Tyler's Hall Farm and open access land near Harold Court.

The elevated views are likely to allow for a large scale panoramic views and encompass Weald Brook Valley with the A12 road. Majority of views from these locations are likely to encompass grazed fields with the network of hedgerows and trees as well as woodland blocks that dominate the view which is flanked by residential areas around Harold Hill and Brentwood.

Receptor 2: Views of employees within business parks adjacent to Brook Street near Junction 28 (group receptor).

The employees of the business parks adjacent to Brook Street will have partial views towards surrounding landscape and views will include the M25 and Junction 28, the A12 and views of primarily grazed fields with hedgerows, woodland blocks located on elevated slopes of the South Weald, Tylers Common and Harold Hill. Partial views are likely to be available towards nearby railway line to the south and residential areas at the western edge of Brentwood.

Receptor 3: Views from residential receptors located to the north of the M25 in South Weald (group receptor) including Lake House, Colmar Farm, Colmar, Park Farm and Halfway House.

Most of the views from houses will be restricted to close views due the presence of trees within gardens as these will be blocked partially or screened by woodland belts and woodland blocks including The Oaks, Vicarage Wood, Lower Vicarage Wood, Weald Park and other smaller copses. Partial views into surrounding landscape are likely to be available from the upper storeys of few residential receptors.

Receptor 4: Views from residential receptors located on Nag's Head Lane linking Brook Street area with Tyler's Common to the south of the M25 Junction 28.

Views from residential receptors along Nag's Head Lane are largely screened by garden vegetation including trees and vegetation along Great Eastern Mainline (GMEL). It is likely that partial views into adjacent landscape to the north will be available from the upper storeys of some properties and these are likely to include views of Weald Valley.

Receptor 5: Views from residential receptors located along Dark Lane.

Views from residential receptors along Dark Lane are screened largely by belt of trees along the railway line, and within the network of grazed fields around Boyles Court as well as by rapid undulation of adjacent terrain. It is expected that partial views will be available from the upper storeys of some houses along Dark Lane.

Receptor 6: Views from bridleway that follows Nag's Head Lane and along bridleway section that follows the crest of the cutting along the existing M25, close to Dark Lane.

The views available from Nag's Head Lane are screened completely by a hedgerow with trees along the road for users of the bridleway. More open views are likely to be available to the users of the bridleway section along the crest of the cutting associated with the M25. Whilst close and middle distance views are available the availability of longer views is restricted by field boundary vegetation including belts of trees and blocks of trees within the field network as well as vegetation along the railway line.

Receptor 7: Views from residential receptor Grove Farm near Junction 28.

The views from Grove Farm are restricted by garden vegetation and the Grove woodland. Views, if not blocked completely will be partially screened by road infrastructure associated with the M25 Junction 28 and raising landform in the surrounding landscape.

Receptor 8: Views from Maylands Golf Course, located to the north west of the Junction 28.

The views from the Maylands Golf Course are largely blocked by presence of tree belts within the Golf Course. Where open views are available, long views towards adjacent landscape will be available. They are likely to encompass valley of Weald Brook, South Weald, Tylers Common and Great Warley.

Receptor 9: Views from Maylands Cottages and Harold Park to the west of Junction 28.

The views from the Harold Park are blocked by overlapping built form consisting of houses as well as existing woodland near Oak Farm and vegetation along the A12. Views are partially screened by garden vegetation around Maylands Cottages, however longer views with wide panoramic views to the west are available from the upper storeys of the house.

Receptor 10: Views from Putwell Bridge Farm and Oak Farm.

Views from Oak Farm are blocked completely by a belt of vegetation along Ingrebourne River adjacent to the farm. Close views of the M25 Junction 28 are available from the Putwell Bridge Farm. These views are also likely to include mosaic of fields to the south, and partial views of elevated landscape further to the south including Tylers Common, South Weald and Harrold Hill.

This chapter is accompanied by Figures 6.1 and 6.2 in Appendix D illustrating key landscape features, location of visual receptors and relevant landscape character areas.

6.5 Regulatory/Policy Framework

European Union and national legislation and policies

Key relevant legislation for the Scheme includes The Town and Country Planning Act 1990, Countryside and Rights of Way Act 2000, and the Planning Act 2008, 'Part 7 – Orders granting development consent', including Public Rights of Way (PRoW) and Green Belt, as well as 'Schedule 8 – Tree Preservation Orders: further amendments'. Legislation of specific relevance to this chapter is outlined below.

The European Landscape Convention (ELC) sets out an internationally agreed definition of landscape and key actions that countries should follow. The ELC provides an integrated, holistic approach and international context for landscape, under the headline banner that "All Landscapes Matter". The convention is a treaty between states (not an EU Directive) and seeks to influence governments' decisions rather than direct them. It was signed by the UK government in 2006, and came into effect in March 2007.

The National Planning Policy Framework (NPPF) was published in March 2012 and sets out the Government planning policies for England and how these are expected to be applied.

The NPPF sets out a clear presumption in favour of sustainable development, which should be seen as a 'golden thread' running through plan-making and decision-taking.

The NPPF sets out 13 aspects relating to the delivery of sustainable development, including 'Conserving and enhancing the natural environment' which is of particular importance to the proposed development. These core aims are designed to guide and influence local authorities in developing their local plans, demonstrating the government's commitment to ensure the planning system does everything it can to support sustainable economic growth.

Local policies

At a local level, development is controlled through local planning policy prepared in accordance with national policy. Local Plans set out a vision and a framework for the future development of the area within boundaries of the local authorities.

The study area is located within boundaries of Brentwood Borough Council and London Borough of Havering.

The Brentwood Borough Council is currently preparing a new Local Plan for the Borough which, once adopted, will supersede saved policies in the current Replacement Local Plan (2005). The plan provides a comprehensive statement of land use policies and proposals for the Borough. This is the Borough's current development plan until replaced by the emerging Local Development Plan.

The Havering London Borough adopted Core Strategy and Development Control policies as well as Proposals Maps in 2008.

Table 6-2 includes also relevant policies of Brentwood Borough Council and Havering London Borough as well as relevant policies of London Plan written by the Mayor of London and publicized by the Greater London Authority.

Table 6-2: Summary of relevant local policies.

Planning Policies	Summary of Policy Content
Brentwood Borough Council	Brentwood Replacement Local Plan (25 August 2005)
Policy CP1 General Development Criteria	"Any development will need to satisfy all of the following: i) the proposal would not have an unacceptable detrimental impact on visual amenity, or the character and appearance of the surrounding area. ii) the proposal would not have an unacceptable detrimental impact on the general amenities of nearby occupiers or the occupiers of the proposed development by way of overlooking, lack of privacy, overbearing effect or general disturbance. iii) the proposal should be of a high standard of design and layout and should be compatible with its location and any surrounding development (and, in the case of alterations and extensions, with the existing building), in terms of size, siting, scale, style, design and materials. iv) means of access to the site for vehicles and pedestrians and parking and servicing arrangements are satisfactory. v) the transport network can satisfactorily accommodate the travel demand generated and traffic generation would not give rise to adverse highway conditions or highway safety concerns or unacceptable loss of amenity by reason of number or size of vehicles. vi) the proposal should not give rise to the net loss of a residential unit (except as provided for in policy tc19)."
Policy GB1 New Development	"Within the green belt, as defined on the proposals map, planning permission will not be given, except in very special circumstances, for changes of use of land or the construction of new buildings or extension of existing buildings, for purposes other than those appropriate to a green belt, or for the re-use of existing buildings that do not comply with the criteria set out in policies gb15 and gb16.
GB2 Development Criteria	When considering proposals for development in the green belt, the local planning authority will need to be satisfied that they do not conflict with the purposes of including land in the green belt and do not harm the openness of the green belt. the precedent created by allowing even an individually innocuous or well-merited proposal which cumulatively would undermine green belt objectives will be taken into account. account will also be taken of the following: i) the effect of proposals on public rights of way ii) the need to preserve or enhance existing landscape features iii) any building must be satisfactorily located in respect of the surrounding landscape and any adjoining buildings."
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. satisfactory measures must be taken prior to the start of any development to protect landscape features during development. all development schemes must be accompanied by: (i) a site survey showing existing landscape and natural features and existing ground levels

Planning Policies	Summary of Policy Content
	(ii) a plan showing all the existing trees and landscape and natural features to be retained and any trees or features proposed to be felled or otherwise affected by the development (iii) a plan showing proposals for all new tree planting or other landscaping work, including proposed finished ground levels (iv) a method statement for arboricultural work on site development schemes should also consider opportunities for additional habitat creation in any proposals."
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 programme of environmental improvement schemes throughout both the urban and rural areas of the borough. Within the landscape improvement area, as defined on the proposals map, any development proposals will be expected to contribute positively towards the restoration of its original character."
Havering London Borough Council	Local Development Framework (LDF) 2008
Policy CP14 Green Belt	The boundary of the Green Belt is shown on the Proposals Map.
Policy DC32 The Road Network	"New development which has an adverse impact on the functioning of the road hierarchy will not be allowed. Planning permission for new road schemes will only be allowed where they: are consistent with the Council's road hierarchy; improve conditions for pedestrians and cyclists and disabled people by providing safe and convenient facilities; improve public transport accessibility; have net environmental benefits; improve safety for all users; contribute to regeneration objectives;" are consistent with the Council's Local Implementation Plan and the Mayor of London's Transport Strategy; allocate street space in accordance with the London Plan; Contributions may be sought from developers towards new road schemes or road improvements.
Policy DC34 - Walking	"In the design and location of access and circulation arrangements within, and between, development and local pedestrian destinations, developers will be required to: take account of the needs of pedestrians; address 'desire lines' to local shops, services and schools, including safer routes to school, and public transport nodes, lighting, rest facilities, safety and security, and barriers to local movement; In appropriate circumstances, contributions will be sought towards initiatives either planned, or underway, to promote walking in the borough as included in Havering's Local Implementation Plan, and the strategic walking routes set out in the Transport for London Walking Plan including the Greenways. This includes the implementation of a continuous Thames Path across the borough which increases access to the Thames frontage. Where relevant, contributions may also be sought towards increasing pedestrian accessibility between the development and important local facilities including shops and services and local public transport nodes, for example crossings, drop kerbs, tactile paving, lighting and so on.

Planning Policies	Summary of Policy Content
	This would include contributions toward improving the pedestrian environment at transport interchanges including stations and bus stops. In major new developments used by the public the provision of public conveniences may be sought on site or contributions to off-site Universal Super Loos in line with the Council's Street Environment Maintenance and Management Plan."
Policy DC35 - Cycling	"The design and layout of developments will be required to take account of the needs of cyclists by: encouraging safe and secure cycle parking and changing and shower facilities to be provided appropriate to the nature and scale and location of the development; encouraging the design and location of access and circulation arrangement of the development to take account of the needs of cyclists; In major new development encouraging cycle priority measures which link with existing routes and networks; and where appropriate seeking contributions towards off-site improvements to the cycle network and cycle facilities including facilities at key public transport nodes and destinations and contributions towards the London Cycle Network Plus and Thames Chase Forest Circle. Applicants will be required to provide cycle parking to the standards provided in Annex 6 from Transport for London. In applying this policy regard will be had to the London Cycling Action Plan 'Creating a chain reaction', and the London Cycle Design standards and other relevant documents."
Policy DC45 – Appropriate Development in the Green Belt	"The Council will promote uses in the Green Belt that have a positive role in fulfilling Green Belt objectives. Planning permission for development in the Green Belt will only be granted if it is for the following purposes: agriculture and forestry, outdoor recreation, nature conservation, cemeteries; mineral extraction provided policies in the Council's Local Development Framework are complied with Park and Ride facilities provided that the criteria in Annex E of PPG13 are met. Planning permission for new buildings will only be granted for the following purposes: they are essential for the uses listed above; or they involve limited infilling or redevelopment on a site designated as a Major Developed Site in accordance with DC46 Extensions, alterations and replacement of existing dwellings will be allowed provided that the cubic capacity of the resultant building is not more than 50% greater than that of the of the original dwelling. Planning permission for the reuse of existing buildings will only be granted if the criteria set out in PPG2 are satisfied. Particular care will be taken to ensure that the proposed use (including the use of any adjoining land) does not have a greater impact on the openness of the Green Belt. Subject to the Departure procedure, planning permission for the redevelopment of authorised commercial/industrial sites will be granted provided there is a substantial decrease in the amount of building on the site and improvements to the local Green Belt environment."

Planning Policies	Summary of Policy Content
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; and not granting planning permission for development that would adversely affect ancient and secondary woodland."
Policy DC69 – Other areas of special townscape or landscape character	"Planning permission will only be granted if it maintains, or enhances, the special character of: the Emerson Park Policy Area which is typified by large and varied dwellings set in spacious mature, well landscaped grounds; the Hall Lane Policy Area which is typified by large detached and semi-detached dwellings set in large gardens with considerable tree and shrub planting; the Gidea Park Special Character Area which is derived from the quality of its urban design and architectural detailing and also its locally important heritage and historical associations. Detailed criteria for dealing with planning applications in these areas will be contained within three separate SPDs. The Council will also seek to preserve the special character of Havering Ridge including protecting views to and from the area."
London Plan (2015-2016)	Relevant policies from the Draft Replacement London Plan (2015-2016) included below.
Policy 7.16 Green Belt	"Strategic A. The Mayor strongly supports the current extent of London's Green Belt, its extension in appropriate circumstances and its protection from inappropriate development. Planning decisions B. The strongest protection should be given to London's Green Belt, in accordance with national guidance. Inappropriate development should be refused, except in very special circumstances. Development will be supported if it is appropriate and helps secure the objectives of improving the Green Belt as set out in national guidance."
Policy 7.21 Trees and Woodlands	"A Trees and woodlands should be protected, maintained, and enhanced, following the guidance of the London Tree and Woodland Framework (or any successor strategy). In collaboration with the Forestry Commission the Mayor has produced supplementary guidance on Tree Strategies to guide each borough's production of a Tree Strategy covering the audit, protection, planting and management of trees and woodland. This should be linked to a green infrastructure strategy. Planning decisions B Existing trees of value should be retained and any loss as the result of development should be replaced following the principle of 'right place, right tree'[1]. Wherever appropriate, the planting of additional trees should be included in new developments, particularly large-canopied species. LDF preparation C Boroughs should follow the advice of paragraph 118 of the NPPF to protect 'veteran' trees and ancient woodland where these are not already part of a protected site. D Boroughs should develop appropriate policies to implement their borough tree strategy."

6.6 Design, mitigation, enhancement and monitoring measures

Generic environmental design or mitigation measures that have the potential to be incorporated into the Scheme have been identified. The assessment takes into consideration the potential for reduction of adverse effects through the introduction of these environmental design or mitigation measures. A concept landscape and visual mitigation plan will be prepared to identify opportunities to reduce the significance of effects at future stages. Below there is a list of potential mitigation measures that could be applied to the proposed scheme options:

- Avoid the loss of trees and hedgerows through selection of the option that would result in minimal loss of trees and hedgerows of high quality or prefer alignment in which the loss of trees could potentially be mitigated;
- Where possible there may be potential to provide mitigation measures for screening consisting of planting or mounds;
- Where the field pattern is affected it should be reinstated where possible, through the addition of woodland copses, tree belts, or planting of hedgerow with trees;
- Where earth mounding or cuttings are proposed their profile should be modelled to fit with the local landscape character. Shallow gradients of slopes and shallow crests of embankments and cuttings would be in keeping;
- The scheme may give an opportunity for opening up or screening of the views into and from the altered sections of the network where appropriate;
- Introduction of new vegetation could help absorb the junction into the landscape and improve habitat connectivity through the provision of wildlife corridor links with the surrounding areas; and
- New planting should include native broad-leaved species appropriate to the locations favouring long lived tree species located at safe distance from the road but also hedgerows and woodland edge planting, located outside constraints of sight lines, to improve landscape quality and safety.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

6.7 Potential significance of effects

Landscape

The key expected landscape effects could include the loss of vegetation and tree belts, including partial loss of part of Vicarage Wood Ancient and Semi-Natural Woodland. The significance of this change will depend on the option selected. The area around the junction has undulating topography and varied carriageway heights and therefore options are likely to result in the introduction of earthworks. The alterations to the junction would reinforce the landscape pattern of road corridors in the area, however the change is unlikely to give rise to significant effects at regional or national scale due to the relatively small scale of the proposed scheme options. The effects on the local landscape character will however be considered and effective mitigation measures identified to help integrate the proposed scheme options into the landscape.

It is expected that potential significant landscape effects would be restricted to the land required or directly adjacent for accommodation of proposed scheme options, that are centred mainly on the existing road corridor linked to the M25 Junction 28. However, consideration will be given to the wider area within 1.5km radius from the centre of the junction or within 1000m buffer both side of the proposed scheme options.

The assessment indicates the potential effects on valued landscapes or landscape elements and would indicate the potential for their protection and enhancement were possible.

Table 6-3 below considers the effects on landscape character during construction stage. The landscape effects during operational stage are considered in Table 6-4.

The detailed assessment of landscape effects is presented in the Appendix D in Table 6.3 describing effects during construction stage, whilst the effects during operational stage are described in Table 6.4.

Table 6-3: Potential effects on landscape receptors (Construction)

Potential landscape effects	Option 6	Option 2	Option 4	Option 5A	Option 5B	Option 5C	Option 5D	Option 5E
Effects on landscape character including: -introduction of compounds, parking and welfare facilities; - loss of vegetation; - alteration to landform (introduction of embankments and cuttings); -requirement for temporary construction land; and - temporary presence of material set down areas and stock piles	**Sensitivity**: The sensitivity of landscape character is considered at **medium** level.							
	Magnitude							
	Moderate adverse	Major adverse	Major adverse	Moderate adverse	Minor adverse	Moderate adverse	Major adverse	Moderate adverse
	Potential effects							
	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Moderate adverse (significant)	Slight adverse (not significant)

Table 6-4: Potential effects on landscape receptors (Operation)

Potential landscape effects	Option 6	Option 2	Option 4	Option 5A	Option 5B	Option 5C	Option 5D	Option 5E
Effects on landscape character including: -introduction of permanent viaducts and earthworks; -introduction of permanent road diversions; -introduction of gantries and other smaller elements of highway infrastructure eg. signage; -realignment of kerb lines and	**Sensitivity**: The sensitivity of landscape character is considered at **medium** level.							
	Magnitude							
	Minor adverse	Moderate adverse	Moderate adverse	Minor adverse	Negligible	Minor adverse	Moderate adverse	Minor adverse
	Potential effects							
	Slight adverse (not significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Moderate adverse (significant)	Slight adverse (not significant)

Potential landscape effects	Option 6	Option 2	Option 4	Option 5A	Option 5B	Option 5C	Option 5D	Option 5E
-Introduction of new planting and other mitigation measures.								

Visual

Visual effects will occur during both the construction and operational stage. During construction effects are likely to occur as a result of the introduction of construction machinery, compounds and loss of existing vegetation. The change in the views is likely to include earthmoving operation, formation of temporary spoil areas, road formation and creation of earthworks. The visual receptors will also be affected by views of HGV vehicles and other tall machinery used on the construction site. The effects of construction activities would be temporary, short term and reversible.

It is expected that the proposed scheme options will be visible in the short and medium term for receptors close to the M25 Junction 28. Depending on the option selected the significance of effects will vary between receptors located around the junction. The operational effects will be long term and permanent. The proposed scheme options will give an opportunity to introduce environmental design measures or/and mitigation measures to help reduce the effects and provide landscape and visual enhancements where possible. The introduced measures will mature over a time to accommodate the proposed scheme options into the existing landscape.

Table 6-5 below considers the effects on visual receptors during construction stage. The landscape effects during operational stage are considered in Table 6-6.

The detailed assessment of visual effects is presented in the Appendix D in Table 6.5 describing effects during construction stage, whilst the effects during operational stage are described in Table 6.6.

Table 6-5 Potential effects on visual receptors (Construction)

Potential visual effects (Construction)									
Receptors	**Options**	**Option 6**	**Option 2**	**Option 4**	**Option 5A**	**Option 5B**	**Option 5C**	**Option 5D**	**Option 5E**
Receptor 1 Views from open access land including Tyler's Common to the south of Tyler's Hall Farm and open access land near Harold Court. Sensitivity: High	Magnitude	Negligible	Negligible	Negligible	Negligible	No change	No change	Negligible	Negligible
	Potential effects	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Neutral	Neutral	Slight adverse (not significant)	Slight adverse (not significant)
Receptor 2 Views of employees within business parks adjacent to Brook Street near Junction 28 (group receptor). Sensitivity: Low	Magnitude	Major	Moderate	Moderate	Moderate	No change	No change	Major	Major
	Potential effects	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Neutral	Neutral	Neutral	Slight adverse (not significant)	Slight adverse (not significant)
Receptor 3 Views from residential receptors located to the north of the M25 in South Weald (group receptor) including Lake House, Colmar Farm, Colmar, Park Farm and Halfway House.	Magnitude	Major	Major	Major	No change	No change	No change	Minor	Minor
	Potential effects	Large adverse (significant)	Large adverse (significant)	Large adverse (significant)	Neutral	Neutral	Neutral	Moderate adverse (significant)	Moderate adverse (significant)
Receptor 4 Views from residential receptors located on Nag's Head Lane linking Brook Street area with Tyler's Common to the south of Junction 28.	Magnitude	Major	Major	Major	Major	No change	No change	No change	No change
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Neutral	Neutral	Neutral	Neutral

Potential visual effects (Construction)									
Receptors	**Options**	**Option 6**	**Option 2**	**Option 4**	**Option 5A**	**Option 5B**	**Option 5C**	**Option 5D**	**Option 5E**
Sensitivity: High									
Receptor 5 Views from residential receptors located along Dark Lane. Sensitivity: High	Magnitude	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Moderate	Moderate
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)	Slight adverse (not significant)	Moderate adverse (significant)	Moderate adverse (significant)
Receptor 6 Views from bridleway section that follows the crest of the cutting along the existing M25, close to Dark Lane. Sensitivity: High	Magnitude	Major	Major	Major	Major	No change	No change	Major	Major
	Potential effects	Large adverse (significant)	Large adverse (significant)	Large adverse (significant)	Large adverse (significant)	Neutral	Neutral	Large adverse (significant)	Large adverse (significant)
Receptor 7 Views from residential receptor Grove Farm near M25 Junction 28. Sensitivity: High	Magnitude	Minor	Major	Moderate	Major	Major	Major	Major	Major
	Potential effects	Moderate adverse (significant)	Very large adverse (significant)	Moderate adverse (significant)	Very large adverse (significant)	Very large adverse (significant)	Very large adverse (significant)	Very large adverse (significant)	Very large adverse (significant)
Receptor 8 Views from Maylands Golf Course, located to the north west of the Junction 28. Sensitivity: Medium	Minor	Moderate	Moderate	Moderate	Minor	Minor	Moderate	Moderate	Minor
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)	Slight adverse (not significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)
Receptor 9 Views from Maylands Cottages and Harold Park to the west of Junction 28.	Magnitude	Minor	Moderate	Moderate	Moderate	Minor	Minor	Moderate	Moderate
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)	Slight adverse (not significant)	Moderate adverse (significant)	Moderate adverse (significant)

Potential visual effects (Construction)									
Receptors	**Options**	**Option 6**	**Option 2**	**Option 4**	**Option 5A**	**Option 5B**	**Option 5C**	**Option 5D**	**Option 5E**
Sensitivity: High									
Receptor 10 Views from Oak Farm. Sensitivity: High	Magnitude	No change	No change	No change	Moderate	Moderate	Moderate	Minor	Minor
	Potential effects	Neutral	Neutral	Neutral	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Slight adverse (not significant)	Slight adverse (not significant)

Table 6-6: Potential effects on visual receptors (Operation)

Potential visual effects (Construction)									
Receptors	**Options**	**Option 6**	**Option 2**	**Option 4**	**Option 5A**	**Option 5B**	**Option 5C**	**Option 5D**	**Option 5E**
Receptor 1 Views from open access land including Tyler's Common to the south of Tyler's Hall Farm and open access land near Harold Court. Sensitivity: High	Magnitude	Negligible	Negligible	Negligible	Negligible	No change	No change	Negligible	Negligible
	Potential effects	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Neutral	Neutral	Slight adverse (not significant)	Slight adverse (not significant)
Receptor 2 Views of employees within business parks adjacent to Brook Street near Junction 28 (group receptor). Sensitivity: Low	Magnitude	Moderate	Minor	Minor	Minor	No change	No change	Moderate	Moderate
	Potential effects	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Neutral	Neutral	Slight adverse (not significant)	Slight adverse (not significant)
Receptor 3 Views from residential receptors located to the north of the M25 in South Weald (group receptor) including Lake House, Colmar Farm, Colmar, Park Farm and Halfway House.	Magnitude	Moderate	Moderate	Moderate	No change	No change	No change	Minor	Minor
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Neutral	Neutral	Neutral	Moderate adverse (significant)	Moderate adverse (significant)
Receptor 4 Views from residential receptors located on Nag's Head Lane linking Brook Street area with Tyler's Common to the south of Junction 28.	Magnitude	Moderate	Moderate	Moderate	Moderate	No change	No change	No change	No change
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Neutral	Neutral	Neutral	Neutral

Potential visual effects (Construction)									
Receptors	**Options**	**Option 6**	**Option 2**	**Option 4**	**Option 5A**	**Option 5B**	**Option 5C**	**Option 5D**	**Option 5E**
Sensitivity: High									
Receptor 5 Views from residential receptors located along Dark Lane. Sensitivity: High	Magnitude	Minor	Minor	Minor	Minor	Negligible	Negligible	Minor	Minor
	Potential effects	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)
Receptor 6 Views from bridleway section that follows the crest of the cutting along the existing M25, close to Dark Lane. Sensitivity: High	Magnitude	Moderate	Moderate	Moderate	Moderate	No change	No change	Moderate	Moderate
	Potential effects	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Moderate adverse (significant)	Neutral	Neutral	Moderate adverse (significant)	Moderate adverse (significant)
Receptor 7 Views from residential receptor Grove Farm near M25 Junction 28. Sensitivity: High	Magnitude	Minor	Major	Moderate	Major	Major	Major	Major	Major
	Potential effects	Negligible adverse (not significant)	Large adverse (significant)	Moderate adverse (significant)	Large adverse (significant)	Large adverse (significant)	Large adverse (significant)	Large adverse (significant)	Large adverse (significant)
Receptor 8 Views from Maylands Golf Course, located to the north west of the Junction 28. Sensitivity: Medium	Magnitude	Negligible	Minor	Minor	Minor	Negligible	Negligible	Minor	Minor
	Potential effects	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)
Receptor 9 Views from Maylands Cottages and Harold Park to the west of Junction 28.	Magnitude	Negligible	Minor	Minor	Minor	Negligible	Negligible	Minor	Minor
	Potential effects	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Slight adverse

Potential visual effects (Construction)									
Receptors	**Options**	**Option 6**	**Option 2**	**Option 4**	**Option 5A**	**Option 5B**	**Option 5C**	**Option 5D**	**Option 5E**
Sensitivity: High		(not significant)	(not significant)	(not significant)	(not significant)	(not significant)	(not significant)	(not significant)	(not significant)
Receptor 10	Magnitude	No change	No change	No change	Minor	Minor	Minor	Negligible	Negligible
Views from Oak Farm. Sensitivity: High	Potential effects	Neutral	Neutral	Neutral	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)	Slight adverse (not significant)

6.8 Summary of landscape and visual effects

Landscape effects

Construction

During construction the adverse landscape effects would occur as a result of combination of adverse landscape effects including loss of vegetation, alteration to landscape pattern and landform combined with construction activities. New landscape elements associated with construction sites like compounds, stockpiles, material storage areas, site and welfare office would be temporarily introduced in the local landscape. It is expected that compounds of varying size will need to be introduced depending on options selected, however it is expected that tall machinery will be required in each of the considered options. Most of the options will introduce significant but temporary increase in the construction traffic in the local landscape.

During the construction stage significant landscape effects are expected for the following options: 6, 2, 4, 5D and 5E.

Operation

During the operational stage the selected option would be partially integrated through the implementation of the environmental design measures. It is expected that over a time the proposed vegetation would mature to accommodate the development to some degree. Some of the proposed options include bridges and viaducts which are likely to be prominent within the local landscape character. In some options features like viaducts although will remain prominent would not alter the landscape pattern at the ground level, enabling retention of vegetation and landscape pattern. All options would result in extension of the infrastructure road pattern to varying degree.

During the operational stage significant landscape effects are expected for the following options: 2, 4 and 5C.

Visual

Construction

During the construction stage significant effects are expected as a result of combination of adverse effects like the introduction of uncharacteristic elements of the views including formation of earthworks, construction of elevated structures including bridges and viaducts, views of material set down areas, welfare facilities, and site office and parking areas. Views may include construction operations at land that is temporarily acquired for construction, views of construction traffic and deliveries in and out of the site. The receptors are likely to experience views of increased construction traffic and increase of dust in the local area. Some of the identified receptors may have a full or partial views of the compound area with material set down areas, welfare facilities, site office and parking areas.

- A list of receptors that are likely to sustain significant effects during construction stage are as follows:
- Option 6 - Significant effects are expected for receptors nos.3, 4, 5, 6 and 7.
- Option 2 - Significant effects are expected for receptors nos.3, 4, 5, 6, 7 and 8
- Option 4 - Significant effects are expected for receptors nos.3, 4, 5, 6, 7 and 8.
- Option 5A - Significant effects are expected for receptors nos.4, 5, 6, 7 and 8.
- Option 5B - Significant effects are expected for receptors no. 7.
- Option 5C - Significant effects are expected for receptors no. 7.

- Option 5D - Significant effects are expected for receptors no. 3,5,6,7 and 8.
- Option 5E - Significant effects are expected for receptors no. 3,5,6,7 and 8.

Operation

During operational stage potential significant effects are expected as a result of deterioration to the view through the introduction of uncharacteristic and detracting features that could dominate the views. The views would include large engineering structures including bridges, viaducts as well as small elements of road infrastructure including signage, vehicle restraint barriers, lighting and others. The views are likely to include earthworks with maturing vegetation including belts of trees, hedgerows and grassland areas alongside fully or partially visible roads.

A list of receptors that are likely to sustain significant effects during the operational stage are listed below:

- Option 6 - Significant effects are expected for receptors nos. 3, 4 and 6.
- Option 2 - Significant effects are expected for receptors nos.3, 4, 6 and 7.
- Option 4 - Significant effects are expected for receptors nos.3, 4, 6 and 7.
- Option 5A - Significant effects are expected for receptors nos.4, 6, and 7.
- Option 5B - Significant effects are expected for receptors no. 7.
- Option 5C - Significant effects are expected for receptors no.7.
- Option 5D - Significant effects are expected for receptors nos.3, 6, and 7.
- Option 5E - Significant effects are expected for receptors nos.3, 6 and 7.

6.9 Summary and Recommendations

It has been established that some proposed scheme options would give rise to significant landscape effects and all options would significantly affect some receptors. Therefore a detailed assessment is recommended at PCF Stage 2.

This will include detailed desk and fieldwork to identify the character of the landscape, including its condition and value, and the nature and sensitivity of the visual receptors that may be affected by the project.

At PCF Stage 2 of the assessment further refinements to the design will be considered, to review identified landscape and visual effects to reflect on the details the scheme design. This will take into the consideration specific landscape and visual environmental and design measures.

Prior to PCF Stage 2 of the assessment a production of outline landscape design drawings would be necessary to show the proposed environmental design or agreed mitigation measures to enable full assessment of landscape and visual effects.

The assessment at PCF Stage 2 will be extended to explain any additional evaluation methodologies with differentiation of construction and operational stages and will be accompanied by illustrative plans showing:

- Topography (1:25000)
- Landscape Character (1:25000)
- Viewpoint location plans (1:25000)
- Photographic Viewpoints (1:25000)
- Cross sections (1:1000)

- Landscape Designations (1:25000)
- Outline Landscape Design (1:2500)

6.10 Limitations to assessment

The following limitations have been identified in production of this report:

- The report provides broad indication of effects, reporting on the potential landscape and visual effects based on simple assessment;
- A broad understanding of landscape and visual constraints associated with the proposed scheme was gained by a short site visit;
- Landscape character description in the baseline section refers to the local level landscape character assessments;
- The visibility from visual receptors have been established from publicly accessible places. Access in some locations was restricted due to the safety considerations e.g. Motorways or some other locations along the highway network; and
- At this stage, where options are explored there is no detailed information available on the construction and therefore the assessment is based on assumptions about the construction process.

7 Cultural Heritage

7.1 Introduction

This chapter assesses potential impacts on the cultural heritage resource from each option. From examining the proposed works and location of heritage assets, an assessment has been made of any potential significant effects upon the cultural heritage resource and recommendations provided for further assessment or mitigation.

7.2 Assessment methodology

This chapter of the ESR assesses potential impacts on the built heritage resource and buried archaeology. Information on designated and non-designated heritage assets was sourced from the following locations:

- Historic England National Heritage List for designated assets; and
- Essex Historic Environment Record for both designated and non-designated historic environment assets, find spots and previous investigations.

Heritage assets are associated with a unique ID, for National Heritage List entries (NHLE) and the Historic Environment Record (HER).

This assessment has been carried out in accordance with the methodology set out in the Design Manual for Roads and Bridges, Volume 11 Section 3, Part 2, HA208/07 (DMRB)[1]. It also reflects guidance for assessing impacts on the setting of heritage assets contained in 'Historic Environment Good Practice Advice in Planning Note 3: The Setting of Heritage Assets' (Historic England, 2015).

Sensitivity of resource

The value of each heritage asset is assessed, and determined to be Very High, High, Medium, Low or Negligible. Heritage value is determined by professional judgement, grounded in established criteria and carried out by a suitable qualified heritage professional. These criteria are elaborated in English Heritage's (now Historic England) Conservation Principles (2008), which sets out four values: evidential, historical, aesthetic and communal. These encapsulate architectural, historic and archaeological interest and are consistent with the DMRB methodology. Table 7.1 sets out the criteria for assessing the value of historic environment assets.

Table 7-1 Value of Heritage Assets

Value	Description	Example
Very High	Internationally important or significant heritage assets	World Heritage Sites, or buildings recognised as being of international importance.
High	Nationally important heritage assets generally recognised through designation as being of exceptional interest and value.	Grade I and II* Listed Buildings, Grade I and II* Registered Parks and Gardens, Scheduled Monuments, Protected Wreck Sites, Registered Historic Battlefields, Conservation Areas with notable concentrations of heritage assets and undesignated assets of national or international importance.
Medium	Nationally or regionally important heritage assets recognised as being of	Grade II Listed Buildings, Grade II Registered Parks and Gardens, Conservation Areas and undesignated assets of regional or national importance, including archaeological remains,

[1] http://www.standardsforhighways.co.uk/dmrb/vol11/section3/ha20807.pdf

Value	Description	Example
	special interest, generally designated.	which relate to regional research objectives or can provide important information relating to particular historic events or trends that are of importance to the region.
Low	Assets that are of interest at a local level primarily for the contribution to the local historic environment.	Undesignated heritage assets such as locally listed buildings, undesignated archaeological sites, undesignated historic parks and gardens etc. Can also include degraded designated assets that no longer warrant designation.
Negligible	Elements of the historic environment which are of insufficient significance to merit consideration in planning decisions and hence be classed as heritage assets.	Undesignated features with very limited or no historic interest. Can also include highly degraded designated assets that no longer warrant designation.
Unknown	The importance of an asset has not been ascertained.	

As consistent with DMRB methodology, the magnitude of effect on the cultural heritage baseline is determined by consideration of a combination of the magnitude of the impact and the value of each asset with a level of professional judgement in the determination. The magnitude of impact to a heritage asset is identified by the degree of change that would be experienced by the asset and its setting if the scheme were to be completed as compared to a 'do nothing' situation. The definition of the magnitude of impact, and the matrix for determining the significance of effect, can be found in DMRB (Volume 11 Section 3, Part 2, HA208/07, 5/5) and in Section 5 of this ESR.

7.3 Study area

For the PCF Stage 1 a desk based appraisal of effects on cultural heritage, a 500m study area has been defined around the alignment of each option. Within the study area designated and non-designated heritage assets were examined.

7.4 Baseline conditions

The study area contains 20 designated heritage assets of high or medium value. In summary, these comprise:

- 1 Scheduled Monument
- 1 Grade II* Listed Building
- 15 Grade II Listed Buildings
- 1 Grade II Registered Park and Garden
- 2 Conservation Areas

The designated assets are largely grouped within three areas. In the north of the study area a number of listed buildings are located within the village of South Weald, adjacent to Weald Park Registered Park and Garden, while both the village of South Weald and Weald Park themselves are designated Conservation Areas. To the east of the parkland, on the north-eastern edge of the study area lies a univallate hillfort which is a Scheduled Monument. A second small group of listed buildings lies along the A1023 Brook Street, including the Golden Fleece Inn, the sole Grade II* listed building within the study area. A final trio of listed structures is grouped at Boyles Court Farm in the south of the study area.

The designated assets located within the study area are listed below in Table 7-2. They are also mapped in Figure 7.1 in Appendix E.

Table 7-2 Designated Heritage Assets within the Study Area

Reference	Name	Description	Value
1013833	Slight univallate hillfort 300m west of Calcott Hall Farm (Scheduled Monument)	Slight univallate hillfort situated on the crest of a ridge of sands and gravels. Almost circular including defensive bank and external ditch enclosing an area of approx. 2.8ha. The bank is visible on the W side of the monument as a slight earthwork. Modified scarp slope between bank and ditch on W side. On the remaining sides surrounding ditch partly infilled, survives as a buried feature no longer visible from ground level. Pottery sherds recovered from just above the ditch floor were dated to about the C1 BC/C1 AD. The interior survives in good condition and is believed to contain features and deposits.	High
1197231	The Golden Fleece Inn (Grade II* Listed Building)	House now public house. c1400, additions and alterations early C16, C18, C19, C20. Timber-framed and plastered, peg-tiled roofs. H-plan with C18 and C19 rear and end additions, two storey. Front S elevation central range with flanking, jettied cross-wings of unequal size, W small, E larger. Central rectangular stack, also similar stack on E side of E cross-wing. Inner plain stack through roof of W cross-wing. Plain parapet on central range. Ground floor, E-W jetty. Early C19 bay and sash window. Central C20 door. Early C20 casement in earlier frame. Old doorway (on cross passage site) now a fixed window. W cross-wing jetty with C18 cornice and early C20 bay window. Lean-to out-shut with early C20 window. First floor, E-W, cross-wing has triple sash window, small fixed light in roof space. Central range, 2 early C19 sash windows. W cross-wing C18 cornice and Venetian sash window. Rear of centre range has C18 infilling between cross-wings. E cross-wing has a fixed light in roof space and W cross-wing has a plain first floor casement window. E end elevation has projecting stack c1600, rebuilt shafts. First floor, N end, early C19 sash window. C20 shed, stair and rear addition. First floor, S end small doorway. To N C18 addition. First floor, two casement windows, both early C20. Considerable C20 additions masking old structure. The high level of construction in second phase providing a remarkable 4-bayed open hall and cross-wing of similar status, has caused historians to speculate as to whether improvements done by Waltham Abbey to provide a court house on their land in order to draw prestige and trade away from Brentwood, which was held by St Osyth's Abbey. If so it was added to an earlier existing building, the W cross-wing.	High
1197190	Nag's Head Inn (Grade II	Public house. C17, early C18, C19. Red brick, machine-made tile roof. Rectangular plan with C20	Medium

Reference	Name	Description	Value
	Listed Building)	additions to rear. Two storey and attic with gable end chimneys. N front elevation, 5-bay range, centre bay with door. Ground floor has a C19 sash window each side of central front door. Door C20. Simple C20 gabled porch with bracing integrated with full length C20 lean-to tiled canopy. First floor, 2 pairs of sash windows. Roof has moulded eaves board and 2 hip roofed dormers. Gable ends have brick parapets and kneelers. Rear, S elevation additions, no wall of original house visible. To E end, small mansard roof extension, weatherboard W gable end. E end elevation with gable end stack and single window on ground and first floor.	
1197206	Barn at Boyle's Court Farm (Grade II Listed Building)	Barn. Dated 1774 on porch. Refaced in late C19. Timber-framed, part weatherboard. C19 brick out-shut to S and imitation timber-framing to porches. Rectangular plan. S front elevation to courtyard, 2 symmetrical waggon porches, late C19 bell cupola and clock turret. Brick out-shut has stable door, simple windows, unglazed openings, waggon porches, C20 door of 1930 style. Rear, N, elevation, late C19 facade decorated to be seen from Boyles Court. Weatherboard with large central window and two similar windows. Below, window under cornice hood. W, end elevation rendered with mock timbering above. C20 double garage doors, timber continues into brick out-shut. E end similarly treated, ground floor has 4 windows in 2 pairs.	Medium
1197264	Browne's Charity Almshouses and Chapel (Grade II Listed Building)	Almshouses. 1858. By S Teulon. Red brick with stone dressings to windows and doors, peg-tiled roof. Long group, stepped down along Wigley Bush Lane. Plan comprises 10 cottage units in row with central chapel with axis at right angles, group breaks forward roughly symmetrically each side of chapel and N and S end cottages have axes at right angles to create prominent gable ends. Classical composition with Gothic detail. Cottage units single storey, with two rooms, expressed with different sized casement windows, front door between. Doors boarded with iron work in doorhead. Roof steep and eaves carried forward on brackets to create a pentice. Chapel W gable end, buttressed angles, window in 2-centred arch with geometrical tracery, string course below. Frieze below pointed roof.	Medium
1197265	The Cottage and attached Railings (Grade II Listed Building)	House. Early C19. Timber-framed, weatherboarded and rendered, low pitch, hipped, slate roof. Two storeys, stacks rise through end roof pitches. W front elevation. 3 window range, ground floor, 2 sash windows, between windows a door, upper 2 panels glazed. Open wooden verandah across whole front with swept roof and arcade arches. First floor, 3 sash windows with shutters. S end elevation, weatherboarded with central stack. Ground floor, early C20 casement window, to E sash window, with architrave, similar window above on first floor. To E set back, first floor projection,	Medium

Reference	Name	Description	Value
		below and behind, 2-storey projection with C19 door. E rear elevation with central 2-storey projection and, to S, first-floor deeper projection. House block N end, sash window on each floor. Central 2-storey projection, ground floor, casement, above on first floor, C20 casement. First floor projection, sash window. Front, iron railings continuous with those at the Old Post Office Luptons, Wealdcote and granary, and the Tower Arms.	
1205707	17, 19 and 21, Brook Street (Grade II Listed Building)	House, now 3 cottages. Early C16, C18. Timber-framed, rendered and colourwashed, peg-tiled roofs. Rectangular plan, rear additions. One and a half storeys. Dormers with tile hung sides, central C19 brick stack, brick lean-to at W end, continuing hipped roof as a catslide. 4-bayed facade, E-W, (1) No.17: 2 bays, door with upper glazed panels, two C20 casement windows, above, two C20 restored gabled dormer windows. (2) No.19: C18 door with 4 panels, attached C18 window, sash, above, simple C18 gabled dormer and sash window (3) No.21: Door and attached window as No.19, but window plain sash, dormer window above as No.19, brick lean-to has casement. Rear, N elevation, Nos 19 & 21 have C20 additions, No.17, rear brick C19 additions. House E end gable visible, weatherboard, door with 2 panels and attached window.	Medium
1206439	Boyles Court (Grade II Listed Building)	House, now school. 1776 by T Leverton. Red brick. Plan of echelon form; central block with deeply recessed pavilions with linking wings. Roof of central block flat with no stacks, result of rebuilding of upper structure (post a C20 fire), particularly towards the front. Pavilions have hipped slate roofs. Front, N elevation, stuccoed ground floor, brick above. Central block, 3 storeys and attic. 5 bays, central 3 bays break forward with pediment. Ground floor, central C20 door and C20 plain fixed windows each side, outer bays sash windows, deep portico to central 3 bays with columns and cornice, balustrade. First floor, central 3 windows with stuccoed architraves and cornices, outer windows have semi-circular panels. Second floor divided from first by raised band continuing round sides of central block. Attic above has centre pediment. All brickwork above 2nd storey windows is renewed. Pavilions 2 storeyed, single bay with large Venetian window on first floor. Ground floor sash window. Side link wings single bay, first floor sash window. Ground floor E wing sash window. W wing C20 door with glazing. To E ground floor podium continued as a courtyard wall. Rear, S elevation, now considerably closed in by C20 work. 3 storey and attic central block similar to front. Ground floor stuccoed, 3 sash windows, two C20 doors. First floor, central blind window. 2nd floor, 3 sash windows. Attic storey has five C20 casement windows. Link wings, 2 window range and hipped	Medium

Reference	Name	Description	Value
		slate roofs. Pavilions, 2 window range, 3 storeyed with hipped ridge, stuccoed ground floor. W end elevation central block 3 window range. Attic (rebuilt to front) C20 windows. Pavilion S end rebuilt. Pavilion as W elevation but 4 window range with external C20 stack. First and second floor windows at S end replaced by C20 doorways. Courtyard continues from front elevation.	
1206447	Stables at Boyles Court Farm (Grade II Listed Building)	Stables. Late C19. Red brick and timber-framing, tile roof. 2 U-shaped courts, back to back, principal to N. N court brick, single storey with canopy on columns. Central timber-framed feature, 2 window range with central stack. Windows break through eaves. Court wings terminate with Dutch gables. Stable doors and segment headed windows round. Below, 2 windows. At E inner corner, arched opening. E and W end elevation in similar style, with Dutch gabled ends to principal range. Stack at E end. Wings have three casement windows. Rear, S court, plain. E wing longer than W. Gable ends simple. Principal range has narrow window and 2 large door openings. Stable doors in wings. Stable door and side light with adjacent boarded door in W gable. E gable, segment headed window.	Medium
1208633	Lych Gate to Church of St Peter (Grade II Listed Building)	Lych gate. 1868. S Teulon, who rebuilt the medieval church at that time. Oak framed. Roof of C19 flat tiles. 2 bays, 3 principal trusses, crown-posts with upper king struts and arched braces to collars. Tie-beams knee braced to unjowled principal posts. Roof projects with purlin supported by brackets from crown posts. Barge boards with decoration. Lower framing onto ground sill on stone base.	Medium
1208663	Halfway House Farm (Grade II Listed Building)	House. Early C18, early C19. Timber-framed, pebble dash, hipped peg-tiled roof. 2 early C19 stacks rising at E and W sides. Rectangular plan with brick C19 out-shut to W and central projection at rear. 2 storey and attics. N front elevation, roof projects slightly, 3 window range, outer windows, ground and first floor all sashes. Central doorway, architrave and reveals, frieze and pediment. Door, with 6 panels, sash window over, C20 skylights replacing flat roofed dormers. To W C19 brick lean-to, slated. S rear elevation, similar to front but central projection (once probably a stair tower). Brick on ground floor with blocked door opening, sash window above. 3 similar windows, one on ground floor and 2 on first floor. Doorway on ground floor to E, C20 lean-to porch and conservatory in front. 2 sky-lights replacing dormers as on front. Doorway in out-shut to W. E side elevation, irregular, central stack, C19 doorway off centre to S with fanlight. To S dairy window, iron and wood mullions, to N sash window. First floor, single window of same type. W elevation. Central stack, ground floor single sash window, C19 out-shut with casement window. Small lean-to extension to N. The house has retained its early C18 shape, but	Medium

Reference	Name	Description	Value
		principal windows and chimney-stacks replaced in the early C19.	
1208739	The Towers Arms Inn (Grade II Listed Building)	Public house. Dated 1704. Red brick, hipped peg-tiled roof with prominent stacks on end walls. Rectangular plan. 2 storey and attics. N front elevation, 5 bays, string course between ground and first floors. Central front door and dormers with casement windows over bays 2 and 4. All other windows C19 mullion and transom casements. Front doorway, door with 8 panels, upper 2 now glazed. Above, datestone, initials, L over AA and 1704. S, rear elevation, 5 bays, all windows early C18 frames, mullions and transoms with C20 replacement casements. Ground floor, central doorway, upper 2 panels glazed. To W C20 ground-floor extension. First floor, 4 windows and central stair window dropped to half storey height, 2 gabled dormers in bays 2 and 4. E end elevation, brickwork and roof as front, central C19 door with wooden porch. First-floor window above, C19 casement set in C18 aperture. Large central stack. W end, brickwork and roof as front, 3 bays with 6 window apertures, early C18 stack, upper part is C20 rebuild.	Medium
1208759	Luptons and attached Garden Wall (Grade II Listed Building)	House. C17, early C18, early C19, C20. Timber-frame, rendered, colour-washed, peg-tiled roof slate. Plan, original house rectangular with added units, short rear wing to W and long side and rear wing to N. 2 single-storey extensions to W. W front elevation, 2 adjacent blocks. S block, rendered timber-framing, 2 storeys and attic, large C18 central stack. Ground floor, to N end, early C19 front door. To S C19 front addition in red brick, to W round window, to N 2 sash windows. First floor, 2 casement windows. N block, C19 brick, colour-washed, 2 storeys, hipped slate roof. Ground floor C19 single-storey gable front extension with 2 C19 casement windows. To S 2 blind window apertures. S elevation. S block timber-framing and hipped roof, projecting eaves continue from W front but with attic dormer. 2 stacks. Ground floor central French window and similar side lights. Open verandah with swept roof. To W, C19 double doorway. First floor, 2 sash windows and side lights. Central attic dormer, sash. N block brick, colour-washed, 2 storeys, hipped slate roof, stack E end wall. Ground floor, C19 door. 3 C19 sash. First floor, 2 similar sashes. Rear, E elevation, N and S wings projecting with additional linking sections to rear masking original house. S wing timber-framed and rendered. Ground floor, one French window same style as on S elevation. First floor, two sash windows. Central dormer with sash window. 2 other dormers. Linking section timber-framed, rendered with slate roof. 2 sash windows, one above another, lower window larger. N wing plain, colour-washed brick end wall with stack and hipped roof. C20 line of garages attached on ground floor. N elevation, long colour-	Medium

Reference	Name	Description	Value
		washed brick side wall of N wing, continuous hipped roof, 3 stacks. Irregular sash windows to W. Early C19 door with fanlight. Adjacent single storey extension to W. Garden wall C18 brickwork extends from the house to S then Ealong Wigley Bush Lane.	
1208794	Granary 18 metres south of Wealdcote (Grade II Listed Building)	Granary. c1800. Timber-framed, weatherboard, peg-tiled pyramidal roof. Square plan, on brick piers. N side, door of boards. S side, C20 double doors, C20 casement window on W side. Walls have secondary strengthening by internal brick infilling up to half height.	Medium
1292971	The Old Post Office and attached Railings (Grade II Listed Building)	House. Early C19, C20. Timber-framing, rendered, brick, slate roof. Plan truncated circle segment, curved frontage following the road corner. 2 storeys with end wall stacks. Front, NW elevation, curved wall in rendered timber-framing with end buttresses. 3 window range, all cast-iron casements. Ground floor, two windows with upper transom. Early C19 door between. C20 door-case with flat hood, early C19 style. First floor, 3 windows. NE garden elevation, early C19 red brick gable end wall. Central stack. Ground floor, French window. C20 red brick single-storey addition on NE corner with balcony above. Ground floor, one casement and door. Front iron railings continuous with those at The Cottage, Luptons, Wealdcote and granary, The Cottage, The Old Post Office and the Tower Arms.	Medium
1297219	Wealdcote (Grade II Listed Building)	House. Early C16, C17, C18, C20. Timber-framed, plastered and rendered, brick, peg-tiled roofs. Plan has early C16 long principal range with 2 rear projecting C17 and C18 wings. 2 storey and attic. W front elevation has continuous early C16 jetty supported at S end by C18 gable end wall. 3 window range, all casements. Ground floor, S-N, 2 windows with double casements. 2 small C20 single casement windows sit in C18 frames, C18 front door between. 2 jetty joists over doorway suggest this to be an original door site. S elevation, complex of rear ranges, E-W, gable end of jettied range, rebuilt in early C18 in red brick, gable weatherboard, central stack, ground floor, lean-to porch with C20 French window, first floor, C20 casement, and a blocked window. To W, C18 projecting brick wing, simple timber porch with lean-to hipped roof, C20 door. Behind roof, principal stack, lateral to C16 block. To W, C17 N rear wing, timber-framed, rendered on ground floor, weatherboard above. Ground floor, two casement windows, first floor, one window, lateral stack to block, rebuilt C20, visible above roof apex. To W continuation of the range with C18 smaller unit, brick and weatherboard, end gable stack, ground floor, 2 doors and windows. W elevation, C16 range has ground-floor casement window, first floor has two casements. 2 dormer windows with gabled roofs. N elevation, C16 range, weatherboard. 5	Medium

Reference	Name	Description	Value
		casements: 3 ground floor, 2 first floor. Restored attic, window in gable. To W C17 wing, rendered and weatherboard, one casement window, old stack, totally rebuilt in C20, to W smaller block, weatherboard with two C20 casement windows.	
1297259	The Bull Inn (Grade II Listed Building)	Public house. c1600, c1900. Timber-framed and plastered, brick end extensions, roofed with C20 flat tiles. Rectangular plan. 2 storey. Principal unit to W, 4 window range, three 2-storey bays, minor unit to E set back with lower roof, 3 window range. Gable stacks at W end and at junction of units. Front, S elevation, ground floor, sash casement and bay windows, doors with flat hood. First floor, 3 bay windows with simple sashes, 2 simple casement windows, blocked window between. Rear, N elevation, principal block has three C19-C20 additions, 2 units with lean-to roofs and one flat roofed. Sash and casement windows, one set in older frame. E minor unit has rear and side lean-tos and C20 shed. Front bay windows inserted within each original bay. The W old front door probably denotes the service-cross entry.	Medium
1000747	Weald Park (Grade II Registered Park and Garden)	Until the Dissolution, manor of South Weald belonged to Waltham Abbey. Deer park formed during the C12. Henry VIII sold the manor to Sir Brian Tuke who built an H-plan hall just to the NW of the church. A NW wing was added post 1548. A painting from the late C17 or early C18 shows the hall surrounded by walled courtyards. Improvements to hall and grounds during C18. Map commissioned 1738 records formal walled gardens, Belvedere tower on a mount surrounded by a wilderness, and an extensive formal park landscape. Late C18 park extended to the N, water deformalised, and further changes to the hall made 1778 (Robert Adam). Park extended S in C19. The estate sold and broken up in 1940s. The hall was demolished in 1951, leaving C19 granary and C16 Chapel. In 1953 the park, excluding the C19 addition to the S, bought by Essex County Council who turned it into a country park. Weald Park is c212ha and is bounded to the N by farmland, to the E by Sandpit Lane, to the SE by Wiggly Bush Lane in South Weald village, and to the W by Lincoln's Lane and farmland. The gently rolling land falls to a shallow valley across the centre of the park with a string of C18 lakes formed from a stream running from NE to SW. The park enjoys a rural setting despite its close proximity to Brentwood. There are three late C20 entrances off Lincoln's Lane: one at the S end close to South Weald village following the line of the late C18 drive; the second c100m to the N; and the third just to the S of the C19 West Lodge. None of the C19 maps show a drive connected to West Lodge, suggesting that it was either abandoned or that West Lodge marked the N perimeter of the park. A	Medium

Reference	Name	Description	Value
		fourth, late C20 drive enters Weald Park off the S boundary. Garden and pleasure grounds to the E of the hall site survive today as earthworks and one set of brick steps, from the C19 terraced formal garden, edged by a ha-ha wall on its E boundary. Some of the late C19 planting survives. Only the base of the Belvedere Tower remains. The area immediately NE of the hall site represents the area of the C12 deer park. It remains under grass, scattered with trees, retaining its historic character. To the N of the hall site, covering the W half of the park, a more open character, with fewer trees of mainly C19 origin. The NE quarter of the park is heavily wooded and known partly as The Forest. This is cut through with rides and paths, one of which survives from the early C18. The walled kitchen garden lies NW of the hall site; no longer used for cultivation it is partly given over to a service yard for the park. A range of C19 glasshouses survives on the inside N wall. Part of this area at least seems to be survive from the C17 formal layout, the walls dating from the C17, C18, and C19.	
22821	South Weald Conservation Area	The village of South Weald contains a number of historically significant buildings, many of which are designated as listed buildings. A compact small historical hamlet, the village has not suffered from extensive modern development, and maintains its historic integrity. In spite of its relative proximity to the M25, the village has maintained a secluded setting away from the larger sprawling settlements of Brentwood and Harold Park. The Conservation Area borders the Weald Park Conservation Area to the north.	Medium
22829	Weald Park Conservation Area	The Weald Park Conservation Area has the same boundary as the Weald Park Registered Park and Garden (see above). Though changes have been made to the built and designed landscape environment of the parkland over the centuries, the area maintains much of its historic character, and continues in use as a public country park today. The Conservation Area borders the South Weald Conservation Area to the south.	Medium

In addition to the designated assets, the study area also contains 39 non-designated assets. These non-designated assets are of low or negligible value. The non-designated assets are listed in a gazetteer in Appendix E. Non-designated assets are referred to with their HER asset numbers which correspond to those used in the gazetteer in Appendix E and Figure 7.1 in Appendix E.

The non-designated assets recorded on the HER within the study area consist of a mixture of non-designated historic buildings, areas of historic woodland, and archaeological sites. In summary, these include:

- The course of the Roman Road from London to Chelmsford and Colchester (HER 565)

- A medieval leper hospital site near Shenfield Road (HER 562), the medieval settlement of South Weald (HER 19297), the site of a medieval manor house (HER 19299)
- Post-medieval domestic and farm buildings (HERs 563, 564, 19298, 27379, 27455), 18th and 19th century landscape features within Weald Park (HERs 19624, 19626) 19th century nineteenth century hospital schools (HERs 15388, 17778), a Victorian silt trap (HER 16127)
- Military installations dating from the Second World War (HERs 20238, 20239, 20241, 20242, 20243)
- A number of areas of historic woodland (HERs 45512, 45514, 45516, 45517, 45518, 45520, 45540)
- In addition, the HER also records a number of archaeological findspots, including a Mesolithic axe (HER 584), a Roman ring finger (HER 587), and medieval and post medieval findspots (HERs 45443, 52320, 52323). Findspots are not assets in themselves, as there cannot be impacts on archaeological finds which have been removed. However, they provide evidence of the potential for unknown archaeological deposits within the study area.
- The specific age of a number of the areas of historic woodland are not known, according to their HER entries. As such, those of unknown date have been ascribed a low value, in accordance with the DMRB approach for non-designated assets. Further detail on areas of ancient woodland are found in Section 6 Landscape and Section 8 Nature Conservation.

7.5 Regulatory/Policy framework

The National Planning Policy Framework (NPPF) was introduced in March 2012. It sets out national policy for the determination of planning applications and for plan making. Section 12 of the NPPF contains specific policy relating to the historic environment. It discusses how the importance of a heritage asset should be considered in the light of new development proposals. In any proposal there should be:

- A description of the significance of heritage assets, where the level of detail should be proportionate to the assets' significance and no more than is sufficient to understand the potential impact of the proposal on significance (NPPF, paragraph 128)
- Minimisation of any conflict between the preservation of the significance of the heritage asset and the proposal (NPPF, paragraph 129)
- Provision of a clear and convincing justification for the development (NPPF, paragraph 132); and
- Where there are potential adverse impacts to an asset, the harm should be weighed against the public benefits of the proposal (NPPF, paragraph 134)

Both of the local planning authorities in which the scheme options are located have planning policy (adopted or emerging) which is of relevance to the assessment of significant effects on cultural heritage. In summary, these are:

Brentwood Borough Council Replacement Local Plan

Policy C9 'Ancient Landscapes and Historic Parks and Gardens'. This states that development should seek to conserve and enhance ancient landscape and designated parks and gardens, development damaging the character of such assets will not be permitted.

Policy C14 'Development Affecting Conservation Areas'. This identifies that development within and in the vicinity of conservation areas should preserve or enhance their character or appearance

Policy C16 'Development within the Vicinity of a Listed Building'. This states that development should not detract from the character of setting of a listed building.

Policy C18 'Ancient Monuments and Archaeological Sites'. This identifies that important archaeological sites or monuments, whether designated or not, should be preserved as should their settings in the event of development which may impact on them or their settings. Archaeological work should be carried out in cases where proposed development would affect such sites.

London Borough of Havering Local Development Framework Core Strategy

Policy CP18 'Heritage' identifies that all new development which affects sites or buildings, landscapes or townscapes, considered of special architectural, historical or archaeological importance must preserve or enhance their character or appearance.

7.6 Design, mitigation, enhancement and monitoring measures

There are opportunities to introduce mitigation and enhancement measures into the scheme design, and the management of the scheme. These include:

- The maintenance, enhancement or replacement of existing vegetation screening along the M25 and A12 to ensure that any operational impact following completion of the scheme on the setting of heritage assets is reduced;
- Minimising the size of signage along the route, and ensuring it is sympathetic to any surrounding screening, which can prevent the introduction of further impacts on the setting of heritage assets within view of the scheme route. This could constitute the installation of roadside signage as opposed to gantry signs, or the painting of highways equipment to complement vegetation screening;
- The installation of noise fencing along the scheme route which could reduce the level of harm from increased traffic noise on the setting of heritage assets;
- Minimising the height of viaducts within the scheme designs which can reduce the level of harm on heritage assets within view of these sections of the scheme route; and
- Compliance with best practice guidance during the construction phase to reduce the level of harm to the setting of heritage assets. For example, keeping construction plant and hoardings to a minimum within the vicinity of assets would reduce the temporary impacts of such work on their settings.

Prior to construction, a Construction Environmental Management Plan (CEMP) would be compiled to provide guidance on specific areas during the construction process. This would detail both generic and specifically targeted instructions to enable construction to be undertaken with minimal impact on the environment, including the cultural heritage resource.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

7.7 Potential effects

As per the DMRB methodology, impacts are defined as changes to the cultural heritage resource caused by the mitigated scheme. It should be noted that while details of the construction activities are not currently available at this stage, an indicative assessment of the construction stage impacts has been made below.

Option 2

The construction of Option 2 would have the potential to negatively impact on Weald Park Registered Park and Garden (Grade II NHLE 1000747) and the Weald Park Conservation Area (22829), assets of medium value. The edge of the designated area of the parkland is located approximately 400m to the north of the northern edge of the option route. Though views of the scheme would be screened by areas of woodland, additional traffic noise in addition to temporary construction noise and dust may be introduced into the setting of the assets. This would result in both temporary and permanent minor adverse impacts, resulting in slight adverse effects on both assets, which are not significant.

The option route is located approximately 800m from the listed buildings within the village of South Weald, and South Weald Conservation Area. Due to screening from woodland, it is envisaged that the construction of Option 2 would have at most negligible temporary and permanent impacts on the setting of these assets of medium value. This would result in at most slight adverse effects, which are not significant.

The construction of Option 2 would have the potential to adversely impact on the non-designated Lower Belt Wood (HER 45517), an asset of low value. The realignment of Nags Head Lane would bring the movement of traffic and noise closer to the woodland. This would constitute a permanent minor adverse impact on the asset's setting, resulting in a slight adverse effect, which is not significant.

As with Option 1, there is the potential for impacts on unknown buried archaeology within the areas of land take and construction associated with the scheme, particularly those in areas which have not been developed previously. For Option 2, this would be particularly the on land to the north east of Junction 28, where previous disturbance of archaeological deposits is unlikely.

Option 4

As with Option 2, the construction of Option 4 would have the potential to negatively impact on the setting of Weald Park Registered Park and Garden (Grade II NHLE 1000747) and the Weald Park Conservation Area (22829). As with Option 2, temporary and permanent minor adverse impacts are anticipated, resulting in slight adverse effects on both assets, which are not significant.

The option route is located approximately 700m from the listed buildings within the village of South Weald, and South Weald Conservation Area. The alignment of the option route would result in an amount of the existing woodland screening being removed or negated, which would result in the introduction of traffic movement and noise, in addition to temporary construction noise and dust, into the setting of some of these assets. This would constitute temporary and permanent minor adverse impacts, resulting in slight adverse effects, which are not significant.

As with Option 2, the construction of Option 4 would have the potential to negatively impact on the non-designated Lower Belt Wood (HER 45517). As with Option 2, a permanent minor adverse impact is recorded, resulting in a slight adverse effect, which is not significant.

As with Option 6, there is the potential for impacts on unknown buried archaeology within the areas of land take and construction associated with the scheme, particularly

those in areas which have not been developed previously. For Option 4, this would be particularly the land to the north east of Junction 28, where previous disturbance of archaeological deposits is unlikely.

Options 5A, 5B, 5C and 5F

These will not result in any impacts on designated heritage assets.

As with Option 2, the construction of these options would have the potential to negatively impact on the non-designated Lower Belt Wood (HER 45517). As with Option 2, a permanent minor adverse impact is recorded, resulting in a slight adverse effect, which is not significant.

As with Option 6, there is the potential for impacts on unknown buried archaeology within the areas of land take and construction associated with the scheme, particularly those in areas which have not been developed previously. For Option 4, this would be particularly the land to the north west of Junction 28, where previous disturbance of archaeological deposits is unlikely. This may include the potential for Roman deposits associated with the Roman road along Brook Street (HER 565), as while archaeological remains are likely to have been removed within the road corridor, some associated with the road may remain in such undeveloped areas.

Option 5D and 5E

As with Option 2, the construction of Option 5D and 5E would have the potential to negatively impact on Weald Park Registered Park and Garden (Grade II NHLE 1000747) and the Weald Park Conservation Area (22829). The widening of the M25 carriageway at the north end of both Option 5.1 and 5.2, to accommodate the slip road to the eastbound A12, will be visible in views from Weald Park, impacting on its setting, including temporary construction noise and dust. Though the existing alignment of the M25 already appears in such views, this would constitute both a temporary and permanent minor adverse impact, resulting in slight adverse effects on both assets, which are not significant.

The option route is located approximately 900m from the listed buildings within the village of South Weald, and South Weald Conservation Area. Due to screening from woodland, it is envisaged that the construction of Option 5 would have at most a permanent negligible impact on the setting of these assets of medium value, resulting in at most slight adverse effects, which are not significant.

As with Option 1, there is the potential for impacts on unknown buried archaeology within the areas of land take and construction associated with the scheme, particularly those in areas which have not been developed previously. For Options 5A and 5B, this would be particularly the land to the north east and north west of Junction 28, where previous disturbance of archaeological deposits is unlikely. This may include the potential for Roman deposits associated with the Roman road along Brook Street (HER 565), as while archaeological remains are likely to have been removed within the road corridor, some associated with the road may remain in such undeveloped areas.

Option 6

The construction of Option 6 would have the potential to negatively impact on the setting of the Nag's Head Inn (Grade II NHLE 1197190), an asset of medium value. During construction of the proposed viaduct potential noise and dust during construction would alter the setting of the listed building, resulting in a temporary minor adverse impact on the setting of the listed building, resulting in a slight adverse effect, which is not significant.

The proposed viaduct spanning Brook Street, local businesses, A12 and Wigley Bush Lane, located approximately 200m from the Nag's Head, would be visible in views to

and from the listed building, though these may be filtered by vegetation. Even though a number of main roads already feature in the building's setting, the presence of the viaduct in views to and from the listed building would introduce additional traffic movement and noise into the setting of the asset. The construction of the viaduct would result in a permanent minor adverse impact on the setting of the listed building, resulting in a slight adverse effect, which is not significant.

The construction of Option 6 would potentially result in the removal of a small area of non-designated Jermains Wood (HER 45516), an asset of low value. The small area of woodland which may be removed means that this would only constitute a permanent minor adverse impact, resulting in a neutral adverse effect, which is not significant.

There is the potential for impacts on unknown buried archaeology within the areas of land take, and construction associated with the scheme. Along much of the route, it is highly likely that unknown archaeological deposits would have been removed by the construction of the existing road network. However, there is potential for unknown deposits to remain in areas which have not been developed. For Option 6, this is particularly the case with the construction of the proposed viaduct spanning Brook Street, local businesses, A12 and Wigley Bush Lane, where previous disturbance of archaeological deposits is unlikely. This may include the potential for Roman deposits associated with the Roman road along Brook Street (HER 565), as while archaeological remains are likely to have been removed within the road corridor, some associated with the road may remain in such undeveloped areas.

Conclusion

No significant effects are recorded in relation to the cultural heritage resource for any of the proposed scheme options. Permanent slight adverse effects are recorded in relation to at least one heritage asset for each of the proposed scheme options, except for Option 5B where no effects in relation to the cultural heritage resource are recorded. Option 5A does not record any effects on designated heritage assets.

For all the proposed scheme options, there is the potential for impacts on unknown buried archaeology in areas of land take and construction which have not been developed previously.

7.8 Limitations to assessment

The assessment of impacts on the setting of designated and non-designated assets has been conducted pending on site assessment.

The baseline assessment has been undertaken using existing data. The assessment of impacts and effects on this baseline is reliant on the sources of data outlined above. We are not responsible for the accuracy of this data, and though no errors within the data available have been identified, the assessment in this chapter is still reliant on its accuracy. There were limitations to the sources consulted for the baseline: paper records and grey literature held by Essex HER have not been consulted for this stage of the scheme assessment.

7.9 Summary and recommendations

No significant effects are recorded in relation to the cultural heritage resource for any of the proposed options. Minor effects are recorded on heritage assets for all the Options, except for Option 5B, where no effects on any heritage assets are recorded. The potential for impacts on unknown archaeological deposits is present for all Options.

It is recommended that a PCF Stage 2 assessment in relation to cultural heritage includes the following scope:

- Impact assessment of the frozen scheme design options.
- Built heritage setting assessment for both designated and non-designated built heritage assets.
- Assessment of historic mapping to inform the potential for archaeology, and identify more clearly the age of areas of woodland.
- Assessment of any available geotechnical data and reports for previous archaeological investigations to inform the potential for buried archaeology.
- Consultation with local authority conservation officers and archaeological advisors.

8 Nature Conservation

8.1 Introduction

This chapter describes the ecological baseline and evaluates the nature conservation value of ecological receptors (hereafter referred to as 'ecological features') present with the Ecological Zone of Influence (EZoI) for the proposed scheme. The potential impacts on ecological features are characterised, methods of avoidance, mitigation, compensation and enhancement are set out, and the significance of the residual effects of the proposed scheme on these ecological features is determined.

This assessment presented in this chapter has been undertaken with reference to Interim Advice Note (IAN) 130/10[2], current industry good practice for Ecological Impact Assessment (EcIA) produced by the Chartered Institute for Ecology and Environmental Management (CIEEM)[3], and the DMRB Volume 11, Section 2 Part 5[4].

Ecological information was obtained from a desk-study undertaken in January 2016 and a walkover survey undertaken in February 2016.

8.2 Assessment methodology

Desk study

In January 2016, up-to-date ecological records of the following were obtained from Greenspace Information for Greater London (GiGL), Essex Field Club (EFG), and Essex Wildlife Trust (EWT):

- Records of non-statutory designated sites - including locally designated Sites of Importance for Nature Conservation (SINC)[5] in Greater London and Local Wildlife Sites (LWS) in Essex; and
- Records of notable and legally protected species[6] (fauna and flora).

The Multi-Agency Geographic Information for the Countryside (MAGIC) website[7] (www.magic.gov.uk) was reviewed for information on designated sites of nature conservation importance (statutory sites only). These included:

- Internationally designated Special Areas of Conservation (SACs), Special Protection Areas (SPAs), and Wetlands of International Importance (Ramsar sites);
- Nationally designated Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR); and
- Locally designated Local Nature Reserves (LNR).

MAGIC was also used to identify notable habitats[8] and ancient woodland.

[2] Highways Agency (2010) *Ecology and Conservation: Criteria for Impact Assessment.* Interim Advice Note 130/10. HA, Bristol
[3] Chartered Institute of Ecology and Environmental Management (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal 2nd edition.* CIEEM, Winchester
[4] Highways Agency (2008) Assessment and Management of Environmental Effects. *Design Manual for Roads and Bridges,* Volume 11, Section 2, Part 5. HA, Manchester
[5] SINCs in Greater London are classified into four categories: Sites of Metropolitan Importance (SMI); Sites of Borough Importance Grade 1 (SBI Grade 1); Sites of Borough Importance Grade 2 (SBI Grade 2); and Sites of Local Importance (SLI).
[6] Notable species are those determined as Species of Principal Importance (SPI), listed under Section 41 of the Natural Environment and Rural Communities Act (2006); any species listed under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended); any species listed under Annex II or Annex IV of the Habitats Directive (1992); any species listed in an IUCN Red Data Book; and any other species listed under a local Biodiversity Action Plan (London BAP, LB Havering BAP or Essex BAP), or as national or county rare or scarce.
[7] *www.magic.gov.uk*
[8] *Notable habitats are those determined as Habitats of Principal Importance (HPI), listed under Section 41 of the Natural Environment and Rural Communities Act (2000).*

The extent of the Study Area for ecological features used during the desk study is defined in Section 8.3.

Ordnance Survey (OS) maps were used to initially identify the presence of water bodies within 500 m of the proposed scheme, in order to establish if the land within and immediately surrounding the proposed scheme could be used as terrestrial habitat for great crested newts (*Triturus cristatus*). This species typically uses suitable terrestrial habitat up to 500 m from a breeding pond[9]. However, there is a notable decrease in great crested newt abundance beyond a distance of 250 m from a breeding pond[10].

The Havering Nature Conservation and Biodiversity Action Plan[11] and Essex Biodiversity Action Plan (BAP)[12] were reviewed for details of priority habitats and species within those plans that may potentially be affected by the proposed scheme. A review of local planning policy relevant to the proposed scheme was also undertaken as part of the desk study.

Extended Phase 1 Habitat Survey

An extended Phase 1 habitat survey was undertaken in February 2016 broadly following the Phase 1 habitat survey methodology as set out in Joint Nature Conservation Committee guidance[13]. Accessible land within and adjacent to the proposed scheme (the Survey Area, see Section 8.3 for extent) was surveyed according to current good practice guidance[14]. Plant names recorded in this survey follow *The New Flora of the British Isles*, Third Edition[15].

The extended Phase 1 habitat survey recorded the following information on notable or protected species within the Survey Area:

- Potential roosting sites for bats within trees and structures, identified from the ground only;
- The potential of terrestrial and aquatic habitats to support great crested newts;
- Signs of badger (*Meles meles*) activity including setts, tracks, forage marks and latrines;
- The suitability of habitats for nesting birds (including any old nests);
- The suitability of habitats for common species of reptile – adder (*Vipera berus*), grass snake (*Natrix natrix*), slow worm (*Anguis fragilis*) and common lizard (*Zootoca vivipara*);
- The suitability of watercourses for water vole (*Arvicola amphibius*), otter (*Lutra lutra*) and white-clawed crayfish (*Austropotamobius pallipes*);
- The suitability of woodland and scrub habitats for hazel dormouse (*Muscardinus avellanarius*); and
- The suitability of habitats for notable invertebrates.

[9] English Nature (2001). *Great Crested Newt Mitigation Guidelines*.
[10] *Natural England (2004).* An assessment of the efficiency of capture techniques and the value of different habitats for the great crested newt *(ENRR576). http://publications.naturalengland.org.uk/publication/134002.*
[11] *London Borough of Havering (2014). Havering Nature Conservation And Biodiversity Action Plan (2014-16). Appendix to* Havering Local Development Framework: Protecting and Enhancing the Borough's Biodiversity Supplementary Planning Document*, Adopted May 2009.*
[12] *Essex Biodiversity Project (2011).* Essex Biodiversity: The Essex Biodiversity Action Plan 2010 – 2020*.*
[13] *Joint Nature Conservation Committee (2010).* Handbook for Phase 1 habitat survey - a technique for environmental audit*. JNCC, Peterborough.*
[14] *Chartered Institute of Ecology and Environmental Management (2012).* Guidelines for Preliminary Ecological Assessment*. CIEEM, Winchester*
[15] *Stace C.E. (2010).* New Flora of the British Isles, 3rd edition*. Cambridge University Press.*

Nature conservation evaluation / value / sensitivity

Accepted criteria[16] were used to assess the nature conservation value of a defined area of land (*e.g.* diversity, rarity and naturalness). The nature conservation value or potential value of an ecological feature was determined within the following geographic context:

- International – such as SAC, SPA and Ramsar sites;
- National – such as SSSI and NNR;
- Regional – such as Environment Agency regional biodiversity indicators, important features in Natural England Natural Areas;
- Metropolitan (*i.e.* Great London) or County (*i.e.* Essex) – such as Sites of Metropolitan Importance, LWS;
- Borough – such as Sites of Borough Importance (grade 1 or 2) in London Borough of Havering
- Local (parish) – such as LNR, Sites of Local Importance, or undesignated ecological features such as old hedges, woodlands and ponds;
- The proposed scheme boundary – such as small ponds, marshy grassland, mature trees and species-rich hedgerow ; and
- Negligible e.g. areas of hardstanding and amenity grassland.

Ancient woodland and notable habitats have also been valued on the scale above using the Ratcliffe criteria based on professional judgement of a qualified ecologist. Populations of notable species effected by the proposed scheme are also attributed a value if, based on professional judgement, it is considered appropriate.

Impact assessment

The significance of effects on ecological features identified has been categorised where appropriate according to Highways England Interim Advice Note (IAN) 130/10. This IAN allows characterisation of impacts and determination of effects which are significant following CIEEM guidance, with the significance of effects categorised according to Table 3 in IAN 130/10. For instance, where there is no significant effect predicted, the significance is referred to as 'neutral'. Significant effects are categorised on a scale from 'slight' to 'very large'.

The assessment of the potential effects of the proposed scheme has taken into account both effects within the proposed scheme and those that may occur to adjacent and more distant ecological features. Impacts can be permanent or temporary, positive or negative and can include:

- Direct loss of wildlife habitats;
- Fragmentation and isolation of habitats;
- Disturbance to species from noise, light or visual stimuli;
- Changes to key habitat features; and
- Changes to the local hydrology, water quality and/or air quality.

Significance of effects is likely to be neutral where features of low value or sensitivity are subject to small or short-term impacts. However, if a number of small scale effects

[16] *set out in Ratcliffe (1977)* A Nature Conservation Review. *Cambridge University Press.*

occur that are not significant alone, an assessment has been made as to whether, cumulatively, these may result in an overall effect of greater significance.

For designated sites, effects were considered significant if the potential effects of the proposed scheme is likely to either undermine (or support) the conservation objectives or condition of the site(s) and its features of interest.

For habitats, which may constitute either whole or in part an ecosystem, effects were considered significant if the potential effects of the proposed scheme is likely to result in a change in ecosystem structure and function.

Consideration was given to whether:

- Any processes or key characteristics of the ecosystem would be removed or changed;
- There will be an effect on the nature, extent, structure and function of component habitats of the ecosystem; and
- There is an effect on the population size and viability of component species within an ecosystem.

Functions and processes acting outside the formal boundary of a designated site were also considered, particularly where a site falls within a wider ecosystem *e.g.* wetland sites.

Some ecosystems can tolerate a degree of minor changes, such as localised or temporary disturbance or changes in physical conditions, without such changes harming their function or value. Ecological effects were considered in the light of any information available about the resilience of ecosystems to accommodate change.

The conservation status of undesignated habitats and species within a defined geographical area is described as follows:

- For habitats, conservation status was determined by the sum of the influences acting on the habitat that may affect its extent, structure and functions as well as its distribution and its typical species within a given geographical area; and
- For species, conservation status is determined by the sum of influences acting on the species concerned that may affect its abundance and distribution within a given geographical area.

The conservation status was used to determine whether the effects of the proposed scheme options on habitat or species are likely to be significant.

In assessing the potential effects on conservation status, the known or likely background trends and variations in status have been taken into account. The level of ecological resilience or likely level of ecological conditions, that would allow the population of a species or area of habitat to continue to exist at a given level, or continue to increase along an existing trend or reduce a decreasing trend, was estimated where appropriate to do so.

The proposed mitigation measures described within Section 8.6 have been taken into account in the assessment of the residual significance of effects. These mitigation measures include those required to achieve the minimum standard of established good practice together with additional measures to further reduce any negative impacts of the proposed scheme.

The mitigation measures also include those required to reduce or avoid the risk of committing legal offences.

In addition to measures required to ameliorate negative impacts on valued ecological features, further biodiversity enhancement measures have been identified to be

incorporated into the proposed scheme as it is progressed in accordance with the Highways England Biodiversity Action Plan[17].

Where species are protected by law (see 8.4.4 and refer to Appendix F for a summary of relevant nature conservation legislation), specific impacts on individuals including direct harm to species were considered in the impacts assessment; in order to identify any potential activities associated with the proposed scheme that may lead to an offence with respect to protected species.

8.3 Study area

The Study Area was determined by the predicted Ecological Zone of Influence (EZoI), which is area in which there may be ecological features subject to impacts and subsequent effects as a result of the proposed scheme. The extent of the EZoI was reviewed throughout the assessment.

The EZoI used to inform the desk study and walkover survey was based on the proposed scheme area boundary (which encompasses the proposed extent of the combined option designs, as shown on Figures 8.1 and 8.2 in Appendix F), with assumptions made of the potential construction and operation effects based on available information including an initial review of the landscape surrounding the proposed scheme. The EZoI was reviewed once the survey was complete, and records received for the desk study, and considered appropriate for the assessment.

The EZoI was used for the assessment of impacts and potential effects on ecological features reported in this chapter.

The EZoI also encompasses potentially beneficial effects of habitat creation and establishment of new ecological networks.

Depending on their relative importance for nature conversation (and the mobility of related species), information on designated sites was sought from within the following search areas (measured from the limits of the proposed scheme options):

- 30 km for SACs where bats are one of the qualifying species (DMRB guidance[18] recommends this wide search area due to the mobility of bats);
- 2 km for other statutory designated sites; and
- 1 km for non-statutory designated sites and ancient woodland.

Based on the predicted extent of impacts on habitats and species, and the mobility for certain species, information was sought from the following search areas:

- 5 km for records of bat roosts;
- 500 m for water bodies that may potentially be used as breeding ponds by great crested newts; and
- 500 m for notable habitats, and all other notable or legally protected species.

The Survey Area for the extended Phase 1 habitat survey included accessible land within the footprint of the proposed scheme options and adjacent land up to 50 m.

[17] Highways England (2015) *Our Plan to Protect and Increase Biodiversity.* HE, Guildford
[18] *Highways Agency (2009)* Design Manual for Roads and Bridges *Volume 11, Section 4 Part 1 :Assessment of Implications on European Sites. HD 44/09*

8.4 Baseline conditions

Designated sites

There is one statutory designated site located within 2 km of the proposed scheme options (see Appendix F). This site is The Manor LNR, the closest point of which is approximately 940 m east of Junction 28 at central grid reference TQ555923. A summary of the features of this site is provided in Table 8-1 below.

Table 8-1 Summary of statutory designated sites within 2 km of the proposed scheme

Site name	Approximate distance and direction from junction	Description	Area	Grid reference
The Manor LNR	940 m to the west	Supports wildflower meadows, ancient coppiced woodland, ponds, scrub, and veteran trees. Species recorded include great crested newts, harvest mouse (*Micromys minutus*), bumblebees, stag beetle (*Lucanus cervus*), green woodpecker (*Picus viridis*), house martin (*Delichon urbica*), skylark (*Alauda arvensis*) and song thrush (*Turdus philomelos*).	60 ha	TQ555923

There are 26 non-statutory designated sites located within 1 km of the proposed scheme options. These are summarised in Table 8-2 below.

Table 8-2 Summary of non-statutory designated sites within 1 km of the proposed scheme

Site name	Approximate distance and direction from junction	Description	Area	Grid reference
Ingrebourne Valley SMI	Immediately adjacent	A riparian corridor that leads down to Rainham Marshes, including extensive reedbeds, lakes, and wet grasslands that support an exceptional wetland invertebrate and bird fauna. The upper reaches are largely wooded. A good population of water voles is present throughout.	263 ha	TQ538842
Dagnam Park and Hatter's Wood SMI	1.3km north-west	An historic landscaped park with ancient woodland, a variety of grassland habitats, and ponds. The ponds support important populations of amphibians, including great crested newt. The site is important for its breeding and wintering birds, including skylark, yellowhammer (*Emberiza citronella*), hawfinch (*Coccothraustes coccothraustes*), jackdaw (*Corvus monedula*) and various thrushes.	75 ha	TQ550930
Lower Vicarage Wood LWS	400m north-east	A large ancient woodland with overgrown hornbeam (*Carpinus betulus*) coppice and frequent	6.1 ha	TQ569929

Site name	Approximate distance and direction from junction	Description	Area	Grid reference
		standards of pedunculate oak (*Quercus robur*).		
The Oaks LWS	575m north	Mixed deciduous woodland dominated by pedunculate oak.	14 ha	TQ566930
Vicarage Wood LWS	800m north-east	Ancient woodland with overgrown hornbeam coppice and pedunculate oak standards.	4.2 ha	TQ570932
St Faith's/Honeypot Lane Meadows LWS	1.9 km north-east	This site comprises extensive grassland, hedgerow and streamside habitat.	15.6 ha	TQ586937
High Wood LWS	2.7 km north-east	The main body of this wood is ancient, although the eastern tip is of more recent origin.	4.9 ha	TQ582950
St Charles Nature Reserve	2.5 km north-east	This site is a remnant of old woodland now in a predominantly urban environment.	0.4 ha	TQ587942
Jackson's Wood and Tyler's Shaw LWS	1.3km south	Ancient woodland formed of hornbeam coppice with scattered ash (*Fraxinus excelsior*) and pedunculate oak standards.	4.4 ha	TQ574908
Warley Country Park LWS	1.3km east	Lowland mixed deciduous woodland and scrub interspersed by grassy glades. Marshy grassland is present in the north section.	25 ha	TQ584924
Bachelor's Walk Woods LWS	1.5km south-east	Two sections of streamside woodland The northern section has a canopy dominated by hornbeam coppice with pedunculate oak standards, whilst alder (*Alnus glutinosa*) is found in by the stream. Ground flora is typical of ancient woodland.	1.4 ha	TQ582916
Weald Country Park LWS	1.8km north-east	Lowland mixed deciduous woodland, lowland dry acid grassland, wood-pasture and parkland.	139 ha	TQ570947
La Plata Grove LWS	2.1 km east	This woodland close to the centre of Brentwood has a variety of tree species and supports a sizable population of a threatened Essex plant.	1.7 ha	TQ587932
Warley Place LWS	1.9km south-east	A former house and gardens with native trees and woodland ground flora, and exotic trees, shrubs and herbs.	10 ha	TQ583909
Foxburrow Wood LWS	2 km south	This large ancient wood has suffered losses to the construction of the M25 and also expansion of	6.9 ha	TQ575902

Site name	Approximate distance and direction from junction	Description	Area	Grid reference
		the grounds of the adjacent Foxburrow house		
Coombe Wood LWS	2.2 km south-east	The woodland's diverse habitat structure supports important ancient woodland species.	7.9 ha	TQ579901
Tylers Common SBI Grade 1	1.6km south	A large common with a good range of wildlife habitats, with some uncommon plants. Habitats present include acid grassland, hedgerow, lake, scrub, semi-improved neutral grassland, and unimproved neutral grassland. The site supports a range of common butterflies including common blue (*Polyommatus icarus*), Essex skipper (*Thymelicus lineola*) and meadow brown (*Maniola jurtina*), and breeding birds including skylark and meadow pipit (*Anthus pratensis*).	29 ha	TQ566905
Long Wood and Sage Wood SBI Grade 1	1.8km west	A large area of ancient woodland likely to support a good assemblage of woodland birds and invertebrates.	4.3 ha	TQ544922
Duck Wood SBI Grade 1	1km west	A large ancient woodland, with a series of ponds that are valuable for amphibians. Breeding birds include sparrowhawk (*Accipiter nisus*), woodpeckers, bullfinch (*Pyrrhula pyrrhula*) and hawfinch. In addition the wood supports several notable invertebrates.	10 ha	TQ555923
Carter's Brook and Paine's Brook SBI Grade 2	2 km west	Two streams lined with woodland and grassland, forming a valuable green corridor across the north of Havering. Considered to be of use by bats, birds, invertebrates and water voles.	12 ha	TQ541929
Tylers Hall Pond SBI Grade 2	1km south	A large pond with a good range of aquatic plants.	0.9 ha	TQ566913
Jermains Wood SBI Grade 2	1.3km south	An ancient woodland providing invertebrate and breeding bird habitat.	7.3 ha	TQ570908
Bourningwood Fields SBI Grade 2	1.8km south-west	Semi-improved neutral grassland surrounded by mature native hedgerows. Habitats present are of value to breeding birds and invertebrates.	7.0 ha	TQ557906

Site name	Approximate distance and direction from junction	Description	Area	Grid reference
Romford to Harold Wood Railsides SBI Grade 2	940m south-west	Marsh/swamp, scrub, secondary woodland, semi-improved neutral grassland, and tall herbs alongside a railway that provide a wildlife corridor.	28 ha	TQ531894
Shoulder of Mutton Wood SLI	1.6 km west	A small ancient woodland with a wet ditch running from east to west across the site.	2.2 ha	TQ551919
Folkes Lane Woodland SNCI	2 km south	Ancient woodland.	2.1 ha	TQ573902

Ancient woodland

There are ten ancient woodlands within 1 km of the proposed scheme. These are listed in Table 8.3 below.

Table 8-3 Summary of ancient woodland parcels within 1 km of the proposed scheme

Site name	Approximate distance and direction from junction	Area (ha)	Grid reference
Lower Vicarage Wood	400 m north-east	5.8 ha	TQ570928
Vicarage Wood	800 m north-east	4.2 ha	TQ571932
Duck Wood	1 km west	9.5 ha	TQ556923
Jackson's Wood	1.3 km south	4.4 ha	TQ574908
Fir Wood	1.3 km north-west	3.4 ha	TQ556930
Shoulder of Mutton Wood	1.6 km west	1.9 ha	TQ551919
The Osiers	1.6 km north-west	4.2 ha	TQ555935
Folkes Lane Woodland	2 km south	2.1 ha	TQ573902
Coombegreen Wood	2 km south	17 ha	TQ575902
High Wood	2.7 km north-east	4.9 ha	TQ582950

Habitats

A review of the MAGIC website identified two potential Habitats of Principal Importance (HPI) located within 500 m of the proposed scheme. These are lowland mixed deciduous woodland, hedgerows, rivers and ponds.

The main habitats[19] recorded within the Survey Area during the extended Phase 1 habitat survey undertaken in February 2016, were:

- Broadleaved semi-natural woodland;
- Scrub (continuous and scattered);
- Scattered trees;
- Semi-improved grassland;

[19] *Based on Phase 1 habitat types published in JNCC, 2010.*

- Improved grassland;
- Tall ruderal;
- Standing water (ponds); and
- Running water.

The broadleaved semi-natural woodland habitat recorded within the Survey Area during the extended Phase 1 habitat Survey is in part regarded as HPI.

The London Borough of Havering BAP priority habitats: woodlands, hedgerows, and ponds and lakes; and Essex BAP priority habitats: hedgerows, ponds and rivers, were also identified within the survey area.

Habitats within the Junction

The land central to Junction 28, beneath the M25 overpass, and between the main carriageways of the A12/M25 and their slip roads, was comprised of young broadleaved woodland and scattered scrub. The broadleaved woodland canopy was dominated by ash, with abundant pedunculate oak, frequent silver birch (*Betula pendula*), and hazel (*Corylus avellana*). Scrub species were dominated by blackthorn (*Prunus spinosa*), with frequent bramble (*Rubus fruticosus* agg.), hawthorn (*Crataegus monogyna*), dog rose (*Rosa canina*) and dogwood (*Cornus sanguinea*). The ground flora was mostly dominated by semi-improved (species-poor) grassland and tall ruderal vegetation. Grass species included Yorkshire fog (*Holcus lanatus*), cock's-foot (*Dactylis glomerata*), common bent (*Agrostis capillaris*), meadow grasses (*Poa* species) and fescues (*Festuca* species), interspersed with frequent teasel (*Dipsacus fullonum*) and common nettle (*Urtica dioica*).

A wide band of bare ground was located directly beneath the M25 overpass, between the broadleaved woodland and scrub mosaic.

The land surrounding Junction 28 is described below in four quadrants, referring to north-east, south-east, south-west and north-west.

North-east Quadrant

The north-east quadrant contains agriculturally improved grassland bordered by ancient woodland 320 m further east and broadleaved woodland 480 m to the north. A further narrow band of broadleaved woodland is located along the clockwise verge of the M25 immediately north of the junction. A line of mature trees, mainly pedunculate oak and silver birch follows a wet ditch adjacent to the eastbound carriageway of the A12 immediately east of the junction. The mature trees were fronted by continuous blackthorn scrub and semi-improved grassland interspersed with tall ruderal vegetation.

Approximately 800 m to 1 km north-east of the junction are small fields of improved grassland separated by hedgerows, and a number of dwellings. There are at least four ponds within fields east of Wigley Bush Lane, and a further two (one of which appears to be a newly constructed fishing lake) east of Weald Park Way.

South-east Quadrant

The south-east quadrant is intersected by the A1023 Brook Street. Between the A12 carriageway and services on A1023 Brook Street is a large area of dense bramble scrub 100 m east of the junction. Improved grassland, hedgerow, scattered trees and scrub are also present in this quadrant. Scattered trees surround the buildings that are associated with the services, 70 m east of the junction, and include species such as horse chestnut (*Aesculus hippocastanum*), pedunculate oak, Lombardy poplar (*Populus nigra* 'Italica') and willow (*Salix* species). Two disused residential dwellings are present; adjacent to the services and 'The Poplars', located approximately 30 m

east of the junction. Semi-improved (species-poor) grassland and tall ruderal vegetation occupy the Brook Street roadside verges 50 m east, which were consistent in distribution and species composition throughout the survey area. South of Brook Street are improved pasture fields with hedgerows.

The Great Eastern Mail Line railway, which runs west to east crosses the M25 280 m south of Junction 28. The railway embankment is mainly wooded, with patches of dense bramble scrub.

Further south of the railway line are houses and gardens on Nags Head Lane and arable fields to the east of the M25. The M25 forms a wide cutting south of Nags Head Lane overbridge, 570 m south of the junction, which is predominately semi-improved neutral grassland, with scattered-dense scrub and new plantation of broadleaved trees towards the top of the slope.

South-west Quadrant

The south-west quadrant is mainly comprised of improved and semi-improved grassland, a wet ditch, hedgerows, continuous scrub, scattered mature trees and two ponds. One pond is situated 220 m west of the junction, within a field and surrounded by scattered trees; and the other is a balancing pond for the M25, located 170 m south of the junction (and 35 m west of the M25) is dominated by common reed (*Phragmites australis*).

The A12 west of the junction is bordered by a continuous line of blackthorn-dominated scrub with frequent mature cherry (*Prunus* species) trees. Between improved and semi-improved grassland and residential housing 380 m further west, is a large parcel of broadleaved woodland, scrub and grassland mosaic, which also contains the Ingrebourne River.

South of the junction and west of the M25 are arable and improved grassland fields separated by hedgerows, as well as houses and gardens alongside Nags Head Lane.

North-west Quadrant

The north-west quadrant consists primarily of semi-natural habitats: broadleaved woodland, semi-improved grassland, and scattered scrub. The Ingrebourne River (known as the Weald Brook north of the A12) is 350 m west of the junction, and two ponds are present. The first is located 40 m from the junction at Grove Farm. The second is located 270 m west of the junction, obscured by the surrounding broadleaved woodland known as The Grove. A stream is also present adjacent to the A12, bounded by broadleaved woodland and scrub. North of Grove Farm is improved grassland adjacent to the M25 carriageway.

The Weald Brook flows through the north-west quadrant to where it becomes the Ingrebourne River south of the A12, 300 m west of Junction 28. The watercourse is shrouded by trees and has a slow flow rate. A narrow stream is present, which flows through the north-west and north-east quadrants adjacent to the A12 via a culvert beneath the north extent of Junction 28. The west extent of the stream is covered by dense broadleaved woodland and scrub. The eastern extent is more open and lined by mature trees, scrub and tall ruderal vegetation.

Notable and protected species

Notable plants

The desk study returned no records for nationally or locally notable[20] plant species within 500 m of the proposed scheme. However, two species: purple toothwort

[20] *Notable plant species are those determined as Species of Principal Importance, listed under Section 41 of the NERC Act (2006), any species listed under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended); any species listed under*

(*Lathraea clandestina*) and pepper saxifrage (*Silaum silaus*), recorded close to Grove Farm within 500 m of Junction 28, are listed on the Essex Red Data List[21].

The road verges were predominantly narrow and comprised of rough semi-improved (species-poor) grassland, tall ruderal, and scrub vegetation. It is considered unlikely that notable species or significant assemblages of notable plant species are present within the roadside or disturbed habitats surveyed immediately surrounding Junction 28.

The ecological legislation for protected species is provided in Appendix F.

Invertebrates

The desk study returned numerous records for notable invertebrates within 500 m of the proposed scheme; of those notable invertebrates recorded within 500 m of the junction, a total of five are SPI: wall (*Lasiommata megera*), small heath (*Coenonympha pamphilus*) and white-letter hairstreak (*Satyrium w-album*) butterflies; and shaded broad-bar (*Scotopteryx chenopodiata*) and latticed heath (*Chiasmia clathrata*) moths. These species are also London BAP priority species. Stag beetle, an SPI, London BAP priority, London Borough of Havering BAP priority and Essex BAP priority species, has also been recorded with 1 km of the junction. This species is also listed on the Essex Red Data List. No records of legally protected invertebrates were identified

The habitats immediately surrounding Junction 28 were not particularly suitable to support significant assemblages of invertebrates, due to their disturbed and young successional nature. However, individuals of notable species may be present within adjacent scrub, improved and semi-improved fields. Broadleaved and ancient woodland habitats have potential to support stag beetle and other notable invertebrate species. The tree species on which white-letter hairsteak is known to breed (elm species) was not recorded during the targeted ecological scoping survey. However, it may be present in broadleaved woodland within the survey area.

Weald Brook, Ingrebourne River and an unnamed stream have potential to support white-clawed crayfish, which is protected under the Wildlife and Countryside Act 1981 (as amended). However, no records of this species were identified from within 500m of the junction during the desk study.

Amphibians

The desk study returned no records of great crested newt within 500 m of the proposed scheme. The nearest record for great crested newt is 680 m to the north of the proposed scheme within Weald Country Park. Great crested newts are protected under the Conservation of Habitats and Species Regulations 2010 (as amended) and the Wildlife and Countryside Act 1981 (as amended). The species is also an SPI, London BAP priority, London Borough of Havering BAP priority, Essex BAP priority, and Essex Red Data List species.

The extended Phase 1 habitat survey identified suitable aquatic habitat for breeding great crested newts, including two ponds in the north-west quadrant, two ponds in the south-west quadrant, six ponds in the north-east quadrant, and a number of wet ditches and drains surrounding Junction 28, all within 500 m of the proposed scheme options.

Annex II or Annex IV of the Habitats Directive (1992); any species listed in a Red Data Book or Red List using IUCN criteria; and any other species listed under a local Biodiversity Action Plan (London BAP, LB Havering BAP or Essex BAP), or as national or county rare or scarce

[21] Criteria include those plant species that are: In the national Red Data List (where one exists); Nationally Scarce/Notable (where there is an available definition and list); Species which are rare, declining and/or subject to a high degree of threat in Essex (and not in either of the above categories).

Suitable terrestrial habitat for great crested newts is present adjacent to the M25 and A12 carriageways, including unmanaged grassland, tall ruderal and scrub in a mosaic, as well as continuous scrub. The land within each quadrant also contains hedgerows and parcels of broadleaved woodland with standing and fallen dead wood. These terrestrial habitats provide habitat connectivity to nearby ponds and offer suitable foraging and hibernation opportunities for great crested newts.

Suitable habitat, including ponds and terrestrial habitat, is present within the proposed scheme boundary for other notable amphibians, in particular common toad (*Bufo bufo*), which is an SPI and London BAP priority species, as well as common frog (*Rana temporaria*) and palmate newt (*Lissotriton helveticus*), which are also London BAP priority species.

Reptiles

The desk study returned records of grass snake and adder from within 500 m of the proposed scheme. Grass snake has been recorded within Maylands Golf Club (750 m west) and the Weald Brook (350 m west), which is within the proposed scheme boundary. Adders have been recorded at Jermains Wood approximately 100 m to the south of the proposed scheme. Common reptiles (including all those listed above) are protected under the Wildlife and Countryside Act 1981 (as amended). Grass snake and adder are SPI and London BAP priority species. Adder is also an Essex Red Data List species.

During the extended Phase 1 Habitat Survey it was identified that areas of unmanaged grassland, tall ruderal and scrub mosaic; continuous scrub; and young broadleaved woodland adjacent to the M25 and A12 carriageways offer suitable habitat for reptiles, including slow worm and common lizard, for which no records were identified during the desk study. These species are both SPI and protected under the Wildlife and Countryside Act 1981 (as amended). Slow worm is also a London BAP priority and London Borough of Havering BAP priority species. Common lizard is also a London BAP priority species.

Semi-improved grassland and scrub is present within the north-west quadrant between Grove Farm and Maylands Golf Club (approximately 300 m from the junction), and grassland and scrub to the south of the A12 approximately 400 m west of Junction 28 is also suitable for common reptiles. Parcels of broadleaved woodland containing fallen trees and dead wood within the north-east, south-west and north-west quadrants also provide suitable hibernacula for reptiles.

Birds

The desk study returned three records of notable birds, within 500 m of the proposed scheme. These are song thrush, kingfisher (*Alcedo atthis*) and willow warbler (*Phylloscopus trochilus*). Song thrush is an SPI, London Borough of Havering BAP priority, Essex BAP priority, and Essex Red Data List species, and a red-list Bird of Conservation Concern[22]. Kingfisher is listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Kingfisher and willow warbler are amber-list Birds of Conservation Concern, and willow warbler is also an Essex Red Data List species. The Weald Brook and Ingrebourne River offer suitable habitat for kingfishers.

The habitats within the proposed scheme boundary are also suitable for a number of other notable birds, records of which were not identified within 500 m during the desk study. This includes grey partridge (*Perdix perdix*) and skylark which are SPI, and London BAP, London Borough of Havering BAP, and Essex BAP priority species. Also

[22] *Eaton MA, Aebischer NJ, Brown AF, Hearn RD, Lock L, Musgrove AJ, Noble DG, Stroud DA and Gregory RD (2015) Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and Isle of Man.* British Birds ***108****, 708–746.*

dunnock (*Prunella modularis*), which an SPI and London BAP priority, and barn owl (*Tyto alba*) which is an SPI and London Borough of Havering BAP priority species.

The road system on and around Junction 28 provides suitable foraging habitat for raptors, in particular red kite (*Milvus milvus*) and buzzard (*Buteo buteo*). Barn owls typically occupy disused buildings and may be present in the old dwellings within the south-east quadrant, or farm buildings within the south-west quadrant.

The extended Phase 1 Habitat Survey identified areas of scrub, broadleaved woodland and scattered trees within the survey area that offer highly suitable nesting opportunities for a wide variety of birds.

Bats

The desk study returned records of at least eight bat species within 5 km of the proposed scheme: Daubenton's (*Myotis daubentonii*), Natterer's (*Myotis nattereri*), Leisler's (*Nyctalus leisleri*), noctule (*Nyctalus noctula*), Nathusius' pipistrelle (*Pipistrellus nathusii*), common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), and brown long-eared bat (*Plecotus auritus*). The nearest records were for Natterer's and Daubenton's, recorded approximately 820 m to the north-west of Junction 28.

All bat species in the UK are protected under the Conservation of Habitats and Species Regulations 2010 (as amended) and the Wildlife and Countryside Act 1981 (as amended). Of the bat species listed above, noctule, soprano pipistrelle and brown long-eared are SPI. All the above bat species are listed on the London BAP and are Essex Red Data List species. Common pipistrelle and soprano pipistrelle are also Essex BAP Priority species.

The extended Phase 1 habitat survey identified two disused residential dwellings and a number of other farm buildings in the north-east, south-west and north-west quadrants that may have potential to support roosting bats. Habitats within the survey area such as hedgerows, broadleaved woodland, scrub, ponds and rivers offer abundant foraging habitat for bats in the immediate area, and provide commuting links across the landscape.

A number of mature and semi-mature scattered trees in all quadrants and broadleaved woodland in the north-east, south-west and north-west quadrants also offer potentially suitable roosting habitat for bats.

Hazel dormouse

The desk study returned no records for hazel dormouse within 500 m of the proposed scheme. Hazel dormice are protected under the Conservation of Habitats and Species Regulations 2010 (as amended) and the Wildlife and Countryside Act 1981 (as amended). They are also listed as SPI, London BAP priority, Essex BAP Priority, and Essex Red Data List species.

The extended Phase 1 habitat survey identified dense and continuous scrub adjacent to the carriageways and between fields, which offer suitable habitat for hazel dormice. These habitats are connected to intact hedgerows and parcels of broadleaved woodland located in the north-east, south-west and north-west quadrants, all of which have potential to support hazel dormice. These habitats are all considered suitable for hazel dormice and provide a continuous corridor for the movement and dispersal of this species across the wider landscape.

Otter and water vole

The desk study returned two records of water vole within 500 km of the proposed scheme. The nearest record for water vole was located approximately 175 m south-west of Junction 28. Water vole is protected under the Wildlife and Countryside Act

1981 (as amended). It is also listed as SPI, London BAP priority, London Borough of Havering BAP priority, Essex BAP Priority, and an Essex Red Data List species.

No records were provided for otter within 500 m of the proposed scheme. Otters are protected under the Conservation of Habitats and Species Regulations 2010 (as amended) and the Wildlife and Countryside Act 1981 (as amended). They are also listed as SPI, London BAP priority, Essex BAP priority and Essex Red Data List species

The extended Phase 1 habitat survey identified Weald Brook and the Ingrebourne River, as well as other tributary streams that had potential to support water voles and otters.

Badger

The desk study returned one record of badger from within 500 m of the proposed scheme. Badgers are protected under the Protection of Badgers Act (1992). They are also included on the Essex Red Data List.

The extended Phase 1 habitat survey identified extensive suitable foraging habitat for badgers, including; hedgerows, scrub, improved and semi-improved field margins, and broadleaved woodland. Parcels of broadleaved woodland located in the north-east, south-west and north-west quadrants offer potentially suitable habitat for badger setts.

Other mammals

The desk study also returned two records hedgehog (*Erinaceus europaeus*) within 500 m of the proposed scheme. Hedgehog is an SPI, London BAP priority and Essex Red Data List species. The extended Phase 1 habitat survey identified suitable foraging habitat for hedgehog.

Brown hare (*Lepus europaeus*) is a species that is an SPI and included as a priority species within the London BAP, London Borough of Havering BAP, and Essex BAP. Although there are no records identified from within 500 m of the proposed scheme, the habitats within the proposed scheme boundary are suitable for this species.

Non-native Invasive Species

No records of non-native invasive species of plants listed on Schedule 9 of the Wildlife and Countryside Act 1981, (as amended), (see Appendix F.) were identified within 500m of the junction during the desk survey or extended Phase 1 habitat survey.
Regulatory/Policy framework

National Planning Policy Framework 2012

The National Planning Policy Framework (NPPF) 25 sets out the Governments planning policies for England and how these are expected to be applied by Local Authorities within their Local Development Frameworks (LDF). Chapter 11 of the NPPF ‘Conserving and enhancing the natural environment’ sets out the requirements to consider biodiversity in planning decisions.

The paragraphs within Chapter 11 relevant to the proposed scheme are summarised below:

> *109 The planning system should contribute to and enhance the natural and local environment by:*

- Protecting and enhancing valued landscapes, geological conservation interests and soils;
- Recognising the wider benefits of ecosystem services; and

- Minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures.

114 Local planning authorities should set criteria based policies against which proposals for any development on or affecting protected wildlife or geodiversity sites or landscape areas will be judged. Distinctions should be made between the hierarchy of international, national and locally designated sites, so that protection is commensurate with their status and gives appropriate weight to their importance and the contribution that they make to wider ecological networks.

117 Local planning authorities should set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure.

To minimise impacts on biodiversity and geodiversity, planning policies should:

- Plan for biodiversity at a landscape-scale across local authority boundaries; identify and map components of the local ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity, wildlife corridors and stepping stones that connect them and areas identified by local partnerships for habitat restoration or creation;
- Promote the preservation, restoration and re-creation of priority habitats, ecological networks and the protection and recovery of priority species populations, linked to national and local targets, and identify suitable indicators for monitoring biodiversity in the plan; and,
- Aim to prevent harm to geological conservation interests; and where Nature Improvement Areas are identified in Local Plans, consider specifying the types of development that may be appropriate in these Areas.

118 When determining planning applications, local planning authorities should aim to conserve and enhance biodiversity by applying the following principles:

- If significant harm resulting from a development cannot be avoided (through locating on an alternative site with less harmful impacts), adequately mitigated, or, as a last resort, compensated for, then planning permission should be refused.
- Proposed development on land within or outside a Site of Special Scientific Interest likely to have an adverse effect on a Site of Special Scientific Interest (either individually or in combination with other developments) should not normally be permitted. Where an adverse effect on the site's notified special interest features is likely, an exception should only be made where the benefits of the development, at this site, clearly outweigh both the 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 Sites of Special Scientific Interest;
- Development proposals where the primary objective is to conserve or enhance biodiversity should be permitted;
- Opportunities to incorporate biodiversity in and around developments should be encouraged; and,

- Planning permission should be refused for development resulting in the loss or deterioration of irreplaceable habitats, including ancient woodland and the loss of aged or veteran trees found outside ancient woodland, unless the need for, and benefits of, the development in that location clearly outweigh the loss.

Local planning policy

At a local level, development is controlled through local planning policy prepared in accordance with national policy. Local Plans set out a vision and a framework for the future development of the area within boundaries of the local authorities.

The study area is located within boundaries of Brentwood Borough Council and Havering London Borough Council.

The Brentwood Borough Council is currently preparing a new Local Plan for the Borough which, once adopted, will supersede saved policies in the current Replacement Local Plan (2005). The plan provides a comprehensive statement of land use policies and proposals for the Borough. This is the Borough's current development plan until replaced by the emerging Local Development Plan.

The Havering London Borough adopted Core Strategy and Development Control policies as well as Proposals Maps in 2008.

Table 8-4 includes also relevant policies of Brentwood Borough Council and Havering London Borough as well as relevant policies of London Plan written by the Mayor of London and publicized by the Greater London Authority.

Table 8-4: Summary of relevant local policies.

Planning Policies	Summary of Policy Content
Brentwood Borough Council	**Brentwood Replacement Local Plan (25 August 2005)**
Policy C3 County Wildlife Sites, 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. Where appropriate, the authority will require appropriate mitigation and compensatory measures to be provided. The council will encourage the enhancement and management of such sites and natural features, and, where desirable, their use for informal recreation. 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 C7 Development Affecting Preserved Trees, Ancient Woodlands and	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 arboricultural/silvicultural practice or the

Planning Policies	Summary of Policy Content
Trees in Conservation Areas	development clearly outweighs the amenity and/or nature conservation value of the tree.
Havering London Borough Council	**Local Development Framework (LDF) 2008**
Policy 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 (SPD), 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; • protecting the individual quality and character of, and promoting access to, each Countryside Conservation Area shown on the Proposals Map; and • protecting and enhancing the biodiversity of the Blue Ribbon Network including rivers and their associated corridors."
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; and • not granting planning permission for development that would adversely affect ancient and secondary woodland."
London Plan (2015-2016)	**Relevant policies from the Draft Replacement London Plan (2015-2016) included below.**
Policy 7.19 Biodiversity and access to nature	"Development Proposals should: a. wherever possible, make a positive contribution to the protection, enhancement, creation and management of biodiversity;

Planning Policies	Summary of Policy Content
	b. prioritise assisting in achieving targets in biodiversity action plans (BAPs); c. not adversely affect the integrity of European sites and be resisted where they have significant adverse impact on European or nationally designated sites or on the population or conservation status of a protected species or a priority species or habitat identified in a UK, London or appropriate regional BAP or borough BAP. On Sites of Importance for Nature Conservation development proposals should: a. give the highest protection to sites with existing or proposed international designations (SACs, SPAs, Ramsar sites) and national designations (SSSIs, NNRs) in line with the relevant EU and UK guidance and regulations; b. give strong protection to sites of metropolitan importance for nature conservation (SMIs). These are sites jointly identified by the Mayor and boroughs as having strategic nature conservation importance; c. give sites of borough and local importance for nature conservation the level of protection commensurate with their importance. When considering proposals that would affect directly, indirectly or cumulatively a site of recognised nature conservation interest, the following hierarchy will apply: 1. avoid adverse impact to the biodiversity interest 2. minimize impact and seek mitigation 3. only in exceptional cases where the benefits of the proposal clearly outweigh the biodiversity impacts, seek appropriate compensation.”
Policy 7.21 Trees and Woodland	“Planning decisions Existing trees of value should be retained and any loss as the result of development should be replaced following the principle of ‘right place, right tree’[1]. Wherever appropriate, the planting of additional trees should be included in new developments, particularly large-canopied species”.

Local biodiversity policy

The London Mayor’s Biodiversity strategy[23] sets out the policies that are necessary to ensure the conservation of London’s natural environment and improve the ecology of the city. The objective of the strategy is to promote the conservation of biodiversity, by providing direction to London authorities to:

- establish a network of SINCs;
- support and encourage boroughs, land-owners and Londoners to take practical actions to improve the ecology of land they own or manage, including private gardens;
- use the planning system to green the urban environment through the installation of green roofs, planting of street trees and restoring rivers; and
- create more semi-natural green spaces to increase habitat for wildlife and provide Londoners with better access to nature.

[23] *https://www.london.gov.uk/sites/default/files/biodiversity_strategy.pdf*

The London Borough of Havering Biodiversity SPD provides details on how Policies DC58 and DC60 (see Table 8-4) are implemented, and Illustrates good practice for identification, protection, mitigation and enhancement of biodiversity through the planning process.

Biodiversity action plans

The UK BAP is the UK's initiative to maintain and enhance biodiversity in response to the Convention on Biological Diversity signed in 1992.

The UK BAP was used to draw up the 'England Biodiversity List' (see below) and has been succeeded by the UK Post-2010 Biodiversity Framework in 2012, due to a change in government strategy by all UK countries, focussing on managing the environment as a whole rather than dealing with different aspects of biodiversity and environment separately. However, the UK BAP list of priority habitats and species continue to be regarded as conservation priorities in the UK Post-2010 Biodiversity Framework.

The London Biodiversity Partnership published the London BAP in 2002. There are 11 priority habitats and 214 priority species included within the plan. All 11 habitats and eight of the species have specific Action Plans.

London Borough of Havering BAP has six priority habitats and 15 priority species. All priority habitats are also London BAP priority, but ten of the 16 priority species on the Havering BAP are not included as London priorities, reflecting the focus on species of the suburban and greenbelt land more associated with Havering than urban London.

The Essex BAP focusses on 11 priority habitats and provides Habitat Action Plans for each.

Summary of relevant ecological legislation

A summary of UK wildlife legislation relevant to the proposed scheme is provided in Appendix F.

Section 40 of the Natural Environment and Rural Communities (NERC) Act 2006 sets out the duty for public authorities to conserve biodiversity in England. Habitats and species of principal importance for the conservation of biodiversity as identified by the Secretary of State for England, in consultation with Natural England, are referred to in Section 41 of the NERC Act 2006 for England. The list of Habitats of Principal Importance (HPI) and Species of Principal Importance (SPI) was based on UK BAP priority habitats and species and was updated in 2008. It is known as the 'England Biodiversity List'.

8.5 Design, mitigation enhancement and monitoring measures

Designated sites

To avoid significant effects to designated sites, alternative options, avoidance and minimisation of loss or fragmentation of these sites will be considered to reduce the significance of any likely effects associated with the proposed works. Retention and enhancement of the riparian corridor within Ingrebourne Valley SMI will be considered a priority for avoiding and reducing potentially significant impacts.

If the loss of an area of a designated site is unavoidable, then suitable compensatory measures will be provided, including the creation of an equal or greater area of similar habitat to that lost. The compensation habitat will be adjacent to, or as close to the relevant designated site as possible. If suitable compensation areas are not available close to the designated site, then compensation habitat will be created at an alternative suitable site. A plan and programme to ensure effective establishment and

continued management of compensatory habitat will be implemented. Decisions taken on the location of land available for habitat compensation will take into account the requirement for requirement for access for future maintenance.

Mitigation measures will be implemented as set out in Chapter 9 to reduce the significance of any potential effects caused by air pollution.

Ancient woodland

Ancient woodland is an irreplaceable resource. To avoid a significant effects to ancient woodland, alternative options, avoidance and minimisation of loss or fragmentation of these sites will be considered to reduce the significance of any likely effects associated with the proposed works.

If the loss of ancient woodland is unavoidable, then suitable compensatory measures as proposed for designated sites above will be implemented, which would include creation of new habitat and a plan and programme for establishment and future management. The translocation of ancient woodland soil and associated features will be considered as an option for establishment of compensatory broadleaved woodland.

Notable Habitats

Any proposed loss of HPI, London BAP, London Borough of Havering BAP, and Essex BAP habitats within the proposed scheme boundary, in particular undesignated secondary woodland, species-rich hedgerows and semi-improved neutral grassland will be mitigated for through the creation of new habitats of similar value to ensure no net loss of the habitats affected. These new habitats will be subject to appropriate management to ensure successful establishment.

Notable and protected species

Mitigation will provided within the design or construction practices to avoid or reduce potentially significant impacts to notable species. This will be implemented during establishment of the detailed baseline and continual review throughout the design and construction process of potential impacts. Good communication between the designers, contractor and ecologists will be established to facilitate this. Mitigation will allow the majority of potentially significant effects on populations of notable species to be avoided or reduced to a level where they are not significant.

Potential impacts on legally protected species that could lead to offences under the Conservation of Habitats and Species regulations 2010 (as amended), the Wildlife and Countryside Act 1981 (as amended), or the Protection of Badgers Act 1992 (as amended) will be avoided or reduced through appropriate mitigation provided in the design and construction phases. Such mitigation may include capture and translocation of animals, licensed works, and precautionary methods of working. Further survey will be undertaken in order to provide a detailed baseline for legally protected species that will inform decisions on mitigation.

General mitigation measures

In accounting for all the proposed scheme options, the following general mitigation measures will be implemented during the design and construction:

- Avoidance and minimisation of habitat loss, particularly within designated sites, ancient woodland, and notable habitats.
- Maintenance and, where possible, enhancement of habitat connectivity and commuting routes for species, including suitable culvert design, hedgerows and woodland connections, and flower-rich grassland;

- Retention of features with potential to provide bat roosting sites where possible (*i.e.* mature trees and suitable structures);
- Provision of a sensitive lighting design that takes bats and other wildlife into account;
- Creation and enhancement of habitat as compensation for areas of habitat loss, using native species appropriate to the local area where possible, and taking into consideration pollinating insects; and
- Creation of log piles and other potential wildlife refuges using material from site clearance where practical.

In order to avoid or minimise any potential damage, loss and disturbance caused by the construction works, good practice methodology, including a Construction Environmental Management Plan (CEMP), would be followed for all construction operations. The CEMP is would include the following measures:

- Protection of designated sites, ancient woodland, and other valuable habitats outside the working area from accidental incursion;
- Protection of retained trees following standard practice;
- Use of mitigation measures under licence if habitats or features afforded legal protection due to their use by protected species (such as badger, bat roosts, dormice habitat, great crested newt habitat, or water vole burrows would be damaged during the works;
- Use of precautionary method of working during construction to minimise risk to individual animals of protected species where licences would not be required; , such as avoiding sensitive seasons for notable or protected species (i.e. bird breeding season), and provision of Ecological Clerk of Works (ECoW); and
- Further survey for invasive species subject to control under the Wildlife and Countryside Act 1981 (as amended), and listed on Schedule 9 of the Act, measure to avoid the spread of these species where necessary.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

8.6 Potential effects

Designated sites

The Manor LNR is located approximately 940 m east of Junction 28 (see Figure number 8.1 and 8.2 in Appendix F). This site is designated at a local level and is considered to have *Local* value for nature conservation. At the closest point Option 45C is 370 m from this LNR. However, it is considered unlikely that this site would be significantly affected due to the distance of the site from the proposed works.

There are 26 non-statutory designated sites located within 1 km of the proposed scheme (see Figure number 8.1 and 8.2 in Appendix F). These are listed in Table 8.2 above.

Three non-statutory designated sites are located within the proposed scheme boundary (see Figure number 8.1 and 8.2 in Appendix F):

- Option 2 will involve direct impacts to Ingrebourne Valley SMI and Lower Vicarage Wood LWS, including loss of habitat;
- Option 4 will involve direct impacts to Lower Vicarage Wood LWS, including loss of habitat;

- Options 5A, 5B and 5C will involve direct impacts to Ingrebourne Valley SMI, including realignment of the stream between Grove Farm and the A12; and
- Options 5D and 5E will involve direct impacts to Ingrebourne Valley SMI (including realignment of the river where it is culverted under the new loop road), The Oaks LWS and Lower Vicarage Wood LWS.

Ingrebourne Valley SMI has *Metropolitan* value within Greater London. The Oaks LWS and Lower Vicarage Wood LWS have *County* value within Essex.

Options 2, 5A, 5B, 5C, 5D and 5E will require direct loss of habitat from Ingrebourne Valley SMI that would have a significant effects on the conservation status of this designated site at the *Metropolitan* level.

Options 2, 4, 5A and 5B would have a significant effect on the conservation status of Lower Vicarage Wood LWS at the *County* level.

Options 5.1 and 5.2 would have a significant effect on the conservation status of The Oaks LWS at the *County* level.

The Air Quality chapter within this report will detail any potentially significant impacts from air pollution that may affect designated sites within 2 km and habitats adjacent to the proposed scheme.

Ancient woodland

There are 11 ancient woodlands located within 1 km of the proposed scheme (see Figure number 8.1 and 8.2 in Appendix F). These are listed in Table 8.3 above. Ancient woodland is an irreplaceable habitat, which, where not designated, has at least *Borough* value for nature conservation.

Options 2 and 4 will require direct loss of ancient woodland habitat from Lower Vicarage Wood. Loss of this habitat will have a significant effect on the conservation status of the ancient woodland at the *Borough* level.

Notable habitats

Woodland within the proposed scheme boundary includes semi-natural deciduous secondary woodland (not ancient), and semi-mature broadleaved plantation (particularly on the M25 verge and within the junction). Where is not designated and not ancient it has *Local* value for nature conservation. This habitat is an HPI and local BAP priority.

Established semi-natural hedgerows are present segregating arable and pasture fields. Species-rich hedgerows, where present, are also HPI and a London Borough of Havering BAP priority habitat. These have *Local* value for nature conservation.

The habitats within the highway soft estate include semi-improved neutral grassland and species-poor grassland, often forming a mosaic with tall ruderal and scrub vegetation. These habitats did not have a relatively high species diversity and are mostly segregated. As such, they are not more than of *Local* value for nature conservation. Any major loss or damage to this habitat would have an effect that would be significant on a *Local* scale at most.

Notable and legally protected species

Habitats within the proposed scheme boundary have potential to support notable and legally protected species. There are records of notable plants, invertebrates, reptiles, birds and mammals (including bats, water vole, hedgehog and badger) from within the proposed scheme boundary.

Suitable habitat is present for a number of other notable species where records from within 500 m of the proposed scheme were not identified during the desk study, as

described in Section 8.4. These include stag beetle, white-clawed crayfish, great crested newt, common toad, palmate newt, slow worm, common lizard, notable birds, hazel dormouse, otter and brown hare.

Based on the proposed options, there is considered to be a medium risk of significant impacts on populations of notable species at least the *Local* scale. However, due to the fact that the proposed scheme options largely affect farmland (arable or pasture), any potential significant effects would likely be the result of the removal of woodland, scrub, trees, hedgerows or semi-improved grassland vegetation, effecting populations of notable species. The risk of significant effects on populations of notable species above the *Local* level is considered to be low.

There is potential all proposed options to have impacts on legally protected species (including European protected species), including killing, injury or disturbance during construction; or disturbance, loss of foraging areas, population fragmentation, or disruption of migratory or commuting routes over the long term. Legally protected species that have been identified from the desk study and extended Phase 1 habitat survey within the proposed scheme boundary include reptiles, bats, and badger; and there is potential for others, particularly white-clawed crayfish, great crested newt, nesting birds, hazel dormouse, and water vole.

Any of the above effects could cause an offence in relation to the Conservation of Habitats and Species regulations 2010 (as amended), the Wildlife and Countryside Act 1981 (as amended), or the Protection of Badgers Act 1992.

Further surveys are required for notable and legally protected species to confirm presence or absence, the status of any population, and its potential value for nature conservation.

8.7 Limitations to assessment

The extended Phase 1 Habitat Survey was undertaken from safely accessible land adjacent to the highway network, and public rights of way, and therefore complete access to the land affected by the proposed scheme was not available. In some instances, even within publically accessible land, the presence of dense scrub or lack of safe access made some areas inaccessible. For highways verges, the walkover survey was supplemented by a 'drive-by' inspection. This level of survey was considered appropriate and proportionate to the current stage of the proposed scheme and the predicted level of significance of effects on ecological features, and is in accordance with IAN 125/15[24].

The extended Phase 1 habitat survey was undertaken in February 2016, at a time of year when certain botanical species are not readily identifiable. The timing of the survey is not considered to be significant limitation to this assessment.

Ecological surveys are limited by factors which affect the presence of plants and animals such as the time of year, migration patterns and behaviour. The extended Phase 1 habitat survey undertaken to support this assessment has not therefore produced a complete list of plants and animals, and the absence of evidence of any particular species should not be taken as conclusive proof that the species is not present or that it will not be present in the future. However, the results of the desk study and extended Phase 1 habitat survey are considered to be sufficient to undertake the assessment for this stage in the proposed scheme.

[24] *Highways England (2015) Environment Assessment Update. Interim Advice Note 125/15. HE, Exeter*

8.8 Summary and recommendations

The PCF assessment for effects of the proposed scheme options on nature conservation features has identified potential significant effects of the options on designated sites, ancient woodland and populations of notable species. The significant effects on nature conservation features may be significant from the *Local* up to the County level. Based on guidance provided in Interim Advice Note 130/10[25], this would give a category of significance of Slight to Moderate adverse.

Appropriate compensatory measures and mitigation will potentially reduce the level of overall significance. In summary, the proposed scheme options that avoid or reduce impacts to designated sites or ancient woodlands will result in overall effects of the least significance on nature conservation features.

All the proposed scheme options may potentially impact on legally protected species during construction, if mitigation is not provided during, or in advance of construction. Subject to further survey and confirmation of presence, the construction may cause harm or disturbance of individuals, or cause damage or destruction of roosts, nests or places of shelter of white-clawed crayfish, great crested-newt, and reptiles, nesting birds, bats, hazel dormouse, water vole, otter and badger.

The presence of notable or legally protected species must be taken into account throughout the design and construction process, so that mitigation measures can be identified that will reduce or avoid impacts on these species.

[25] *Highways Agency (2010)* Interim Advice Note 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment

9 Air Quality

9.1 Introduction

This chapter describes air quality constraints in the study area and presents the findings of a preliminary air quality study of the potential air quality effects associated with each of the proposed scheme options as described in Chapter 3. Recommendations for further assessment are also provided.

9.2 Assessment methodology

Construction

In line with a proportionate and appropriate approach for PCF Stage 1, construction impacts have not been assessed at this stage, on the assumption that these can usually be mitigated by following best practice. Construction effects will be considered in later PCF stages.

Operation

For the assessment of operational impacts, the Design Manual for Roads and Bridges (DMRB) HA207/07[26] provides methodologies for undertaking simple and / or detailed levels of assessment. A simple assessment has been undertaken for the air quality assessment at PCF Stage 1 using an appropriate and proportionate risk assessment approach. A review of baseline air quality conditions has been undertaken and potential constraints identified. The PCF Stage 1 VISSIM traffic model[27] provided indicative AADT variables (flow, composition and speed) for a baseline year (2014) and opening year (2022) for the Do-Minimum (DM) and Do-Something (DS) scenarios associated with each Option Variant. The assessment is based on the opening year as the influence of the vehicle exhaust emissions standards is likely to be greater than any additional growth in traffic in subsequent assessment years. The data have been considered in accordance with traffic change criteria defined in the DMRB HA207/07 Volume 11 Section 3 Part 1 (Air Quality) to determine a broadly defined affected road network (ARN) for each option.

The DMRB HA207/07 traffic change criteria are as follows:

- Road alignment will change by 5 metres or more; or
- Daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) or more; or
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more; or
- Daily average speed will change by 10 kilometres per hour (km/hr) or more; or
- Peak hour speed will change by 20 km/hr or more.

The changes are applied to roads (not links), and so where relevant are determined under two-way traffic conditions.

Options 5A, 5B and 5C are considered to be the same in traffic modelling terms, with variations in spatial alignment only. Options 5D and 5E are similarly considered to be the same in traffic modelling terms. Traffic data was provided, and air quality

[26] *Design Manual for Roads and Bridges Volume 11 Section 3 Part 1 HA 207/07 Air Quality* http://www.standardsforhighways.co.uk/

[27] *'AQ_Noise Assessment Traffic Data template v2_0 12-2-15_v8.xlsm', provided by Atkins Transportation in July 2016*

assessment undertaken, for Options 6, 2, 4, 5B and 5D. Detailed descriptions of all Scheme options are provided in Chapter 3.

Qualitative commentary, in the context of existing air quality conditions, on the potential risk of air quality impact associated with each option has been given. Calculation of air pollutant concentrations at receptors and of regional emissions across the ARN are not included in this PCF Stage 1 air quality assessment.

9.3 Study area

For the PCF Stage 1 air quality assessment, the air quality study area has been defined as the area within 200 metres of the proposed scheme options and associated ARN. This is industry best practice screening criteria, specified in HA207/07, which is derived from calculations using atmospheric dispersion modelling. These dispersion profiles have also been reviewed in a series of field measurements[28].

The extent of the ARN determined for each option has been limited by the spatial extent of the traffic data provided within the PCF Stage 1 traffic model which is focussed on Junction 28 and approaches on the M25 and A12.

Receptors

Sensitive human health receptors for the purposes of air quality assessment include residential properties, locations of susceptible populations e.g. schools, hospitals and care homes for the elderly, or any other location where a member of the public may be exposed to an air pollutant for the relevant regulated time period. Sensitive human health receptors within 200 metres of the scheme and roads which form the ARN with all options are provided in Figure 9.1 below and supporting figures in Appendix G.

There are residential properties within 200 metres of Junction 28 itself. These include properties on the A1023 Roman Road to the east, The Poplars to the south east, Putwell Bridge Farm to the south west, and Grove Farm to the north west. In addition, Frenches Farm, located to the north east of the junction could be affected by the proposed new link roads.

East of Junction 28, residential properties in Brook Street and Brentwood are located near both the A1023 Brook Street and the A12. On the A12 to the west of Junction 28 there are residential properties in Harold Park on either side of the carriageway, the Harold Court Primary School, and the Ravensbourne School.

There are few sensitive receptors within 200 metres of the M25 both north and south of Junction 28 which is located in a primarily agricultural landscape. There are residential properties on Benskins Lane and Wrightsbridge Road that are within 200 metres of the M25 north of Junction 28. Residential properties on Nags Head Lane, Warley Road and Beredens Lane are within the air quality study area on the M25 south of Junction 28.

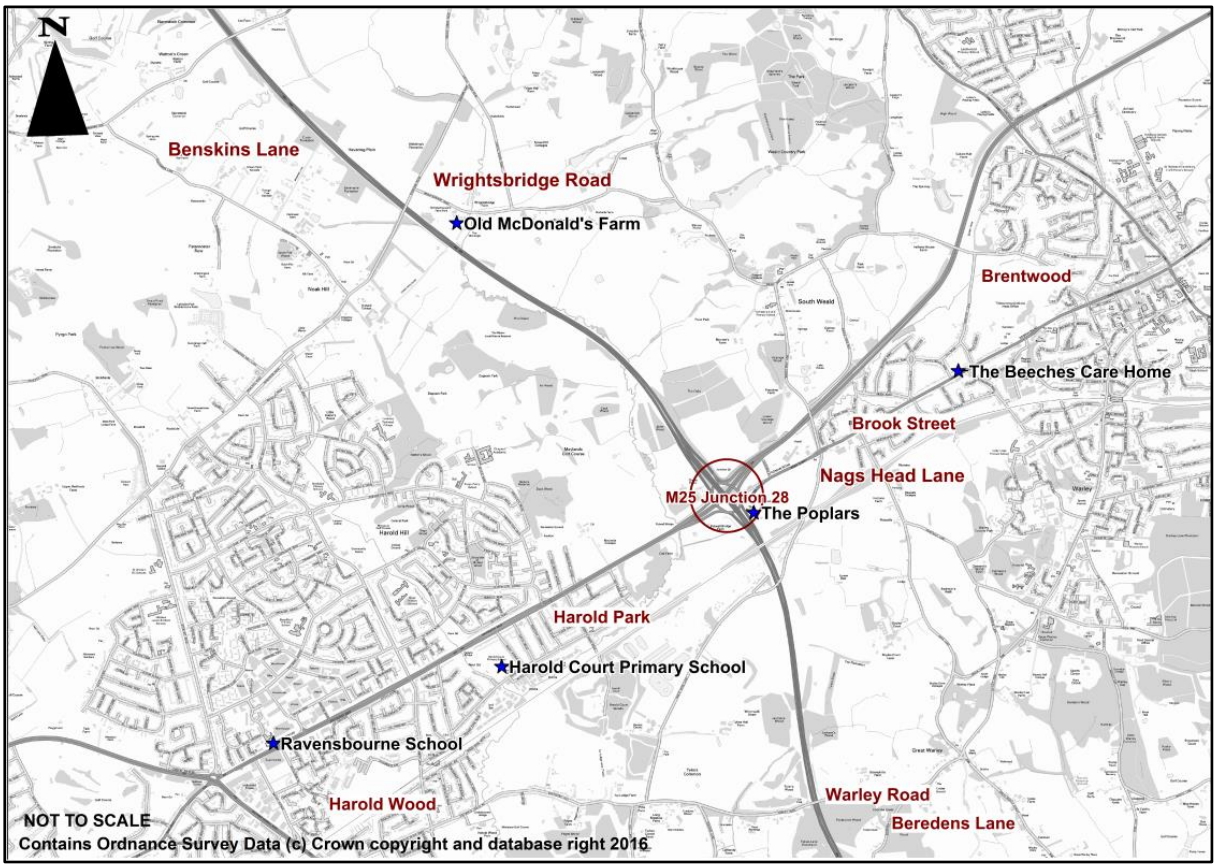
In addition, designated ecological sites may contain features that are sensitive to air pollutants, whereby vegetation may be adversely affected by elevated pollutant concentrations. HA207/07 requires assessment of air quality effects on ecological designations (SACs, SPAs, SSSIs and Ramsar sites) within 200 metres of any road affected by the proposed scheme. There are no statutory ecological designations in the vicinity of M25 J28 or the ARN at this stage, however the Curtismill Green SSSI is located approximately 130 metres from the M25 between junctions 27 and 28, and could potentially be affected. This will be re-examined at PCF Stage 2 following further refinement of the ARN.

[28] *HA207/07 DMRB Volume 11 Section 3 Part 1, May 2007 Paragraph C3.1* http://www.standardsforhighways.co.uk/dmrb/

Table 9-1 Sensitive receptors in the vicinity of the ARN

Affected Road	Sensitive receptors
M25 North	Residential properties on Benskins Lane and Wrightsbridge Road. Old McDonald's Farm.
M25 South	Residential property The Poplars as well as those on Nags Head Lane, Warley Road, Beredens Lane
A12 West	Residential properties in Harold Park and Harold Wood. Ravensbourne School, and Harold Court Primary School.
A12 East	Residential properties in Brook Street and north Brentwood.
A1023	Residential properties in west Brentwood. The Beeches Care Home and Bridge House Care Centre.

Figure 9-1 Sensitive receptors in the vicinity of the scheme and ARN



9.4 Baseline conditions

Information on existing ambient air quality i.e. baseline conditions, and identification of potential air quality constraints to the proposed scheme options have been determined through reference to the following sources:

- Air Quality Management Area (AQMA) mapping [29];

[29] http://uk-air.defra.gov.uk/aqma/maps

- Department for Environment, Food and Rural Affairs (DEFRA) Pollution Climate Model (PCM) GIS data for the latest available year (2014)[30];
- Local Authority Local Air Quality Management (LAQM) Reports[31,32,33];
- Local authority monitoring data;
- Highways England project specific NO2 diffusion tube survey data[34,35];
- DEFRA Automatic Urban and Rural Network (AURN) continuous monitoring data36;
- The London Air Quality Network[37];
- Ordnance Survey base mapping to identify locations of sensitive receptors (residential properties, schools, hospitals and elderly care homes)[38]; and
- DEFRA MAGIC website[39] to identify boundaries of designated ecological sites.

Air Pollutants

Vehicle exhausts contain a number of pollutants including oxides of nitrogen (NO_x), carbon monoxide (CO), hydrocarbons, carbon dioxide (CO_2) and particles. The quantities of each pollutant emitted depend on the type and quantity of fuel used, engine size, speed of vehicle and abatement equipment fitted. Once emitted, the pollutants disperse and subsequently are diluted in the ambient air. Pollutant concentrations in the air can be measured or modelled and then compared with ambient air quality criteria (discussed below).

The air pollutants of concern in the context of the air quality study for the M25 Junction 28 are nitrogen dioxide and particulate matter. These pollutants are most likely to be present in ambient air at concentrations close to or above statutory limit values at receptors near to roads, and are hence the focus of the assessment of vehicle emissions associated with the proposed scheme options.

National assessments have demonstrated that there is no risk of exceedance of the air quality objectives set for 1,3-butadiene, benzene, carbon. These pollutants are therefore not considered further as there is not considered to be a potential for significant effects associated with these pollutants.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a secondary pollutant produced by the oxidation of nitric oxide (NO). NO and NO_2 are collectively termed nitrogen oxides (NO_x). Almost a third of the UK NO_x emissions are from road transport[40]. The majority of NO_x emitted from vehicles is in the form of NO, which oxidises rapidly in the presence of ozone (O_3) to form NO_2. In high concentrations, NO_2 can affect the respiratory system and can also enhance the response to allergens in sensitive individuals, whereas NO does not have any observable effect on human health at the range of concentrations found in ambient air. Elevated concentrations of oxides of nitrogen can have an adverse effect on vegetation, including leaf or needle damage and reduced growth. Deposition of

[30] http://uk-air.defra.gov.uk/data/gis-mapping
[31] *Brentwood Borough Council (2015) LAQM Updating and Screening Assessment*
[32] *London Borough of Havering (2014) Air Quality Progress Report for London Borough of Havering*
[33] *London Borough of Havering (2015) Updating and Screening Assessment for the London Borough of Havering*
[34] *Atkins (2015) M25 DBFO Air Quality Monitoring (Quarter 4): Connect Plus Services.*
[35] *Atkins (2016) M25 DBFO Air Quality Moitoring 2014 – 2015 Annual Report: Connect Plus Services.*
[36] https://uk-air.defra.gov.uk/data
[37] https://www.londonair.org.uk/LondonAir/Default.aspx
[38] https://www.ordnancesurvey.co.uk/business-and-government/products/opendata-products.html
[39] http://magic.defra.gov.uk/
[40] *NAEI (2015). Pollutant Information: Nitrogen oxides (NO_x expressed as NO_2). Retrieved from National Atmospheric Emissions Inventory:* http://naei.defra.gov.uk/overview/pollutants?pollutant_id=PMFINE

pollutants derived from oxides of nitrogen emission contribute to acidification and/or eutrophication of sensitive habitats.

Particulate Matter

The principal sources of 'primary' polluting particles are combustion processes, which include traffic and industry. Diesel engines produce the majority of particulate emissions from the vehicle fleets. Approximately a fifth of primary PM_{10} emissions in the UK are derived from road transport[41]. Finer fractions of particulate matter appear to be associated with a range of symptoms of ill health including effects on the respiratory and cardiovascular systems, on asthma and on mortality

Local Air Quality Management

The physical extent of each proposed scheme option lies within the boundaries of the London Borough of Havering (LBH) and Brentwood Borough Council (BBC). The ARN at PCF Stage 1 is also encompassed by the LBH and BBC administrative areas.

A summary of local air quality conditions in both of these local authority areas is provided below, providing context in proximity to Junction 28 and the wider area.

The whole of the LBH has been declared an AQMA due to exceedances of both the annual mean AQS objective for NO_2 and the 24-hour mean AQS objective for PM_{10}. This AQMA encompasses M25 Junction 28.

BBC has declared seven AQMAs, five of which are shown on Figure 9.1 in Appendix G to the ESR and two of which are in close proximity to M25 Junction 28: AQMA 1 is 200 metres to the south (Nags Head Lane crossing); and AQMA 2 covers the eastern half of Brook Street roundabout at M25 Junction 28 itself. Both of the AQMAs were declared for exceedances of the annual mean AQS objective for NO_2.

AQMAs 3 to 7 were all declared for exceedances of the annual mean AQS objective for NO_2. AQMAs 3 and 4 are both located adjacent to the A12 within the extent of the study area (determined by the VISSIM model), located 2.5 kilometres and 3 kilometres east of M25 Junction 28 respectively. AQMA 7, Wilson's Corner, is located in Brentwood town centre, situated just over three kilometres north east of M25 Junction 28. AQMAs 5 and 6 are located over 9 kilometres north east of M25 Junction 28 are unlikely to be affected by any of the proposed scheme options.

It is noted that the 2015 Updating and Screening Assessment produced by BBC recommends that AQMAs 1, 3, 5 and 6 are revoked due to the lack of exceedances of the AQS objectives within these AQMAs in recent years.

The AQMAs within the area surrounding the air quality study area are described below in Table 9-2 and shown on Figure 9.1 in Appendix G to the ESR.

[41] *NAEI (2015) Pollutant Information: $PM_{2.5}$, PM_{10} and $PM_{0.1}$ (Finer Particulates). Retrieved from National Atmospheric Emissions Inventory: http://naei.defra.gov.uk/overview/pollutants?pollutant_id=PMFINE*

Table 9-2 AQMAs in the area surrounding the air quality study area

Local Authority	Name	Air Quality Criteria Exceeded	Description
London Borough of Havering	Havering AQMA	NO_2 annual mean PM_{10} 24 hour mean	An area encompassing the entire Borough of Havering.
Brentwood Council	AQMA No.1	NO_2 annual mean	Comprises parts of Nags Head Lane, Brentwood and the M25.
Brentwood Council	AQMA No.2	NO_2 annual mean	Comprises parts of Brook Street, Brentwood and the A12.
Brentwood Council	AQMA No.3	NO_2 annual mean	Comprises parts of Greenshaw and Porters Close, Brentwood and the A12.
Brentwood Council	AQMA No.4	NO_2 annual mean	Comprises parts of Warescot Road, Hurstwood Avenue and Ongar Road, Brentwood and the A12.
Brentwood Council	AQMA No.7	NO_2 annual mean	Comprises parts of Ongar Road, Ingrave Road, High Street and Shenfield Road, Brentwood in proximity to Wilsons Corner (the junction of the A128 and A1203).

DEFRA Mapping

Pollution Climate Mapping (PCM)

Further information on areas exceeding EU limit values is available from DEFRA's PCM model. This model provides estimates of roadside concentrations of pollutants, including annual mean NO_2 and PM_{10}, which are used in annual reporting to the EU regarding compliance with the limit values. The modelled roadside concentration comprises a background component together with a roadside increment. Not all roads are included within the PCM model. In the immediate vicinity of M25 Junction 28, DEFRA's PCM model only includes the A12 east and west of Junction 28 and the A1023.

The PCM model shows that for 2014, there were exceedances of the annual mean NO_2 EU limit value of 40 µg/m^3 on the A12 both east and west of Junction 28 but not on the A1023. There were no exceedances of the annual mean PM_{10} EU limit value. DEFRA PCM links and exceedences are illustrated on Figure 9.1 in Appendix G to the ESR.

Background Mapping

Estimates of current and future year background pollutant concentrations in the UK are available on the DEFRA UK-Air website. The background estimates, which are a combination of measured and modelled data, are available for each one kilometre grid square throughout the UK for a base year of 2013, which is the basis for the future year estimates up to 2030. These background estimates include contributions from all source sectors, e.g. road transport, industry and domestic and commercial heating systems.

Estimated annual mean background concentrations for the grid squares covering the M25 Junction 28 air quality study area for the current year (2016) are presented below in Table 9-3 for the pollutants NO_2 and PM_{10}. Background concentrations of NO_2 and PM_{10} were expected to be below relevant air quality criteria in 2016. This indicates that concentrations at background locations in the vicinity of the proposed scheme and

associated ARN are likely to currently meet relevant air quality criteria for these pollutants.

Table 9-3 DEFRA Background Air Quality Mapping. Pollutant concentrations for 2016 (µg/m^3)

Grid Square x,y	NO_2	PM_{10}
559500, 195500	16.39	18.26
554500, 194500	18.79	19.06
555500, 194500	14.32	17.72
558500, 194500	17.85	18.92
555500, 193500	18.63	18.54
556500, 193500	16.83	18.62
557500, 193500	17.21	17.95
558500, 193500	18.22	17.49
556500, 192500	21.40	18.81
557500, 192500	17.60	18.29
554500, 191500	18.72	17.13
555500, 191500	18.37	17.19
556500, 191500	15.57	16.49
557500, 191500	19.16	18.97
553500, 190500	20.54	18.09
554500, 190500	17.66	16.71
557500, 190500	19.07	18.76
Average	18.02	18.06

Air Quality Monitoring

Highways England Monitoring

Connect Plus measure NO_2 concentrations using diffusion tubes at a number of sites around the M25 on behalf of Highways England. The survey started in September 2013 and has continued for a further two years. One of the sites is located in close proximity to the scheme as shown on Figure 9.1 in Appendix G to the ESR. The annual mean NO_2 concentrations for this monitoring site between September 2013 and 2015 are presented in Table 9-4. The results show that measured pollutant concentrations at Site 7 exceeded the NO_2 annual mean air quality criterion during both monitoring periods. Site 7 is located at the junction of Brook Street (A1023) with the M25 Junction 28, with relevant exposure within 50 metres.

Table 9-4 Connect Plus monitoring results (µg/m^3)

Location	Bias Adjusted Annual Mean	
	Sept 2013 – Sept 2014	Sept 2014 – Sept 2015
CP7	40.2	40.8
Note : data in **bold** represents exceedances of the air quality objective		

Highways England has also conducted a diffusion tube survey for the purpose of informing the M25 Junction 28 Improvement Scheme. The survey consists of 25 diffusion tubes located near to Junction 28 as shown in Figure 9-2. The results are provided in Table 9-5.

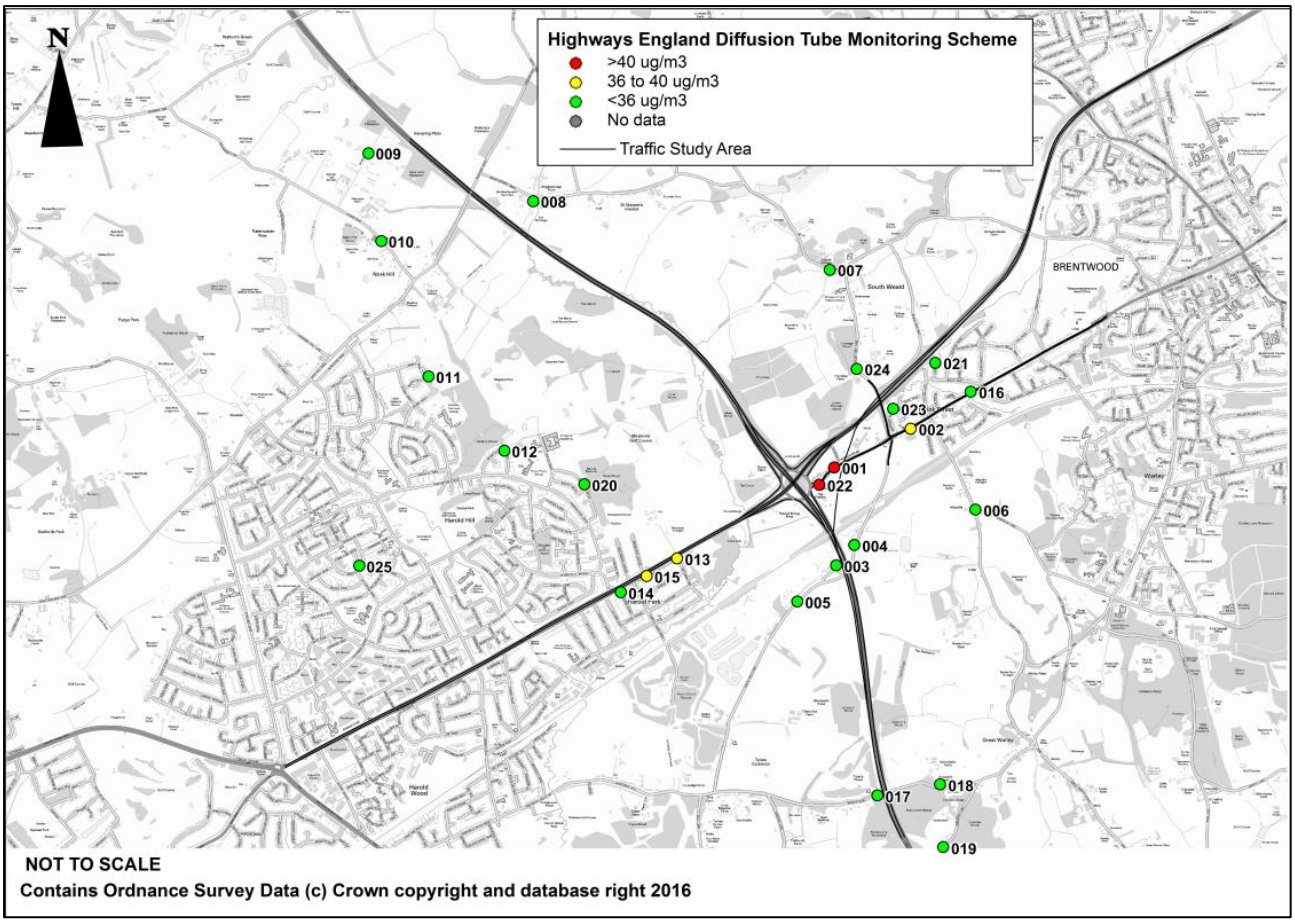
The six month unadjusted NO_2 concentrations were annualised for 2015 using a factor of 1.04 following analysis of data from two background continuous monitoring sites within 50 miles of the scheme (Redbridge – Ley Street and Thurrock – London Road (Grays)) in accordance with LAQM.TG(16). The annualised mean results were then adjusted using a factor of 0.85 derived from DEFRA's bias adjustment spreadsheet for diffusion tubes prepared by Staffordshire Scientific Services using 20% TEA in water. The results show that the NO_2 annual mean AQS objective of 40 µg/m^3 was exceeded at two sites. Both these sites (001 and 021) are located on Brook Street in close proximity to M25 Junction 28 and within the Brentwood AQMA No.2.

Table 9-5 Highways England NO_2 concentrations (µg/m^3)

Site ID	Grid Ref	Location	Site Type	2016 six month unadjusted mean	2015 annualised mean	2015 adjusted mean
001	557030, 192496	Brook Street	Roadside	65.2	67.5	57.4
002	557531, 192749	Brook Street	Roadside	43.5	45.0	38.2
003	557043, 191854	Nags Head Lane	Roadside	31.4	32.5	27.6
004	557162, 191987	Nags Head Lane	Roadside	31.7	32.8	27.9
005	556788, 191618	Nags Head Lane	Roadside	29.9	31.0	26.3
006	557956, 192219	Mascalls Lane	Roadside	26.8	27.7	23.5
007	557001, 193790	Weald Road	Roadside	30.4	31.4	26.7
008	555057, 194239	Wrightsbridge Road	Roadside	21.0	21.8	18.5
009	553977, 194554	Benskins Lane	Roadside	23.0	23.8	20.2
010	554061, 193978	Church Road	Roadside	31.1	32.2	27.3
011	554371, 193091	Priory Road	Roadside	22.8	23.5	20.0
012	554868, 192605	Sedgefield Crescent	Roadside	23.5	24.3	20.6
013	556000, 191900	Johns Terrace	Roadside	41.8	43.2	36.8
014	555631, 191678	Thurso Close	Roadside	40.6	41.9	35.7
015	555801, 191784	Johns Terrace	Roadside	43.1	44.6	37.9

Site ID	Grid Ref	Location	Site Type	2016 six month unadjusted mean	2015 annualised mean	2015 adjusted mean
016	557925, 192992	A1023 London Road	Roadside	32.1	33.2	28.2
017	557313, 190348	Warley Road	Roadside	40.1	41.6	35.3
018	557724, 190420	Warley Road	Roadside	27.0	27.9	23.7
019	557744, 190009	Beredens Lane	Roadside	27.9	28.9	24.6
020	555392, 192385	Sheffield Drive	Roadside	23.5	24.3	20.7
021	557693, 193181	Talbrook	Roadside	33.4	34.5	29.3
022	556933, 192382	Brook Street	Roadside	50.9	52.7	44.8
023	557416, 192880	Wingrave Court	Roadside	34.4	35.7	30.3
024	557177, 193141	Wigley Bush Lane	Roadside	25.6	26.5	22.5
025	553917, 191852	Dartfields	Background	25.2	26.1	22.2

Figure 9-2 Highways England Diffusion Tube Survey



Local Authority Monitoring

Both LBH and BBC also undertake monitoring in the vicinity of Junction 28 and the air quality study area.

Continuous Monitoring

None of the local authorities operate a continuous monitoring station (CMS) within the air quality study area. The closest CMS to the study area is an urban background site operated by BBC located at the Brentwood Council offices approximately three km to the north east of Junction 28. LBH operate two CMS, however both of these are located over seven km from the scheme.

Nitrogen Dioxide

Annual mean NO_2 data for the three CMS sites within the LBH and BBC administrative areas are presented in Table 9-6 for 2011 to 2014 inclusive. It is noted however, that these CMS sites are all located beyond the extent of the ARN (as determined at PCF Stage 1), and therefore may not be representative of conditions at receptor locations. Data collated shows that the only instance of an exceedance of the annual mean criterion for NO_2 was during 2014 at site LBH_2, although the data capture at this site was below 75%, so the data should be treated with caution. No exceedances were recorded at sites LBH_1 or Br_1 during the period 2011 to 2014 inclusive. The 1-hour mean criterion was also met in all years at all sites.

Table 9-6 Annual Mean Nitrogen Dioxide concentrations at CMS sites (µg/m³)

Site ID	Local Authority	Site Name	Grid Ref	Site Type	2011	2012	2013	2014
LBH_1	LB Havering	HV1 Rainham	553250, 182750	Roadside	31.0	n/a	30.2	35.3
LBH_2	LB Havering	HV3 Romford	551108, 188257	Roadside	32.0	36.2	34.0	57.5**
Br_1	Brentwood Borough Council	BRW1 Council Office	559860, 193617	Urban background	26.3	26.9	25.0	22.5
** = data capture below 75%; n/a = data not available; Exceedances of annual mean NO_2 air quality criterion of 40µg/m³ are highlighted in **bold**.								

Particulate Matter

There are two CMS sites in the LBH area that measure PM_{10} concentrations (LBH_1 and LBH_2). Table 9-7 presents the annual mean and 24-hour mean concentrations of PM_{10} from 2011 to 2014 inclusive. There were no exceedances of the relevant air quality criteria at either site. LBH_1 and LBH_2 are both roadside sites located more than seven kilometres from M25 Junction 28, as such it is unlikely that these CMS are representative of conditions at potential receptor locations.

Table 9-7 London Borough of Havering Continuous Air Quality Monitoring Data for PM_{10} (µg/m³)

Site ID	Site Name	Grid Ref	Site Type	Air Quality Criteria	2011	2012	2013	2014
LBH_1	HV1	553250, 182750	Roadside	PM_{10} Annual Mean (µg/m³)	n/a	n/a	n/a	19
				Number of exceedance of PM_{10} 24hour mean objective (50 µg/m³)	n/a	n/a	n/a	3
LBH_2	HV3	551108, 188257	Roadside	PM_{10} Annual Mean (µg/m³)	23	23	24	25
				Number of exceedance of PM_{10} 24hour mean objective (50 µg/m³)	17	11	6	11

Passive Monitoring

Passive monitoring of NO_2 using diffusion tubes has been undertaken by both LBH and BBC. Figure 9.1 in Appendix G presents an overview of the locations of monitoring sites within the locality of the air quality study area. The monitoring sites are colour coded by the concentration measured during the base year 2014.

Annual mean concentrations recorded at sites within the locality of the air quality study area for the period of 2011 to 2014 inclusive are provided in Table 9-8 and Table 9-9 for the LBH and BBC local authority areas respectively. The NO_2 diffusion tube network in LBH was enlarged from four to 37 sites in 2014 which explains why data is only available for 2014 for these sites.

Key areas and traffic corridors where exceedances of the annual mean AQS objective for NO_2 were measured in 2014 include:

- M25 Junction 28;
- A12 south west of Junction 28 at Harold Court Road;
- The roundabout junction at Gallows Corner between the A12 Colchester Road, A127 Southend Arterial Road and A118 Main Road;

- The junction between the A127 and Wingletye Lane
- A1023 just north of Kings Road in Brentwood; and
- The A118 Main Road west of Gallows Corner.

In 2014 six of the monitoring sites in the locality of Junction 28 operated by LBH recorded exceedances of annual mean NO2 concentrations. All of these exceedances occurred at kerbside or roadside sites along the A12, A118 and A127. Concentrations at background sites were all below the annual mean air quality criterion.

Table 9-8 London Borough of Havering Annual Mean Nitrogen Dioxide Diffusion Tube Monitoring Results 2014 (µg/m^3)

Site ID	Site Name	Grid Ref	Site Type	2014
LBH_18	HAV12	552096, 189619	Roadside	40.3
LBH_28, 29, 30	HAV22, 23, 24 - colocated	553707, 190817	Urban background	25.8
LBH_31	HAV25	553727, 193161	Urban background	25.1
LBH_38, 39, 40	HAV32, 33, 34 – co-located	553410, 190558	Kerbside	42.4
LBH_41	HAV35	554204, 193704	Urban background	24.2
LBH_42	HAV36	551979, 191230	Rural	18.5
LBH_43	HAV37	555723, 191750	Kerbside	53.4
LBH_44	HAV38	553434, 191656	Roadside	24.5
LBH_46	HAV40	553174, 190306	Roadside	51.9
LBH_47	HAV41	552517, 189826	Roadside	46.0
LBH_50	HAV44	553952, 189731	Kerbside	39.0
LBH_53	HAV47	554730, 189487	Roadside	50.2
LBH_57	HAV51	551180, 189432	Urban background	28.9
LBH_58	HAV52	554741, 190626	Roadside	39.5
LBH_59, 60, 61	HAV53, 54, 55 – colocated	553671, 192074	Urban background	29.2

During 2014 only three out of the 31 diffusion tube monitoring sites operated by BBC, in the locality of Junction 28, recorded exceedances of annual mean NO_2 concentrations: Br_5 (40 µg/m3) which is an urban background site, Br_35 (76.8 µg/m3) and Br_39 (43.4 µg/m3) which are both roadside sites. Concentrations at the majority of background sites were below the annual mean air quality criterion in all years. Exceptions included Br_5, located within AQMA No. 2, and Br_8 located in

AQMA No. 7, both of which recorded exceedances in more than one year between 2011 and 2014.

Table 9-9 Brentwood Borough Council Annual Mean Nitrogen Dioxide Diffusion Tube Monitoring Results (µg/m^3)

Site ID	Site Name	Grid Ref	Site Type	2011	2012	2013	2014
Br_2	BRW1, BRW2, BRW3 triplicate tubes located next to CMS	559861, 193617	Urban background	31.5*	30.0*	29.3*	22.7*
Br_5	BRW5	556887, 192412	Urban background	52.3	55.8	45.9	40.0
Br_6	BRW6	557014, 192493	Roadside	48.2	44.0	37.7	33.1
Br_7	BRW7	557118, 191978	Roadside	31.7	35.8	27.5	24.5
Br_8	BRW8	559691, 193912	Urban background	44.7	43.9	44.2	35.6
Br_9	BRW9	559643, 193889	Roadside	37.2	42.8	40.5	32.1
Br_10	BRW10	559699, 193948	Roadside	60.7	38.1	45.8	36.2
Br_11	BRW11	559604, 194035	Roadside	40.2	23.9	34.2	28.0
Br_12	BRW12	559187, 193658	Roadside	31.8	32.8	32.3	26.9
Br_13	BRW13	559195, 193681	Roadside	39.9	39.7	35.4	29.2
Br_14	BRW14	559148, 193660	Roadside	40.4	39.2	44.0	33.4
Br_15	BRW15	559085, 193601	Roadside	28.0	27.1	26.4	20.7
Br_16	BRW16	557379, 192900	Urban background	35.5	34.3	32.5	26.7
Br_17	BRW17	557632, 193151	Roadside	33.4	33.3	29.7	24.5
Br_18	BRW18	557826, 193333	Urban background	29.7	29.0	26.7	23.2
Br_19	BRW19	558769, 194873	Roadside	24.6	35.0	33.1	26.7
Br_20	BRW20	558818, 194913	Kerbside	41.5	37.1	43.5	28.0
Br_21	BRW21	558681, 194799	Roadside	31.5	28.4	29.6	23.9
Br_22	BRW22	558683, 194894	Roadside	39.9	43.0	38.3	33.0
Br_23	BRW23	558742, 194928	Roadside	41.9	49.0	43.2	35.9

Site ID	Site Name	Grid Ref	Site Type	2011	2012	2013	2014
Br_24	BRW24	558624, 194695	Roadside	32.0	32.6	30.8	25.2
Br_25	BRW25	558482, 194547	Urban background	36.6	34.3	32.7	27.2
Br_31	BRW32	556964, 192288	Urban background	37.4	38.8	34.9	30.0
Br_32	BRW33	559139, 195012	Urban background	32.5	31.1	28.1	22.1
Br_33	BRW34	557719, 193226	Roadside	33.7	29.2	30.2	25.1
Br_34	BRW36	556603, 194628	Urban background	20.4	29.0	18.7	15.8
Br_35	BRW37	558800, 194947	Roadside	98.6	91.8	93.5	76.8
Br_38	BRW40	559191, 193681	Roadside	n/a	n/a	n/a	38.8
Br_39	BRW41	559292, 193710	Roadside	n/a	n/a	n/a	43.4

* = average of the three diffusion tubes

n/a = data not available;

Exceedances of annual mean NO_2 UK AQS objective of 40 µg/m^3 are highlighted in **bold**.

Data for BBC sites for 2011 to 2014 is from the 2015 Updating and Screening Assessment.

In summary, there are exceedances of the annual mean air quality criterion for NO_2 in several areas of LBH and BBC, including roads on the ARN. There are also areas of non-compliance for annual mean NO_2 as indicated by the DEFRA PCM mapping, including on roads on the ARN. On this basis, there is a risk of continuing exceedances for annual mean NO_2 within the air quality study area in future years.

9.5 Regulatory/Policy Framework

Air Quality Criteria

For the local air pollutants of concern (NO_2 and PM_{10}), there are two sets of ambient air quality criteria for the protection of public health, namely those set by the EU and transposed in to UK law by The Air Quality Standards Regulations 2010[42] and those implementing the UK National Air Quality Strategy (AQS)[43,44,45].

The criteria set out in the AQS include standards and objectives for local authorities to work towards achieving. These apply in locations with relevant public exposure which are defined in the DEFRA Technical Guidance LAQM.TG(16)[46].The standards set by

[42] *The Air Quality Standards Regulations 2010: http://www.legislation.gov.uk/uksi/2010/1001/contents/made*
[43] *The Air Quality (England) Regulations 2000: http://www.legislation.gov.uk/uksi/2000/928/contents/made*
[44] *The Air Quality (England) (Amendment) Regulations 2002: http://www.legislation.gov.uk/uksi/2002/3043/contents/made*
[45] *https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1*
[46] *DEFRA (2016) Local Air Quality Management Technical Guidance (TG16) http://laqm.defra.gov.uk/documents/LAQM-TG16-April-16-v1.pdf*

the EU are legally binding, mandatory limit values (LV) requiring national Government compliance.

Table 9-10 Relevant Air Quality Criteria (Human Health)

Pollutant	Criteria
NO_2	Hourly average concentration should not exceed 200 µg/m^3 more than 18 times a year.
	Annual mean concentration should not exceed 40 µg/m^3
PM_{10}	24-hour mean concentration should not exceed 50 µg/m^3 more than 35 times a year.
	Annual mean concetrations should not exceed 40 µg/m^3

National Planning Policy

The National Planning Policy Framework (NPPF) sets out the Government's requirements of the planning system. The NPPF requires local planning authorities (LPAs) to take account of air quality in plan making, stating at paragraph 124:

"Planning policies should sustain compliance with and contribute towards 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 from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan."

Highways England Air Quality Policy

The National Networks National Policy Statement (NN NPS), prepared by the Department for Transport (DfT), provides policy and guidance relating to the development of nationally significant infrastructure projects. NN NPS requires a judgement to be made as to the risk of a project affecting the UK's ability to comply with the Air Quality Directive (paragraph 5.9 of the NN NPS). Paragraph 5.11 of the NN NPS states

"Air quality considerations are likely to be particularly relevant where schemes are proposed: within or adjacent to Air Quality Management Areas (AQMAs); roads identified as being above Limit Values or nature conservation sites; and 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.".

Furthermore, paragraph 5.13 of the NN NPS, states "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 with the most recent timescales reported to the European Commission at the time of the decision."

The DfT Road Investment Strategy (RIS) published in 2015 sets out the DfT's aspirations for the Strategic Road Network over the next 25 years. It states that by 2040 DfT aspires to a network that will be sustainable with "*zero breaches of air quality regulations and major reductions in carbon emissions across the network"*.

The Highways England Delivery Plan 2015-2020 identifies Highways England's commitment to investing £75m *"in a range of projects to reduce pollution and ensure the air around the network is clean and healthy"*. Key Performance Indicators (KPIs) and Performance Indicators (PI) are also identified including the following PI performance specification in relation to air quality: *"Suite of PIs to provide additional information about environmental performance*. These should, at a minimum, include: - Air Quality". The Delivery Plan includes a commitment to develop a PI for vehicle

derived emissions of carbon dioxide, and other greenhouse gases arising from the use of the Strategic Road Network by March 2016.

Local Planning Policy

Brentwood Borough Council is currently preparing a new Local Plan which, once adopted, will supersede saved policies in the current Replacement Local Plan (2005)[47]. Of relevance to air quality policy CP1 General Development Criteria states

"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…air (including noise, fumes, vibration, smells, smoke, ash, dust and grit).et.al". In addition policy PC6 Transport Pollution states: "*All new transport proposals and improvements to existing transport infrastructure and services will be assessed against their impact on air quality…and will need to be designed so as to minimised any negative impacts and, where necessary, incorporate reasonable and appropriate mitigation measures."*

In the draft Local Plan[48], which is expected to be adopted in 2017, Policy 10.11: Air Quality states: "The Council will promote measures to improve air quality, particularly within designated Air Quality Management Areas, and will expect development proposals to reduce sources of air pollution. Where the Council considers that air quality objectives are likely to be prejudiced or proposals fall within an Air Quality Management Area, applicants will be required to submit a detailed air quality assessment which sets out the impact the proposed development would have upon air quality.".

The BBC Air Quality Action Plan (AQAP)[49] states that the main source of air pollution in the borough is derived from road traffic. In order to achieve the NO_2 air quality objective the AQAP describes three specific schemes to help reduce congestion including: the M25 Junction 28/A12/Brook Street improvement; Junction 27 to 30 M25 Widening; and Wilson's Corner in Brentwood town centre. In addition the AQAP describes general measures to be taken such as the implementation of Low Emission Zones (LEZ), park and ride facilities, travel plans, freight management, and the promotion of public transport services, walking, cycling and bus priority measures. BBC will also encourage Essex County Council's Local Transport Plan that comprises the Essex Transport Strategy[50]. The strategy sets out the council's transport aims over a fifteen year period. One of the strategy's five broad outcomes is to *"reduce carbon dioxide emissions and improve air quality through lifestyle changes, innovation and technology"* by reducing the carbon intensity of travel in urban areas and along key corridors.

LBH's Local Development Framework (LDF) was adopted in 2008 and is currently being updated. The Core Strategy[51], as part of the LDF, sets out the council's approach to planning up to 2020. Core Policy 15 - Environmental Management states:

"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" In addition, DC52 – Air Quality states: *"Planning permission will only be*

[47] *Brentwood Borough Council (2005) Brentwood Replacement Local Plan* http://www.brentwood.gov.uk/pdf/30102013165238u.pdf
[48] *http://brentwood.gov.uk/pdf/08022016165904u.pdf*
[49] *Brentwood Borough Council (2008) Air Quality Action Plan October 2008* http://aqma.defra.gov.uk/action-plans/BBC%20AQAP%202008.pdf
[50] *Essex County Council (2011) Essex Transport Strategy: the Local Transport Plan for Essex June 2011* http://www.essex.gov.uk/Environment%20Planning/Planning/Transport-planning/Documents/Essex_Transport_Strategy.pdf
[51] *London Borough of Havering (2008) Core Strategy and Development Control Policies Development Plan Document Adopted 2008* https://www.havering.gov.uk/Documents/Planning/LDF/Core-Strategy-Development-Control.pdf

granted where new development, both singularly and 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. 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".

9.6 Design, mitigation, enhancement and monitoring measures

Construction

Construction impacts will be assessed and mitigation measures proposed at a later PCF stage, in line with a proportional assessment.

Operation

The main route for mitigation is to influence the scheme option design to reduce potential impacts on air quality once a scheme is complete. This could include such measures as realignment of roads away from receptors, and maximising the benefits of free-flow traffic conditions to reduce vehicle emissions near receptors.

The need for and the effectiveness of any design suggestions would be investigated with further air quality modelling at PCF Stage 2 if required. Mitigation measures during operation will also be considered at PCF Stage 2.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

9.7 Potential Effects

The scheme options have the potential to affect local air quality, both during construction and once in operation in the following ways:

- There could be increased emissions of dust during construction of the preferred scheme route option from dust-raising activities on site;
- Air quality could be affected by changes in traffic flows during construction, as a result of temporary traffic management measures and / or additional vehicles travelling to and from the construction site transporting materials, plant and labour;
- Once operational, air quality could be affected (positively or negatively) by changes in vehicle activity (flows, speeds and composition) as a result of the scheme options; and
- Operationally, air quality could also be affected by any changes to the distance between sources of emissions and air quality sensitive receptors.

Construction

Demolition and construction activities can give rise to dust emissions under particular circumstances, if not effectively managed. Construction of any of the proposed scheme options has the potential to affect nearby receptors either due to dust from demolition and construction activities, or the tracking out of dust from heavy goods vehicles (HGV) onto the local road network. Implementation of best practice mitigation measures will generally control construction dust and minimise any short term adverse effects.

In addition, the local highway network may experience changes in traffic flows and speeds during construction as a result of temporary traffic management measures and

/ or additional vehicles travelling to and from the construction site transporting materials, plant and labour. However, any effects on air quality would be short term and temporary (i.e. during the period of construction works only).

Operation

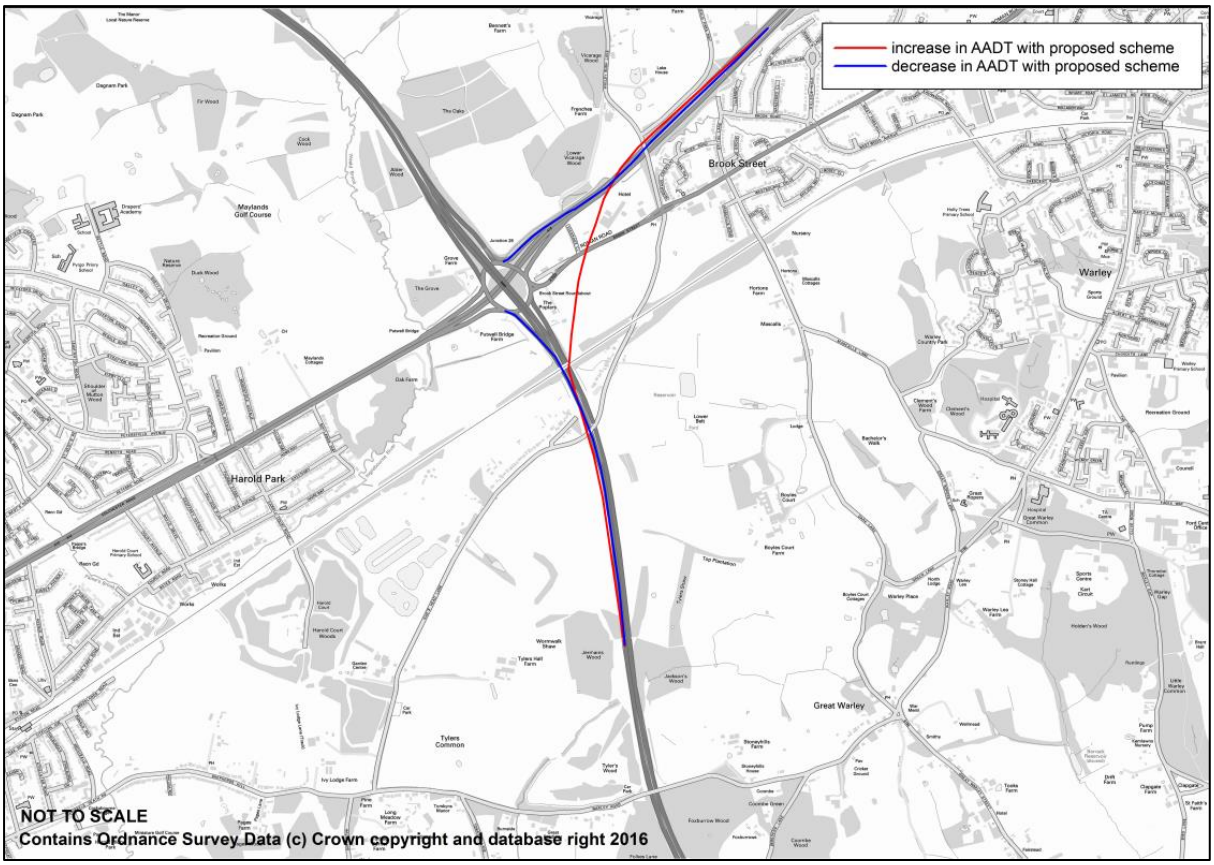
Once operational, air quality could be affected (positively or negatively) by changes in vehicle activity (flows, speeds and composition). Air quality could also be affected by any changes to the distance between emissions sources and sensitive receptors as a result of the change to road alignment for the operational scheme.

Five proposed scheme options (6, 2, 4, 5A, 5B, 5C, 5D and 5E) have been considered for the PCF Stage 1 air quality study. In all options, road links around the junction meet specified ARN criteria for traffic changes. These are described for each option in turn below. It should be noted that only the ARN for AADT has been examined at this stage.

Option 6

In Option 6, the proposed works include a new link road that exits the M25 south of Nag's Head Lane and over a viaduct that spans Nag's Head Lane, the M25 south of Junction 28 and the railway before re-joining the A12 eastbound. The ARN for scheme Option 1 is illustrated in Figure 9.3 and shows that there is expected to be an increase in AADT on the new link road. Receptors near this new link road could potentially be affected by an increase in pollutant concentrations, including those within Havering AQMA and Brentwood AQMA Nos. 1 and 2. However, the sections of road expected to have a decrease in AADT include: the M25 south of Junction 28; the M25 northbound offslip to Junction 28 south of the junction; the A12 east of Junction 28; and the eastbound onslip to the A12 east of Junction 28. Receptors near these roads could potentially be affected by a decrease in pollutant concentrations, including those within Havering AQMA and Brentwood AQMA Nos. 1, 2, 3 and 4. The DEFRA PCM mapping showed that roadside concentrations at all links included within the model around Junction 28 are expected to be compliant with the NO_2 annual mean EU limit value by 2020.

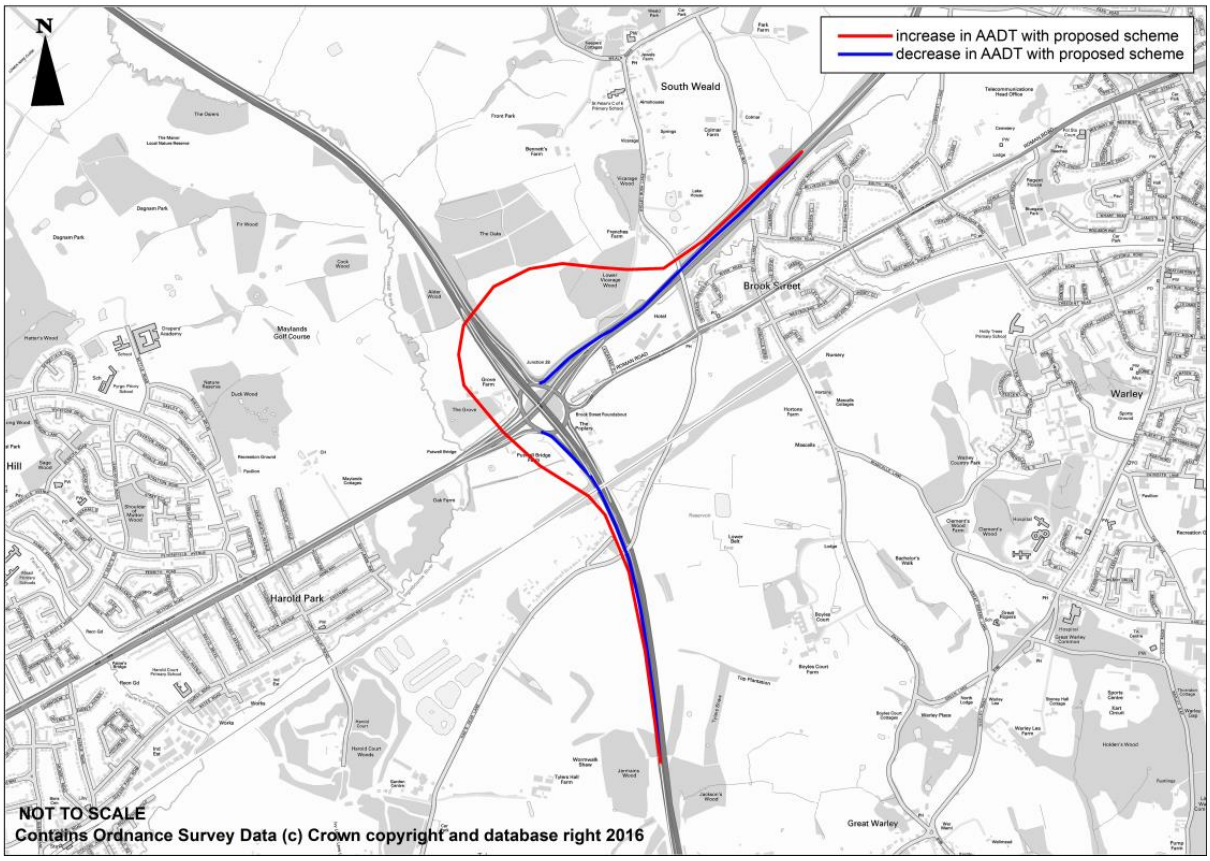
Figure 9-3 M25 J28 Option 6 AADT Affected Road Network



Option 2

In Option 2 (Northern Hook), the proposed works include a new link road that exits the M25 south of Nag's Head Lane and under the existing railway embankment. Consequently the distance between this emission source and residential properties on Nags Head Lane (west) would be reduced, potentially increasing pollutant concentrations at these receptors. The link would then cross the A12 and M25 on new structures before merging with the A12 eastbound east of Wigley Bush Lane over-bridge. Figure 9-4 shows that the receptors near to this link road including Putwell Bridge Farm, Grove Farm, and Frenches Farm, could potentially be affected by an increase in pollutant concentrations (Grove Farm currently lies within the Havering AQMA). The realignment of Nags Head Lane away from existing receptors may lead to a reduction in pollutant concentrations at these properties, which are currently within Brentwood AQMA No. 1. In addition, there is expected to be a decrease in AADT on the A12 east of Junction 28 and on the M25 south of Junction 28, due to the introduction of the new dedicated right turn link. Receptors within 200 metres of these roads could potentially be affected by a decrease in pollutant concentrations, including those within Havering AQMA and Brentwood AQMA Nos. 1 and 2. The DEFRA PCM mapping showed that roadside concentrations at all links included within the model around Junction 28 are expected to be compliant with the NO_2 annual mean EU limit value by 2020.

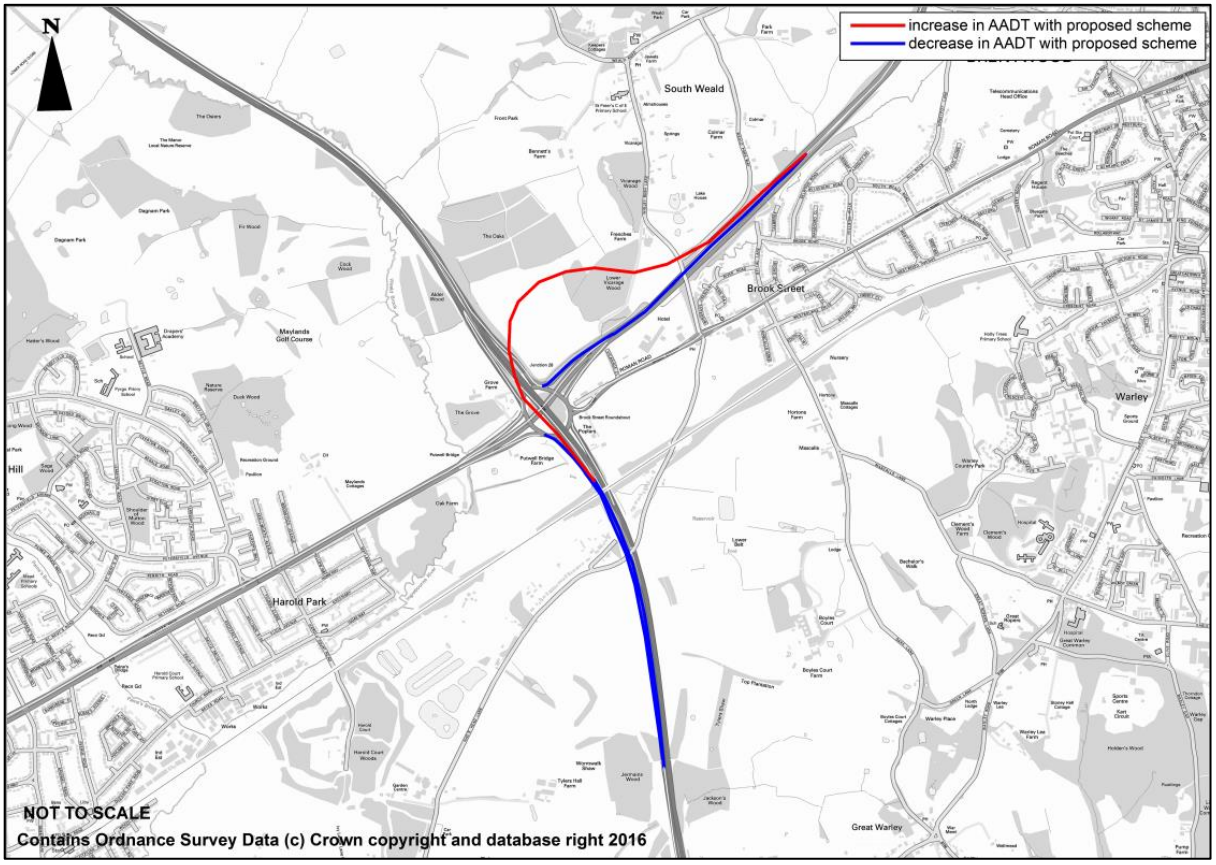
Figure 9-4 M25 J28 Option 2 AADT Affected Road Network



Option 4

In Option 4, the proposed works include a new link road that exits the M25 south of Nag's Head Lane and under the existing railway embankment before re-joining the A12 to the east of Junction 28. The distance between this new link road and residential properties on Nags Head Lane (west) would be reduced, potentially increasing pollutant concentrations at these receptors west of the M25, within Brentwood AQMA No. 1. Figure 9-5 shows that the receptors near to this link road including Grove Farm and Frenches Farm, could potentially be affected by an increase in pollutant concentrations, with Grove Farm currently within Havering AQMA. The realignment of Nags Head Lane away from existing receptors may lead to a reduction in pollutant concentrations at these properties. In addition, there is expected to be a decrease in AADT on the A12 east of Junction 28 and on the M25 south of Junction 28 due to the introduction of the new dedicated right turn link. Receptors within 200 metres of these roads could potentially be affected by a decrease in pollutant concentrations, including those within Havering AQMA and Brentwood AQMA Nos. 1 and 2. The DEFRA PCM mapping showed that roadside concentrations at all links included within the model around Junction 28 are expected to be compliant with the NO_2 annual mean EU limit value by 2020.

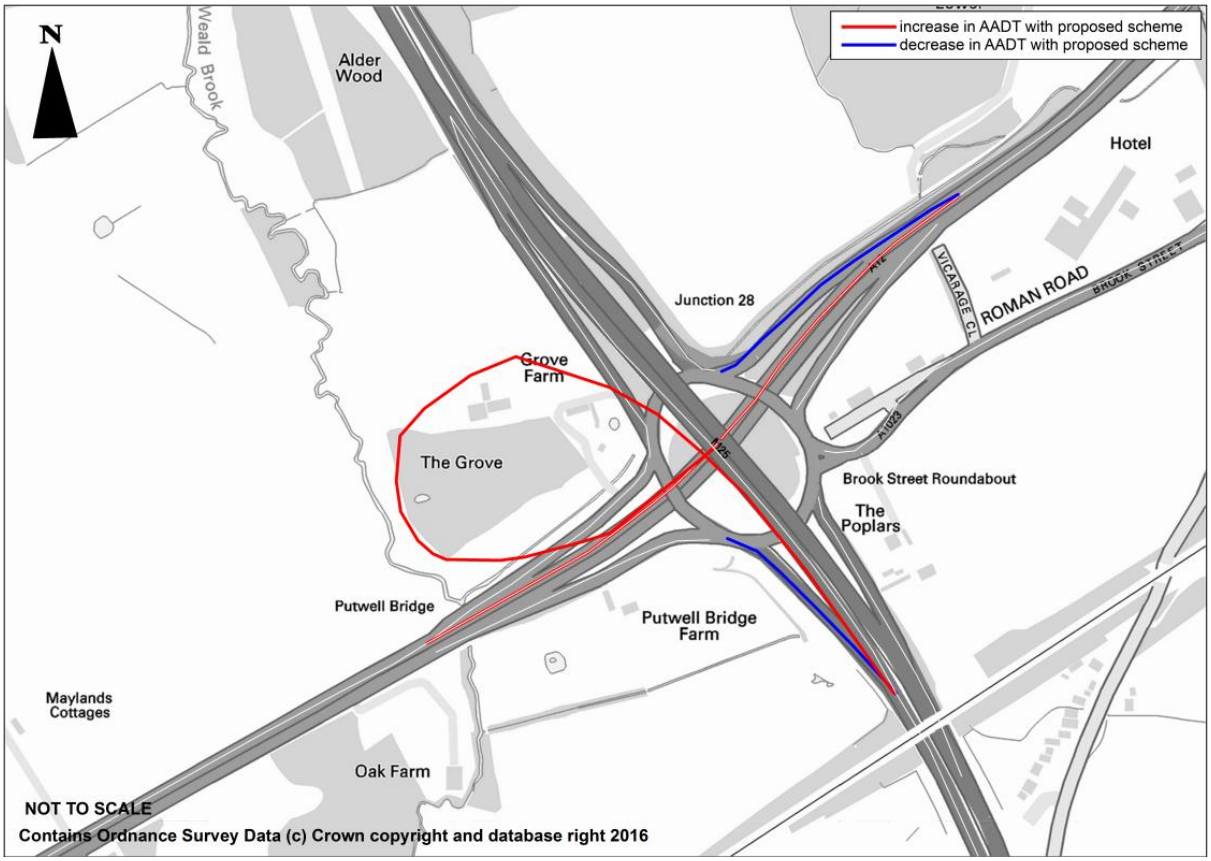
Figure 9-5 M25 J28 Option 3 AADT Affected Road Network



Option 5A, 5B and 5C

Options 5A, 5B and 5C provide a new link road routed from the M25 Junction 28 northbound, before merging with the A12 east of Junction 28 via an anti-clockwise loop. Properties to the north west of Junction 28 including Grove Farm, which are within the Havering AQMA may potentially be affected by increased pollutant concentrations due to this new road link as shown on Figure 9-6. In addition, with Option 5A, Nags Head Lane will be realigned, leading to a potential reduction in pollutant concentrations at receptors near this road, which are within Brentwood AQMA No. 1, as a result of the increased distance between the receptors and emission source. With all options there is expected to be a decrease in traffic on the M25 northbound offslip south of Junction 28 which could potentially offset any adverse effect in this area. There is also expected to be a decrease in traffic on the eastbound onslip onto the A12 east of Junction 28 which could potentially lead to a decrease in pollutant concentrations at nearby receptors including those within Havering AQMA and Brentwood AQMA Nos. 1 and 2. The DEFRA PCM mapping showed that roadside concentrations at all links included within the model around Junction 28 are expected to be compliant with the NO_2 annual mean EU limit value by 2020.

Figure 9-6 M25 J28 Options 5A, 5B and 5C Affected Road Network

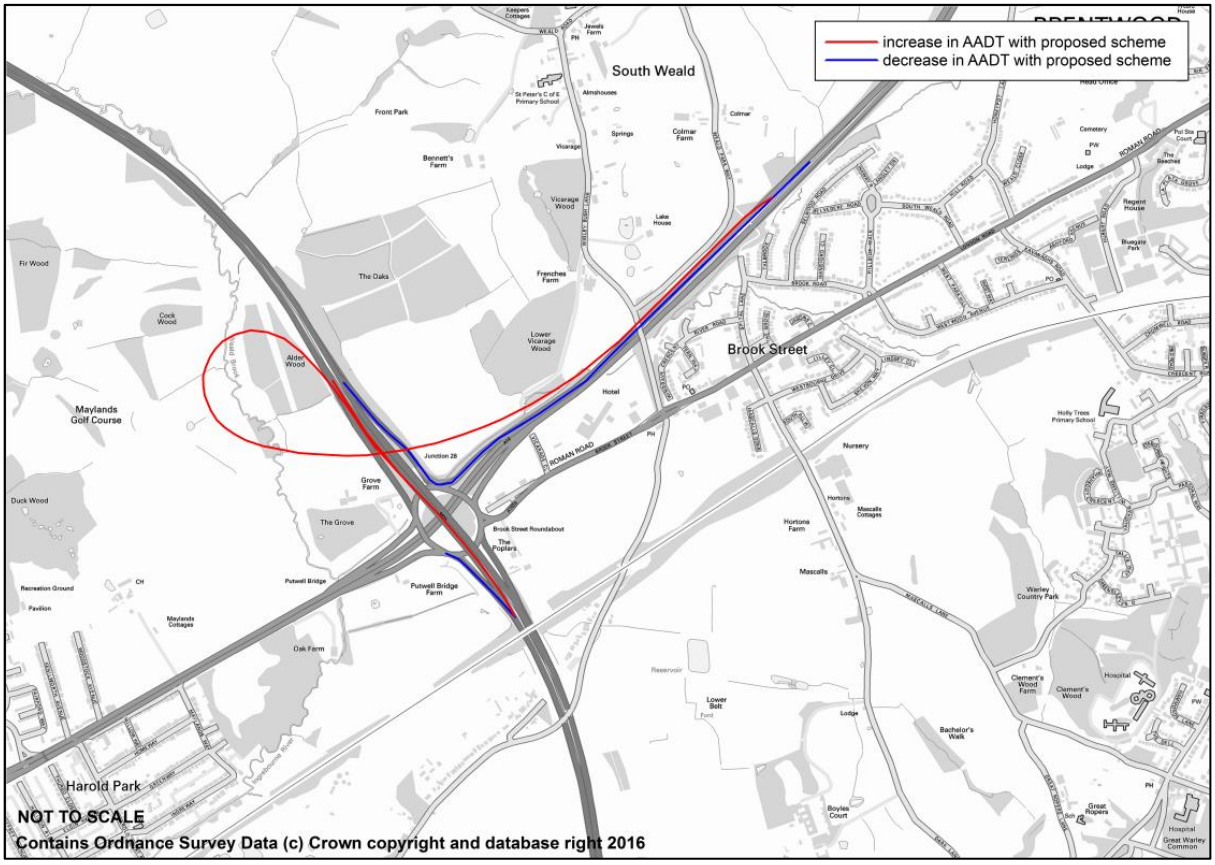


Option 5D and 5E

Options 5D and 5E also provide a connective link between the M25 anti-clockwise to the A12 eastbound, via an anti-clockwise loop north of Junction 28. In combination with reconfiguration and widening works for the A12 eastbound to M25 northbound link, Grove Farm, located within the Havering AQMA, may experience a deterioration in air quality due to proximity to additional vehicle emissions sources. Provision of a dedicated left turn lane from M25 southbound offslip onto the A12 eastbound, including reconfiguration for lane merges may adversely affect pollutant concentrations at Frenches Farm due to a reduced distance between the receptor and emissions sources.

Figure 9-7 shows that there is expected to be a decrease in AADT on the M25 southbound off-slip north of Junction 28, the northbound off-slip south of Junction 28, the A12 east of Junction 28 and the A12 eastbound on-slip, which could potentially lead to a reduction in pollutant concentrations at nearby sensitive receptors, including those within Havering AQMA and Brentwood AQMA Nos. 1, 2, 3 and 4. There are expected to be increases in AADT on the M25 through Junction 28 as well as on the new link roads. Receptors near these roads could potentially be affected by an increase in pollutant concentrations, including those within Havering AQMA and Brentwood AQMA Nos. 1 and 2. However, the DEFRA PCM mapping showed that roadside concentrations at all links included within the model around Junction 28 are expected to be compliant with the NO_2 annual mean EU limit value by 2020.

Figure 9-7 M25 J28 Opt 5D and 5E AADT Affected Road Network



9.8 Limitations to assessment

The primary assumption for PCF Stage 1 lies in the use of the VISSIM traffic model. The study area has been limited to the spatial extent of the model for the purposes of determining the ARN at this stage. It is likely that the affected road network could potentially be extended. This will be reviewed at PCF stage 2 following refinement of the traffic model. Requirements for further, detailed quantitative modelling of pollutant concentrations from which significance of effects may be determined will be reviewed at PCF Stage 2.

Assessment in accordance with relevant Highway England Interim Advice Notes (IAN) has not been completed in this PCF Stage 1 assessment as quantitative assessment of air quality has not been undertaken. Requirements for further, detailed quantitative modelling of pollutant concentrations from which significance of effects may be determined will be reviewed at PCF Stage 2.

At this stage there are no designated ecological sites within 200 metres of the ARN for any option. However, following refinement of the ARN at PCF Stage 2, this will be reviewed and the impact of oxides of nitrogen (NO_x) concentrations on vegetation considered further, in quantitative analysis in a future Stage of PCF reporting.

9.9 Summary and recommendations

The scheme and the associated ARN is located within the boundaries of the London Borough of Havering (LBH) and Brentwood Borough Council (BBC). At this stage there are five AQMAs within the air quality study area which could potentially be affected by the scheme: the whole of LBH has been declared for exceeding both the annual mean NO_2 AQS objective and the 24-hour mean PM_{10} AQS objective, while Brentwood

AQMA Nos. 1, 2, 3, and 4 were declared for exceeding the annual mean NO_2 AQS objective. AQMA No. 7 in Brentwood town centre is not within 200 metres of the ARN at this stage, although this will be re-examined at a future stage following any revision to the traffic model.

DEFRA PCM mapping shows that for 2014, of the roads that were included in the model there were exceedances of the annual mean NO_2 EU limit value of 40 $\mu g/m^3$ within the air quality study area on the A12 both east and west of Junction 28 but not on the A1023. There were no exceedances of the annual mean PM_{10} EU limit value.

The traffic model for the opening year has shown that there are likely to be a number of roads affected with each option. For all options there is expected to be an increase in traffic on the proposed new link roads, with a corresponding potential increase in pollutant concentrations at nearby receptors. Conversely, in all cases except option 5 variants, there is expected to be a decrease in traffic on the A12 east of Junction 28 and the M25 south of Junction 28, with a potential decrease in pollutant concentrations at nearby receptors. Option 5 variants is expected to have an increase in traffic on the M25 through Junction 28, but a decrease in traffic on the M25 north of the junction and on the A12 east of the junction.

At this stage, all options are considered likely to pose a risk of a potentially significant adverse effect at nearby receptors, particularly those within the Havering and Brentwood AQMAs. However, given that the DEFRA PCM mapping for 2020 showed that roadside concentrations at all links included within the model around Junction 28 are expected to be compliant with the NO_2 annual mean EU limit value, there may be less risk of pollutant concentrations at nearby receptors exceeding criteria. Options 2, 4 and 5A additionally provide for a realignment of Nags Lane which could potentially lead to an improvement in air quality at the properties within the AQMA.

It is recommended that a simple air quality assessment at PCF Stage 2 is undertaken which should include calculation of air pollutant concentrations at representative receptors for the scheme opening year using the DMRB screening tool to allow the potential significant effects to be determined for each option.

10 Noise and Vibration

10.1 Introduction

This chapter provides an indication of the potential noise and vibration impacts resulting from a number of options for the improvement of Junction 28 of the M25. The options are described in full in Chapter 3. Traffic data has been supplied by Atkins Traffic Planners for Options.6, 2, 4, 5B and 5D.

10.2 Assessment methodology

Construction

As baseline noise monitoring will be undertaken at a future design stage as appropriate. A full construction noise assessment using BS5228-1:2009+A1:2014[52] will be deferred until such baseline noise monitoring data is available.

The significance criteria for construction noise will be confirmed at a future design stage (PCF Stage 3) as the significance criteria used in BS5228-1:2009+A1:2014 are set depending on the ambient noise levels measured at noise sensitive receptors in proximity to the proposed construction works.

The assessment at this design phase (PCF Stage 1) will be qualitative. The construction assessment will identify those activities which have the highest potential to cause disturbance at nearby noise sensitive receptors.

Operation

Noise impacts arising from the design options for the Proposed Scheme have been assessed in accordance with the guidance provided in the Design Manual for Roads and Bridges Volume 11, Section 3, Part 7 (DMRB 11:3:7) HD213/11.

DMRB 11:3:7 presents the threshold criteria that could trigger a detailed traffic noise assessment if the criteria are likely to be met or exceeded, which are:

- A change in daytime traffic noise impacts in the short term (opening year) of 1 dB $L_{A10,18h}$. This can be caused by traffic flow increases of 25% or decreases of 20%, provided that the traffic speed and composition remains constant, or where there is a new or altered road alignment.
- A change in daytime traffic noise impacts in the long term (typically 15 years after the project opening) of 3 dB $L_{A10,18h}$. A change of 3 dB $L_{A10,18h}$ is equivalent to doubling or halving the traffic flow, provided that the speed and proportion of heavy vehicles remains constant, or where there is a new or altered road alignment.
- A change in night-time traffic noise impacts of 3 dB $L_{night,outside}$ in the long term where $L_{night,outside}$ is predicted to be greater than 55 dB $L_{night,outside}$ in any scenario.

The short term and long term impact magnitude criteria from DMRB 11:3:7 are reproduced below:

[52] *British Standards Institution (2014) BS5228:2009 + A1:2014 Code of practice for noise and vibration control on construction and open sites, Part 1: Noise. London BSI.*

Table 10-1 Classification of magnitude of noise impacts in the short term and the long term

Short Term Noise Change $L_{A10,18h}$	Long Term Noise Change $L_{A10,18h}$	Magnitude of Impact
0	0	No Change
0.1 – 0.9	0.1 – 2.9	Negligible
1.0 – 2.9	3.0 – 4.9	Minor
3.0 – 4.9	5.0 – 9.9	Moderate
5+	10+	Major

It is important that an appropriate and proportionate approach is taken throughout the design process of the Proposed Scheme. At this design stage (PCF Stage 1), a basic quantitative noise assessment has been undertaken to identify areas that may exceed DMRB's threshold levels and trigger the need for a detailed assessment in a future design stage. This has been achieved using traffic data obtained through microsimulation of the M25 Junction 28. Any baseline noise monitoring in the study area will be carried out at a future assessment stage.

The noise assessment has been completed by computing the Basic Noise Level (BNL) at 10m from the edge of the carriageway for each traffic link within the study area, using the calculation methodology presented in the Calculation of Road Traffic Noise[53] (CRTN). The Basic Noise Level is calculated using the following output from the traffic model for each road link:

- 18 hour (06:00 to 24:00) Annual Average Weekday Traffic Flows (AAWT),
- Traffic speed,
- Percentage of Heavy Duty Vehicles (HDV) defined as all vehicles with an unladen weight greater than 3.5 tonnes.
- The road surfacing of the traffic link.
- The gradient of the road link.

In the absence of better information at this stage, the road gradient and road surfacing corrections have been assumed to be zero.

No information is currently available about existing mitigation in the study area and therefore this has not been taken into account in the assessment.

For assessments following the DMRB methodology, DMRB requires a Future Year assessment to be undertaken, which is normally taken to be 15 years after the Opening Year of the proposed scheme, however at this early stage, it is unlikely that the assessment of future year BNL changes would provide any further useful information and hence this has not been included in the assessment. Typically impacts on opening of a scheme are higher than in the future year due to the lower threshold levels.

It has not been possible to indicate the number of properties affected by the predicted BNL changes as detailed property data is currently not available. This will be included in a future design stage assessment.

Road traffic noise levels will be calculated for six traffic scenarios for the Opening Year (2022) and the Design Year (2037). Comparisons will be made for each option against the Do Minimum in the Opening Year.

[53] *Department of Transport and the Welsh Office (1988). Calculation of Road Traffic Noise. London: HMSO.*

The traffic scenarios that will be assessed are:

- Do Minimum
- Option 6
- Option 2
- Option 4
- Option 5B
- Option 5D

10.3 Study area

The study area for the assessment is defined in DMRB 11:3:7 as 600m from the carriageway edge of any proposed new routes or existing routes to be bypassed or improved, and 600m from any other affected routes within 1km of the proposed new routes or altered existing routes. An affected route is where there is a possibility of a change of 1dB $L_{A10,18h}$ in the short term or 3dB $L_{A10,18h}$ in the long term.

The Proposed Scheme is located between Romford and Brentwood, which are separated by agricultural land and the M25. Road traffic noise from the M25 and the A12 is the dominant source of ambient noise in the study area. The land use within 600m of the M25 Junction 28 is generally agricultural and commercial, with the closest business located 55m from the junction on Brook Street. Maylands Golf Course is located approximately 600m from the existing junction layout.

The closest residential areas to the Proposed Scheme are The Poplars (50m) and Nag's Head Lane (250m). Further residential communities are located at Brook Street (600m), Harold Park (800m), Wigley Bush Lane (850m), and South Weald (1.1km). These are areas of mixed residential and commercial land use.

The following non-residential noise sensitive receptors have been identified within 1km of proposed design options for alleviating congestion at the M25 Junction 28: Harold Park Recreation Ground, Drapers' Academy, Harold Court Primary School, St Peter's C of E Primary School, St Peter C of E Church, Holiday Inn Brentwood, Colmar Farm Riding School, Brentwood Police Station and Court, and London Road Cemetery.

Table 10.2 sets out the location of the Noise Important Areas (NIAs) and their distance to Junction 28. These are also shown in Appendix L to this ESR.

10.4 Baseline conditions

A noise survey has not yet been undertaken to ascertain the baseline noise levels at noise sensitive receptors within the study area. However, based on aerial imagery it is expected that road traffic noise from the M25 and the A12 are the main noise source influencing noise levels in the study area. A railway operating between Stratford and Shenfield is also to the south of the study area (approximately 290m south of Junction 28), influencing noise levels to the south of the Harold Park and Brook Street residential areas.

Strategic noise maps were published during 2015 by Defra for major road and railway sources to meet the requirements of the Environmental Noise Directive (Directive 2002/49/EC) and the Environmental Noise (England) Regulations 2006 (as amended). The strategic noise maps for road traffic noise during the daytime (07:00-23:00) and night-time (23:00-07:00) periods are shown in Appendix L. The noise levels shown in the strategic noise maps represent the annual average noise from road sources during 2012 within areas with populations of 100,000 people (agglomerations) and along

major traffic routes. The noise levels shown were calculated for a receptor height of 4m above ground level.

The 'Important Areas' for noise have been identified to highlight any particular constraints on the design options for the Proposed Scheme. Important Areas are the locations where the top 1% of the population are affected by the highest noise levels from major roads and railways according to the strategic noise mapping undertaken by Defra. The locations of the Important Areas in proximity to the Proposed Scheme are also shown in Appendix L. Table 10-2 identifies the NIA ID, given by Defra Noise Maps, and the location of the NIA to Junction 28 within a radius of 1km.

Table 10-2 Location and distances of NIAs from Junction 28

NIA ID	Source of Noise	Distance in metres	Distance in Km
5750*	Road	on Juntion 28 (approx. 12m)	0.01
13448	Road	260	0.26
5749	Road	400	0.40
5752	Road	810	0.81
RI_596	Rail	920	0.92
13446	Road	1000	1.08

Appendix L indicates that the annual average road traffic noise levels exceed 65 dB $L_{Aeq,16h}$ during the daytime at the closest noise sensitive receptors to the junction, such as The Poplars and Grove Farm, with lower noise levels of at least 55 dB $L_{Aeq,16h}$ towards the edge of the study area. The annual average noise levels at the majority of locations within 600m of the Proposed Scheme exceeded 55 dB L_{night}. Higher noise levels are indicated close to the M25 Junction 28, affecting isolated buildings occupying rural land.

10.5 Regulatory / Policy framework

Current noise policy in England is based on the Noise Policy Statement for England (NPSE)[54], which through the effective management and control of environmental noise within the context of Government policy on sustainable development, aims to:

- avoid significant adverse impacts on health and quality of life
- mitigate and minimise other adverse impacts on health and quality of life
- contribute to improvements to health and quality of life, where possible
- These aims are reflective of those contained in the National Planning Policy Framework (NPPF) and are further echoed in the National Policy Statement for National Networks (NPSNN)[55] and Planning Practice Guidance concerning noise[56]

The Explanatory Note to the NPSE assists in the definition of significant adverse and adverse with the following concepts:

[54] *DEFRA (2010). "NOISE POLICY STATEMENT FOR ENGLAND (NPSE).*
[55] *DEPARTMENT FOR TRANSPORT (DEC 2014). "NATIONAL POLICY STATEMENT FOR NATIONAL NETWORKS".*
[56] *DEPARTMENT FOR COMMUNITIES AND LOCAL GOVERNMENT, PLANNING PRACTICE GUIDANCE (http://planningguidance.planningportal.gov.uk/).*

- NOEL – no observed effect level. This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- LOAEL – lowest observed adverse effect level. This is the level above which adverse effects on health and quality of life can be detected.
- SOAEL – significant observed adverse effect level. This is the level above which significant adverse effects on health and quality of life occur.

The Government policy and guidance do not state values for the NOEL, LOAEL and SOAEL, rather, it considers that they are different for different noise sources, for different receptors and at different times and should be defined on a strategic or project basis taking into account the specific features of that area, source or project.

NPSE also states that sustainable development is a core principle underpinning all government policy. The goal is pursued in ways that protect and enhance the physical and natural environment, and that use resources and energy as efficiently as possible.

The Highways England Licence states that Highways England should ensure the best practicable environmental outcomes across its activities, while working in the context of sustainable development and delivering value for money.

Section 5(2) of the Infrastructure Act 2015 and the Highways England Licence seek to minimise the environmental impacts of projects, protect and enhance the quality of the surrounding environment and conform to the principles of sustainable development.

In line with this, the Department for Transport RIS 2015-2020 aspires to the target that by 2040 over 90% fewer people are impacted by noise from the strategic road network. The target for the first Road Period 2015-2020, is to mitigate at least 1,150 noise Important Areas expecting to reduce the number of people severely affected by noise from the strategic road network by at least 250,000.

The legislation and policies considered in undertaking this noise assessment are detailed in Table 10-3 and 10-4 for construction and operation respectively.

Table 10-3 Regulatory and policy framework for construction noise and vibration

Regulation/policy	Summary of requirements
NPSE NPPF Planning Practice Guidance Noise to NPPF (PPGN) National Policy Statement for National Networks (NPSNN)	Within the context of Government policy on sustainable development: i. Avoid significant adverse effects as a result of the scheme. ii. Mitigate and minimise adverse effects as a result of the scheme. iii. Contribute to the enhancement of the acoustic environment.
Control of Pollution Act 1974 (as amended)	Section 60 – Control of noise on construction sites. Section 61 – Prior consent for work on construction sites. Section 71 – Codes of practice for minimising noise. Section 72 – Best practicable means.
Environmental Protection Act 1990 (as amended)	Section 79 (1) (ga) noise that is prejudicial to health or a nuisance and is emitted from or caused by a vehicle, machinery or equipment in a street is a statutory nuisance; (NB if so should be inspected by the local authority) (9) interpretation of “best practicable means”
The Control of Noise (Code of Practice for Construction and Open Sites) (England) Order 2015	Approves BS 5228:2009+A1:2014 Part 1 Noise and Part 2 Vibration for the purpose of giving guidance on appropriate methods for minimising noise and vibration

Regulation/policy	Summary of requirements
Noise Insulation Regulations 1975 (as amended)	Regulation 5 provides relevant authorities with discretionary powers to undertake or make a grant in respect of the cost of undertaking noise insulation work in or to eligible buildings with respect to construction noise. This is subject to meeting certain criteria given in the Regulation.

Table 10-4 Regulatory and policy framework for operational noise and vibration

Regulation/policy	Summary of requirements
Environmental Noise (England) Regulations 2006	Take into account Noise Action Plans.
NPSE NPPF PPGN NPSNN	Within the context of Government policy on sustainable development: i. Avoid significant adverse effects as a result of the scheme. ii. Mitigate and minimise adverse effects as a result of the scheme. iii. Contribute to the enhancement of the acoustic environment.
Land Compensation Act 1973	Part I Compensation for depreciation caused by use of public works.
Noise Insulation Regulations 1975 (as amended)	Regulation 3 imposes a duty on authorities to undertake or make a grant in respect of the cost of undertaking noise insulation work in or to eligible buildings. This is subject to meeting certain criteria given in the Regulation. Regulation 4 provides authorities with discretionary powers to undertake or make a grant in respect of the cost of undertaking noise insulation work in or to eligible buildings, subject to meeting certain criteria given in the Regulation.
The Highways Noise Payments and Movable Homes (England) Regulations 2000	Provide highway authorities with a discretionary power to provide a noise payment where new roads are to be constructed or existing ones altered. The relevant Regulations set out the criteria which should be applied in assessing eligibility for making such payments.

10.6 Design, mitigation, enhancement and monitoring measures

Construction

To mitigate any potential noise problems during the construction phase, the construction contractor should consult with the Environmental Health Departments at the relevant Local Planning Authorities to obtain guidance on their requirements for managing and controlling noise and vibration from construction works.

A Construction Environmental Management Plan (CEMP) should be created and implemented by the contractor and be approved by the Local Authorities prior to the commencement of construction works. The CEMP should outline the following:

- Environmental management and responsibilities;
- Monitoring and auditing processes;
- Procedures that will be used to complete different construction activities;
- Complaints response procedures; and

- Community and stakeholder liaison processes.

The contractor may also be able to submit a Section 61 application under the Control of Pollution Act 1974 for some construction works, especially if night-time working is proposed.

The contractor should also be encouraged to join (if not already a member) the Considerate Contractors Scheme that is recognised by industry and the Government for encouraging firms to be sensitive to the environment.

Good stakeholder relations are often the most effective way to manage potential noise impacts on site. Therefore, the contractor should keep local residents and other affected parties informed of the progress of the works, including when and where the noisiest activities will be taking place and how long they are expected to last. All noise complaints should be effectively recorded, investigated and addressed.

In addition, the contractor should use the following good working practices:

- All vehicles and plant should be fitted with effective exhaust silencers which should be maintained in good and efficient working order;
- All compressors and generators should be 'sound reduced' models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use;
- All ancillary pneumatic percussive tools should be fitted with mufflers or suppressors as recommended by the manufacturers which should be kept in a good state of repair;
- Machines in intermittent use should be shut down when not in use or where this is impracticable, throttled down to a minimum;
- The site compound and static machines should be sited as far as is practicable from noise sensitive buildings;
- Where practicable, plant with directional noise characteristics should be orientated to minimise noise at nearby properties;
- Plant should be certified to meet the current EU legislation and should be not be louder than the noise levels provided in Annex C and D of BS5228-1;
- Where appropriate, temporary noise barriers or other noise containment measures should be installed to minimise construction noise levels;
- The loading or unloading of vehicles and the movement of equipment or materials should be undertaken in a manner that minimises noise generation;
- Concrete mixers should not be cleaned by hammering the drums; and
- When handling materials, care should be shown not to drop materials from excessive heights.

In addition to the above good working practices, where piling is required, the piling method should be selected carefully to minimise noise and vibration impacts at noise sensitive receptors. Where practicable, piling methods that result in low levels of vibration, such as rotary bored piling should be used. Methods that cause much higher levels of vibration, such as percussive piling, can cause cosmetic damage to buildings within 50m of the construction works and should be avoided wherever possible.

Even with appropriate mitigation in place, it may not be possible to eliminate all noise impacts. However, best practice, considerate working hours as well as frequent and

open communications with stakeholders will help to reduce the residual impact of construction noise.

Operation

Due to the new infrastructure, all of the proposed scheme options have the potential to increase noise levels at noise sensitive receptors and at identified 'Important Areas' for noise, and therefore noise mitigation may be required to reduce noise levels. Noise mitigation can consist of noise barriers, earth bunds, or low noise road surfacing, and may include any existing noise mitigation in situ that will be retained by the proposed scheme options. Further assessments of mitigation options will be undertaken at a future design phase.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

10.7 Potential effects

Construction

The main construction activities that are likely to take place are site preparation, demolition, earthworks, retaining wall construction and road works. All activities have the potential to cause some disturbance at nearby sensitive receptors. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. Where it is required to close the motorway to undertake the works (e.g. new viaducts passing over live carriageways or railways) the potential for adverse noise impacts at night is very high. This would also be coupled with the wider impacts of re-routed traffic during the night-time.

Particular activities associated with any of the options which have the greatest potential to cause disturbance during construction works (due to activity and proximity to noise sensitive receptors) are as follows:

- Construction of a new viaduct spanning Nag's Head Lane, the M25 and the railway has the potential to have an adverse noise and vibration impact on properties on Nag's Head Lane (Option 6).
- Construction of the new slip road on embankment to the southeast of The Poplars has the potential to have adverse noise and vibration impacts on The Poplars (Option 6).
- Construction of a new viaduct over the A12 to the east of Junction 28 has the potential to adversely affect properties to the south of the A12 in Brentwood (Option 6).
- Construction of a new merge lane to the A12 eastbound (east of Junction 28) has the potential to adversely affect the residential area to the south of A12 in Brentwood (Options 6, 2, 4, 5D, 5E).
- Realignment of Nag's Head Lane has the potential to adversely affect receptors on Nag's Head Lane (Options 2, 4, 5A).
- New diverge lane to west of M25N has the potential to adversely affect properties on Nag's Head Lane, requiring demolition of the existing Nag's Head Lane bridge and construction of a significant retaining wall close to properties (Options 2, 4, 5A).
- Construction of new viaducts over the existing Junction 28 has the potential to adversely affect isolated properties close to the junction (Options 4, 5A, 5B).

- Extending Wigley Bush Lane overbridge has the potential to adversely affect a cluster of properties immediately to the southeast (Options 2, 4, 5D, 5E).
- Construction of a loop to the north-west of the existing junction has the potential to adversely affect Maylands Golf Course and Grove Farm (Options 2, 5A, 5B, 5C, 5D and 5.E with compact loops having a lesser effect).
- Realignment of Weald Park Way has the potential to adversely affect properties on Weald Park Way (Options 6, 2, 4).
- Extending the footbridge from Weald Park Way to Spital Lane has the potential to adversely affect properties in the vicinity (Options 6, 2, 4).

A construction programme detailing the specific activities that will take place, phasing and duration of each activities, and a plant list are not yet available for the proposed scheme options.

The need for temporary noise mitigation during the construction phase will be determined at a future design stage by undertaking a BS5228-1:2009+A1:2014 assessment that takes into account the following factors:

- The ambient noise environment are the closest noise sensitive receptors to the construction works;
- The distance between the nearest noise sensitive receptors and the construction works;
- The duration and time of day that the construction works occur; and
- The noise produced by the plant or equipment involved in the construction activities, which is influenced by the sound power of the equipment and its usage pattern.

Operation – Short Term (2022 on Opening)

Basic noise level changes have been calculated using the 18 hour annual average weekday traffic flows for each option (Options 5B has been used to represent Options 5A to 5C, and Option 5D has been used to also represent Option 5E) in the opening year. Figures 10.1 through to Figure 10.5 show the indicative changes in each direction for the M25, A12 and Brook Street together with existing and proposed slip roads.

Option 2

Option 2 may give rise to increases in noise at Nag's Head Lane (west of M25), Putwell Bridge Farm and Grove Farm due to the new diverge from the M25N to the A12 eastbound. A minor decrease in noise is predicted on the east bound on slip from the circulatory to the A12 in the area of Lower Vicarage Wood.

Option 2 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Option 4

Option 4 is likely to give rise to noise increases in Lower Vicarage Wood but would result in a minor decrease in noise on the east bound on slip to the A12. There is the potential for increases at Nag's Head Lane (west of M25) due to the new diverge in this location.

Option 4 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Options 5A – 5C

Options 5A – 5C are likely to give rise to increases at Grove Farm. Traffic data for option 5Bshows that a moderate increase in basic noise level on the A12 eastbound through the junction is likely; however this is unlikely to have an effect at any receptors.

Option 5A would additionally involve the realignment of Nag's Head Lane taking it away from the housing along this route which may cause some reductions in noise levels where not already dominated by noise from the M25.

Option 5B and 5C have the potential to negatively impact on Noise Important Area 5750 at J28 whilst Option 5A has the potential to additionally impact negatively upon noise Important Area 5749 adjacent to Nag's Head Lane (see Appendix L for ID for NIAs).

Options 5D and 5E

Both options are likely to give rise to noise increases at Alder Wood and Maylands Golf Course as well as at Lower Vicarage Wood. Increases are also possible at Grove Farm.

Option 5D and 5E have the potential to negatively impact on Noise Important Areas 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Option 6

With Option 6 there is the potential for noise increases at properties close to the new slip road, including to the west of the M25 on Nag's Head Lane. At The Poplars there is the potential for an increase affecting the south east façade of the building.

Option 6 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Operation – Long Term (2037 Design Year)

Basic noise level changes have been calculated using the 18 hour annual average weekday traffic flows for each option (Options 5B has been used to represent Options 5A to 5C, and Option 5D has been used to also represent Option 5E) in the design year. Figures 10.6 through to Figure 10.10 show the indicative changes in each direction for the M25, A12 and Brook Street together with existing and proposed slip roads.

In the longer term (by design year 2037), noise increases caused by new infrastructure are likely to have a lower impact rating but could remain significant. Minor changes on existing alignments are likely to be insignificant over the longer term.

Option 2

Option 2 may give rise to increases in noise at Nag's Head Lane (west of M25), Putwell Bridge Farm and Grove Farm due to the new diverge from the M25N to the A12 eastbound. A minor decrease in noise is predicted on the east bound on slip from the circulatory to the A12 in the area of Lower Vicarage Wood. Negligible changes are predicted for all other A12 road links.

Option 2 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Option 4

Option 4 is likely to give rise to noise increases in Lower Vicarage Wood. Negligible changes to noise are predicted on the A12 and M25 road links unaltered by Option 4.

Option4 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Options 5A – 5C

Option 5A covers a vast section of the M25 with an underpass through the railway line. Nag's Head lane is also included in this option proposing a bridge going over the M25. It also includes the loop road beside Junction 28. Both Option 5B and Option 5C mainly features the loop road, with Option 5C having a longer, widened loop road.

All options are likely to give rise to increases at Grove Farm. Traffic data for Option 5B shows that a moderate increase in basic noise level on the A12 eastbound through the junction is likely; however this is unlikely to have an effect at any receptors.

Option 5A would additionally involve the realignment of Nag's Head Lane taking it away from the housing along this route which may cause some reductions in noise levels where not already dominated by noise from the M25.

Option 5B and 5C have the potential to negatively impact on Noise Important Area 5750 at Junction 28 whilst Option 4.1 has the potential to additionally impact negatively upon Noise Important Area 5749 adjacent to Nag's Head Lane (see Appendix L for ID for NIAs).

Option 5D and 5E

Both options are likely to give rise to noise increases at Alder Wood and Maylands Golf Course as well as at Lower Vicarage Wood. Increases are also possible at Grove Farm.

Option 5D and 5E have the potential to negatively impact on Noise Important Areas 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Option 6

With Option 6 there is the potential for noise increases at properties close to the new slip road, including to the west of the M25 on Nag's Head Lane. At The Poplars there is the potential for an increase affecting the south east façade of the building.

Option 6 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road (see Appendix L for ID for NIAs).

Figure 10-1 Option 2 Opening Year (2022) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

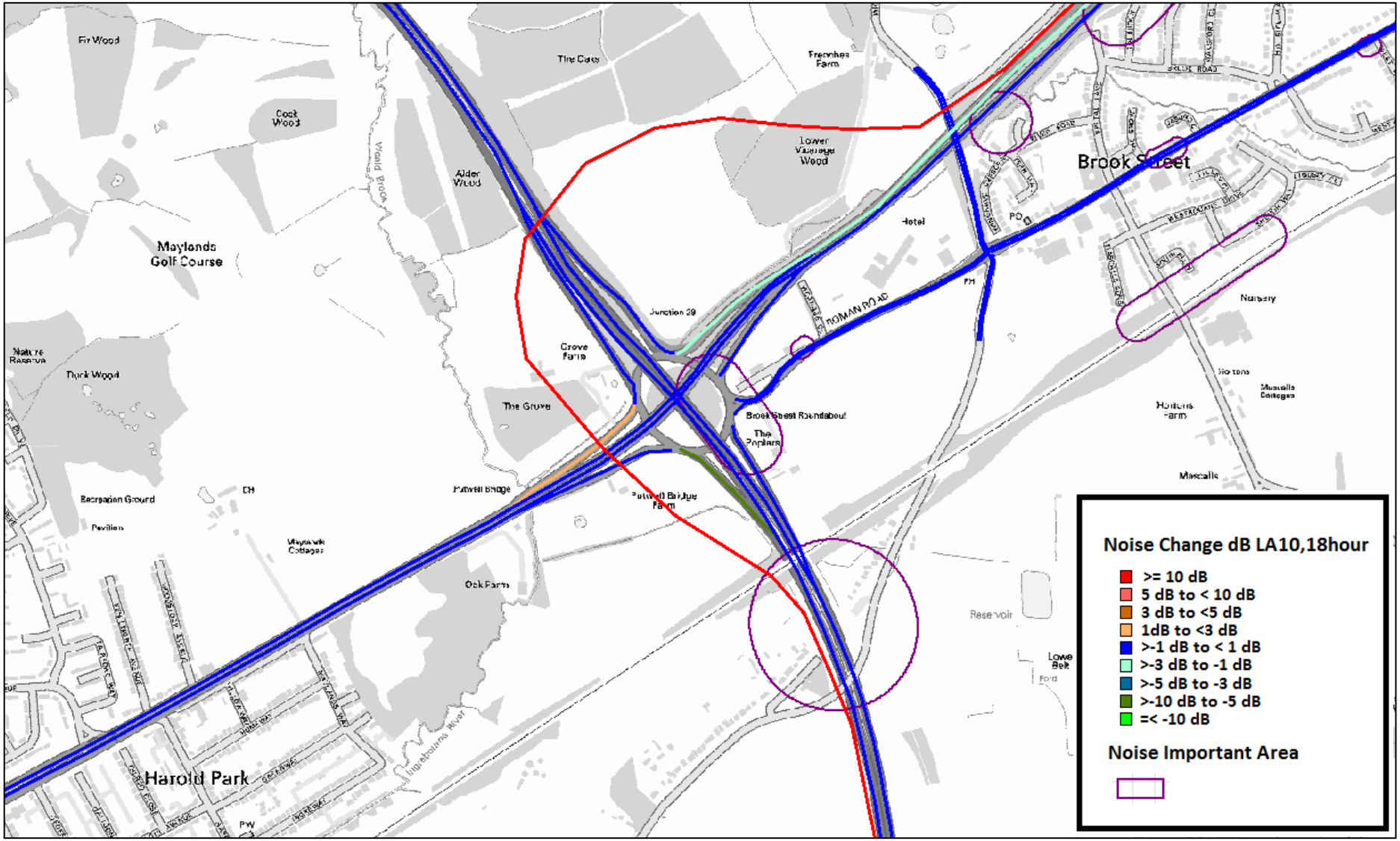


Figure 10-2 Option 4 Opening Year (2022) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

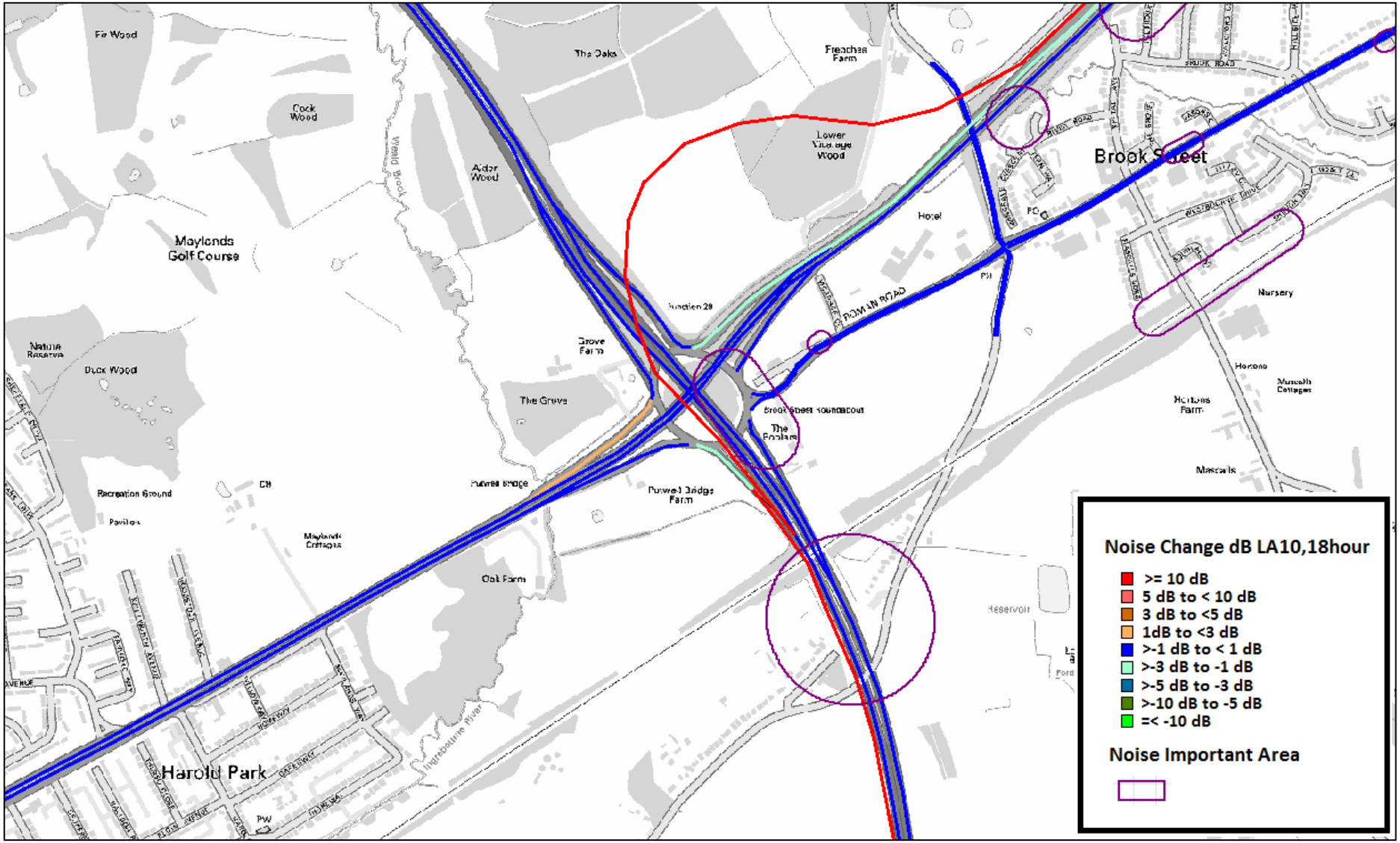


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Figure 10-3 Option 5B Opening Year (2022) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

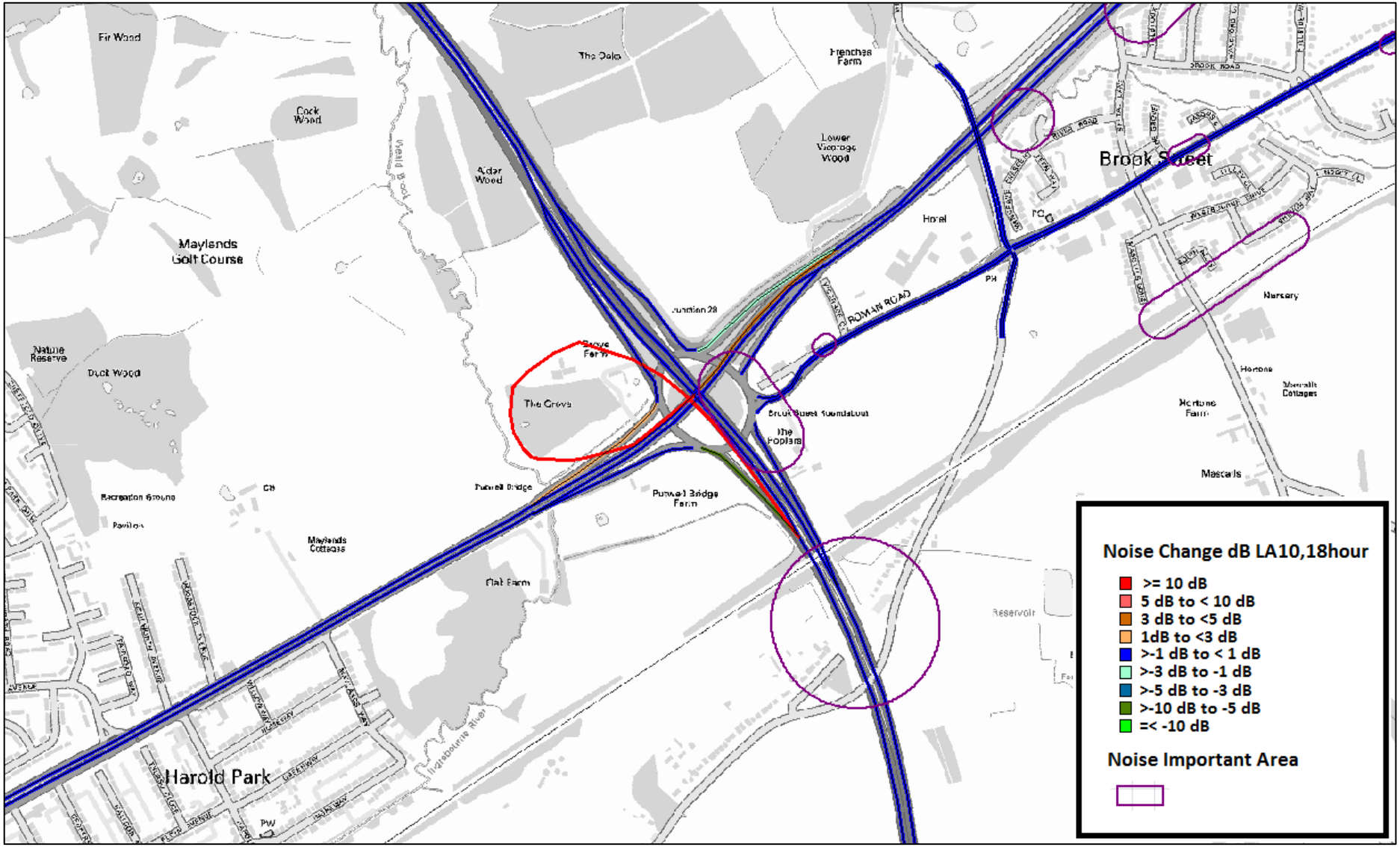

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Figure 10-4 Option 5D Opening Year (2022) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

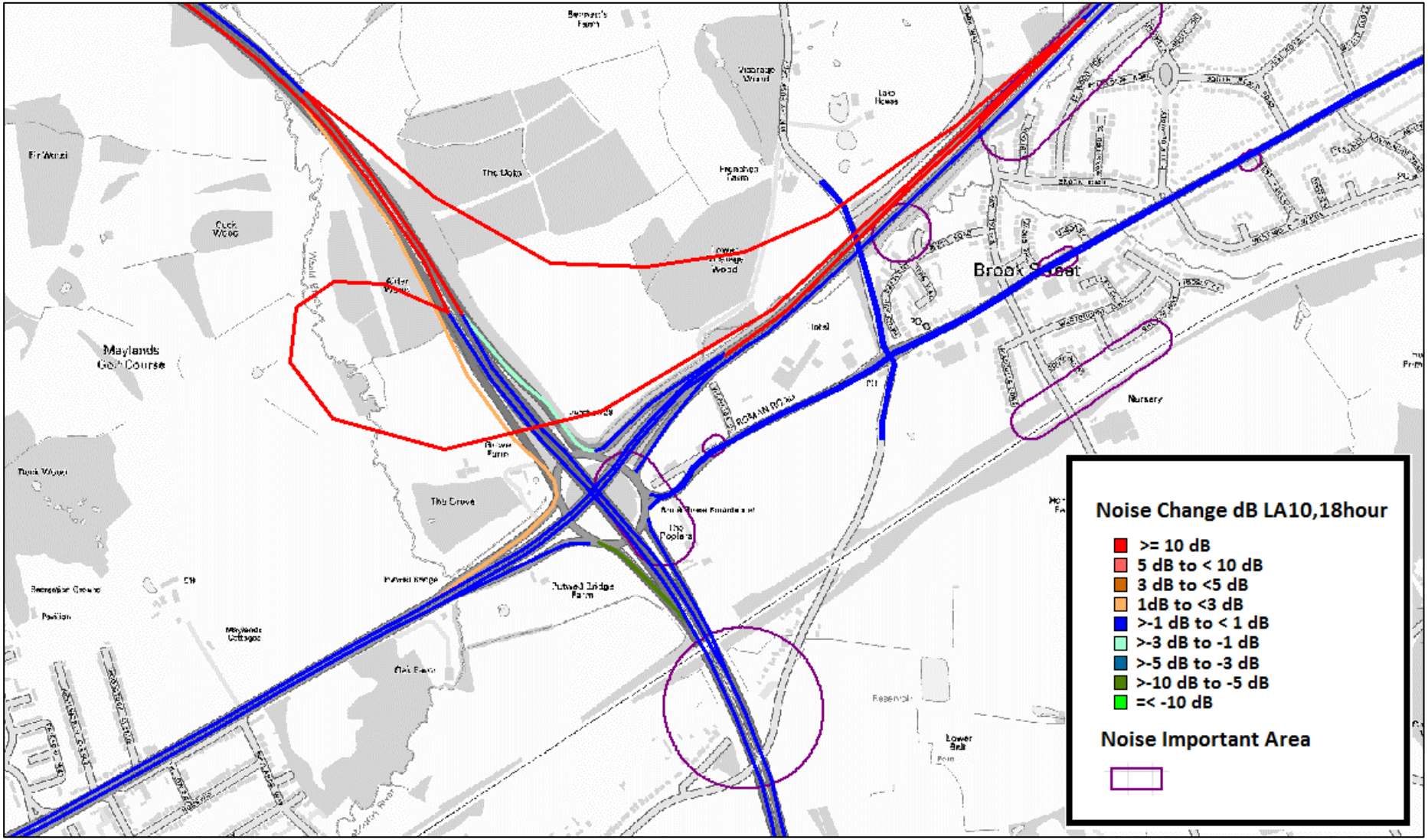

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Figure 10-5 Option 6 Opening Year (2022) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

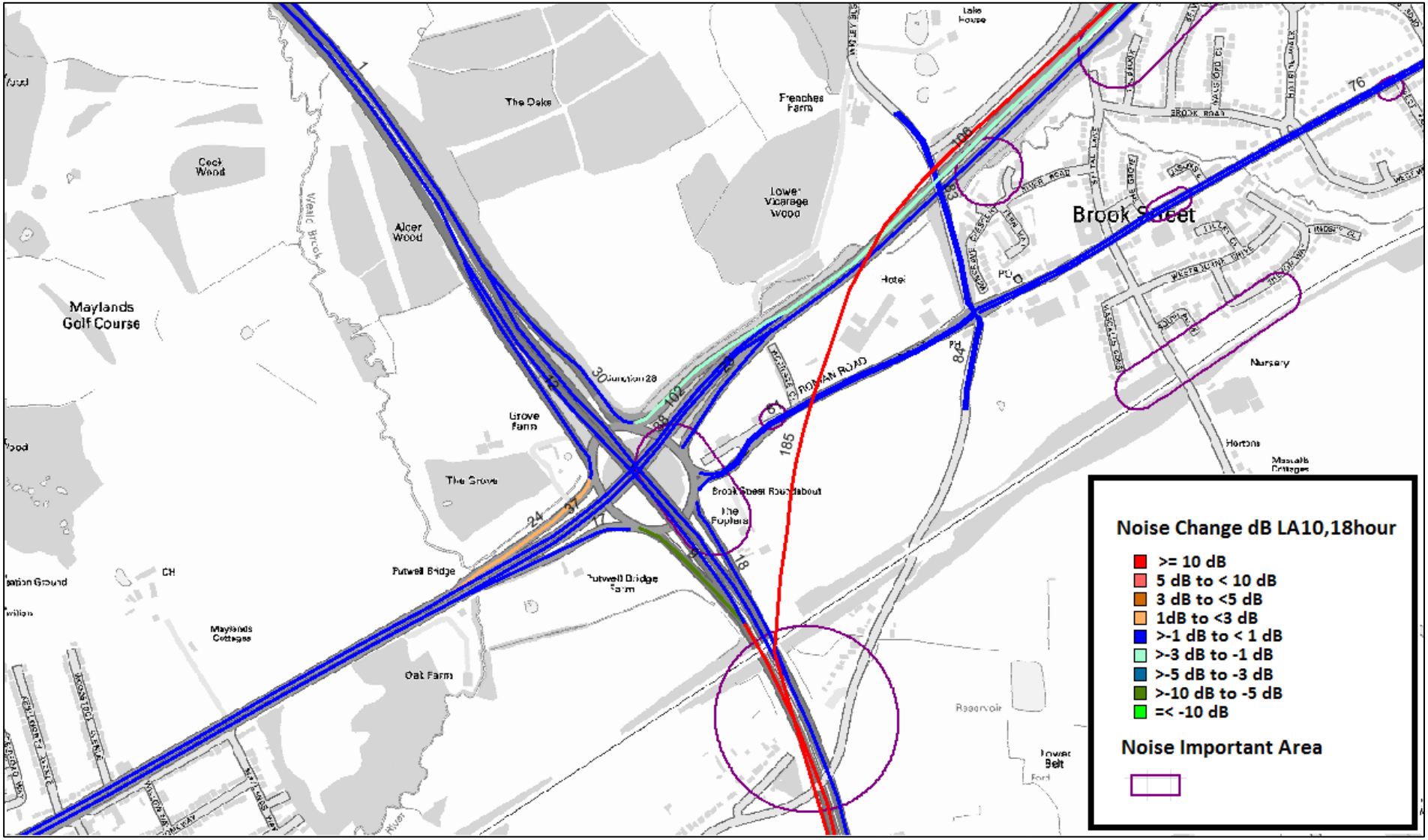

Figure 10-6 Option 2 Design Year (2037) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

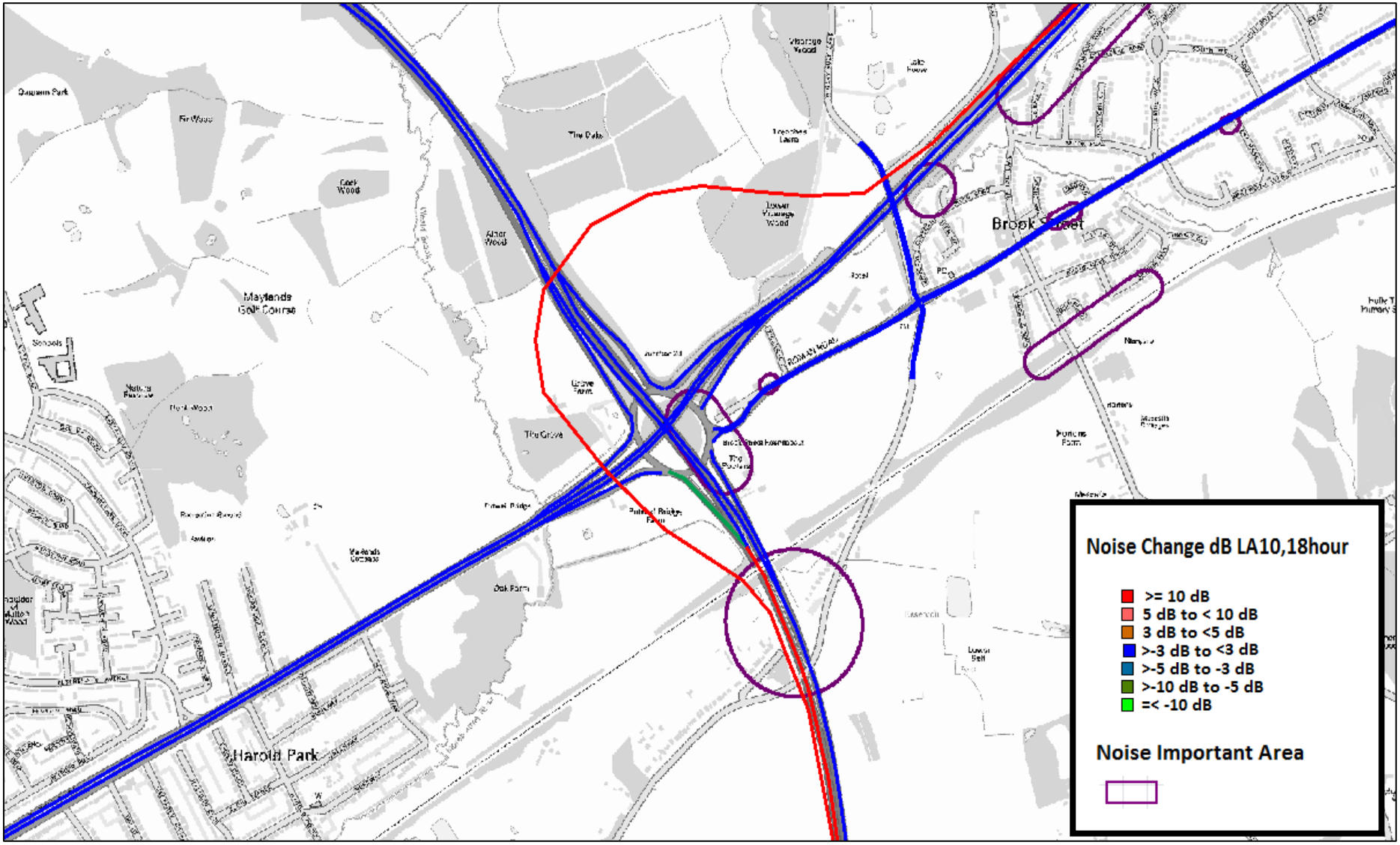

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Figure 10-7 Option 4 Design Year (2037) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

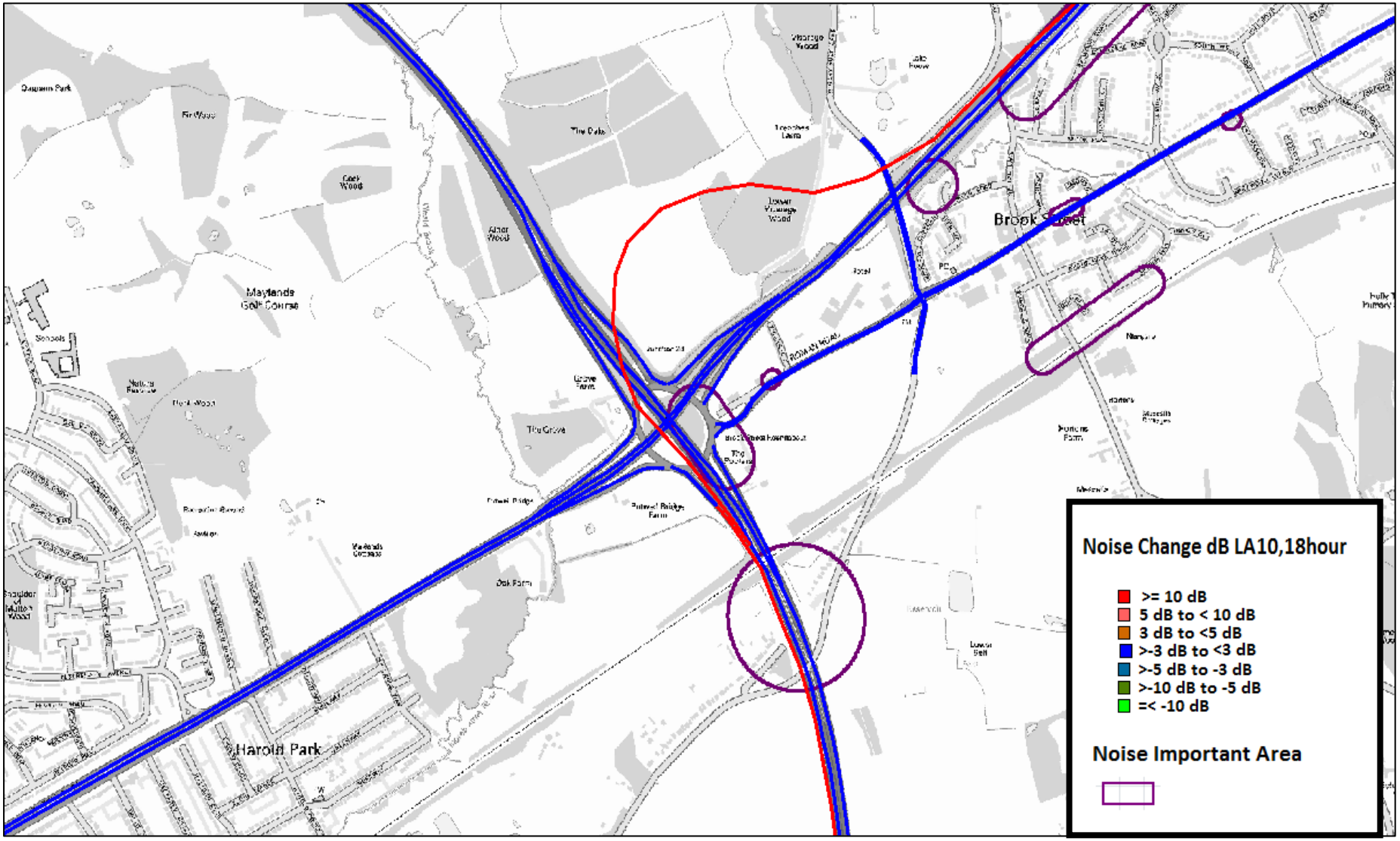


Figure 10-8 Option 5B Design Year (2037) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

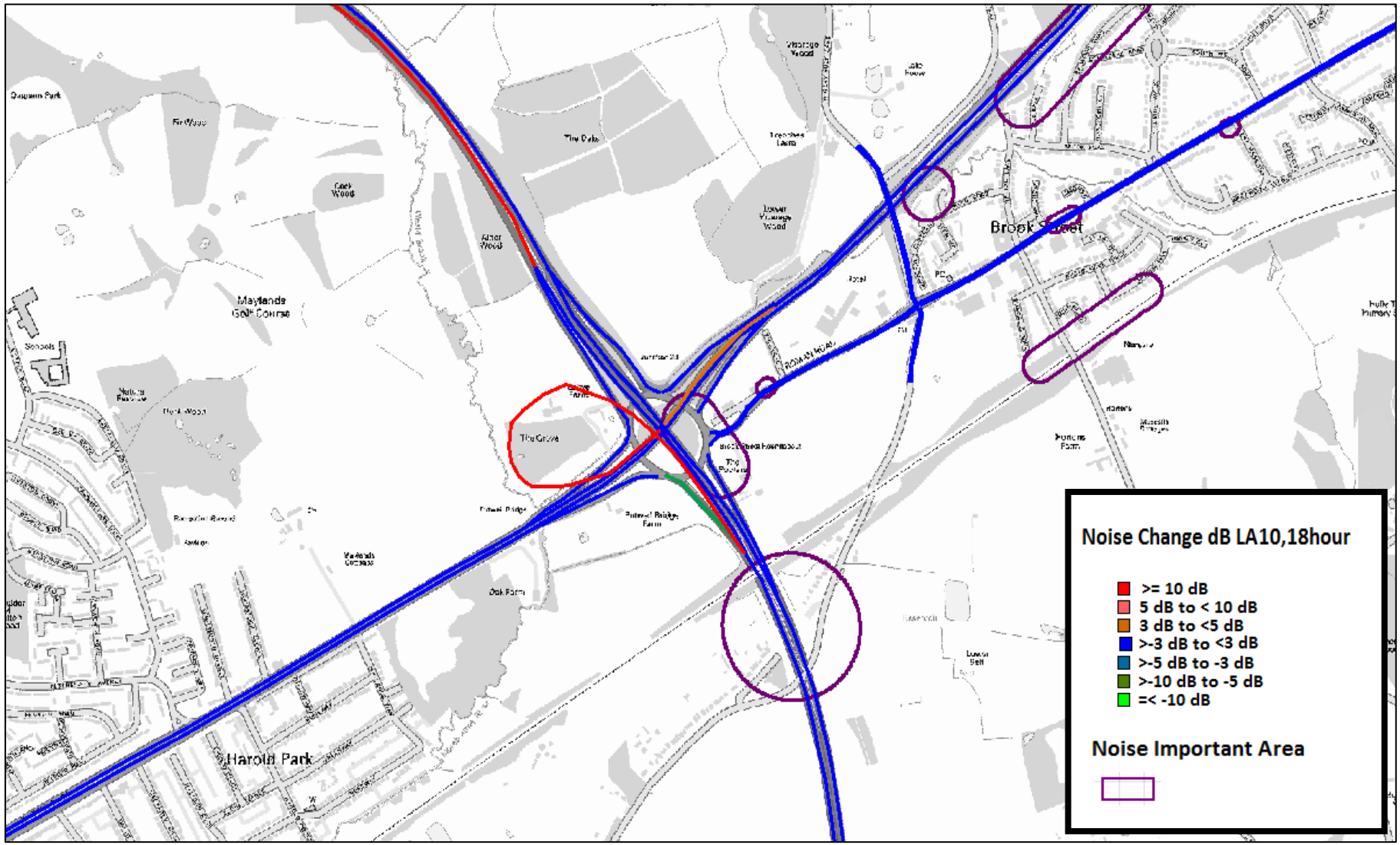


Figure 10-9 Option 5D Design Year (2037) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]

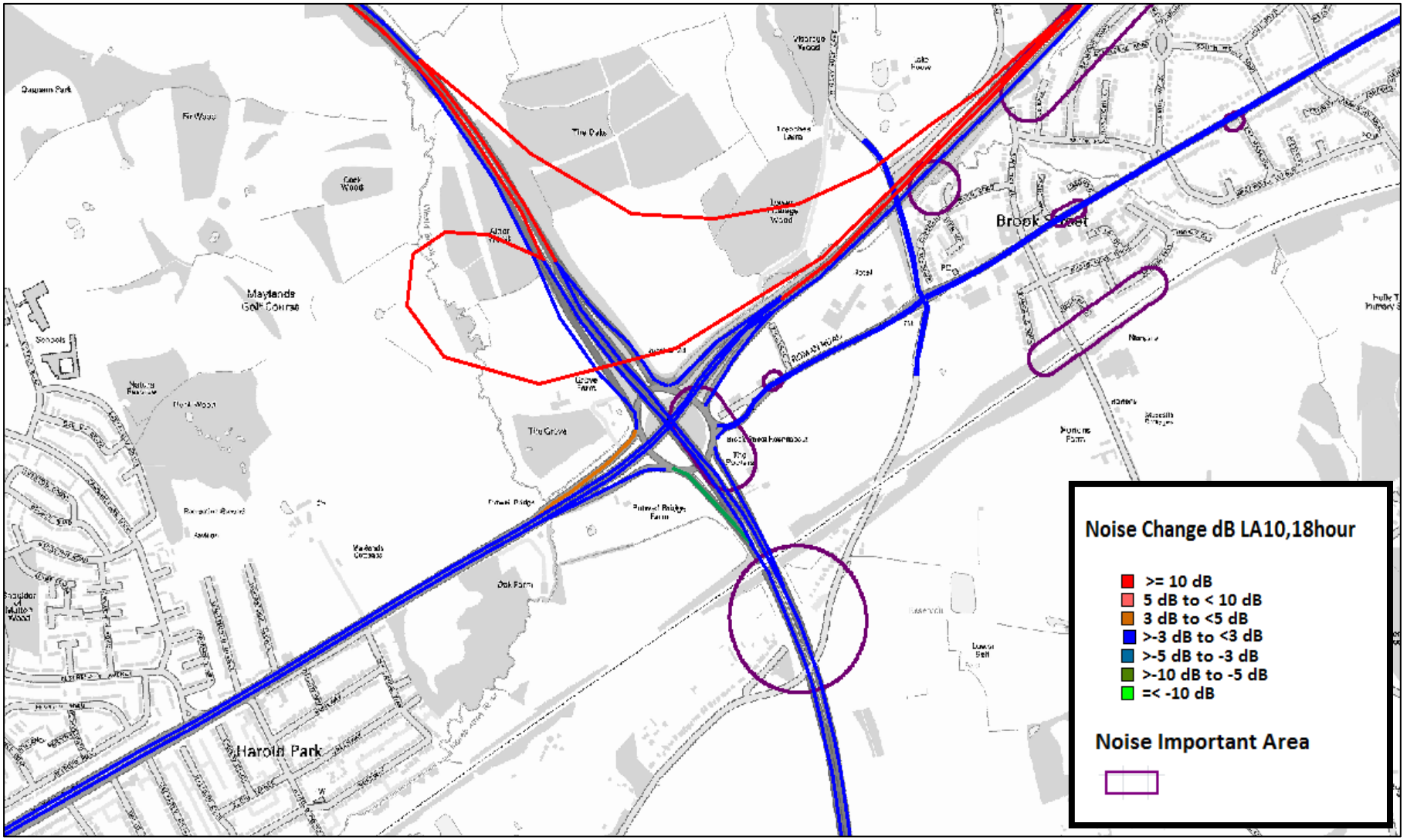
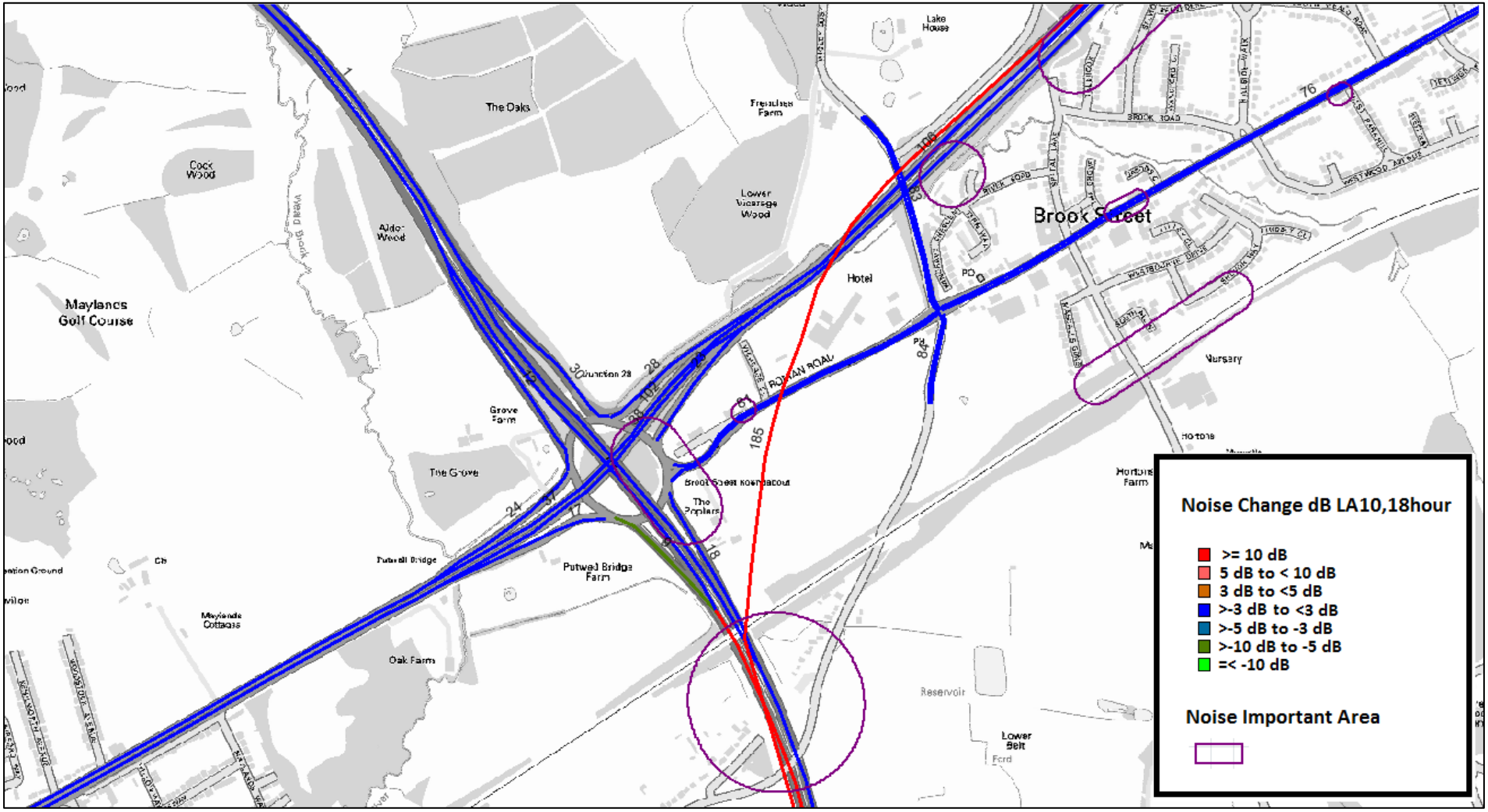


Figure 10-10 Option 6 Design Year (2037) Basic Noise Level Change (dB $L_{A10,18hour}$) [not to scale]



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10.8 Limitations to assessment

At this stage no detailed information about construction methods or timing are available and hence a very high level overview of potential construction impacts has been provided.

No address data identifying the usages of individual properties is currently available and therefore it is not possible to identify where noise level changes are likely to impact upon noise sensitive receptors.

A 3 dimensional noise model has not been constructed at present and therefore no account has been taken of ground topography or road gradients in undertaking the basic noise level calculations.

Road surfacing types are not currently available and therefore this has not been taken into account in the basic noise level calculations.

Basic noise level calculations may show an impact on a road link which would in fact be masked by higher noise levels from adjacent links (e.g. where a slip road is adjacent to the main carriageway, it is unlikely that a change in noise on the slip road would have an effect on the overall noise level).

All potential impacts have been identified in the absence of any mitigation.

11 Road Drainage and the Water Environment

11.1 Introduction

This section sets out a review of the water environment relevant to the M25 Junction 28 Improvements. The assessment has used publicly available data and is based on the potential options at the time of reporting. Should any of the options change, baseline conditions may be subject to change.

An overview of the baseline conditions is included, together with descriptions of proposed methods and a scope of the work likely to be required to undertake a detailed assessment of the impact of road drainage on the water environment as part of PCF Stage 2 assessment.

11.2 Assessment methodology

Scoping of the environmental assessment for the M25 Junction 28 Improvements was undertaken in April 2016.

The scoping was based on a broad understanding of the proposed improvements. Due to the absence of detailed design information assumptions were made. The scoping exercise was undertaken to identify the water topics requiring consideration in the environmental assessment (and the appropriate level of assessment for these).

The results are presented in the Environmental Scoping Report (Highways England, April 2016)[57] and will not be repeated here. In summary, the following water topics were scoped into further assessment:

- Surface watercourses
- Lakes and other water features
- Groundwater
- Abstractions and discharges
- Flood risk

The following topics were scoped out

- WFD designated lakes – as there are none within the study area
- Statutory designated sites – as there are none within the study area

The assessment is based on guidance contained in the DMRB Volume 11, Section 3, Part 10 HD 45/09 - Road Drainage and the Water Environment (November 2009) and further notes from the IAN 161/15 - Smart Motorways (November 2015).

The method of assessing the importance, magnitude and significance of effects is stated within tables in the DMRB, HD45/09 (Annex IV, Tables A4.1 to A4.6) and has not been reproduced in this section.

At this stage, a high level desk-based assessment has been undertaken using publicly available data. These include the Environment Agency website, the Environment Agency catchment data explorer and magic maps.

[57] *Highways England. April 2016. Road Investment Strategy. M25 Junction 28 Improvements. Environmental Study Scoping Report. HE551522-ATK-EGN-1-RP-EN-0004*

Each option has been categorised/graded based on its alignment but does not take account of the nature of any watercourse crossings shown (e.g. viaducts versus culverts) or the approach to potential river realignments as these are not finalised at this stage in the programme.

11.3 Study area

The spatial scope of the assessment includes as a minimum, features of the water environment within 1km of proposed scheme options. This study area may extend as necessary as the programme progresses, in order to gather relevant data from upstream or downstream of the options.

11.4 Baseline conditions

This section sets out the baseline conditions of the water environment. Appendix H provides the supporting figures to this assessment chapter.

Surface watercourses

Waterbodies within the study area fall within the Thames River Basin District (RBD). The revised Thames River Basin Management Plan (RBMP) was published in February 2016.

The existing alignment of the M25, A12 and A1023 intersect several watercourses. One of which, the River Ingrebourne, is designated under the Water Framework Directive (WFD, 2000/60/EC). This is the only WFD waterbody in the study area. It is not designated as an Artificial or Heavily Modified Waterbody.

The River Ingrebourne is a tributary of the River Thames. It rises near Brentwood, Essex, and flows in a south westerly direction under the M25 near Junction 28, where the first of its tributaries, is Weald Brook, followed by Paynes Brook.

Upstream (north) of the A12, Environment Agency data indicates that the River Ingrebourne flows parallel to the A12 in a south-westerly direction from Brentwood. Ordnance Survey data indicate that there are tributaries in Brook Street and Brentwood (to the south of the A12) and further tributaries to the north of the A12 to the east of South Weald. The Weald Brook is a final tributary of the River Ingrebourne to the north of the A12, flowing parallel to the M25 in a southerly direction. Its confluence with the River Ingrebourne is immediately north of the A12 at Junction 28 of the M25. Further upstream the Weald Brook is crossed by the M25 at The Osiers and at Burnt Wood. The nature of the flow network and the characteristics of the tributaries should be confirmed at the next stage of the assessment.

The assessment of the importance of the River Ingrebourne has been determined using the criteria in HD45/09. Details of this waterbody are summarised in Table 11-1. The table also shows the current and predicted status of the water body and provides the status for each element that makes up the overall status. This shows the element that drives the overall status as it is based on the lowest classification. For example, the overall status is moderate, which is driven by a moderate status for both Invertebrates and for Macrophytes and Phytobenthos combined.

Further, in the context of the scheme the status for specific pollutants relevant to roads (i.e. zinc and copper) is also provided.

The River Ingrebourne waterbody is designated as a Protected Area, linked to the Freshwater Fish Directive (FWFD). Although the FWFD was repealed in 2013, the sensitivity of the watercourses is still relevant and its legislative standing is now covered by the WFD. In line with the DMRB, watercourses which are designated as

Protected Areas due to their original designation under the FWFD have been assigned a very high importance.

The other watercourses within 1km of the works, are outside of the classified WFD stretches but are part of WFD water body catchments and contribute to their overall quality and status. Consequently, these 'other' watercourses are all considered to have an objective of good status and are assigned high importance. Where they contribute to the FWFD watercourses they are assigned a very high importance.

At the time of reporting, the exact alignments of watercourses is unclear due to inconsistencies between OS base mapping and digital river mapping. However, due to their status as important receptors surface watercourses' are scoped in for further assessment.

Table 11-1 River Ingrebourne (GB106037028130) WFD watercourse[58]

Classification Item	Element	Classification (2015)	Predicted Outcome (2027)
Morphological designation		Not designated	
Protected area		Nitrates Directive	
Overall waterbody		Moderate	Moderate
Ecological		Moderate	Moderate
	Invertebrates	Moderate	Moderate
	Macrophytes and Phytobenthos Combined	Moderate	Moderate
Hydromorphological Supporting Elements			
	Morphology	Good	Good
Specific pollutants			
	Zinc	High	High
	Copper	High	High
Chemical		Good	Good

Lakes and other water features

There are other water features, within 1km of the existing alignment, including a reservoir. The exact number and status are unknown at the time of reporting. In addition, their dependence on groundwater is not known. These details should be confirmed at the next stage of the assessment and therefore 'lakes and other water features' are scoped in for further assessment.

There are no WFD designated lakes within 1km of the existing alignment. Lakes are therefore scoped out and further assessment is not required.

Ponds will be considered in an ecological context in the Nature Conservation section above.

Groundwater

The existing alignment is not underlain by any groundwater Source Protection Zones (SPZ). The Environment Agency interactive mapping[59] indicates that there are pockets of Secondary A superficial aquifers within the study area.

[58] *Environment Agency. 2016. Catchment Planning http://environment.data.gov.uk/catchment-planning*
[59] *Environment Agency. Accessed 2016. What's in your backyard.*

Secondary A aquifers are 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. Generally, these were formerly classified as minor aquifers[2]. The alignment of the secondary aquifer reflects the surface hydrology, following the current or historical course of the surface watercourses and is likely to be associated with the presence of river terrace gravels. It is considered to be of low importance.

The existing alignment is not underlain by any WFD Groundwater body. Please see Section 12 for further discussion of geology.

Abstractions, discharges and outfalls

The Environment Agency website[2] indicates that there is one surface water abstraction within 1km. At the time of reporting, no data were available for this license. Confirmation of this is recommended at the next stage of the assessment and therefore abstractions are scoped in for further assessment.

At the time of reporting, no data was available for discharges. Confirmation of numbers and locations is recommended at the next stage of the assessment and therefore discharges are scoped in as further assessment is required. It is assumed that Nags Head Lane Wastewater Treatment Works will discharge to the River Ingrebourne within the study area.

Of note, spatial data for abstractions and discharges presented on the Environment Agency website can be inaccurate. Therefore, the data reviewed to date should be treated with caution and does not remove the need for a formal data request to be made.

Highways Agency Drainage Data Management System (HADDMs) records several outfalls on the A12 around Junction 28 and one outfall on the M25 within the study area. Baseline assessments have been undertaken for these outfalls, with all the outfalls on the A12 assessed as low risk and the outfall on the M25 assessed as high risk.

Flood risk

The Environment Agency's Flooding from Rivers interactive map [2] indicates that the Junction is within areas of Flood Zone 2 and 3. These sources of flood risk include the following:

- River Ingrebourne
- Weald Brook
- Paine's Brook

The scale of the options and their proximity to areas identified as being at risk from flooding means that further flood risk assessment is required. Consequently flood risk is scoped in.

Designated sites

There are no statutory designated sites within the study area. From a water perspective, designated sites are therefore scoped out and will not be considered further in the context of water resources. Further details of these are described in the Section 8.

11.5 Regulatory / Policy Framework

With regard to the protection of specific water resources, water quality standards and related policy relevant to the proposed improvements these are set out in Table 11-2.

Table 11-2 Water resources legislation

Legislation	Description
European legislation	
Water Framework Directive 2000/60/EC)	The Water Framework Directive (WFD) requires that all inland waters within defined river basin districts must reach at least good status by 2015 and defines how this should be achieved through the establishment of environmental objectives and ecological targets for surface waters.
Groundwater Directive (2006/118/EC)	The Groundwater Directive complements the WFD. It requires measures to prevent or limit inputs of pollutants into groundwater to be operational so that WFD environmental objectives can be achieved.
The Floods Directive (2007/60/EC)	The aim is of this Directive is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity.
National legislation	
Antipollution Works Regulations (1999)	Where pollution occurs or is likely to occur the Environment Agency can serve a works notice under Section 161A of the Water Resources Act on any person who has caused or knowingly permitted the pollution (or risk of pollution) to a water course, requiring them to carry out anti-pollution / preventative works and operations. The Environment Agency can also recover the costs of any investigation and anti-pollution works carried out. The Anti-Pollution Works Regulations prescribe the content of anti-pollution works notices. They also prescribe the particulars of such matters as are required to be placed on the pollution control registers maintained by the Environment Agency.
Environment Act (1995)	The Act provides for the establishment of a body corporate to be known as the Environment Agency.
Environmental Damage (Prevention and Remediation) Regulations (2009)	The emphasis of these Regulations is proactively putting in place appropriate pollution prevention measures to reduce risks to the environment.
Environmental Protection Act (1990)	This Act brings in a system of integrated pollution control for the disposal of wastes to land, water and air.
Flood risk regulations (2009) Amended SI2011/2880 transpose directive 2007/60/EC	The Regulations aim to provide a consistent approach to managing flood risk. The Environment Agency are responsible for managing flood risk from main rivers, the sea and reservoirs. Lead Local Flood Authorities are responsible for local sources of flood risk, in particular surface water, groundwater and ordinary watercourses.

Legislation	Description
Flood and Water Management Act 2010 and Commencement Orders	The key areas covered by this Act are : • roles and responsibilities for flood and coastal erosion risk management • improving reservoir safety • encouraging sustainable urban drainage systems • designation of third party flood management assets • special administration regime for water companies • powers for water companies to control non-essential uses of water • various provisions relating to charging
Highways Act 1980	Where flooding on a highway is caused by another person (e.g. an adjoining landowner), the Highway Authority can take action against the person responsible.
Groundwater (England and Wales) Regulations (2009)	These Regulations implement the Groundwater Directive by preventing entry into groundwater of “hazardous substances” and the pollution of groundwater by non-hazardous pollutants. Both direct and indirect (percolation) inputs of pollutants are covered by the Regulations although a discharge which leads to a direct input of such matter is already an offence under Water Resources Act 1991.
NPPF (Department for Communities and Local Government, 2012)	The NPPF sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow.
Water Act 2003	The Act requires that dewatering operations are subject to an abstraction licence except for short term situations where pumping is carried out for emergency purposes.
Water Industry Act (1991) (Amendment) (England and Wales) Regulations (2009)	Section 118 of the Act makes it an offence to discharge trade effluent to public sewers without consent. Companies can discharge their effluents into the public sewer on condition of a trade effluent discharge consent. These consents are granted by the relevant local water and sewage undertaker. The Regulations extend controls on activities to include those which cause harm to controlled waters in addition to activities which risk or cause pollution.
Water Resources Act 1991, The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003	The Act defines the Environment Agency’s role in water pollution, water resource management, flood defences, fisheries and navigation. It covers discharges to surface and groundwaters, estuaries and coastal waters and controls abstracting and impounding water. Controls extend to accidental spillage so where there is a risk of this, preventative action should be taken.
The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015	The new Directions set out the environmental standards to be used for the second cycle of river basin plans. Along with the updated Water Environment (WFD) (England and Wales) Regulations 2003, they transpose Directive 2013/39/EC on environmental quality standards for priority substances.

11.6 Design, mitigation, enhancement and monitoring measures

Impacts to the water environment can generally be dealt with through careful design and the application of appropriate mitigation measures. The following sections set out the considerations that should be made for the construction and operation phases of the scheme.

Construction

The risk of pollution and the increase in flood risk during construction can be reduced by the adoption of good working practices.

It is recommended that all works are undertaken with regard to the Environment Agency's Pollution Prevention Guidelines[60]. These detail good practice advice for undertaking works which may have the potential to result in surface and groundwater pollution.

The proposed works should avoid encroaching within 8m[61] of a water feature if possible to avoid potential effects to the water feature or to flood risk. Where this is not possible, further assessment will be required and there would be a need for permitting[62].

For the river realignments in particular, it will be important for the design to adequately account for the sensitivity of the surface watercourses and the potential long-term morphological consequences of the scheme. At this stage the nature of the crossings or realignments for each option is uncertain, but mitigation would be required to address potential impacts to channel morphology.

Temporary works (during construction) do not require a formal WFD Compliance Assessment. Water quality mitigation measures will ensure no deterioration in water quality during the construction phase and will thus conform to WFD legislation.

For groundwater, high risk construction activities such as cuttings and retaining walls, the building of embankments and piling will require appropriate mitigation to control effects on groundwater levels. Any requirements for dewatering would need to be controlled by the use of sustainable drainage solutions.

There may be opportunities to incorporate measures into the scheme which enhance the water environment, such as reducing flood risk or by increasing morphological diversity. These should be explored as the scheme progresses.

Operation

The design of the drainage system for the scheme should involve the use of sustainable drainage principles. This should ensure mitigation for the discharge in terms of both quantity (and effects on flood risk) and quality. If required, additional mitigation measures such as floodplain compensation storage should be designed to reduce the impact on flood risk where reductions in floodplain capacity are unavoidable.

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[60] Pollution Prevention Guidelines (PPGs) with particular reference to PPG1 (general guide to the prevention of water pollution), PPG3 (use and design of oil separators in surface water drainage systems), PPG5 (works near or liable to affect watercourses) and PPG6 (working at construction and demolition sites). The PPGs contain a mix of regulatory requirements and good practice advice. They have been withdrawn by the Environment Agency but are still considered good practice advice to avoid pollution of watercourses. All of the PPGs are available from http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx

[61] *https://www.gov.uk/guidance/flood-risk-activities-environmental-permits*

[62] *https://www.gov.uk/guidance/changes-to-your-flood-defence-consent-after-6-april-2016*

Direct morphological changes to the watercourses (such as new culverts or realignments) and changes in drainage patterns need to be considered with respect to the WFD. A WFD compliance assessment report should be prepared at the next stage, to assess the impacts and to make recommendations for specific mitigation or compensatory enhancements (where appropriate).

Residual impacts on groundwater flows, where they are affected by intrusive elements of the scheme, may need to be controlled with specific mitigation such as cut off walls. There may be a need to control residual dewatering with appropriately designed sustainable drainage solutions.

Future monitoring requirements will depend on the outcome of further detailed survey work. The nature of monitoring will be set out once this work has been completed.

11.7 Potential effects

The scheme options have the potential to affect water quality, both during construction and once in operation. The following section deals with the specific areas of impacts within these phases, with a summary table detailing the impacts for each option.

Construction

Water Quality

The proposed construction works have the potential to impact water quality in any of the receiving surface or groundwater receptors. This may be due to:

- The excavation, and the subsequent deposition of soils, sediment, or other construction materials.
- Spillage of fuels or other contaminating liquids.
- The mobilisation of contamination following disturbance of contaminated ground or groundwater, or through uncontrolled site runoff.

Providing adherence to best practice mitigation during the construction period, there should be no significant effects to the water environment.

Flood risk

Potential impacts on flood risk during construction include the storage of materials and temporary impermeable areas at site compounds which can increase flood risk when located in flood zones. However, with adherence to best practice mitigation during the construction period, there should be no significant effects to flood risk.

Channel morphology

All options would require new additional crossings of watercourses and the majority would require river realignments which would result in potential impacts. At this stage in the scheme development the nature of the crossings or realignments is uncertain, but mitigation should mean no significant effects for channel morphology.

Groundwater

All the options being considered will cross areas defined as Secondary Aquifer. Potential effects of the proposed scheme options during construction may be associated with cuttings and retaining walls. In addition, construction will most likely require piling.

These works may affect the flow of groundwater in the secondary aquifer, indirectly affecting surface water features and abstractions which are dependent upon groundwater inputs. The works may introduce new pollutant pathways to the

underlying aquifer. The inherent risks of contamination during construction presents a further risk to the underlying aquifer.

The inclusion of specific mitigation to control the potential pathways of pollution during construction and additional mitigation to control flows and dewatering should mean there are no significant effects for groundwater. Groundwater will be subject to further investigation.

Operation

Water quality

During operation there would be potential impacts to water quality from discharge of polluting runoff through drainage outfalls. All surface watercourses will be assessed for this impact through the DMRB tests which would also highlight the need for any mitigation measures. There would also be potential for increased runoff due to the increase in impermeable surface area. The implementation of attenuation and pollution prevention measures in the form of SUDs would mitigate the impacts to the receiving watercourses.

There is a potential opportunity to improve the status of existing outfalls by incorporating additional mitigation measures where appropriate.

Flood risk

During operation the proposed works have the potential to impact on flood flows in the rivers and on the floodplain because of new or altered river crossings and constructed earthworks on the floodplain. Mitigation measures such as floodplain compensation storage should reduce this impact.

The increase in impermeable area and associated increase in the risk of surface water flooding will be assessed for all watercourses the relevant DMRB tests which would highlight the need for any mitigation measures, in the form of sustainable drainage.

Channel morphology

A WFD compliance assessment should be conducted in parallel to the production of the ESR to consider if the works are compliant with WFD objectives for the Thames RBMP. This assessment will help to ensure appropriate mitigation is included within the design.

The watercourses directly affected by potential morphological changes are both Main and non-Main Rivers and the lead local flood authority has a duty to ensure the works comply with the WFD. Further work will be required to ensure that the design adequately accounts for the requirements of the WFD.

Groundwater

Potential residual effects of the proposed scheme options on groundwater may be associated with cuttings and retaining walls during operation.

Mitigation controlling the flow of groundwater in the secondary aquifer should limit any potential for significant effects on surface water features and abstractions which are dependent upon groundwater inputs.

11.8 Potential effects

Table 11-3 sets out a summary of the assessment results.

Table 11-3 Environmental concerns for each option

Option	Environmental concerns	Rank[63]
6	• 1 new watercourse crossing over the River Ingrebourne. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality • Option within 500m of a sewage treatment works located on Nags Head Lane • Cuttings, earthworks and piling presents a potential mechanism for impacts on groundwater level and quality • Works could potentially affect the flow of groundwater in the Secondary Aquifer, indirectly affecting surface water features and abstractions which are dependent upon groundwater inputs • Works may introduce new pollutant pathways to the underlying Aquifer	1
2	• 4 new watercourse crossings over tributary watercourses. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossing over the River Ingrebourne. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Cuttings, earthworks and piling presents a potential mechanism for impacts on groundwater level and quality • Works could potentially affect the flow of groundwater in the Secondary Aquifer, indirectly affecting surface water features and abstractions which are dependent upon groundwater inputs • Works may introduce new pollutant pathways to the underlying Aquifer • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality • Option within 500m of a sewage treatment works located on Nags Head Lane	6

63 Key: 1 = Least environmental impact; 7 = most environmental impact

Option	Environmental concerns	Rank[63]
4	• 4 new watercourse crossings over tributary watercourses. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality • Potential pollution issues with respect to surface and groundwater - as the option includes works to existing railway structure, which could open a pollution pathway • Option within 500m of a sewage treatment works located on Nags Head Lane	2
5A	• 2 new watercourse crossings over tributary watercourses. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossing over Weald Brook. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossing over the River Ingrebourne. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality • Potential pollution issues with respect to surface and groundwater - as the option includes works to existing railway structure, which could open a pollution pathway • Option within 500m of a sewage treatment works located on Nags Head Lane	4
5B	• 1 new watercourse crossing over Weald Brook. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossing over the River Ingrebourne. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality	3

Option	Environmental concerns	Rank[63]
5C	• 3 new watercourse crossing over Weald Brook. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 2 new watercourse crossings over tributary watercourses. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality	5
5D	• 3 new watercourse crossing over Weald Brook. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossings over tributary watercourses. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossing over the River Ingrebourne. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality	7
5E	• 3 new watercourse crossing over Weald Brook. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossings over tributary watercourses. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • 1 new watercourse crossing over the River Ingrebourne. Direct morphological changes to the watercourse (in the form of new culverts or realignments) and changes in drainage patterns • Traverses the flood risk zone from River Ingrebourne to accommodate the widening. This has the potential to increase flood risk and associated pollutant discharge could impact water quality	7

11.9 Limitations to assessment

Conservative estimates for importance of attributes have been assigned where there is potential for variation within the options or the importance is not yet definable due to lack of information.

Data quality – desk study, using mainly web-based data has only been reported at this stage and therefore the level of detail for certain topics, such as abstractions and discharges is limited/unknown.

Data quantity – as per quality, only open, freely licensed data has only been reported at this stage and therefore the amount of detail on certain topics is limited.

No consultation with stakeholders has been undertaken to date.

The assessment considers the most recent option alignment designs. Should any of the option alignments change, the water environment baseline conditions may be subject to change.

All rivers/drains have been assigned an equal weighting in the assessment.

The assessment is based on existing data sources and has not been verified through a site walkover survey.

It is assumed that the provision of mitigation or compensation for any effects will be equally effective for each option. To date, no investigations have been made of potential opportunities to mitigate scheme effects which may only be associated with particular route alignments.

The feasibility of adapting drainage infrastructure to derive benefits to the water environment has not been investigated.

The vulnerability of the Secondary Aquifer is assumed to be consistent between the options.

It is assumed that cumulative effects will be comparable for each route option.

11.10 Summary and Recommendations

One of the key recommendations for all water topics is a data request to the Environment Agency to refine the data collated at scoping stage. Table 11-4 sets out the recommendations for the next stage of the assessment.

Table 11-4 Recommendations

Water topic	Recommendations
Surface water (including other Surface water features)	Source details of the proposed drainage strategy Source proposed traffic volume data Consider the implications of how the existing baseline may/may not as a consequence of climate change Review any contaminated land investigation which will refine the groundwater pathways and receptors
Groundwater	A data request
WFD compliance assessment (surface and groundwater)	Site visits/surveys (ecological, geomorphological) to set the baseline and then the mitigation requirements would be proposed for the design Consultation with the Environment Agency to determine if a WFD compliance assessment is required and the scope of the assessment Geomorphology and WFD assessment criteria to be confirmed. It is anticipated this will be on professional judgement, experience and close communication with the Environment Agency and other relevant stakeholders during the EIA process
Abstractions and discharges	Further investigation in abstractions to ensure local abstraction is not affected

Water topic	Recommendations
Flood risk	Consultation with the Lead Local Flood Authority and the Environment Agency in developing appropriate mitigation for surface water and groundwater management Liaison with the Environment Agency to obtain the available modelling Hydraulic modelling to assess the impact upon flood risk and to determine mitigation requirements Undertake an FRA with consideration of all sources of flood risk, including groundwater and climate change Reporting on the FRA, prepared in accordance with the guidance in DMRB HD45/09 (which complements NPPF)
Cumulative impact assessment (CIA)	In combination effects and cumulative impacts from other proposed schemes should be considered to ensure risks are captured and the aims of these disciplines and schemes are not undermined

All options could potentially, without appropriate mitigation, result in a deterioration of the water environment with potentially significant effects through construction and/or operation.

Options 5A and 5B cross more watercourses than the other options so at the time of reporting these are potentially the most environmentally damaging for the water environment.

Option 6 is the least environmentally damaging for the water environment based on the limited number of watercourse crossings.

The very high importance of a range of receptors and potential impacts from cuttings and crossing watercourses and their floodplains will all need to be assessed in detail at the next stage. This assessment will need to be underpinned by both desk-based analysis and fieldwork.

12 Geology and Soils

12.1 Introduction

This section presents a summary of the indicated ground conditions relevant to the proposed scheme options. It includes a high level preliminary geotechnical assessment, a review of historical land use and potential land contamination and outlines the preliminary geotechnical and geoenvironmental considerations/risks. Where applicable, relevant geological designated sites, active landfills/historical landfills and the quality of soils/agricultural land classification within and adjacent to the route have also been identified.

12.2 Assessment methodology

The assessment has been carried out in accordance with:

- The technical framework for structured decision-making about land contamination set out in Model Procedures for the Management of Land Contamination, Environment Agency Contaminated Land Report (CLR) 11 (September 2004).
- Guidance in DMRB Volume 11, Section 3, Part 11 - Geology and Soils (June 1993) in conjunction with supplementary guidance in IAN 125/15 – Environmental Assessment Update (Highways England, October 2015).
- Guidance in DMRB Volume 4, Section 1, Part 2 – Managing Geotechnical Risk (HD 22/08) (August 2008).

12.3 Study area

The assessment of geology and soils has been carried out over a study area that accounts for all of the proposed Junction 28 scheme options, encompassing:

- a radial zone of 1 km around the existing M25 Junction 28 roundabout;
- a 400m wide window centred around the M25, extending from 1.2km to the north-west of M25 Junction 28 to 1.7km to the south of M25 Junction 28; and
- a 400m wide window centred around the A12 from the M25 Junction 28 to 2km to the north-east of the M25 Junction 28.

12.4 Baseline conditions

Sources of information

Baseline information was gathered from the readily available sources listed below. As such, it should be noted that this high level desk based assessment is indicative only at this stage and is pending the findings of a future geotechnical desk study and investigation.

- British Geological Survey (BGS) 'Geology of Britain Viewer', 1:50,000 (http://mapapps.bgs.ac.uk/geologyofbritain/home.html), accessed 13/06/2016.
- British Geological Survey Lexicon (http://www.bgs.ac.uk/lexicon), accessed 13/06/2016.

- British Geological Survey Borehole Scans (http://mapapps.bgs.ac.uk/boreholescans/boreholescans.html), accessed 13/06/2016.
- British Geological Survey, England and Wales Sheet 257 Solid and Drift Geology, 1:50,000, BGS, 1996.
- BGS Mining Access Portal: http://mapapps2.bgs.ac.uk/mineplans/home.html accessed 16/06/2016.
- BGS Coal Authority interactive Map: http://mapapps2.bgs.ac.uk/coalauthority/home.html, accessed 16/06/2016.
- Environment Agency What's In Your Backyard website http://apps.environment-agency.gov.uk/wiyby/default.aspx, accessed 15/06/2016.
- GeoEssex website: http://www.geoessex.org.uk/, accessed 15/06/2016.
- HE, n.d. *Highways Agency Geotechnical Data Management System (HAGDMS) v5.6.0.* [Online] Available at: http://www.hagdms.co.uk/, accessed 13/06/2016.
- Natural England Designated Sites View website: https://designatedsites.naturalengland.org.uk, accessed 15/06/2016.
- Natural England Agricultural Land Classification Map of England and Wales: http://publications.naturalengland.org.uk/publication/141047?category=5954148537204736, accessed 15/06/2016.

An Envirocheck Report was purchased from Landmark Information Group and is presented in Appendix I.

This preliminary high level desk study assessment excludes the following at this stage:

- A full review of historical borehole records;
- Information from flood assessment data;
- A literature review of the local area;
- Mining reports; and
- UXO reports.

Due to the high level nature of this desk study, encompassing all five options (and sub options) under consideration at this stage, some of the information presented in the above sources may identify additional effects on the scheme. It is therefore recommended that, in accordance with HD 22/08, that a full Preliminary Sources Study Report be carried out prior to preliminary design stage.

Current site setting

The study area comprises the M25 Junction 28 interchange roundabout, encompassing a 2.9km stretch of the M25 from marker post (MP) 173.9 to 171.0 approximately orientated north-east to south-west, and a 2.75km stretch of the A12 which is approximately orientated south-east to north-west. As well as providing an interchange between the M25 and the A12, the roundabout at Junction 28 also allows access to Brook Street (A1023), which runs north-eastwards from Junction 28 approximately parallel to the A12.

The majority of the surrounding area comprises open space, agricultural fields and some mixed development including residential and commercial.

There are six farms present within the study area, including Putwell Bridge Farm and Oak Farm near to the southern edge of the A12, west of Junction 28, the Poplars which is near to the southern edge of the A12, east of Junction 28 and Frenches Farm, Colmar Farm and Bennets Farm to the north of the A12 and to the east of Junction 28.

Maylands Golf and Country Club is located to the west of Junction 28.

Residential properties are present within the study area, notably in proximity to and along Nag's Head Lane to the south of Junction 28 and surrounding various residential roads extending off London Road A1023 (River Road, Brook Road, Talbrook, Selwood Road, Belvedere Road, Wansford Close, Hillside, Wingrave Crescent, Spital Lane Walk and South Weald Road).

Commercial activities within the study area include a waste management facility (G & R Skips and Recycling) adjacent to the Junction 28 roundabout in the north-west quadrant formed from the intersection of the A12 and M25, and a petrol filling station and hotel within a services area situated adjacent to the Junction 28 roundabout in its south-eastern quadrant.

A north-east to south-west orientated railway line is present within the study area, intersecting the M25 approximately 400m to the south of Junction 28.

Site history

The earliest available historical map dates from 1868 and latest available dates from 2006. The historical development at the site is summarised in Table 12-1.

Table 12-1 Historical development of the site and surrounding area

Date	Summary of development at the site and surrounding area
1868	An unnamed road which follows a similar alignment to the current day A12 is mapped. The site and surrounding land is situated amongst open fields except for the area to the north of the site which is occupied by Alder Wood and Lower Vicarage Wood. Brook Street is a small village approximately 1km to the north-east of the location currently occupied by Junction 28 of the M25. Development within the village includes residential properties, a farm, a public inn and a hospital. The railway line is mapped in its current configuration and is identified as the Great Eastern Railway. There are three large ponds located 800m to the south-east from the location of Junction 28. Boyles Court is a large estate situated approximately 900m south-east from the location of Junction 28 and Boyles Court Farm is located immediately south of the estate. An unnamed road which follows a similar alignment to the current day Colchester Road is mapped.
1872	Weald Brook is mapped in its current alignment, joining Ingrebourne River where the watercourse passes under the current A12. Mapping identifies that Putwell Bridge supports the road over the river. Three ponds are situated within 250m of the centre of Junction 28; two located approximately 200m to the north-west in open fields (one situated within the current extents of the M25 main carriageway) and one located approximately 100m south-east of Putwell Bridge. Putwell Farm is situated immediately south of Junction 28 in its current location. The Poplars is situated immediately south-east of the junction and the Grove (woodland) is situated immediately to the north-west. A windmill is located 100m to the north-east of the Poplars.
1896	No significant change.
1898	Brentwood Sewage Works is located approximately 300m to the south-west from the centre of the current location of Junction 28.
1920	The unnamed road (currently Colchester Road) is mapped as a Roman Road. Old filter beds are located approximately 100m to the south-west from the location of Junction 28; alongside Nag's Head Lane and close to Brentwood sewage works

Date	Summary of development at the site and surrounding area
	(now named sewage works). The sewage works development has increased in size and now comprises at least 10 tanks and some new filter beds. The aforementioned windmill is no longer shown on the maps.
1938	The railway line is identified as the London and North Eastern Railway. Minor residential development of Harold Park is evident (approximately 1km south-west of Junction 28).
1961	The Roman Road is identified as Brook Street north of Junction 28 location and as Colchester Road to the south. Significant residential development has occurred, namely in and around Brook Street and Harold Park and alongside Nag's Head Lane. A reservoir is present south-east from the current location of Junction 28 and approximately 130m to the east of the location currently occupied by the M25. A coal yard and garage now operate in the village of Brook Street.
1968	A roundabout has been constructed at the current location of Junction 28; significant earthwork construction has been undertaken to develop what appears to be an elevated roundabout. The Brook Street/Colchester Road follows the current day alignment. The road has seen structural changes and is raised on embankment. An electricity substation is located immediately east of Junction 28.
1973	No significant change.
1978	A hotel has been constructed on the northern side of Brook Street which has an electricity substation within the grounds. This is 300m to the east of the junction.
1984	The M25 has been constructed in its current configuration and embankment extends some 60m either side of the road. The two ponds situated approximately 200m north-west of Junction 28 are no longer mapped (the M25 main carriageway has been built over one of them). A garage is located north of Brook Street and close to the Colchester Road roundabout.
1986	A filling station is shown immediately west of Putwell Bridge and on the southern side of Colchester Road.
2006	No significant change.

Environmental datasheets, taken from the site specific Envirocheck Report presented as Appendix I, identified the following features and land uses which historical maps did not reveal:

- An unknown heap located 782m to the north-west;
- Infilled ponds located 277m east, 302m north-west, 335m north-east and 357m to the north-west;
- An historical landfill site located immediately north-west of Junction 28 which ceased receiving waste in 1983;
- An historical swimming pool service company operating between Brook Street and the A12 approximately 450m to the northeast of the centre of the Junction 28 roundabout;
- An MOT service and repair centre 189m to the south;
- Air conditioning and refrigeration contractors 752m to the west; and
- A gas pipeline which passes through the study area, running approximately parallel to the M25 about 300m to the north-east.

Geology

Structural geology

The study area is located within the London Basin. The north-east to south-west trending London Basin Syncline is located directly south of the southern extent of the study area.

No faults are shown near to the study area within the available resources.

Artificial deposits

Activities likely involving infilling of ground have been identified within the vicinity of the study area, such as landfill sites, infilled ponds and the construction of embankments. Associated with infilling activities and the construction of localised infrastructure, Made Ground is expected within the study area. Made Ground has been differentiated into two types for the purpose of this report – Landfill Materials associated with Brook Street Landfill, and Made Ground associated with infill, including but not limited to the construction of embankments and backfilling of ponds.

Superficial deposits

Geological mapping suggests that localised superficial deposits of Head are expected at the site and that Alluvium is anticipated at the location of Weald Brook and its tributaries. Weald Brook generally follows the alignment of the M25 and A12 carriageways; passing under the M25 at approximately 1km north-west of Junction 28 and flowing north-west to south-east generally on the anticlockwise side of the M25. Weald Brook then passes under the A12 at the end of the A12 southbound on slip. A tributary of Weald Brook flows in a north-east to south-west direction adjacent to the northbound carriageway of the A12; consequently Alluvium is anticipated at the location of Junction.

Head deposits are poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hillwash and soil creep. Deposits comprise gravel, sand and clay depending on the upslope source and distance from source.

Alluvium typically comprises very soft and soft low strength organic clays and peat. Alluvium may also contain layers of silt, sands and gravels.

Bedrock geology

Underlying solid geology is anticipated to comprise London Clay Formation of the Thames Group. The London Clay Formation is generally described as a bioturbated or poorly laminated, fissured, blue-grey or grey-brown (when weathered) silty to very silty gravelly fissured clay. It is likely that the London Clay Formation will be weathered in its upper portion.

The Claygate Member forms the uppermost beds of the London Clay Formation and is anticipated to be present approximately 300m to the south of the M25 Nags Head Lane overbridge, and within the north-east quadrant of Junction 28. The Claygate Member typically consists of laminated dark grey clay thinly interbedded with sand, and occasional bioturbated silt layers.

Summary of anticipated geology

Table 12-2 summarises the anticipated ground conditions expected at the site.

Table 12-2 Summary of anticipated geology

Group	Formation	Thicknesses (m)	Top depth encountered in BGS boreholes (m bgl)	Location and description (BGS Lexicon)
Made Ground	Landfill Material	Unknown	Ground level	Materials deposited in Brook Street Landfill. The exact composition remains unknown, although the landfill is recorded as comprising inert material. Likely variable including materials such as glass, concrete, bricks, tiles and stones.
	Made Ground	0 – 4.2	Ground level	Highly variable materials associated with construction or infilling of ground. Made Ground is anticipated at embankments associated with the railway line, M25 and A12, and at infilled ponds indicated within the Envirocheck datasheets. Made Ground will likely comprise reworked Head, London Clay Formation or imported granular material.
Fluvial Deposits	Alluvium	0 – 2.7	Ground level	Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present.
Mass Movement Deposits	Head	0 - 3	Ground level	Gravel, sand and clay depending on upslope source and distance from source. Poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hillwash and soil creep. Essentially comprises sand and gravel, locally with lenses of silt, clay or peat and organic material.
Thames Group	London Clay Formation (Claygate Member)	0 – 10	Ground level	Mainly comprises dark grey clays with sand laminae, passing up into thin alternations of clays, silts and fine-grained sand, with beds of bioturbated silts. Ferruginous concretions and septarian nodules occur in places.
	London Clay Formation	30+ (base unproven)	Ground level	Mainly comprises bioturbated or poorly laminated, blue-grey or grey-brown, slightly

Group	Formation	Thicknesses (m)	Top depth encountered in BGS boreholes (m bgl)	Location and description (BGS Lexicon)
				calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. Commonly contains thin courses of carbonate concretions ('cementstone nodules') and disseminated pyrite. It also includes a few thin beds of shells and fine sand partings or pockets of sand, which commonly increase towards the base and towards the top of the formation. At the base, and at some other levels, thin beds of black rounded flint gravel occurs in places. Glauconite is present in some of the sands and in some clay beds, and white mica occurs at some levels.

Hydrogeology

The Environment Agency have identified the alluvial deposits in the study area as a superficial Secondary A Aquifer[64]. The alluvial deposits appear to be located within and adjacent to current or historical watercourses. Head deposits are present around the periphery of the alluvial deposits and have been classified as a superficial Secondary Undifferentiated Aquifer[65]. Both the Claygate Member and the Bagshot Formation, located at the northern and eastern edge of the study area, are classified as Bedrock Secondary 'A' Aquifers. The London Clay Formation which underlies the majority of the study area is an unproductive stratum. There are no groundwater abstractions or groundwater Source Protection Zones located within the study area. The site is not subject to tidal influence.

Hydrology

The existing alignment intersects/crosses six water courses, which include the Ingrebourne River (designated under the WFD, 2000/60/EC), the Weald Brook and likely four land drainage ditches (to be confirmed in the next stage of assessment).

[64] *A Secondary A aquifer is defined as an aquifer with, '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. These are generally aquifers formerly classified as minor aquifers'.*

[65] *A Secondary (undifferentiated) aquifer is defined as an aquifer that 'has been assigned in cases where it has not been possible to attribute either category 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'.*

Junction 28 is situated within areas classified as Flood Zone 2[66] and Flood Zone 3[67] and that the sources of flood risk include both the Ingrebourne River and the Weald Brook.

There is a surface water abstraction point located 311m to the east of the site but there are none within the study area.

The site is located in a Surface Water Nitrate Vulnerable zone.

Mining activity and quarrying

The site is not located in an area affected by mining or quarrying based upon a review of the Coal Authority interactive map viewer and BGS non-coal mining plans.

Geological SSSI

There are no geological SSSI or Regionally important Geological Sites reported within 250m of the site on the GeoEssex website. The nearest of which is Thorndon Country Park, 2km to the south-east of the site at its closest point.

In summary, no further consideration of special geological features is required for any of the proposed scheme options.

Quality of Soils / Agricultural Soils Classification

The land within the study area is classified Grade 3[68] (good to moderate quality land). As previously stated, the study area is also located within a surface water nitrate vulnerable zone.

Ground stability

The 1:50,000 scale ground stability maps provided within the Envirocheck Report have been used to inform the potential for ground stability hazards for the study area.

The whole of the study area is located in an area of very low potential for collapsible ground as a stability hazard, and ground dissolution is not shown to present a ground stability hazard.

The majority of the study area is shown to be in an area of moderate potential for shrinking or swelling clay as a stability hazard, likely associated with the bedrock geology of the Claygate Member and the London Clay Formation.

The potential for running sand as a ground stability hazard varies across the study area. Where Alluvium is anticipated, the potential for running sand as a ground stability hazard is shown as Low. Where Made Ground, Head Deposits, or the Claygate Member are anticipated, the potential for running sand as a ground stability hazard is shown as Very Low.

The potential for compressible ground as a ground stability hazard is shown to be moderate where Alluvium is anticipated, and very low where Made Ground is anticipated.

The potential for landslides as a ground stability hazard is shown to vary across the study area, with the hazard potential shown as very low for the majority of the site. Some areas whereby earthworks associated with the A12 and M25 are present are shown to present low to moderate potential for landslides as a ground stability hazard.

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[66] *Flood Zone 2 - a flood zone with up to a 0.1 per cent (1 in 1000) chance of occurring each year*
[67] *Flood Zone 3 - a river flood zone with up to a 1 per cent (1 in 100) chance of occurring each year*
[68] *Grade 3 – good to moderate quality agricultural land – is defined as 'Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in Grades 1 and 2'.*

Contaminated land

The Environment Agency website identifies that Brook Street historical landfill underlies the north-western quadrant of the study area and is located at the site of Grove Farm, adjacent to the M25 anticlockwise on slip at Junction 28. Records show that this landfill last received waste on 1st August 1983. The waste is recorded as inert.

There is potential for Made Ground and any related contamination to be present, associated with the infilling of ponds, road construction (including embankments) and with the construction of the railway line transecting the southern part of the study area.

To the south of the former Brook Street landfill, and approximately 50m from the gyratory at its closest point, is an operational waste management facility known as G & R Skips and Recycling.

The Sewage Works located along Nags Head Lane, is situated approximately 300 m south-west from the centre of Junction 28. Filter beds were once located closer to the site, as detailed on historical maps.

A number of potentially contaminative land uses have been operating within the immediate vicinity of the study area including MOT centres, service and repair garage (an associated tanks) and petrol filling stations. The nearest of which is a petrol station located in the south east quadrant of the study area, approximately 60m east of the existing Junction 28 gyratory at its closest point.

There are 16 recorded pollution incidents which have occurred within the vicinity of the site. Of these, two were significant incidents (which occurred in 1990 and 1993). None of the incidents occurred post 2000. However, the five most noteworthy incidents (based on the severity and distance of the incident from the site) are detailed below:

- in 1990 there was a significant impact to receiving surface water in the field immediately south-west of Junction 28 (according to NGR details of the incident) from an oil spill which occurred on the motorway;
- in 1993 there was a significant impact to receiving surface water in a field 650m to the south-east from the centre of Junction 28 from agricultural pollutants;
- in 1996, an agricultural pollutant was released into the environment 20m to the south of the railway line alongside Nags Head Lane, which resulted in minor impact to a pond approximately 850m to the south-west from the centre of Junction 28;
- in 1999, a minor incident occurred after the accidental release of unknown sewage substances entered the environment close to where the A12 passes beneath the M25. It is not known what the source of this was but it is considered that this may have emanated from a sewer system associated with the treatment works; and
- in September 2010 there was also a significant impact to water from a pollution event occurring which involved the spill of surfactants and detergents on the roundabout beneath Junction 28, approximately 60 m to the west of the Shell Garage.

Existing earthwork condition

A review of the HA GDMS, has identified that all recorded earthworks, located either adjacent to the A12 or M25 within the study area, are classified as being in either ‘A – As New’ or ‘C – Satisfactory’ condition in accordance with Schedule 14 of the M25

Design, Build, Finance and Operate contract (Connect Plus Services, Geotechnical Asset Condition Methodology, June 2011).

Ten geotechnical observations, relating to the earthworks, are recorded in the study area and include:

- one Major Defect;
- six Minor Defects; and
- three At-Risk Areas.

Earthworks are inspected and geotechnical observations are recorded in accordance with Highways England guidance in the DMRB Volume 4, Section 1, Part 3 – Maintenance of Highway Geotechnical Assets (HD 41/15). Observation classification is determined based on the feature and its location observed during walkover inspections.

Geotechnical observations are summarised in Table 12-3. It should be noted that records for observations are not provided within the HA GDMS database for the portion of the A12 within the M25.

Table 12-3 Geotechnical observations within HA GDMS

Feature ID, as recorded on HA GDMS	Classification, in accordance with HD41/15	Description
6_A12_30559_599210	1A – Major defect	New slip adjacent to remediated slope section (3A). Rear scarp 1m, slip 20m wide. Toe bulge isn't affecting carriageway. Concrete and brick rubble present within slope. No deterioration observed between 2014 and 2016.
5_M25_62173_523720	1D – Minor defect	Minor slip at toe. 0.5m backscar, no toe/debris bulge. Possible site of unbackfilled excavation.
5_M25_62124_522850	1D – Minor defect	Minor slip at crest in area steepened for installation of the lighting column. 0.3m backscar, well vegetated. Occasional tension cracks below backscar in mid slope.
5_M25_62138_522944	2 - At-risk area	Extensive burrowing mid slope.
5_M25_62178_523742	1D – Minor defect	Washout within area of bare ground over lower 8m of slope. Max depth of channel 100mm. Lower slope has been steepened as part of widening.
5_M25_62179_523744	1D – Minor defect	Minor slip within vicinity of unbackfilled excavation filled with water directly above mid slope (possibly a relocated drainage manhole). High moisture content and silt material downslope of excavation. Backscar is approximately 0.4m high, well vegetated.
5_M25_62179_523745	1D – Minor defect	Area of uneven ground above mid slope bench/gravel drain. High moisture content, some minor cracking.

Feature ID, as recorded on HA GDMS	Classification, in accordance with HD41/15	Description
5_M25_62179_523746	1D – Minor defect	Tension cracking evident as extents of steepened lower slope for widening, 9m from toe possible settlement of backfill to toe wall. Some patches of high moisture content within vicinity of cracking.
5_M25_62205_523882	2 – At-risk area	Extensive burrowing in front of sheetpile retaining wall.
5_M25_62206_523886	2 – At-risk area	Extensive burrowing behind wall exposing service duct.

12.5 Regulatory / Policy framework

This assessment has been prepared in line with the National Planning Policy Framework 2012 which states that the site should be suitable for its new use. The suitable for use designation takes account of ground conditions and land instability, including issues arising from natural hazards or former activities, and pollution arising from former land uses.

This section highlights the regulations and policy directly concerning geology and soils for the M25 Junction proposed options. The applicable regulations, policy and guidance documents are outlined below:

- Mines and Quarries Act 1954;
- Control of Pollution Act 1974;
- Wildlife and Countryside Act 1981 (amended 1985) (for Geological SSSIs);
- Environmental Protection Act 1990 (c. 43), as amended by the Environment Act 1995;
- Town and Country Planning Act 1990;
- Anti-Pollution Works Regulations 1999;
- Pollution Prevention and Control Act 1999;
- Water Framework Directive 2000 (2000/60/EC);
- Contaminated Land (England) Regulations 2000;
- Control of Pollution (Oil Storage) (England) Regulations 2001;
- Control of Substances Hazardous to Health (COSHH) Regulations 2002;
- Water Resources Act 2003;
- Brentwood Replacement Local Plan (Brentwood Borough Council, 2005) – updated with saved policies in August 2008;
- The Dangerous Substances Directive (78/44/EEC) (replaced by the CLP Regulation, 2008);
- Safeguarding our Soils – A Strategy for England 2009;
- Waste Management Regulations 2011;
- National Planning Policy Framework 2012;

- National Networks National Policy Statement 2014;
- DMRB Volume 11, Section 3, Part 11 (as amended), 1993;
- Interim Advice Note 125/15 (2015);
- DMRB Volume 4, Section 1, Part 2 (HD 22/08) (2008);
- DMRB Volume 4, Section 1, Part 3 (HD 41/15) (2015);
- MCHW Volume 1, Series 600 (2016);
- MCHW Volume 2, Series 600 (2016);
- MCHW Volume 1, Series 1600 (1998);
- MCHW Volume 2, Series 1600 (1998);
- MCHW Volume 1, Series 1700 (2014);
- MCHW Volume 2, Series 1700 (2014);
- Interim Advice Note 124/11 (2011);
- Interim Advice Note 161/15 (2015);
- Eurocode 0: Basis of Structural Design; and
- Eurocode 7: Geotechnical Design.

Good practice guidance is also provided by the Environment Agency and Defra in Contaminated Land Report (CLR) 11 – Model Procedures for the Management of Land Contamination. CLR11 provides a technical framework for the application of a risk management process for dealing with land affected by contamination. The assessment framework and guidance given within these documents have been considered in this assessment.

12.6 Preliminary engineering assessment

This section includes an assessment of the anticipated ground conditions associated with each of the currently proposed options. Consideration has also been given to the differing engineering requirements of each option.

Table 12-4 summarises the anticipated ground conditions and identifies variation in relation to chainage for each of the proposed routes. Geological maps overlaid with route options are provided as Figures 12.1 to 12.5 in Appendix J.

Option 6

In order to accommodate construction of a new slip road to carry traffic directly from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following is proposed:

- Chainage (Ch) 0 to 600 – Widening of the existing M25 anticlockwise carriageway from marker post (MP) 173.9B to 173.3B within an existing cutting of the Claygate Member and the London Clay Formation.
- Ch 600 to 1200 – Construction of a new bridge over Nags Head Lane, the M25 and the railway line. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.

- Ch 1200 to 1500 – Construction of a new embankment, where ground conditions are anticipated to comprise superficial Head Deposits over solid geology of London Clay Formation.
- Ch 1500 to 2100 – Construction of a new bridge over London Road and the A12. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of the London Clay Formation.
- Ch 2100 to 2400 – Further cutting and construction of a new embankment and a retaining wall within an existing cutting of Head Deposits and the London Clay Formation. Made Ground associated with Weald Park Way is anticipated.
- Ch 2400 to 3215 – Development and redevelopment of new and existing earthworks (cuttings and embankments) to accommodate widening of the existing A12 northbound carriageway. Ground conditions are anticipated to comprise Made Ground, Head Deposits and London Clay Formation.

In order to accommodate realignment of Weald Park Way to join Wigley Bush Lane further to the north, the following is proposed:

- Ch 0 to 540 - Development of new earthworks to accommodate construction of new road. Ground conditions are anticipated to comprise solid geology of London Clay Formation; a
- Extension of the existing footbridge crossing over the A12 from Weald Park Way to Spital Lane. Ground conditions are anticipated to comprise Made Ground over solid geology of London Clay Formation.

Option 2

In order to accommodate the construction of a new slip road to carry traffic directly from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following is proposed:

- Ch 0 to 600 - Widening of the existing M25 anticlockwise carriageway from MP 173.8B to 173.2B within an existing cutting of the Claygate Member and the London Clay Formation.
- Ch 600 to 850 – Development of new earthworks and retaining walls, where ground conditions are anticipated to comprise solid geology of London Clay Formation.
- Ch 850 to 2800 – Development of new earthworks, where ground conditions are anticipated to comprise Landfill Material, Made Ground and superficial deposits of Head and Alluvium over solid geology of London Clay Formation.
- Ch 975 – Construction of a new bridge to carry the existing railway line over the proposed new M25 anticlockwise offslip, where the ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.
- Ch 1200, 1375 to 1475, 1875 to 2000, 2350 and 2400 - Construction of new bridges over the A12, M25 and existing waterways. Ground conditions are anticipated to comprise Made Ground, and superficial Head Deposits and Alluvium over solid geology of the London Clay Formation.
- Ch 2800 to 2950 - Construction of a new A12 onslip in an existing cutting of Head Deposits and London Clay Formation. Made Ground associated with the nearby bridge crossing over the A12 is anticipated.

- Ch 2950 to 3755 – Redevelopment of existing earthworks to accommodate widening of the existing A12 northbound carriageway. The anticipated ground conditions comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.
- Extension of the existing bridge carrying Wigley Bush Lane over the A12, where the anticipated ground conditions comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.

In order to accommodate realignment of Nags Head Lane, the following is proposed:

- Ch 0 to 500 – Development of new earthworks, where ground conditions are anticipated to comprise superficial Head Deposits over solid geology of London Clay Formation.
- Ch 500 to 600 – Construction of a new bridge over the M25, where ground conditions are anticipated to comprise solid geology of London Clay Formation.
- Ch 600 to 900 – Construction of new and redevelopment of existing earthworks. Ground conditions are anticipated to comprise solid geology of London Clay Formation.
- Realignment of Weald Park Way is proposed as per Option 6.

Option 4

In order to accommodate the construction of a new slip road to carry traffic from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following is proposed:

- Ch 0 to 375 – Redevelopment of an existing embankment to accommodate widening of the existing M25 carriageway from MP 172.9B to 172.5B. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.
- Ch 375 to 800 – Construction of a new bridge over the Junction 28 roundabout and the M25. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits and Alluvium over solid geology of London Clay Formation.
- Ch 800 to 1750 –Development of new earthworks, where ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.
- Ch 1750 to 2339 – Widening of the existing A12 northbound carriageway in cutting of Head Deposits and London Clay Formation.
- Extension of the existing bridge carrying Wigley Bush Lane over the A12, where the anticipated ground conditions comprise Made Ground and superficial Head Deposits over solid geology of the London Clay Formation.

In order to accommodate construction of a new slip road to carry traffic from the M25 anticlockwise carriageway to Junction 28 roundabout, the following is proposed:

- Ch 0 to 600 - Widened of the existing M25 anticlockwise carriageway from MP 173.7B to 173.1B in cutting of the Claygate Member and the London Clay Formation.
- Ch 600 to 1200 - Development of new cuttings and a retaining wall to accommodate construction of new road. Ground conditions are anticipated to

comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.

- Construction of a new bridge to carry the existing railway line over the new M25 offslip, where the ground conditions are anticipated to comprise Made Ground and Superficial Head Deposits over solid geology of London Clay Formation.
- Realignment of Nags Head Lane is proposed as per Option 2.
- Realignment of Weald Park Way is proposed as per Option 6.

Option 5A

In order to accommodate construction of a new slip road to carry traffic from the A12 northbound carriageway to the Junction 28 roundabout, the following is proposed:

- Ch 0 to 250 – Redevelopment of existing earthworks to accommodate widening of the A12 northbound. Ground conditions are anticipated to comprise Made Ground over solid geology of London Clay Formation.
- Ch 250 to 450, 625 to 746 – Construction of new embankments and a retaining wall to accommodate new road construction. Ground conditions are anticipated to comprise Made Ground and superficial deposits of Head and Alluvium over solid geology of London Clay Formation.
- Ch 450 to 625 – Construction of a new bridge to carry traffic over an existing watercourse. Ground conditions are anticipated to comprise Made Ground and superficial deposits of Head and Alluvium over solid geology of London Clay Formation.

In order to accommodate the construction of a new slip road to carry traffic from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following is proposed:

- Ch 0 to 150 – Extension of existing embankment to accommodate widening of the existing M25 anticlockwise carriageway from MP 172.8B to 172.6B. Ground conditions are anticipated to comprise superficial Head deposits over solid geology of London Clay Formation.
- Ch 150 to 250 – Construction of a new embankment and retaining wall to allow for new road construction. Ground conditions are anticipated to comprise Made Ground and superficial deposits of Head over solid geology of London Clay Formation.
- Ch 250 to 575 and 900 – Construction of new bridges to carry traffic over water courses. Ground conditions are anticipated to comprise Landfill Material, Made Ground and superficial deposits of Head and Alluvium over solid geology of London Clay Formation.
- CH 575 to 1000 – Construction of a new embankment to allow for new road construction. Ground conditions are anticipated to comprise Landfill Material, Made Ground and superficial deposits of Head and Alluvium over solid geology of London Clay Formation.
- Ch 1000 to 1117 – Widening of the existing A12 northbound carriageway. In cutting of London Clay Formation; Made Ground associated with the construction of embankments around Junction 28 is anticipated.
- Construction of a new slip road carrying traffic from the M25 anticlockwise carriageway to the Junction 28 roundabout is proposed as per Option 4.

Option 5B

Construction of a new slip road carrying traffic from the A12 northbound carriageway to the Junction 28 is proposed as per *Option 5A*, with the exception that two bridges separated by an embankment are proposed instead of one longer bridge between Ch 450 and 625.

For the construction of a new slip road carrying traffic from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following is proposed:

- Ch 0 to 175 – Construction of a retaining wall to accommodate for widening of the existing M25 anticlockwise carriageway between MP 172.7B to 172.5B. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.
- Ch 175 to 375 – Extension of the existing bridge carrying the M25 anticlockwise carriageway between MP 172.7B to 172.4B to accommodate for widening of the existing carriageway. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits and Alluvium over solid geology of London Clay Formation.
- Ch 375 to 525 - Construction of a new bridge over the existing Junction 28 roundabout. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits and Alluvium over solid geology of London Clay Formation.
- Ch 525 to 1062 – As per Ch 580 to 1117 of Option 5A.

Option 5C

Construction of a new slip road carrying traffic from the A12 northbound carriageway to the Junction 28 is similar to as per *Option 5A.*

In order to accommodate the construction of a new slip road to carry traffic from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following is proposed:

- Ch 0 to 225 – Extension of an existing embankment to accommodate widening of the M25 anticlockwise carriageway between MP 172.3B to 172.1B. Ground conditions are anticipated to comprise Made Ground over solid geology of London Clay Formation.
- Ch 225 to 350 – Construction of a new bridge over the proposed new M25 anticlockwise onslip, where ground conditions are anticipated to comprise Landfill Material and Made Ground over solid geology of London Clay Formation.
- Ch 250 to 1325 – Development of new earthworks to accommodate construction of a new road. Ground conditions are anticipated to comprise Landfill Material, Made Ground and superficial Head Deposits and Alluvium over solid geology of London Clay Formation.
- Ch 575, 1075, and 1225 – Construction of new bridges over existing waterways. Ground conditions are anticipated to comprise Made Ground and superficial Head Deposits and Alluvium over solid geology of London Clay Formation.
- 1325 to 1429 – Widening of the existing A12 northbound carriageway in an existing cutting of Alluvium, Head Deposits and London Clay Formation. Made Ground associated with embankments is anticipated.

In order to accommodate the construction of a new slip road to carry traffic from the Junction 28 roundabout to the M25 anticlockwise carriageway, the following has been proposed:

- Ch 0 to 475 - A new cutting in Head and London Clay Formation to accommodate the construction of new road. Landfill Material and Made Ground associated with Brook Street Landfill and embankments around Junction 28 are anticipated.
- Ch 475 to 739 - Widening of the existing M25 anticlockwise carriageway between MP 171.9B to 171.6B in cutting of London Clay Formation.

Option 5D

In order to accommodate the construction of a new slip road to carry traffic directly from the M25 clockwise carriageway to the A12 northbound carriageway, the following has been proposed:

- Ch 0 to 375 – Redevelopment of existing earthworks to accommodate widening of the existing M25 clockwise carriageway between MP 1712A to 171.6A. Ground conditions are anticipated to comprise superficial Head Deposits and Alluvium over solid geology of London Clay Formation.
- Ch 375 to 400 - Construction of a new retaining wall to accommodate widening of the exiting M25 clockwise carriageway at MP 171.6A, where ground conditions are anticipated to comprise solid geology of London Clay Formation.
- Ch 400 and 875 – Construction of new earthworks to accommodate construction of a new road, where ground conditions are anticipated to comprise superficial Head Deposits and solid geology of London Clay Formation.
- Ch 1150: Construction of a new bridge to carry traffic over an existing waterway where ground conditions are anticipated to comprise superficial Head Deposits over solid geology of London Clay Formation.

For the construction of a new slip road taking traffic from the M25 anticlockwise carriageway to the A12 northbound carriageway, the following has been proposed:

- Ch 0 to 425 – Extension of an existing embankment to accommodate widening of the existing M25 anticlockwise carriageway between MP 172.3B to 171.9B, where ground conditions are anticipated to comprise Made Ground and superficial Head Deposits over solid geology of London Clay Formation.
- Ch 425 to 575 - Construction of a new bridge above the proposed M25 anticlockwise onslip, where ground conditions are anticipated to comprise solid geology of London Clay Formation.
- Ch 575 to 2325 – Development of new earthworks to accommodate construction of a new road. Ground conditions are anticipated to comprise Landfill Material, Made Ground and superficial Head Deposits and Alluvium over solid geology of the London Clay Formation.
- Ch 775, 1250, 1475 to 1650 and 2000 – Construction of new bridges to carry traffic over waterways and the M25. Ground conditions are anticipated to comprise Landfill Material, Made Ground, superficial deposits of Head and Alluvium over solid geology of London Clay Formation.
- Ch 2325 to 2827- Widening of the existing A12 northbound carriageway within cutting of Head Deposits and London Clay Formation. Made Ground

associated with the bridge carrying Wigley Bush Lane over the A12 is anticipated.

Option 5E

The proposed construction for *Option 5E* is the similar to that proposed for *Option 5A*, with the exception that the slip road carrying traffic from the M25 anticlockwise carriageway to the A12 northbound carriageway is proposed to pass underneath the M25 carriageways and slip roads. Cuttings are therefore proposed instead of embankments, and three new bridges would be required to carry the M25 and slip roads.

Realignment of the existing slip road carrying traffic from the M25 clockwise carriageway to the Junction 28 roundabout is also proposed within *Option 5E*. Redevelopment of existing earthworks are proposed to accommodate this, where ground conditions are anticipated to comprise Made Ground and superficial deposits of Head and Alluvium over solid geology of London Clay Formation.

Table 12-4 Option specific anticipated ground conditions

Geology	Option 6		Option 2			Option 4				Option 5A, 5B and 5C						Option 5D and 5E			
	M25 anti-clockwise to A12 northbound	Realignment of Weald Park Way	M25 anti-clockwise to A12 northbound	Realignment of Nags Head Lane	Realignment of Weald Park Way	M25 anti-clockwise to A12 northbound	M25 anti-clockwise to Junction 28 roundabout	Realignment of Nags Head Lane	Realignment of Weald Park Way	A12 northbound to Junction 28 roundabout (*Options 4.1, 4.2 and 4.3)*	M25 anti-clockwise to A12 northbound (*Options 4.1 and 4.2)*	Junction 28 roundabout to M25 anti-clockwise (*Option 4.3 only*)	M25 anti-clockwise to Junction 28 (*Option 4.1 only)*	Realignment of Nags Head Lane (*Option 4.1 only)*	M25 anti-clockwise to A12 northbound (*Option 4.3 only)*	M25 anti-clockwise to A12 northbound	M25 clockwise to A12 northbound	Junction 28 roundabout to M25 antic-clockwise	M25 clockwise to Junction 28 roundabout (*Option 5.2 only*)
Landfill Material	Not anticipated	Not anticipated	1600 to 1900	Not anticipated	Not anticipated	Not anticipated	Not anticipated	Not anticipated	Not anticipated	Not anticipated	500 to 750	100 to 400	Not anticipated	Not anticipated	200 to 400;	1325 to 1525	Not anticipated	100 to 400	Not anticipated
Made Ground	1100 to 1175; 2050 to 2150; 2500 to 2550	Not anticipated	950 to 1025; 1375 to 1475; 1900 to 2000; 2825 to 2950; 3250 to 3350	Not anticipated	Not anticipated	50 to 125; 225 to 800; 1625 to 1750; 2050 to 2125	875 to 950; 1050 to 1200	Not anticipated	Not anticipated	0 to 758	0 to 550; 900 to 1117	0 to 100	875 to 950; 1050 to 1200	Not anticipated	0 to 200; 1225 to 1429	0 to 425, 1550 to 1650; 2100 to 2200; 2375 to 2450; 2775 to 2827	Not anticipated	0 to 100	0 to 478
Head Deposits	1200 to 1300; 1800 to 2450; 2600 to 2950	Not anticipated	850 to 1150; 1450 to 1550; 2100 to 2275; 3450 to 3675	0 to 50; 150 to 325	Not anticipated	150 to 475; 525 to 650; 850 to 1025; 2200 to 2339	775 to 1200	0 to 50; 150 to 325	Not anticipated	400 to 758	25 to 525; 750 to 950	0 to 50	775 to 1200	0 to 50; 150 to 325	0 to 50; 450 to 1200;	0 to 100; 725 to 775; 825 to 1225; 1275 to 1425; 1900 to 2475	100 to 225; 750 to 875; 1125 to 1381	0 to 50	300 to 400
Alluvium	Not anticipated	Not anticipated	1400 to 1450	Not anticipated	Not anticipated	475 to 525	Not anticipated	Not anticipated	Not anticipated	450 to 758	300 to 400; 925 to 1117	Not anticipated	Not anticipated	Not anticipated	550 to 625; 1050 to 1100; 1200 to 1429	775 to 825; 1225 to 1275	0 to 100	Not anticipated	40 to 476
London Clay Format-ion	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirety	Entirely	Entirety	Entirety	Entirety	Entirety
Claygate Member	150 to 550	Not anticipated	0 to 450	Not anticipated	Not anticipated	Not anticipated	0 to 400	Not anticipated	Not anticipated	Not anticipated	Not anticipated	Not anticipated	0 to 400	Not anticipated	Not anticipated	Not anticipated	Not anticipated	Not anticipated	Not anticipated

12.7 Potential effects

Published geological data and available environmental datasheets, as taken from the site specific Envirocheck Report, have been used to produce the high level preliminary geotechnical risk register presented as Table 12-5. Potential hazards associated with the geology and soils within the study area have been identified, and plausible mitigation strategies have been outlined. This is for indicative purposes only, and further site-specific investigations should be carried out to gain a better understanding of the risks present for each option and to aid more detailed design of mitigation measures. An initial assessment of the risk presented by each identified hazard is presented for each of the proposed scheme options.

Summary of high level risk identification

Where ground conditions associated with an identified hazard are not anticipated at this stage, the risk associated with that hazard is considered Low (L). Where the ground conditions associated with an identified hazard are present, but it is considered that the hazard will have minimal impact on the project, the risk is considered Moderate (M). Where anticipated ground conditions are such that an identified hazard may have a significant impact on the project, the risk is considered High (H).

From a review of the historical maps and other publically available sources of information, several potential sources of contamination have been identified within or in proximity to the scheme. These include Brook Street historical landfill, deposits of Made Ground (and any related contamination) associated with the infilling of ponds, an historical heap, road construction (including embankments) and with the construction of the railway line and gas pipeline, and a number of other potentially contaminative land uses operating within the immediate vicinity of the study area. These include a waste management facility, sewage works, MOT centres, a service and repair garage, petrol filling stations, a swimming pool service company and an air conditioning and refrigeration contractor. There have also been number of pollution incidents which have affected controlled waters within the vicinity of the site from varying sources.

Potential human receptors include local residents, workers at nearby commercial premises and farms and future site workers.

Potential controlled waters receptors comprise groundwater receptors, which include the underlying superficial Secondary A and Secondary (undifferentiated) aquifers and Secondary A bedrock aquifers to the north and east, as well as potential surface water receptors, which include the Ingrebourne River and Weald Brook.

Potential sources of contamination and receptors associated with the scheme options are shown on Figure 12.6 in Appendix J.

Subject to the findings of a ground investigation and based on the identified potential sources and human receptors, plausible exposure pathways for the identified human receptors may include but are not limited to:

- Inhalation, ingestion and dermal contact with contaminants in soil and soil-derived dust/fibres;
- Inhalation, ingestion and dermal contact with contaminants within perched water and shallow groundwater;
- Migration and accumulation of ground gases followed by inhalation or ignition causing asphyxiation and/or explosion; and
- Inhalation of vapours.

Again, subject to the findings of a ground investigation, potential pathways to the identified controlled waters receptors may include but are not limited to:

- Surface water run-off;
- Leaching/migration of contaminants in soils to underlying groundwater;
- Lateral migration of contamination in groundwater;
- Lateral migration of contamination in groundwater to surface waters; and
- Migration of contamination in drainage ditches to controlled surface waters.

Table 12-5 High level risk register

Hazard	Description	Mitigation	Problematic materials or conditions	Risk rating in				
				Option 6	Option 2	Option 4	Option 5A, 5B, 5C	Option 5D, 5E
Unexpected ground conditions	Ground conditions encountered are different to those anticipated, leading to time and cost implications during the ground investigation and construction phases.	Carry out a PSSR and Annex A to determine the likely ground conditions, and perform a site specific ground investigation to assess the ground conditions, including an assessment of contamination and groundwater.	Generic risk	H	H	H	H	H
Buried & overhead services	Buried services associated with the road and other nearby infrastructure are likely abundant throughout the study area. Overhead services are likely present which may interfere with construction or drilling equipment.	Contractor to ensure they are satisfied that all present services have been located prior to intrusive works. Service surveys may be required, and some services may need to be diverted.	Generic risk	H	H	H	H	H
High groundwater table, perched and water ingress.	High groundwater levels or groundwater within more permeable layers above the groundwater table may present a geotechnical risk or cause complications during the construction and ground investigation phases.	Groundwater levels should be monitored during the ground investigation phase, accounting for seasonal variation.	Generic risk	M	M	M	M	M
Variable ground conditions	Inconsistency in material properties may occur due to variable materials and/or weathering profiles. This can lead to complications during the ground investigation phase, and when considering geotechnical parameters during the detailed design phase.	A detailed desk study should be carried out prior to any intrusive ground investigation. Contractors Method Statement should identify ways to deal with variable ground that may be encountered.	Generic risk	H	H	H	H	H
Clay shrink-swell	Clay minerals are susceptible to shrinkage and swelling as the weather and groundwater conditions change. This can cause differential settlement, and thus structural damage, to overlying structures.	Consideration should be given to the foundations during detailed design stage. Foundations must be designed deep enough so that clay shrink / swell has minimal impact on the structure.	Bedrock Geology (Claygate Member; London Clay Formation)	H	H	H	H	H
Soft, compressible and/or low strength ground	Soft, compressible and/or low strength ground may cause excessive settlement or bearing capacity failure to any structures founded onto or above the associated materials.	Consideration should be given to the foundations during detailed design stage. Piled foundations or replacement of the bearing strata with a stronger or less compressible material (such as compacted granular fill) may be required, depending on loading conditions.	Landfill Material;	L	H	L	H	H
			Made Ground	M/H	M/H	M/H	M/H	M/H
			Superficial Deposits (Alluvium; Head Deposits)	M	H	H	H	H
Ground conditions aggressive towards concrete	Presence of sulphate and/or sulphide bearing materials within the ground may induce sulphate attack on buried concrete structures, causing major deterioration to the strength of the concrete.	Chemical testing should be carried out on soil and groundwater samples during the Ground Investigation phase to determine the aggressiveness of the ground towards concrete. Any buried concrete structures should be designed in accordance with the Building Research Establishment Special Digest 1 during detailed design stage.	Landfill Material	L	H	L	H	H
			Made Ground	H	H	H	H	H
			Superficial Deposits (Alluvium)	L	H	H	H	H
			Bedrock Geology (Claygate Member; London Clay Formation)	H	H	H	H	H
Hard layers encountered during drilling / excavation	Hard layers, such as boulders, ferruginous concretions and septarian nodules, may cause delays or damage to drilling equipment during the	A detailed desk study should be carried out prior to any intrusive ground investigation. Contractors Method	Superficial Deposits (Head Deposits)	M	M	M	M	M

Hazard	Description	Mitigation	Problematic materials or conditions	Risk rating in				
				Option 6	Option 2	Option 4	Option 5A, 5B, 5C	Option 5D, 5E
	construction and ground investigation phases, potentially resulting in programme delays and/or cost implications.	Statement should identify ways to deal with hard layers that may be encountered.	Bedrock Geology (Claygate Member; London Clay Formation)	M	M	M	M	M
Weathered bedrock	The surface of the bedrock will likely have an irregular weathering profile, differing geotechnical properties compared to the underlying unweathered material. The weathered surface material will likely be weaker, and fissures may be more abundant causing uncharacteristic behaviour and altering the groundwater regime.	A detailed ground investigation should be carried out to determine the weathering profile of the bedrock geology, and determine the difference in characteristics between the weathered and unweathered bedrock.	Bedrock geology (Claygate Member; London Clay Formation)	H	H	H	H	H
Existing earthwork defects (unidentified or developing)	Defects to the existing earthworks are areas of weakness, and may present a risk of landslip during ground investigation and construction. Whilst some defects have already been identified, there may be existing defects beyond those identified	Continued inspections of nearby earthworks to be undertaken, and identified defects near to the proposed works to be repaired. Remediation of significant defects may be required.	Work on or near existing cuttings and embankments.	H	H	H	H	H
Destabilisation of excavation side walls or existing slopes	Loading or regrading of existing slopes may cause them to become unstable, or large, unsupported excavation walls could collapse.	Consideration should be given to any work carried out on or near to the crest of a slope, and to any regraded slopes during the detailed design phase.	Superficial Deposits (Head Deposits)	M	M	M	M	M
			Work on or near existing cuttings and embankments	H	H	H	H	H
Encountering contaminated materials and creating source-receptor pathways	Historical infilling and landfill wastes may not have been capped and confined within an impermeable membrane.	Physical and/or chemical hazard to human receptors: Appropriate PPE to be worn on site. Removal and correct disposal of such wastes.	Known contamination; Landfill Material, Made Ground	M	H	H	H	H
		Release of contaminants into groundwater or surface water sources from surcharge: Minimising impact of construction work which could lead to the release of contaminants into the environment.		M	H	H	H	M
	Organic and inorganic contaminant residue may have laterally migrated within Made Ground and superficial deposits or within groundwater (if present) freely beneath the site and may have accumulated.	Physical and/or chemical hazard to human receptors: Appropriate PPE to be worn on site. Removal and correct disposal of such wastes.	Unknown, possible contamination; Residue contamination from historical and current land uses including petrol filling stations, servicing garages and sewage treatment works	L	M	M	M	M
		Release of contaminants into groundwater or surface water sources from surcharge: Minimising impact of construction work which could lead to the release of contaminants into the environment.	Unknown, possible contamination; Residue contamination from historical and current land uses including petrol filling stations, servicing garages and sewage treatment works	L	M	M	M	M

Hazard	Description	Mitigation	Problematic materials or conditions	Risk rating in				
				Option 6	Option 2	Option 4	Option 5A, 5B, 5C	Option 5D, 5E
Cutting and earthwork activities impacting groundwater.	Cutting and earthworks activities impacting groundwater and may mobilise contaminants within Made Ground or identified landfill areas (Historical Landfill, infilled ponds). These contaminants may have the potential to migrate to identify surface water bodies in the area.	Mobilise Contamination: Completion of risk assessment to quantify the risk to the surface water environment from construction. Minimise earthworks which impact groundwater.	Unknown, possible contamination; Residue contamination from historical and current land uses including petrol filling stations, servicing garages and sewage treatment works	H	H	H	H	H

Key

- High risk
- Moderate risk
- Low risk

12.8 Design, mitigation, enhancement and monitoring measures

The proposed scheme options will be designed to ensure that construction works will not pose a risk to human health or the environment.

A more detailed assessment of the indicated geology and ground conditions local to the preferred option should be carried out prior to detailed design stage once the locations of proposed structures have been confirmed.

Potential risks have been identified as part of this high level data review. Appropriate mitigation measures will be identified as part of the assessment once the chosen development option has been finalised. Mitigation and enhancement measures are likely to include:

- Production of a Preliminary Sources Study Report in accordance with HD 22/08 to review existing data (geological, hydrological, hydrogeological, geotechnical, past and current land use and the potential for contaminated land), to provide recommendations for further investigation and to confirm the findings of this initial high level study. Existing contamination and geotechnical information will be reviewed, including BGS boreholes, BGS mapping and historical ground investigation reports relating to the construction of the M25.
- Production of a preliminary risk assessment to understand risk to groundwater and surface water environment from proposed works.
- A walkover of the chosen option site to clarify the baseline condition of earthworks and highlight any earthworks that require remediation to facilitate build of the scheme.
- An intrusive ground investigation, including the collection and laboratory analysis of soil samples and subsequent monitoring/sampling/laboratory analysis of groundwater, vapour and ground gas, to:
    - Target areas of instability/bridge design/junction reconfiguration;
    - Confirm the geological succession and provide an assessment of ground conditions;
    - Provide an assessment of the groundwater and gas regime at the site;
    - Determine the presence and nature of any sub-surface obstructions;
    - Determine the level of contamination at the site;
    - Classify waste for disposal off site;
    - Identify geotechnical and geo-environmental risk;
    - Provide geotechnical parameters for design (including pavement, bridge and earthwork design);
    - Identify materials for re-use in construction; and
    - Identify import materials for use in earthwork construction.
- Production of a risk assessment to better determine areas of contaminated ground / groundwater and any necessary mitigation and/or design measures once ground investigation data has been obtained and analysed.
- Classification of waste to inform reuse or disposal of material. This will be undertaken in accordance with current UK and European legislation regarding

management of wastes. The potential effects will be reduced by adoption of mitigation measures including the development of an MMP and a SWMP.

- Geotechnical interpretation of ground investigation data, to include the production of a ground model for the site, the provision of geotechnical characteristic parameters and identification of geotechnical risk.
- Design of geotechnical engineering features to ensure that contamination migration pathways are not created.
- Production of a piling risk assessment to determine risk of introducing contamination pathways.
- On site geotechnical monitoring to analyse stability and settlement during construction.
- Geotechnical supervision during construction to ensure the suitability of materials and construction technique.

Geotechnical reporting and the management of geotechnical risk shall be in accordance with the Design Manual for Roads and Bridges (HD22/08).

Environmental interpretation, reporting and risk assessment will be undertaken in accordance with CLR11 and will include the development of a Conceptual Site Model (CSM) and, subject to the findings of the risk assessment, provide recommendations for further assessment and/or remediation where necessary.

In subsequent stages, sufficient assessment will be undertaken to further refine the choice of route option, identifying significant impacts on geology and soils and, where appropriate, any contaminated land issues. The study will confirm baseline information, report consultations with relevant statutory bodies and report the findings of site investigations. Any significant effects on geological sites will be recorded along with possible methods of treating contaminated land where present.

Good site practices should also be adhered to during construction. Measures are likely to include (but are not be limited to):

- Management of potential risks to ground investigation/construction workers through health and safety legislation, such as the Control of Substances Hazardous to Health (COSHH) Regulations. COSHH requires the employer to carry out an assessment of the risks associated with exposure to hazardous substances and then to prevent and if this is not reasonably practicable, to adequately control such exposures;
  - Working methods during construction to ensure that surface water cannot run from the works and any stockpiles into adjacent surface watercourses.
  - Implementation of appropriate dust control measures.
  - Storage of fuel away from surface watercourses in accordance with Environment Agency Pollution Prevention Guidance (PPG) notes PPG2 and PPG6.
  - Development of a methodology to address what remedial actions will be undertaken and how such actions will be validated and recorded if unsuspected contamination is encountered during the works.

The measures listed above are a small selection of those adopted as standard on all development sites. Further details will be provided in a site specific CEMP.

Assuming appropriate mitigation measures are implemented during the design and construction stages of the projects, it is considered that there should be no significant adverse effects to the identified receptors caused by the implementation of any of the proposed options. On this basis, the overall impact is considered likely to be neutral.

12.9 Limitations to assessment

The current assessment has been based on the collation and evaluation of readily available documentation provided by the Environment Agency, BGS, Envirocheck Report and other data sources made available to Atkins, as detailed in Section 12.4; baseline conditions; sources of information. Some of the opinions may be based on unconfirmed data or information from third parties which cannot be fully verified and, as such, no responsibility can be taken for its accuracy. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. The accuracy of maps cannot be guaranteed and it should be recognised that different conditions within the area may have existed between and subsequent to the various map surveys.

Atkins has not undertaken direct consultation with relevant regulatory bodies in association with this work as consultation is not considered to be appropriate at this stage.

Any borehole data from British Geological Survey (BGS) sources are included on the basis that: ‘The British Geological Survey accept no responsibility for omissions or misinterpretation of the data from their Data Bank as this may be old or obtained from non-BGS sources and may not represent current interpretation’.

This report should be read in light of the legislation, statutory requirements and/or industry good practice applicable at the time of the works being undertaken. Any subsequent changes in this legislation, guidance or design may necessitate the findings to be reassessed in the light of these circumstances.

13 Materials and Waste

13.1 Introduction

This chapter assesses, at a high level, the potential impacts of materials and waste arisings from the proposed M25 Junction 28 scheme options. Proposed mitigation and enhancement measures are detailed towards the end of the chapter.

The chapter is broadly based on the guidance and methodologies outlined in the DMRB Volume 11, Section 1, 2, 3 and 11 and the Department for Transport's Interim Advice Note 153/11 titled 'Guidance on the Environmental Assessment of Material Resources'.

13.2 Assessment methodology

Interim Advice Note 153/11 is intended for the *"identification of impacts associated with materials resource use waste arisings"* for construction, improvement and maintenance projects and as such is applicable to the M25 Junction 28 proposed options.

The Interim Advice Note 153/11 states that a '*Simple Assessment'* should be undertaken before detailed design. The simple assessment collates information and data that is readily available to address the potential effects during the options identification stage (PCF1). This level of assessment would usually be undertaken at the DMRB Scoping Stage, however as the options being assessed within this ESR are preliminary, the assessment undertaken below broadly follows this approach, and is limited in scope due to the lack of relevant information at this options identification stage.

No specific significance criteria is defined in the DMRB for materials and waste. Therefore the assessment follows the methodology set out in Chapter 5 of this ESR. The sensitivity of the receptor is dependent on the capacity of the local environment to provide materials and to dispose / treat of waste arisings (i.e. the capacity of available waste management infrastructure in the county of Essex and the East London area). Once a preferred option has been selected, construction, demolition, and excavation waste arisings estimates will be produced and used to identify the magnitude for change. The magnitude of change will only be assessed for waste arisings as no baseline is available for material use and this is generally not reported for such schemes.

Sensitivity

The sensitivity of the materials cannot be determined as some impacts may occur offsite, or possibly outside of the UK. This includes the depletion of non-renewable resources, the extraction of minerals or during the manufacturing process and transport. This level of information is unlikely to be available until the contractor(s) have been appointed and a detailed Bill of Quantities (BoQs) is available.

With regards to waste, the sensitivity will be dependent upon on the baseline waste arisings and the treatment / disposal capacity, which will be qualitatively assessed during the options selection stage. Both the quantities of waste generated and the composition of the waste will vary with the M25 Junction 28 scheme options.

13.3 Study area

The study area includes the waste disposal and treatment networks within the county of Essex as well as the East London area (Barking & Dagenham, Havering, Newham and Redbridge, the East London Waste Authority borough), which are separated by the boundary of the M25. The M25 Junction 28 is situated in between Brentwood, Essex and Romford, East London.

13.4 Baseline conditions

Materials used and wastes generated have the potential to generate environmental impacts through:

- Use of large quantities of materials (e.g. from non-renewable resources);
- Generation of large quantities of waste; and
- Generation of hazardous waste.

As defined in the Interim Advice Note 153/11 surplus materials and waste are likely to arise from two sources:

- 'Existing site materials'; and
- 'Materials brought onto site but not used for the original purpose'.

It should be noted that materials generated from the works will also include excavation materials as a principle source.

Baseline information was gathered from the sources listed below. It should be noted that the desk based assessment is indicative only and is limited in scope due to the lack of relevant information at the options identification stage.

- Environment Agency 'What's In Your Backyard?' website (available at: http://apps.environment-agency.gov.uk/wiyby/default.aspx);
- Multi-Agency Geographic Information for the Countryside ('MAGIC') website (available at: http://magic.defra.gov.uk/);
- Essex County Council and Southend-on-Sea Borough Council Replacement Waste Local Plan, Capacity Gap Report (2014);
- Joint Waste Development Plan for the East London Waste Authority Boroughs (2012); and
- Envirocheck Report for M25 Junction 28, presented as Appendix I (Order Number: 88528679_1_1).

Baseline information on the ground conditions relevant to the proposed scheme options is provided in the 'Geology and Soils'

With regards to materials, no baseline is available for material use and this is generally not reported for such schemes.

With regards to operational waste, it is anticipated that the waste arisings associated with the M25 Junction 28 at present consists only of litter and ad hoc maintenance waste. Within the surrounding area the waste arisings are likely to be minimal, and will primarily consist of:

- agricultural waste (from the agricultural fields and the areas of open space); and

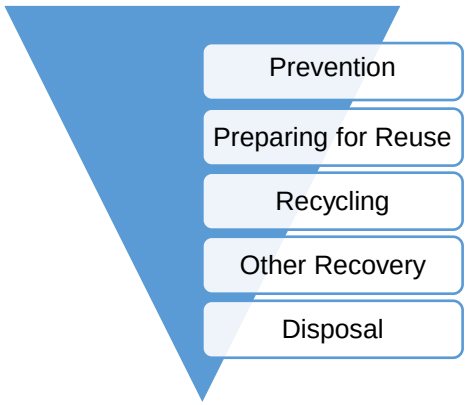
- municipal waste from the nearby farms (e.g. Grove Farm and Putwell Bridge Farm), and the town of Brentwood to the north-east of M25 Junction 28.

As aforementioned, the baseline for waste arisings has been extended to include the waste management networks within the county of Essex and the East London areas as waste is regularly treated / disposed of within these areas.

13.5 Regulatory/Policy framework

This section highlights the regulations and policy which will directly affect materials and waste management for the M25 Junction 28 proposed options. The regulations and policy documents primarily emphasise the waste hierarchy to ensure that waste is managed within the priority order, as shown in Figure 13-1.

Figure 13-1 Waste Hierarchy



The regulations and policy documents are outlined below:

- EU Waste Framework Directive (2006/12/EC);
- EU Landfill Directive (1993/31/EC), as amended by the EU Directive (2003/33/EC);
- Waste (England and Wales) Regulations 2011 (SI 2011/988), as amended in 2012 (SI 2012/1889) and in 2014 (SI 2014/656);
- The Hazardous Waste (England and Wales) Regulations 2005 (SI 2005/894), as amended in 2009 (SI 2009/507), 2015 (SI 2015/1360) and 2016 (SI 2016/336);
- Waste Electrical and Electronic Equipment (WEEE) Regulations 2006 (SI 2006/3289), as amended in 2007 (SI 2007/3454), 2009 (SI 2009/2957), 2010 (SI 2010/1155) and 2013 (SI 2013/3113);
- Environmental Protection (Disposal of Polychlorinated Biphenyls and other Dangerous Substances) (England and Wales) Regulations 2000 (SI 2000/1043), as amended in 2000 (SI 2000/3359);
- The Environmental Permitting (England and Wales) Regulations 2010 (SI 2010/675), as amended in 2011 (SI 2011/2043), 2012 (SI 2012/630) and 2014 (2014/255);
- European Waste Catalogue (2000/532/EC);
- Environmental Damage (Prevention and Remediation) Regulations 2009 (SI 2009/153), as amended in 2010 (SI 2010/587) and 2015 (SI 2015/810);

- The Control of Asbestos Regulations 2012 (SI 2012/632);
- Environmental Protection Act 1990 (c. 43), as amended in 1996;
- Clean Neighbourhoods and Environment Act 2005 (c. 16);
- Environmental Protection (Duty of Care) Regulations 1991 (SI 1991/2839), as amended in 2003 (SI 2003/63);
- Waste Management Plan for England 2013;
- National Planning Policy for Waste 2014;
- National Networks National Policy Statement 2014;
- DMRB Volume 11, Section 1, 2, 3 and 11 (as amended);
- Interim Advice Note 153/11 (2011);
- Essex County Council and Southend-on-Sea Borough Council Replacement Waste Local Plan, Capacity Gap Report (2014); and
- Joint Waste Development Plan for the East London Waste Authority Boroughs (2012).

It should be noted that the European Commission (EC) will soon be revising a number of directives to ensure they align with the Circular Economy Package, which aims to be *"closing the loop of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy"*. The directives which will be revised, which may have an measures for consideration in this the M25 Junction 28 scheme, include the EU Waste Framework Directive (2008/98/EC), the EU Landfill Directive (1993/31/EC) (as amended), and the Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU) (as amended).

13.6 Design, mitigation, enhancement and monitoring measures

With regards to the type, quantity, and source of materials to be used and the type, quantity and composition of waste that will be generated, there are a number of different environmental mitigation and enhancement measures to be considered. These measures can be utilised during construction, demolition, and excavation as outlined (at a high level) in Figure 13-2 and detailed below. These options should be implemented to mitigate the potential for significant environmental impact of the materials and waste associated with the proposed M25 Junction 28 scheme, whilst ensuring legal compliance and meeting all applicable targets.

Figure 13-2 Material and Waste Mitigation and Enhancement Measures

Designing out waste

Ideally waste will be designed out throughout all design stages, to ensure materials are either reused (potentially from excavation) or recovered (potentially from demolition). Further to this, Designing out Waste (DoW) will ensure locally sources, recycled and / or recovered materials are used where practicable.

The UK's Waste Resources Action Programme (WRAP) has produced guidelines for design teams under the following headings:

- Re-use and recovery;
- Offsite construction;
- Materials optimisation;
- Waste efficient procurement; and
- Deconstruction and flexibility.

All of these factors should be considered and implemented in the design of the development to improve the sustainability of the project including minimising waste to landfill. It should be noted that the reuse of excavated materials (associated with earthworks) for the M25 Junction 28 scheme will be dependent upon the design of the preferred scheme option and further investigations of the potential for contaminated land in the surrounding area. Such investigations are detailed in the Geology and Soils section

A 'Lite' Site Waste Management Plan (SWMP) should be prepared in order to estimate the waste arisings, the waste composition and the potential for re-use and recovery. Once the design process progresses further, a full SWMP should be prepared based on the detailed design drawings and the latest available BoQ. The full SWMP will set out the further detail related to waste arisings, procedures, and responsibilities for the

management of waste. If applicable, the potential for reuse of the excavated materials should be detailed in a Materials Management Plan (MMP) which should follow the guidance and framework set out in the 'CL:AIRE Definition of Waste: Development Industry Code of Practice' (DoW CoP).

On site management

The contractor on site should work to maximise reuse and recycling, and minimise waste to landfill. The full SWMP should continually be updated and managed, by the contractor, to facilitate such measures. The full SWMP will provide an auditable trail of the actual reuse / recycling figures and document the final destination of waste materials during construction, demolition and excavation.

In addition, the M25 Junction 28 site should be managed so as to avoid unnecessary waste such as excess material brought to site. Best practice waste management on such schemes is inclusive of but not limited to:

- Designing out waste at the initial stage of the project through utilising standardised sizes and materials where possible and engaging with the design team on the importance of this;
- Having a clear understanding of the nature of the excavated material;
- Undertaking robust sampling and characterisation of waste;
- Setting targets for waste recovery and recycling to enable those working on the scheme to have a clear understanding of what is expected;
- Including a full SWMP so that waste generation and management can be logged and audited;
- Using precast concrete and other materials that can be prepared off site to minimise waste generation on site;
- Avoiding ordering excess materials and using materials brought to site as efficiently as possible;
- Organising deliveries so materials arrive on site as they are needed to reduce the possibility of damage and wastage occurring;
- Having clearly defined and separated skips on site as well as a clearly marked waste area;
- Having a good understanding of the waste market (e.g. waste segregation and sale prices);
- Utilisation, where practicable, of on or offsite treatment to re-introduce waste in to the market as a resource; and
- Training staff to understand how they should sort any waste and having regular reminders and updates.

In addition to the reduction of environmental impacts, best practice measures for waste management also contribute to financial benefits for the M25 Junction 28 scheme, through the avoidance of costs associated with landfilling.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

Treatment and disposal

In order to reduce the environmental impacts of the M25 Junction 28 scheme, commitments to achieving a high recycling and recovery rate for all waste generated

should be made. This can be achieved through source segregation of recyclable materials and the provision of appropriate recycling facilities. Achieving a high recycling rate will minimise the environmental burden (such as pollution and energy impacts) associated with the production of products from virgin material.

Across Essex and the East London area, there are number of contractors, waste collection and waste disposal companies. Highways England should select a waste contractor who is local (where available) and is registered with the Environment Agency as a waste carrier for all the appropriate classes of waste to be transported (to be determined during the next design stage). The contractor should be able to undertake daily collections which will be required during peak construction, demolition and excavation activities. The contractor, on behalf of Highways England, should always ensure to complete Waste Transfer Notes or Hazardous Waste Consignments Notes. These should be kept for a minimum of 2 and 3 years respectively.

13.7 Potential effects

At this stage of the design process no information on the use of materials or generation of waste associated with the proposed options is currently available. However, it is assumed that proposed options which cover the greatest area (physical extent) will require the greatest amount of demolition works, have the greatest volume of earthworks (excavation works), and will require the greatest volume of construction materials, thus have the potential to produce more waste.

A summary of the potential effects on each of the proposed options is provided in Table 13-1 below, x denotes that potential effects are likely.

Table 13-1 Materials and Waste Potential Effects

	Option 6	Option 2	Option 4	Option 5A	Option 5B	Option 5C	Option 5D	Option 5E
Potential excess material use / waste generation. If wastes are not reused / recycled where practicable.	x	x	x	x	x	x	x	x
Potential for the disposal of large quantities of excavated materials, if the materials are found to be hazardous and thus not suitable for reuse (for further details see the ‘Geology and Soils’ chapter in Section 5.9).	x	x	x	x	x	x	x	x

	Option 6	Option 2	Option 4	Option 5A	Option 5B	Option 5C	Option 5D	Option 5E
Potential for enhanced quantities of demolition waste airings associated with the demolition of the existing Nags Head Lane Overbridge.		x	x	x				
Increased waste arisings associated with the construction / widening of viaducts.	x		x	x	x		x	
Increased excavation waste arising due to the underpass beneath the railway line / M25.		x	x	x				x
Increased construction waste arisings associated with the construction / extension of bridge(s).	x	x	x	x	x	x	x	x
Increased construction waste arisings associated with the construction of watercourse realignments.				x	x	x		

13.8 Limitations to assessment

No detailed information regarding material types or potential waste generation is available at this stage of design (PCF1). This assessment should be updated once more information is available on these topics and assessed for the preferred option only, as aforementioned in the *'Methodology'* section. Once further information is available, the magnitude of change will only be assessed for waste arisings as no baseline is available for material use, and this is not typically reported for such schemes. It is anticipated that waste arisings, once the scheme is operational, will be negligible as it these will continue to arise from litter and ad hoc maintenance, and as such will not be assessed.

Additionally, as outlined above, some impacts of materials and waste may occur offsite or potentially outside the UK, including the depletion of non-renewable resources, the production of waste at the point of extraction, and transportation of this materials or waste. These stages of the process are likely to have had their own environmental assessments and, as such, will not be included in the scope of this assessment.

14 People and Communities

14.1 Introduction

The assessment will assess the impacts of the proposed scheme options on People and Communities. This will include considering impacts on Motorised Travellers (MT: drivers and passengers of both public and private vehicles), Non-Motorised Users (NMU: pedestrians, cyclists and equestrians), Community Severance, Land Use, and Community Effects. This assessment follows the updated DMRB interim guidance contained within IAN 125/15, combining published guidance in DMRB Volume 11, Section 3, Parts 6 (Land Use), 8 (Pedestrians, Cyclists, Equestrians and Community Effects) and 9 (Vehicle Travellers) into one assessment of People and Communities.

The assessment considers any impacts that the proposed options may have on:

- Effects on All Travellers: Motorised Travellers (MT) (drivers and passengers of both public and private vehicles) and Non- Motorised Users (NMU) (pedestrians, cyclists and equestrians), including amenity and journey length.
- Effects on Communities, including development land, agricultural land, private and community land, community severance.
- The ESR provides a high level assessment of the potential for the proposed options to effect existing travel patterns, journey lengths and community effects within the study area. Road safety has also been considered, together with effects on severance at the local level.

14.2 Assessment methodology

Motorised Travellers: Views from the road

Using the category description in the DMRB views from the road will be assessed according to travellers' ability to see the surrounding landscape on a four point scale: no view, restricted view, intermittent view, open view as described in Table 14.1.

Table 14-1 DMRB Criteria for Views from the Road

View Categories	Description
No view	Road is in a deep cutting or contained by earth bunds, environmental barriers or adjacent structures
Restricted view	Frequent cuttings or structures blocking the view
Intermittent view	Road generally at ground level but with shallow cuttings or barriers at intervals
Open view	View extending over many miles, or only restricted by exiting landscape features

There are no specific assessment 'significance criteria' or 'magnitude of impact' assessment frameworks associated with 'view from the road' set out in DMRB therefore a qualitative assessment using professional judgment and based on the above criteria, is considered appropriate. The assessment will take into account findings from the landscape and visual impact assessment, including the landscape character, quality of the view experience and route type.

Motorised Travellers: Driver Stress

Driver Stress is defined in DMRB as the adverse mental and psychological effects experienced by a driver traversing a road network. Stress can induce in drivers' feelings of discomfort, annoyance, frustration, or fear culminating in physical or emotional tension that detracts from the value and safety of the journey. DMRB indicates that with increased driver stress, a drop in driving standards occurs, which may be expressed as an increase in aggression towards other road users, or a diminished response to visual and other stimuli.

The level of stress experienced by a driver may be affected by a number of factors including; road layout and geometry, surface riding characteristics, junction frequency and speed and flow per lane. There are three main components of driver stress: frustration; fear of potential accidents; and uncertainty relating to the route being followed:

- Driver frustration – Caused by an inability to drive at a speed consistent with the standard of the road, and increases as speed falls in relation to expectations;
- Driver fear – The main factors are the presence of other vehicles, inadequate sight distances and the likelihood of pedestrians, particularly children, steeping into the road. Fear is highest when speeds, flows and the proportion of heavy vehicles are all high, becoming more important in adverse weather conditions; and
- Driver uncertainty – Caused primarily by signing that is inadequate for the individual's purposes.

The measurable aspect of Driver Stress is associated with frustration due to delays. The level of Driver Stress has been determined through a qualitative assessment of the above factors, under a three point descriptive scale, as recommended under DMRB guidance, as Low, Moderate or High.

Non-Motorised Users and Community Severance

The assessment for NMU will be undertaken in accordance with the guidance for a Simple Assessment in the Pedestrians, Cyclists and Equestrians component of DMRB 11.3.8. It will focus on changes in journey lengths and times, the effect on the amenity value of journeys and changes in community severance band. It will consider:

- The impact of the scheme on the journeys that pedestrians, cyclists and equestrians make in its locality;
- The impact on existing usage of the community facilities and routes by pedestrians and others;
- Changes in safety and amenity value of routes which may be affected by the proposed options; and
- The effects of the proposed options on community severance.

The assessment will involve a desk study to identify likely Non-Motorised Users (NMU) activity, as well as how local community facilities are likely to be impacted by the construction and operation of the junction proposed options in both adverse and beneficial senses. No surveys or consultation has been undertaken for this PCF Stage 1 assessment.

The level of new severance will be taken into account using criteria set out by DMRB Volume 11, Section 3, Part 8 which categorises the level of severance as Slight, Moderate or Severe.

Table 14.2 sets out how the magnitude of impact is assessed for impacts on NMU using a three point scale. The magnitude can be both positive (beneficial) or negative (adverse) and also takes into account the permanence and reversibility of the impact. Professional judgement will be used to assign the correct level of impact.

Table 14-2 Magnitude of Impact – Non motorised travellers

Magnitude of Impact	Criteria
Low	In general the current journey pattern is likely to be maintained, but there will probably be some hindrance to movement for limited amount of time. • Pedestrian at-grade crossing of a new road carrying below 8,000 vehicles per day (AADT); or • A new bridge will need to be climbed or subway traversed; or • Journeys will be increased by up to 250m
Medium	Some people, are likely to be dissuaded from making trips. Other trips will be made longer or less attractive. • Two or more of the hindrances set out under 'Low' are applied to single trips; or • Pedestrian at-grade crossing of a new road carrying between 8,000 – 16,000 vehicles per day (AADT); or • Journeys will be increased by 250m – 500m.
High	People are likely to be deterred from making trips to an extent sufficient to induce reorganisation of their habits. Considerable hindrance will be caused to people trying to make their existing journeys for a prolonged period of time. • Pedestrian at-grade crossing of a new road carrying over 16,000 vehicles per day (AADT); or • Journeys will be increased by more than 500m; or • Three or more of the hindrances set out under 'Low' or two or more hindrances set out under 'Medium'

The sensitivity of the NMU and PRoW will be determined by usage as identified in Table 14.3 below.

Table 14-3 Sensitivity value of NMU users

Sensitive Value	Criteria
High	Frequent or continuous use of a resource, no suitable equivalent alternative resources used by the receptor are reasonably available
Medium	Moderate or occasional use of a resource, limited equivalent alternative resources used by the receptor are reasonably available.
Low	Low or infrequent use of a resource, suitable alternative are readily available.
Negligible	Very infrequent use of resource, multiple equivalent or better alternatives are freely and easily available.

The relationship between the sensitivity of the receptor and the magnitude of impact from the proposed Scheme is considered to determine the significance of the effect as described in Section 5 and repeated in Table 14.4. Moderate and major effects are considered significant and minor and negligible effects are not considered significant. Effects can be either adverse or beneficial.

Table 14-4 Significance of Impact Magnitude of Receptors

Significance		Impact Magnitude			
		High Impact	Medium Impact	Low Impact	Negligible Impact
Sensitivity of receptor	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Minor
	Low	Moderate	Minor	Negligible	Negligible

Private Property, Community Land, Agricultural Land & Development Land

The assessment for loss of these land uses and receptors will be undertaken in accordance with the guidance for “Land Use” DMRB Volume 11.3.6. The magnitude of impact is assessed as the amount of land to be taken, using a three point scale of high medium or low. It also takes in account if there is other land in the vicinity that could be used for exchanged land. Professional judgement will be used to assign the correct level of impact. The methodology for assessing NMU and PRoW will be used for assessment of effected land.

Private property consists of the property required to accommodate the proposed options. Private Property is land outside the existing highways boundary that does not accommodate public open space or any other community facility or asset. It can be residential or commercial/ industrial property.

Community land is any area of public open space and other facilities such as schools, hospitals, libraries and recreation facilities relied upon for community health and well-being.

Agricultural land is land devoted the rearing of livestock and production of crops to produce food and products.

Development land is land designated within the development plan for particular development purposes, or for which planning permission has been granted or is pending. The study area for 'development land' consists of the land parcels required to accommodate the proposed options.

14.3 Study area

The study area for road users MT and NMU comprises the roads, connecting roads, Public Rights of Way (PRoW) and footpaths located within 1km of the proposed scheme options.

The study area for ‘community severance’ will be extended to include communities that may potentially be directly affected by the proposed scheme options, for example, through the severance. These would include communities directly connected by the NMU and MT routes.

The study area for ‘private assets’ (including Private Assets, Agricultural Land and Community Assets) will consist of the land parcels required to accommodate the Proposed Scheme.

14.4 Baseline conditions

Motorised Travellers: View from the Road

The existing views from the road are described below:

- The view from the M25, which crosses over the top of the Junction 28 roundabout north west to south east, is screened by vegetation on the east and west on both approaches to the junction. When traveling clockwise on the M25 above the junction far distance views are afforded of the undulating landscape of Essex beyond, comprising agricultural land and wooded areas. The motorway south of the junction drops down to travel underneath the Great Eastern Main line railway bridge. When traveling along the motorway various overhead structures are a prominent feature.
- From the Junction 28 roundabout, which is positioned below the M25 and above the A12, views looking towards the roundabout from the slips roads are of a planted wooded area. General views away from the roundabout are of planted vegetation and trees with intermittent views of agricultural land. The M25 anticlockwise entry slip road has a partial view of a small residential property and scrap yard to the west. A partial view of the adjacent petrol station can be seen from the eastern portion of the roundabout. A partial view of a dwelling house can be seen from the south eastern portion of the roundabout.
- Views from A12 which runs below the Junction 28 roundabout south west to north east are restricted by vegetation to the north and south of the carriageway. When traveling beneath the junction the views are of planted vegetation and elevated earthworks and retaining walls. The views west of the junction along Colchester Road and east of the junction along the Brentwood bypass provide intermittent views of open land either side of the road screened by planted vegetation, trees and woods.
- The A1023 Brook Street east of the Junction 28 roundabout allows for intermittent views either side of the road which include open land, commercial and residential properties. The road is screened by planted vegetation and trees.

In general, the views from the road for MT on the surrounding road network are restricted or intermittent views over the surrounding landscape comprised of a mixture of agricultural, residential and commercial properties, planted vegetation and engineering structures.

Motorised Travellers: Driver Stress

M25 Junction 28 plays a critical role providing access between the M25 and the A12, particularly the A12 towards Essex. Junction 28 has capacity issues as it caters for high levels of demand between the M25 and A12 routes. The north east quadrant of the M25 has high volumes of traffic and often experiences severe congestion, which cause disruption and delays to the surrounding road network when emergency closures and lane closures of the motorway, gyratory and the Dartford Crossing are imposed.

The sections of the M25 in the north east quadrant feature in the top 10 percentile of all UK roads in terms of vehicle hour delay. M25 Junction 28 has limited capacity on the gyratory section due to the high traffic levels and the capacity of the signalised intersections. The M25 Junction 28 is a major national and inter urban regional transport artery and is intrinsically linked to the performance of the surrounding highway network. Junction 28 experiences a high number of accidents and incidents.

While the majority of these accidents are minor, in many cases these result in significant disruption to traffic and unreliable journey times.

Although it is not possible to assess route uncertainty, it is thought due to the level of fear and frustration experienced by MTs as a result of features described previously, the level of Driver Stress experienced is 'High'.

Non-Motorised Users

There are several PRoW which are located adjacent to, or intersect with, sections of the existing road. These will be considered within the assessment.

There are 4 identified Public Rights of Way (PRoW) within 1km radius of Junction 28 all of which are located within the Borough of Brentwood. All are classified as either footpaths or bridleways and are detailed below. Brentwood 2 PRoW 72_186 continues as Foot Path 286 within the London Borough of Havering.

- Brentwood 272_184 - a 450m stretch of bridleway connecting the east side of the M25 bridleway bridge leading south eastwards to meet FP185 then heading northwards along the western boundary of the field to a point west of Top Plantation at Dark Lane.
- Brentwood 272_186 - a 400m stretch of bridleway which is continuation of the bridleway in Havering leading northwards along the eastern side of a field, adjacent to the M25. At the north eastern corner of the field it turns south westwards along Nags Head Lane to the Havering boundary.
- Brentwood 272_173 - a 70m stretch of footpath which connects the A1023 Brook Street north west to Tern Way.
- Brentwood 272_18 - a 170m stretch of footpath which connects Wingrave Crescent north west towards the trees along the A12 then south west, south of the A12 ending at Wigley Bush Lane.

There are also several footpaths and cycleways within proximity to the proposed options.

The proposed scheme options have the potential to temporarily or permanently affect the users of the existing M25 Junction 28 pedestrian footpath and cycleway which crosses both the south eastern slip roads at grade via level crossings. The footpath provides access from A1023 Brook Street in the east to the A12 Colchester Road in the west. A separate pedestrian footpath exists on the east bound carriageway of the A12 Colchester Road following the slip road up to the junction and stopping at the access road to Grove Farm.

Pavements are also contained on the A1023 Brook Street east and west bound carriageway, the east side of Wigley Bush Lane, on both sides of Weald Park Way, a footpath which alternates sides follows Nags Head lane and a pedestrian footbridge crosses the A12 at Spital Lane.

There are roads which are considered in this assessment to be suitable for use by cyclists. There are currently short sections of pavements or dedicated cycle ways present which would encourage this use such as at Junction 28 along Brook Street-Colchester Road and Spital Lane footbridge which continues along Brook Road.

The existing M25, A12, A1023 and the surrounding road network affect NMU's enjoyment of existing PRoW. The motorway, dual carriageway and junction reduces the sense of isolation created when travelling in the rural areas. In addition, these PRoWs will be affected by traffic noise and the visual intrusion of the road network.

The footpaths and PRoW considered in this assessment serve as both recreational routes and for travelling between the surrounding villages to access services or facilities.

Community Severance

Several of the existing footpaths and PRoWs which cross the area of land to be used by the proposed scheme options provide a pedestrian link between the Brook Street area of Brentwood and Harold Park and neighbouring areas via a footway round the edge of the gyratory which can act as a deterrent to pedestrian movement and increase severance.

There is a cluster of community facilities and services located along Brook Street including a post office, public houses, a parish hall, and leisure and retail provision. In Harold Park a golf course is located to the north of Colchester Road. Community Land, facilities and services are identified later in this chapter.

In addition to recreational use of the footpaths, these may be used by residents utilising the services provided by these community facilities.

Agricultural Land

The agricultural area surrounding Junction 28 is identified on Defra's Agricultural Land Classification maps as Grade 3. The ALC maps, upon which the assessment is based, were created from surveys undertaken by DEFRA between 1989 and 1999, and have been treated with some caution in the absence of detailed site investigation survey results. It is considered likely that a proportion of this land will be Best and Most Versatile (BMV) Agricultural Land. From an aerial inspection, it appears that this land is largely comprised of arable fields.

Residential Properties and Private Land

There are private properties which are located close to the proposed scheme options:

- To the east of the Junction 28 roundabout are commercial properties including a petrol station and restaurant forming a small roadside service area accessed off the A1023 Brook Street. There are two dwellings at either end of the roadside service area.
- To the northwest of the Junction 28 roundabout is Grove Farm comprising a dwelling and farm buildings including a small scrap and storage yard which is accessed via the M25 anticlockwise slip road and the east bound slip road off the A12 entering to the roundabout.
- To the south east of Junction 28 roundabout is a dwelling The Poplars and farm buildings.
- To the south west of Junction 28 roundabout are farm buildings.
- Maylands private property south of the A12 Colchester Road between the Junction 28 junction and Harold Park.
- Residential property either side of the M25 along Nags Head Lane.
- Brentwood Garden Centre north of Brook Street.
- Commercial centre (Petrol Station, Restaurant and Hotel) junction of Brook Street, Wigley Bush Lane and Nags Head Lane.
- Large residential area between Brook Street and the A12 Brentwood Bypass.

- Collection of residential properties along Weald Park Way close to the A12 Brentwood Bypass.
- French's Farm located on Wigley Bush Lane close to the A12 Brentwood Bypass.
- Network Rail owned railway line and bridge over the M25.
- Nags Head Lane Sewage works to west of the M25 south of the railway line.
- The proposed development is located within and surrounded by privately owned agricultural land.

The proposed scheme options are surrounded by a mixture of privately owned uses including agricultural land, residential, and commercial land.

Community Land

There is a formal open space and playground (River Street) within the 1km search area. In River Street there is the River Street allotments. None of these community land areas are located within the land required for the proposed scheme options. There are no areas designated as Open Access Land under the Countryside and Rights of Way Act (2000).

As identified under community severance there is a cluster of community facilities and services which might be public or private located along Brook Street between Junction 28 and Brook Road including a post office, public house's (The Nags Head, The Bull and The Golden Fleece) and a parish hall (South Weald). A small roadside service area is located close to the Junction 28 roundabout located off Brook Street which also contains a garden centre (Brentwood Garden Centre) hotel and spa (Holliday Inn Brentwood). A golf course (Maylands Golf Club) is located to the north of Colchester Road in Harold Park.

Development Land

The Draft Brentwood Site Allocation Maps (2016) identifies areas for future development. Site 022 has been identified for 250 units across 10.9 ha and Site 032 has been identified for 150 housing units on 5.8ha land. The Havering Development Plan (2007) identifies the Nags Head Lane Sewage Works as a major developed site in the Green Belt. Both authorities (Brentwood and Havering) highlight land safeguarded for Crossrail along the Great Eastern Mainline in their respective adopted Local Plans.

The key receptors identified in the baseline study are shown on Figure 14.1 in Appendix K.

14.5 Regulatory/Policy Framework

National Policy

The National Planning Policy Framework (NPPF) sets out the Government's planning policies and how these are expected to be applied. NPPF identifies a set of 12 core land-use planning principles that it is stated should underpin both plan-making and decision-taking. It states that planning should proactively drive and support sustainable economic development to deliver, amongst other things, infrastructure that the country needs.

A relevant principle in the NPPF to this chapter, emphasises the need to manage patterns of growth by making the fullest possible use of sustainable transport modes including public transport, walking and cycling. Chapter 4 of the NPPF sets out how

transport should be considered within the context of planning decisions and sustainable development. The policy encourages solutions that seek to reduce congestion, greenhouse gas emissions and serve to facilitate the use of sustainable transport. Furthermore, local planning authorities (LPAs) are required to identify and protect, where there is robust evidence, sites and routes which could be critical in developing infrastructure to widen transport choice.

Chapter 8 'Promoting Healthy Communities' describes how access to high quality open spaces and opportunities for sport and recreation can make an important contribution to the health and wellbeing of communities. Paragraph 75 states policies should protect and enhance public rights of way (PRoW) and access. Local authorities should seek opportunities to provide better facilities for users, for example by adding links to existing rights of way networks including National Trails.

Countryside and Rights of Way Act 2008

The Countryside and Rights of Way Act 2008 (CRoW) regulates all Public Rights of Way (PRoW) and ensures access to them. It requires local highway authorities to publish a Rights of Way Improvement Plan (RoWIP), which should be reviewed every 10 years. The Act also obliges the highway authority to recognise the needs of the mobility impaired when undertaking improvements.

There is guidance within the Essex Rights of Way Improvement Plan (2009) which sets out how PRoW meet the present and likely needs of the public; the opportunities provided by local rights of way for exercise and other forms of recreation and enjoyment; and the accessibility of local rights of way to blind or partially sighted person and others with mobility issues.

Local Policy

Local policy which has indirect relevance for people, community use and enjoyment are set within Essex County Councils Development and Public Rights of Way (2013) and Local Transport Plan (2011) Policy 15 'Walking and Public Rights of Way'. The Brentwood Replacement Local Plan (2005) policy 8 Sport & Leisure, Tourism and Community Services makes reference to the PRoW network and the interest of cyclists. In the London Borough of Havering policy D22 'Countryside Recreation' of the Core Strategy (2009) promotes informal recreation in the countryside.

14.6 Design, mitigation, enhancement and monitoring measures

There are opportunities to introduce mitigation and enhancement measures into the scheme design, and the management of the scheme. The preferred design option should be designed with future development and housing requirements in mind. The use of best practice construction methods will reduce disruption to users of residential and community receptors within the vicinity of the proposed highways scheme.

The assessment deals with potential outline scheme options without associated environmental design measures. Therefore generic design or mitigation measures that have the potential to be incorporated within the Scheme have been identified. The assessment takes into consideration the potential for reduction of adverse effects through the introduction of environmental design or mitigation measures.

Potential mitigation measures that could be applied to the considered schemes are below:

- The preferred option should where possible either retain or improve the existing access arrangements. Existing footpaths and PRoWs should be

retained and where crossed by the route, provided with proper means of access to prevent severance;

- Clear signage should be positioned to show temporary diversion routes for the effected Motorised Travelers, PRoWs, footpaths & cycleways;
- Users of the effected PRoWs, footpaths & cycleways which are to be effected would be notified of planned diversion with signs along the sections to be closed during construction at least one month prior to the works;
- Construction works will need to be programmed so that affected PRoW, footpaths or cycleways remain open for part or duration of the construction works, and also that other routes can act as a diversion route for those effected;
- The View from the Road for Motorised Travelers where possible should not be further obstructed, and open views of the surrounding countryside should be retained;
- Where possible landscaping that can provide screening and reduce noise levels of the chosen option, and which will also improve amenity for users for non-motorised, residential and community receptors;
- It may be necessary for key stakeholders, including local walking, riding and cycling groups, to be consulted on the effect of the route options on existing NMU routes;
- Take on board the environmental design mitigation from the other topics, notably Landscapes, Air Quality and Noise and Vibration which are linked it this topic;
- Consultation with the public and stakeholders to discuss the proposals and proposed mitigation;
- Consultation with the local authorities (Essex, Brentwood and Havering) to agree diversion routes and the proposed mitigation; and
- Appropriate local media campaign to notify people of the works and update them on construction. This could result in a reduction in Driver Stress associated with delays during construction for Motorised Travellers.

In terms of monitoring measures, future monitoring requirements will be set out, and their nature will depend on the outcome further detailed survey work.

14.7 Potential Effects

Option 6

Effects on All Travellers – driver stress, views from the road, NMUs

Option 6, the southern link, is likely to have a negative impact on views from the road due to the proposed option being a single viaduct raised above the existing road network. Any removal of vegetation required by the option will have the potential to further impact views.

Driver stress is expected to be temporarily adversely impacted by the construction works, however is expected to reduce during operation through increased traffic flows and a more efficient road network reducing driver frustration.

NMU amenity may be temporarily adversely affected by construction works associated with the option through disruptions of PRoWs routes and roadside paths and cycle

ways. It is expected that during operation NMU amenity overall is likely to be negligible adverse due to the extended footbridge at Spital Lane and the viaduct crossing or adjacent to existing NMU routes.

During construction there is the potential for local journey length to increase as a result of construction work and subsequent traffic and NMU delays. Especially users of Nags Head Lane and Weald Park Way which are indicated to be significantly altered. During operation improved access is expected to decrease journey time and make them more reliable for local people and users of the Strategic Road SRN through increased traffic flows and reduced congestion.

Effects on Communities – community severance, community land, agricultural land, development land

As with amenity, it is likely most PRoWs & footpaths will be impacted and there will be community severance during construction. These impacts will be investigated further in subsequent design stages.

The option is likely to have an adverse effect during construction and operation on residential receptors identified especially around Nags Head Lane. It is also likely the Brentwood Garden Centre, private land at Poplar Farm and agricultural land will be adversely impacted by Option 1 through direct land take, resulting in permanent loss of this asset.

Option 2

Effects on All Travellers – driver stress, views from the road, NMUs

Option 2, the northern hook, is likely to have a negative impact on views from the roads due to the proposed option including bridges and embankments. Any removal of vegetation required by the option will have the potential to further impact views.

Driver stress is expected to be temporarily adversely impacted by the construction works, however is expected to reduce during operation through increased traffic flows and a more efficient road network reducing driver frustration.

NMU amenity may be temporarily adversely affected by construction works associated with the option through disruptions of PRoWs routes and roadside paths and cycle ways. It is expected that during operation NMU amenity overall is likely to be negligible adverse due to the extended bridges at Spital Lane and Wigley Bush Lane and the new hook route crossing over or adjacent to existing NMU routes.

During construction there is the potential for local journey length to increase as a result of construction work and subsequent traffic and NMU delays. Especially users of Nags Head Lane and Weald Park Way which are indicated to be significantly altered. During operation improved access is expected to decrease journey time and make them more reliable for local people and users of the SRN through increased traffic flows and reduced congestion.

Effects on Communities – community severance, community land, agricultural land, development land

As with amenity, it is likely most PRoWs & footpaths will be impacted and there will be community severance during construction. These impacts will be investigated further in subsequent design stages. NMU users along Nags Head Lane and Wigley Bush Lane are expected to marginally increase journey length due to minor altered new routes.

The option is likely to have an adverse effect during construction and operation on residential receptors identified especially around Nags Head Lane. It is expected that

private land at Grove Farm and agricultural land will be adversely impacted by Option 2 through direct land take, resulting in a permanent loss

Option 4

Effects on All Travellers – driver stress, views from the road, NMUs

Option 4, the compact hook, is likely to have a negative impact on views from the roads due to the proposed option including bridges and embankments however, this is expected to be less than option 2. Any removal of vegetation required by the option will have the potential to further impact views.

Driver stress is expected to be temporarily adversely impacted by the construction works, however is expected to reduce during operation through increased traffic flows and a more efficient road network reducing driver frustration.

NMU amenity may be temporarily adversely affected by construction works associated with the option through disruptions of PRoWs routes and roadside paths and cycle ways. It is expected that during operation NMU amenity overall is likely to be negligible adverse due to the extended bridges at Spital Lane and Wigley Bush Lane and the new compact hook route crossing over and under or adjacent to existing NMU routes.

During construction there is the potential for local journey length to increase as a result of construction work and subsequent traffic and NMU delays. Especially users of Nags Head Lane and Weald Park Way which are indicated to be significantly altered. During operation improved access is expected to decrease journey time and make them more reliable for local people and users of the SRN through increased traffic flows and reduced congestion.

Effects on Communities – community severance, community land, agricultural land, development land

As with amenity, it is likely most PRoWs & footpaths will be impacted and there will be some community severance during construction. These impacts will be investigated further in subsequent design stages. NMU users along Spital Lane and Nags Head Lane are expected to marginally increase journey length due to minor altered new routes.

The option is likely to have an adverse effect during construction and operation on residential receptors identified especially around Nags Head Lane. It is expected that private land at Grove Farm and agricultural land will be impacted by Option 3 however, this third party land take will be less than option 2.

Option 5A, 5B and 5C

Effects on All Travellers – driver stress, views from the road, NMUs

Options 5A, 5B and 5C are variants on a loop to the north west of Junction 28. These options are likely to have a negative impact on views from the roads due to the proposed option including bridges and embankments, of which sub option 5A will be the greatest of the three sub options however, this is expected to be less than option 6, 2 and 4. Any removal of vegetation required by the option will have the potential to further impact views.

Driver stress is expected to be temporarily adversely impacted by the construction works, however is expected to reduce during operation through increased traffic flows and a more efficient road network reducing driver frustration.

NMU amenity may be temporarily adversely affected by construction works associated with the option through disruptions of PRoWs routes and roadside paths and cycle ways. However, due to the extended bridges at Spital Lane and Wigley Bush Lane,

during operation this option is likely to have a negligible effect on NMU amenity overall. It is likely slightly less PRoWs & footpaths will be disrupted under sub option 4.1 than the other previous options with this effecting even less for sub options 5B and 5C and 4.3 however, it is not known whether any will be temporarily or permanently lost.

During construction there is the potential for local journey length to increase as a result of construction work and subsequent traffic and NMU delays. Especially users of Nags Head Lane which are indicated to be significantly altered under sub option 5A only. The effects on NMU for sub options 5B and 5C are to be less than all the previous options however, they have the potentially to all effect access to Grove Farm. During operation improved access is expected to decrease journey time and make them more reliable for local people and users of the SRN through increased traffic flows and reduced congestion.

Effects on Communities – community severance, community land, agricultural land, development land

As with amenity, it is likely most PRoWs & footpaths will be impacted and there will be some community severance during construction. The sub options are likely to have adverse effects on access to Grove Farm. These impacts will be investigated further in subsequent design stages. Under sub option 5A NMU users along Nags Head Lane are expected to marginally increase journey length due to minor altered new routes.

The option is likely to have an adverse effect during construction and operation on residential receptors identified especially around Nags Head Lane for sub option 4.1 and Grove Farm under sub options 5A, 5B and 5C.It is expected that private land at Grove Farm and agricultural land will be adversely impacted by the sub options reducing in scale from 5A to 5C however, this land take will be less than the previous options.

Option 5D & 5E

Effects on All Travellers – driver stress, views from the road, NMUs

Option 5D and 5E are variants on a loop to the north of Junction 28. These options are likely to have a negative impact on views from the roads due to the proposed option including bridges/ tunnel and embankments. Any removal of vegetation required by the option will have the potential to further impact views.

Driver stress is expected to be temporarily adversely impacted by the construction works, however is expected to reduce during operation through increased traffic flows and a more efficient road network reducing driver frustration.

NMU amenity may be temporarily adversely affected by construction works associated with the option through disruptions of PRoWs routes and roadside paths and cycle ways However, due to the extended bridges at Wigley Bush Lane, during operation this option is likely to have a negligible effect on NMU amenity overall. It is likely only footpath users of Widgley Bush Lane footpath will be disrupted under these sub options however, it is not known whether any will be temporarily or permanently lost.

During construction there is the potential for local journey length to increase as a result of construction work and subsequent traffic and NMU delays. Especially users of Nags Head Lane which are indicated to be significantly altered. During operation improved access is expected to decrease journey time and make them more reliable for local people and users of the Strategic Road Network through increased traffic flows and reduced congestion.

Effects on Communities – community severance, community land, agricultural land, development land

As with amenity, it is likely most PRoWs & footpaths will be impacted and there will be some community severance during construction. The sub options are likely to have direct adverse effects on access to Grove Farm. These impacts will be investigated further in subsequent design stages.

The option is likely to have an adverse effect during construction and operation on residential receptors identified especially around Wigley Bush Lane for both sub options. It is expected that private land including agricultural land will be impacted by the sub options however, this land take will be less than the first three options.

Appendix K provides assessment tables on the effects on all travellers and effects on communities and their sub topics during construction and operation.

Motorised Users Views from the Road

The effects of Views from the Road on Motorised Users for the proposed options based on the methodology set in section 14.2 during construction and operation are detailed in Table 14-5 & Table 14-6.

Table 14-5 Construction Phase Motorised Users Views from the Road

Option	Motorised Travellers: View from the Road
6	• Weald Park Way (No View): Unknown, affected section of road is assumed to be closed during construction and route changed. • Widgley Bush Lane (No view): visual horizontal intrusion of construction works to construct viaduct. • A12 (Restricted View): visual horizontal intrusion of construction works to construct viaduct & linear view along hardshoulder of construction works for new lane and earthworks. • A1023 Brook Street (Restricted View): visual horizontal intrusion of construction works to construct viaduct • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct viaduct & linear view along hardshoulder of construction works for new lane and earthworks. • Nags Head Lane (Restricted View): visual horizontal intrusion of construction works to construct viaduct & linear view along to the south of construction works for new lane and earthworks.
2	• Weald Park Way (No View): Unknown, affected section of road is assumed to be closed during construction and route changed. • Widgley Bush Lane (No view): visual horizontal intrusion of construction works to construct bridge & works for new lane and earthworks. • A12 (Restricted View): visual horizontal intrusion for bridge and earthwork construction & linear view along hardshoulder of construction works for new lane and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridges & linear view along hardshoulder of construction works for new lane and various earthworks. • Nags Head Lane (Restricted View): visual horizontal intrusion of construction works to construct underpass and bridge & linear view along to the south of construction works for new lane and earthworks.
4	• Weald Park Way (No View): Unknown, affected section of road is assumed to be closed during construction and route changed.

Option	Motorised Travellers: View from the Road
	• Widgley Bush Lane (No view): visual horizontal intrusion of construction works to construct bridge & works for new lane and earthworks. • A12 (Restricted View): visual horizontal intrusion for bridge, viaduct and earthwork construction & linear view along hardshoulder of construction works for new lane and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridge and viaduct & linear view along hardshoulder of construction works for new lane and various earthworks. • Nags Head Lane (Restricted View): visual horizontal intrusion of construction works to construct underpass and bridge & linear view along to the south of construction works for new lane and earthworks.
5A	• A12 (Restricted View): visual horizontal intrusion for bridge, viaduct and earthwork construction & linear view along hardshoulder of construction works for new lanes, bridge, viaduct and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridge and viaduct & linear view along hardshoulder of construction works for new lane and various earthworks. • Nags Head Lane (Restricted View): visual horizontal intrusion of construction works to construct underpass and bridge & linear view along to the south of construction works for new lane and earthworks.
5B	• A12 (Restricted View): visual horizontal intrusion for bridge, viaduct and earthwork construction & linear view along hardshoulder of construction works for new lanes, bridge, viaduct and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridge and viaduct & linear view along hardshoulder of construction works for new lane and various earthworks.
5C	• A12 (Restricted View): visual horizontal intrusion for bridge and earthwork construction & linear view along hardshoulder of construction works for new lanes, bridge and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridge & linear view along hardshoulder of construction works for new lane and various earthworks.
5D	• Widgley Bush Lane (No view): visual horizontal intrusion of construction works to construct bridge & works for new lane and earthworks. • A12 (Restricted View): visual horizontal intrusion for bridge and earthwork construction & linear view along hardshoulder of construction works for new lanes, bridge and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridges & linear view along hardshoulder of construction works for new lanes, bridges and various earthworks.
5E	• Widgley Bush Lane (No view): visual horizontal intrusion of construction works to construct bridge & works for new lane and earthworks. • A12 (Restricted View): visual horizontal intrusion for bridge and earthwork construction & linear view along hardshoulder of construction works for new lanes, bridge and earthworks. • M25 (Restricted & Intermittent View): visual horizontal intrusion of construction works to construct bridge, tunnel and slips & linear view

Option	Motorised Travellers: View from the Road
	along hardshoulder of construction works for new lanes, bridge, tunnel and various earthworks.

Table 14-6 Operational Phase Motorised Users Views from the Road

Option	Motorised Travellers: View from the Road
6	• Weald Park Way: No View change unknown, new road. • Widgley Bush Lane: No view with a new visual horizontal intrusion of a viaduct. • A12: Restricted View with a new visual horizontal intrusion of a viaduct and new lane. • A1023 Brook Street: Restricted View with a new visual horizontal intrusion of a viaduct. • M25: Restricted & Intermittent View with a new visual horizontal intrusion of a viaduct and new lane. • Nags Head Lane: Restricted View with a new visual horizontal intrusion of a viaduct.
2	• Weald Park Way: No View change unknown, new road. • Widgley Bush Lane: No view with a new visual horizontal intrusion of a viaduct. • A12: Restricted View with a new visual horizontal intrusion for bridge and lane & linear view for new lane. • M25: Restricted & Intermittent View with new visual horizontal intrusion of bridges & linear view of new lane. • Nags Head Lane: Restricted View: Altered view and route, change unknown.
4	• Weald Park Way: No View change unknown, new road. • Widgley Bush Lane: No view with a new visual horizontal intrusion of a viaduct. • A12: Restricted View with a new visual horizontal intrusion for viaduct and bridge & linear view for new lane. • M25: Restricted & Intermittent View with new visual horizontal intrusion of bridge and viaduct & linear view of new lane, slip and viaduct. • Nags Head Lane: Restricted View: Altered view and route, change unknown.
5A	• A12: Restricted View with a new visual horizontal intrusion for viaduct & linear view for new slip lane and bridge. • M25: Restricted & Intermittent View with new visual horizontal intrusion of bridge and viaduct & linear view of new lane, slip and viaduct. • Nags Head Lane: Restricted View: Altered view and route, change unknown.
5B	• A12: Restricted View with a new visual horizontal intrusion for a viaduct & linear view for new slip lane and bridge. • M25: Restricted & Intermittent View with new visual horizontal intrusion of a viaduct & linear view of slip and viaduct.
5C	• A12: Restricted View with a new linear view for new slip lane and bridge. • M25: Restricted & Intermittent View with new visual horizontal intrusion of a bridge & linear view of slip and bridge.
5D	• Widgley Bush Lane: No view with a new linear view of a lane. • A12: Restricted View new linear view of a new lane. • M25: Restricted & Intermittent View with new visual horizontal intrusion of a bridge & linear view of new lanes.

Option	Motorised Travellers: View from the Road
5E	• Widgley Bush Lane: No view with a new linear view of a lane. • A12: Restricted View new linear view of a new lane. • M25: Restricted & Intermittent View with new visual horizontal intrusion of a bridge & linear view of new tunnel and lanes.

14.8 Limitations to assessment

The assessment is based on professional judgement and takes into account both the adverse and beneficial contribution that proposed development can have upon the existing and surrounding receptors. The report provides broad, high level indication of effects, reporting on the potential effects to people and community based on simple assessment. No site visit has been undertaken and the findings are based upon a desk based study of the area using professional judgement and consultants knowledge based on previous similar schemes. Information were relevant has been used from other specialist topic inputs in helping asses the magnitude of the proposed scheme on receptors. At this stage, where options are explored there is no detailed information available on the construction and therefore the assessment is based on assumptions.

15 Cumulative effects

15.1 Introduction

In accordance with legislation the DMRB Volume 11, Section 2 Part 5: Assessment and Management of Environmental Effects (HA205/08) requires that Cumulative Effects are assessed as part of the assessment process.

Cumulative effects "result from multiple actions on receptors and resources and over time and are generally additive or interactive (synergistic) in nature. Cumulative impacts can also be considered as impacts resulting from incremental changes caused by other past, present or reasonably foreseeable actions together with the project" (Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interaction, European Commission, May 1999) . Cumulative effects are broadly effects that result from the accumulation of a number of individual effects that may also have synergistic aspects.

15.2 Baseline

In order to carry out the assessment it is necessary to define the location and timing of nearby potential developments. In effect, the 'study area' will encompass all schemes which are 'committed' including (but not necessarily limited to):

- Trunk Road projects which have been confirmed (i.e. gone through the statutory processes) close to the M25 Junction 28 Improvements.
- Development projects with valid planning permissions as granted by the Local Planning Authority, and for which statutory EIA is a requirement or a non-statutory EIA has been undertaken.

Although the assessment will primarily include developments that are likely to occur and have some form of planning/land use approval, speculative developments will also be mentioned, specifically when their approval is fairly certain and if they are likely to have significant impacts.

15.3 Potential effects

The DMRB identifies two types of cumulative impact in environmental assessment:

- Cumulative effects from a single scheme (acknowledging the outcomes of each of the environmental topics assessed for the M25 Junction 28 Improvements) or intra-project effects.
- Cumulative effects from different schemes (assessed in combination with the scheme in question) or inter-project effects.

The main source of data for the cumulative effects assessment will be the outcomes and information obtained from the individual environmental topic assessments. The assessment of cumulative effects arising from the proposed scheme options in combination with other schemes will primarily constitute a desk-top study of planning documents broadly covering the location of schemes (if any are identified) considered relevant to the assessment.

The planned infrastructure schemes which are considered to have the potential for cumulative effects together with this scheme are outlined in Table 15.1 and are taken from Brentwood and Havering Local Plans.

Table 15.1 Planned infrastructure schemes for consideration of cumulative effects

Proposal	Council area	Documentation
Crossrail	Brentwood and Havering	Brentwood Replacement Local Plan 2005 Brentwood Draft Local Plan 2016 Havering Core Strategy and Development Control Policies DPD 2008
022 Land At Honeypot Lane Brentwood (South of A12 on east side of M25) The proposal is for 250 residential units	Brentwood	Request for Screening Option - Environmental Impact Assessment http://publicaccess.brentwood.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyVal=O68KJEDJ03100 Supporting Document: Site Allocation Maps 2016
032 Housing development Proposal for 150 residential units	Brentwood	Brentwood Draft Local Plan 2016 Supporting Document: Site Allocation Maps 2016
Site DC46 Nags Head Lane Sewage Works (West of site)	Havering	Havering Core Strategy and Development Control Policies DPD 2008

Cumulative effects associated with noise, air quality and traffic are likely to increase due to Brentwood Borough Council and London Borough of Havering planned housing schemes. The growing housing requirements are likely to result in more cars using the local transport network and increased pressure on the local transport infrastructure.

15.4 Indication of any difficulties encountered

This assessment does not feature a full assessment of the cumulative impacts from different projects together with the scheme being assessed, as described in DMRB 11.2.5 (HD 205/08) and Part 6 (HD 48/08). However, the main expected cumulative impacts from different projects with the M25 Junction 28 are considered likely to be from changes to the flows of traffic, and the associated environmental impacts on noise and air quality. The traffic modelling which would enable such an assessment is not available at this stage, and therefore the assessment of these effects will be undertaken at a later stage and will be supported by the Transport Assessment.

16 Outline Environmental Management Plan

16.1 Introduction

The use of Environmental Management Plans (EMPs) to manage the environmental effects of development is widely considered as best practice for major infrastructure projects by statutory, non-statutory and major companies alike. Use of EMPs conform to best practice guidance from BS EN ISO 14001 (BSI, 1996, as amended) and is guided for Highways England schemes by the Interim Advice Note (IAN) 'Environmental Management Plans' (183/14).

Preparation and implementation of EMPs permits the demonstration of compliance with environmental legislation. They also provide a mechanism by which designers can integrate best practice and sustainability elements into scheme concept and design, whilst contractors can show effective management of good working practices.

The need for environmental management planning extends throughout the whole project cycle, commencing at the early design stage. Obviously there needs to be a certain degree of information available before main design decisions can be made. This restriction is recognised in IAN 183/14, which indicates that initially, during PCF Stages 0-2, there is only need for high level consideration of Client Scheme Requirements, as the level of detail available is insufficient for effective EMP development.

An Outline EMP is required for PCF Stages 3 and 4, leading on to a Construction Environment Management Plan (CEMP) for PCF Stage 5, ultimately evolving into a Handover EMP (HEMP which is the main mechanism for passing essential environmental information to the client and, crucially, to the body responsible for the future maintenance and operation of the asset.

16.2 Client Scheme Requirements (Environment)

For the purpose of the Scheme, the primary Client Scheme Requirement for environmental issues is 'minimise the detrimental environmental effects of the scheme and offset with mitigation measures where technically feasible and economic to do so, taking into account of costs, availability of funding and statutory obligations'.

With this requirement in mind, measure have already been considered to mitigate and minimise the potential environmental implications of both the Online and Offline options. This includes minimisation of land and property take, integration of Offline embankment design to address noise and landscaping mitigation measures and use of possible drainage management to facilitate biodiversity mitigation.

As the Scheme is still in the stage of option identification, it is too early to provide anything more than these preliminary references to environmental management measures. Nevertheless, all environmental factors are being fully evaluated during this assessment and as such, an outline is provided of the way in which it is envisaged that the environmental management plan should be developed for the Scheme.

16.3 Outline of EMP Requirements

One of the prime purposes of an EMP is to help identify potential environmental risks and to provide a mechanism for recording such possibilities and identifying ways in which to manage, control and/or obviate those risks. The EMP must then provide the framework to demonstrate delivery of the environmental responsibilities for

implementing the management of potential adverse effects. Typically a listing of environmental aspects and impact is used to note potential impacts, feeding into the main EMP structure. This is identified in IAN 183/14 as a Register of Environmental Actions and Commitments (REAC), which is critical to the success of the EMP and subsequently, the environmental performance of the project.

The EMP must also demonstrate compliance with relevant environmental legislation, government objectives and scheme specific environmental objectives. It is also important that all relevant consents from regulatory authorities such as Sefton Council, Natural England and the Environment Agency are implemented, managed and updated, where necessary.

In order to demonstrate that all such measures are being taken and followed, the EMP needs to provide a mechanism for monitoring, reviewing, updating and auditing environmental performance and compliance.

The IAN (183/14) acknowledges that it would be too onerous to prepare the EMP at this early stage of option identification, as there are still several options under consideration and insufficient information to be able to develop a clear, robust listing of scheme specific issues to be considered. Therefore a detailed outline of the structure of the EMP will be required at PCF Stage 3, during the preparation of the preferred option.

The indicative elements of the outline EMP are given below:

- Introduction and background: giving a brief summary of the project, any relevant strategy or programme context and the purpose of the EMP;
- Environmental risk assessments: detailing the environmental risks associated with all activities on the project, the mitigation measures to remove or reduce the risks and assigned responsibilities for the risks;
- Description of proposed design and proposed management of that design identifying individuals responsible;
- Environmental Actions and Commitments Register (REAC): to provide a record of the project specific environmental actions and commitment to be implemented and managed thorough all stages of the project.

The Highways England IAN 183/14 provides more detail of the indicative contents of the Construction Environmental Management Plan, which is not required until PCF Stage 5, but which should be borne in mind during the preparation of the Outline EMP at PCF Stages 3 and 4.

Table 16.1 provides a summary of the environmental mitigation and management measures that will be required, based on the current level of understanding of the impacts of the overall scheme. At this stage generic measures are provided that are likely to be required for all of the design options currently being proposed. The specific detail of mitigation required will need to be revisited once an option has been selected and the impacts can be better understood.

Table 16.1 Outline Environmental Management Plan

Topic	Sensitive Receptors	Potential Impact	Management Measures	Time Frame
Air Quality	Sensitive receptors such as residential properties, schools, nurseries, hospitals, or ecological receptors located within 200 m of the scheme or any road affected by a change in traffic.	Annoyance caused by dust deposition during construction. Adverse effect on human health and ecological receptors from additional traffic emissions during construction.	Best practice measures in a CEMP Traffic Management Plan	Prior to construction
Cultural Heritage	Unknown buried remains	Physical disturbance caused during the excavation of new roads, service trenches, topsoil stripping, landscaping features and drainage ponds	Archaeological Investigations to establish nature, extent and survival of any previously unrecorded buried archaeological remains	As part of an update to the ESR Archaeological investigations during construction phase if necessary
	Heritage Assets including Scheduled Monuments, Listed Buildings, Registered Park and Garden, Conservation Area, and non-designated heritage assets	Impact on historic setting Direct impact on historic landscape elements due to removal	High quality design Undertake Setting Assessment if required	Prior to submission for approval
Landscape	Sensitive landscape receptors include: Existing mature trees, belts of trees, woodland blocks, network of hedgerows and Ancient Woodland as well as the existing landscape pattern and land use. Sensitive visual receptors:	Landscape: Potential loss of vegetation, and transformation of landscape pattern and land use. Deterioration of Visual amenity due to alteration of the view both through introduction new elements of the scheme and loss of existing landscape elements in the view.	Preparation of a Landscape and Environment masterplan. At design stage a tree survey should be carried out to inform arboriculture constraints accompanied by tree constraints plans. As design is more defied an Arboriculture Method Statement accompanied by tree retention plans should be produced to inform tree protection measures.	Design stage

Topic	Sensitive Receptors	Potential Impact	Management Measures	Time Frame
	Users of ProW's and Tylers's Common within the study area with views of the scheme. Residential properties within the study area that have views towards the Scheme.		During construction all existing tree, scrub, shrub and hedgerow planting within the highway estate would be retained wherever possible and protected in accordance with BS5837:2012. Loss of tree, scrub and shrub cover should be substituted elsewhere within the highway boundary in the vicinity of the scheme. Construction working methods around tree roots should take account of arboricultural advice for the protection of all retained trees.	Construction stage
Ecology and Nature Conservation	Designated Sites (SINC and LWS)	Direct loss, damage or disturbance. Potential pollution of ground or watercourses	Avoidance during option selection, design of structures, layouts, management plan and aftercare plan. Protection of habitats outside the working area from accidental incursion. Pollution prevention mitigation following EA guidelines.	As part of an update to the ESR
	Valued habitats including ancient woodland	Temporary disturbance or permanent loss of these habitats	Avoidance during option selection, design of structures, layouts, management plan and aftercare plan. Protection of habitats outside the working area from accidental incursion. Protection of retained trees following standard practice.	As part of an update to the ESR
	Notable and protected species	Loss of habitat, disturbance and direct harm	Undertake species surveys to determine presence and species status. Use of mitigation measures under licence if habitats or features afforded legal protection due to their use by protected species (such as badger, bat roosts, dormice habitat, great crested newt habitat) would be damaged during the works.	As part of an update to the ESR at later stage in design process to reduce likelihood of surveys going out-of-date

Topic	Sensitive Receptors	Potential Impact	Management Measures	Time Frame
			Use of precautionary method of working during construction to minimise risk to individual animals of protected species where licences would not be required.	
Geology and Soils	Geology and soils, construction workers and water resources	Contamination, accidental spillage, unforeseen ground conditions and groundwater regime; redesign, programme and cost implications	Best Practice measures in acoordance with CEMP, Eurocode, HD22/08 and HD41/15, to include desk study, ground investigation and geotechnical reporting	Prior to Construction
	Buildings (buried concrete structures)	Damage to the structure due to chemical attack and degradation; redesign, programme and cost implications	Best Practice measures in accordance with, Eurocode, BRE Special Digest 1 HD22/08 and HD41/15, to include desk study, ground investigation and geotechnical reporting	Prior to Construction
Materials and Waste	Material resources.	Use of finite resources.	Designing out Waste (DoW) to ensure locally sourced, recycled and / or recovered materials are used where practicable.	During the development of the design
	Waste treatment and disposal infrastructure.	Increased pressures placed on regional waste treatment and disposal infrastructure.	Implementation of best practice waste management measures e.g. development of an SWMP (‘lite’ and detailed) and if applicable an MMP, designing out waste, setting recovery and reuse targets, promoting offsite construction, materials optimisation, waste efficient procurement, having clearly defined onsite segregation facilities and disposal plans.	Prior to and during construction
Noise and Vibration	Residential receptors (including Noise Important Areas), sensitive land uses (e.g. schools, places of worship), recreational users of footpaths and outdoor space, sensitive habitat and species.	Disturbance from construction phase, aligning roads closer to sensitive receptors, increases to traffic volume, average speed or increased HGV representation in the traffic fleet composition.	Best Practicable Means to minimise construction noise. If required, noise mitigation for the operational phase could include low noise road surfacing, noise barriers, earth bunds, or secondary glazing.	Prior to submitting for approval.

Topic	Sensitive Receptors	Potential Impact	Management Measures	Time Frame
People and Communities	Motorised users of the road NMU of road and off-road routes	Reduced views from the road Change in levels of driver stress Reduction in NMU amenity and journey length	Consideration of landscape screening of the road wherever possible and If required noise mitigation for the operation phase. Use of Best Practice construction methods to reduce disruption to users of facilities within vicinity Agricultural Land Assessment to determine in detail the quality of the agricultural land.	As part of an update to the ESR Prior to submitting for approval
	Users of community facilities Residential Receptors Owners and users of private property Agricultural Land classified as BMV	Community severance Reduction in amentiy to residential receptors Loss of private assets Loss of BMV Agricultural Land		
Road Drainage and the Water Environment	River Ingrebourne	Potential impact to in water quality during construction and through operational discharge Direct morphological changes to the watercourses (such as new culverts or realignments) and changes in drainage patterns	Best Practice Measures in a CEMP A WFD compliance assessment should be conducted The implementation of attenuation and pollution prevention measures in the form of SUDs would mitigate the impacts to the receiving watercourses	During the development of the design
	Weald Brook Other watercourses	Potential impact to in water quality during construction and through operational discharge Direct morphological changes to the watercourses (such as new culverts or realignments) and changes in drainage patterns	A WFD compliance assessment should be conducted The implementation of attenuation and pollution prevention measures in the form of SUDs would mitigate the impacts to the receiving watercourses	
	Secondary A Aquifer	Cuttings, retaining and piling works may affect the flow of groundwater, indirectly affecting surface water features and abstractions which are dependent upon groundwater inputs. The works may introduce new pollutant pathways to the underlying	Areas which may generate contaminated water would be bunded and have water discharged to self contained units with treatment facilities. There would be no discharge to groundwater. Assessment of flood risk and land drainage implications of design for cuttings, retaining and piling works.	

Topic	Sensitive Receptors	Potential Impact	Management Measures	Time Frame
		aquifer and could alter patterns of surface flow and land drainage.		
	Floodplain of Weald Brook and the River Ingrebourne	Increased flood risk as options transverses across flood risk zone The increase in impermeable area would need to be mitigated so as not to increase the risk of surface water flooding	Prepare a FRA once option is decided upon The implementation of attenuation and pollution prevention measures in the form of SUDs would mitigate the impacts to the receiving watercourses	

17 Summary of effects

17.1 Introduction

As this is only the option identification PCF Stage1 of the project process, there is no attempt to make any form of comparative assessment of the options. Therefore, in this conclusion section, the initial findings of the optioneering process for each of the disciplines is presented. Dependent upon the nature of the assessment undertaken, i.e. Simple or Detailed, not all the options within the overall schemes have been assessed individually. Where they have, these are shown, but otherwise, the collective assessment is provided for the overall options' assessment.

17.2 Option 2 – Two lane northern loop

Air quality

The scheme area is located within the Havering AQMA, designated for exceeding the NO_2 annual mean and PM_{10} 24-hour mean AQS objectives and within Brentwood AQMA Nos. 1 and 2, both designated for exceeding the NO_2 annual mean AQS objective. The scheme is expected to lead to an increase in traffic on the proposed link road at Junction 28, which could potentially lead to an increase in pollutant concentrations at receptors near this link road. The option is also expected to lead to a decrease in traffic on the northbound section of the M25 south of Junction 28, and on the eastbound A12, east of Junction 28, which could potentially lead to a decrease in pollutant concentrations at receptors near these roads. There are unlikely to be any significant changes in emissions based on the expected changes in traffic.

Cultural heritage

The construction and operation of Option 2 will not give rise to any significant effects on the cultural heritage resource. The construction and operation of the option would impact on the setting of the Weald Park Registered Park and Garden, Weald Park Conservation Area, South Weald Conservation Area and the listed buildings within the village of South Weald, which would result in temporary and permanent slight adverse effects. The option would also impact on the setting of a small area of non-designated historic woodland, which would result in a permanent slight adverse effect. There is the potential for impacts on unknown buried archaeology as a result of its truncation or removal.

Landscape

Significant landscape effects were identified for Option 2 both during construction and operational stage. Large scale construction activities would alter the key characteristic of the local landscape character as large areas of compounds would be required and construction activities would create a localised new landscape pattern. During operational stage the Proposed Scheme could be partially integrated into the existing landscape, but still would be judged adverse at the local level.

The majority of identified visual receptors would be affected significantly during construction stage due to the scale of operations. Whilst some elements of the Proposed Scheme would be blended into the existing landscape in the operational stage, a number of visual receptors would perceive a noticeable deterioration to their views.

Nature conservation

Option 2 will involve direct impacts to Ingrebourne Valley SMI and Lower Vicarage Wood LWS, including loss of habitat. Direct loss of habitat from Ingrebourne Valley SMI would have a significant effects on the conservation status of this designated site at the Metropolitan level. Loss of habitat from Lower Vicarage Wood LWS would have a significant effect on the conservation status of at the County level. Effects on notable (non-designated) habitats or species are not considered to have an effect above the Local level.

Geology and Soils

The anticipated geology and soils present within the proposed route for Option 2 comprise Landfill Material, Made Ground, superficial Alluvium and Head Deposits and solid geology of London Clay Formation, including Claygate Member in the southern portion of the site. There is potential for impacts to: the scheme associated with ground conditions that may be encountered; and human and/or controlled waters receptors associated with potential sources of contamination within or in proximity to the proposed route, including localised deposits of Made Ground, Brook Street Landfill and other potentially contaminative land uses, such as where the option intersects the railway line and an MOT centre.

Materials and Waste

At this stage of the design process no information on the use of materials or generation of waste associated with the proposed options is currently available. However, it is assumed that proposed options which cover the greatest area (physical extent) will require the greatest amount of demolition works, have the greatest volume of earthworks (excavation works), and will require the greatest volume of construction materials, thus have the potential to produce more waste. A summary of the key effects associated with Option 2 are summarised below:

- Potential excess material use / waste generation if wastes are not reused / recycled where practicable;
- Potential for the disposal of large quantities of excavated materials, if the materials are found to be hazardous and thus not suitable for reuse (for further details see the ‘Geology and Soils’ chapter in Section 5.9);
- Potential for enhanced quantities of demolition waste airings associated with the demolition of the existing Nags Head Lane Overbridge;
- Increased excavation waste arising due to the underpass beneath the railway line / M25; and
- Increased construction waste arisings associated with the construction / extension of bridge(s).

Noise and vibration

The main construction activities that are likely to take place are site preparation, demolition, earthworks, retaining wall construction and road works. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. Where it is required to close the motorway to undertake the works (e.g. new viaducts passing over live carriageways or railways) the potential for adverse noise impacts at night is very high. This would also be coupled with the wider impacts of re-routed traffic during the night-time. The particular construction activities associated with Option 2 that have the greatest potential to cause disturbance are as follows:

- Construction of a new merge lane to the A12 eastbound (east of Junction 28) has the potential to adversely affect the residential area to the south of A12 in Brentwood.
- Realignment of Nag's Head Lane has the potential to adversely affect receptors on Nag's Head Lane.
- New diverge lane to west of M25N has the potential to adversely affect properties on Nag's Head Lane, requiring demolition of the existing Nag's Head Lane Bridge and construction of a significant retaining wall close to properties.
- Extending Wigley Bush Lane overbridge has the potential to adversely affect a cluster of properties immediately to the southeast.
- Construction of a loop to the north-west of the existing junction has the potential to adversely affect Maylands Golf Course and Grove Farm.
- Realignment of Weald Park Way has the potential to adversely affect properties on Weald Park Way.
- Extending the footbridge from Weald Park Way to Spital Lane has the potential to adversely affect properties in the vicinity.

In the operational phase, Option 2 may give rise to increases in noise at Nag's Head Lane (west of M25), Putwell Bridge Farm and Grove Farm in the Opening Year and the Design Year due to the new diverge from the M25N to the A12 eastbound. A minor decrease in noise is predicted on the east bound on slip from the circulatory to the A12 in the area of Lower Vicarage Wood. Option 2 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5752 around River Road and 5751 around Selwood Road.

People and Communities

The construction and operation of Option 2 is likely to have a similar significant effect on all types of receptors as Option 1 with a similar level of magnitude. The construction and operation of the option would impact on the NMUs and Residential receptors identified which would result in temporary and permanent adverse effects ranging from negligible to major adverse. However, identified NMU are only likely to be negligibly effected on operation. It is likely small parts of private property linked to the residential receptors will be required. The impact on motorised travellers views from the road will depend on the design of the bridges and embankments but is likely to create new visual intrusions due to the amount of roads in view from, and crossed.

Road drainage and the water environment

Option 2 ranked 6 out of 7, with 7 being the most environmentally damaging for the water environment based on the five new watercourse crossings, one over the River Ingrebourne. As per option 1, option 2 would also traverse the flood risk zone from this River. Providing adherence to best practice mitigation during the construction period, there should be no significant effects to the water environment. During operation there would be potential impacts to water quality from discharge of polluting runoff and potential direct morphological changes to the River Ingrebourne and the other four watercourse crossings.

17.3 Option 4 – Two lane compact northern loop

Air quality

The scheme area is located within the Havering AQMA, designated for exceeding the NO_2 annual mean and PM_{10} 24-hour mean AQS objectives and within Brentwood AQMA Nos. 1 and 2, both designated for exceeding the NO_2 annual mean AQS objective. The scheme is expected to lead to an increase in traffic on the proposed link road at Junction 28, which could potentially lead to an increase in pollutant concentrations at receptors near this link road. The scheme is also expected to lead to a decrease in traffic on the northbound off slip from the M25 south of Junction 28, and on the eastbound on slip onto the A12, east of Junction 28, which could potentially lead to a decrease in pollutant concentrations at receptors near these roads. There are unlikely to be any significant changes in emissions based on the expected changes in traffic.

Cultural heritage

The construction and operation of Option 4 will not give rise to any significant effects on the cultural heritage resource. The construction and operation of the option would impact on the setting of the Weald Park Registered Park and Garden, Weald Park Conservation Area, South Weald Conservation Area and the listed buildings within the village of South Weald, which would result in temporary and permanent slight adverse effects. The option would also impact on the setting of a small area of non-designated historic woodland, which would result in a permanent slight adverse effect. There is the potential for impacts on unknown buried archaeology as a result of its truncation or removal.

Landscape

Significant landscape effects are expected for Option 4 both in the construction and operational stage. During construction stage a loss of vegetation including trees is expected, where the new route is proposed. Large scale construction operations associated with the proposed viaduct would require introduction of considerable earthworks and large compound areas which combined with the construction machinery activity would create a temporary but adverse alteration to the local landscape character. The scheme could be integrated into the existing landscape partially in the operational stage, however overall significant landscape effects are also expected at this stage due to the scale of change.

Option 4 would require prominent and large scale construction operations. Some of the introduced elements of the Proposed Scheme, such as the viaduct over the existing junction, would result in a noticeable deterioration to the existing views also in operational stage. Therefore some visual receptors would be affected significantly both in construction and operational stage.

Nature conservation

Option 4 will involve direct impacts to Lower Vicarage Wood LWS, including loss of habitat. Loss of habitat from Lower Vicarage Wood LWS would have a significant effect on the conservation status of at the County level. Effects on notable (non-designated) habitats or species are not considered to have an effect above the Local level.

Geology and Soils

The anticipated geology and soils present within the proposed route for Option 4 comprise Made Ground, superficial Alluvium and Head Deposits and solid geology of London Clay Formation, including Claygate Member in the southern portion of the site.

There is potential for impacts to: the scheme associated with ground conditions that may be encountered; and human and/or controlled waters receptors associated with potential sources of contamination within or in proximity to the proposed route, such as localised deposits of Made Ground, the railway line which this option involves tunnelling beneath, and an MOT centre.

Materials and Waste

At this stage of the design process no information on the use of materials or generation of waste associated with the proposed options is currently available. However, it is assumed that proposed options which cover the greatest area (physical extent) will require the greatest amount of demolition works, have the greatest volume of earthworks (excavation works), and will require the greatest volume of construction materials, thus have the potential to produce more waste. A summary of the key effects associated with Option 4 are summarised below:

- Potential excess material use / waste generation if wastes are not reused / recycled where practicable;
- Potential for the disposal of large quantities of excavated materials, if the materials are found to be hazardous and thus not suitable for reuse (for further details see the 'Geology and Soils' chapter in Section 5.9);
- Potential for enhanced quantities of demolition waste airings associated with the demolition of the existing Nags Head Lane Overbridge;
- Increased waste arisings associated with the construction / widening of viaducts;
- Increased excavation waste arising due to the underpass beneath the railway line / M25; and
- Increased construction waste arisings associated with the construction / extension of bridge(s).

Noise and Vibration

The main construction activities that are likely to take place are site preparation, demolition, earthworks, retaining wall construction and road works. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. Where it is required to close the motorway to undertake the works (e.g. new viaducts passing over live carriageways or railways) the potential for adverse noise impacts at night is very high. This would also be coupled with the wider impacts of re-routed traffic during the night-time. The particular construction activities associated with Option 4 that have the greatest potential to cause disturbance are as follows:

- Construction of a new merge lane to the A12 eastbound (east of Junction 28) has the potential to adversely affect the residential area to the south of A12 in Brentwood.
- Realignment of Nag's Head Lane has the potential to adversely affect receptors on Nag's Head Lane.
- New diverge lane to west of M25N has the potential to adversely affect properties on Nag's Head Lane, requiring demolition of the existing Nag's Head Lane bridge and construction of a significant retaining wall close to properties.
- Construction of new viaducts over the existing Junction 28 has the potential to adversely affect isolated properties close to the junction.

- Extending Wigley Bush Lane overbridge has the potential to adversely affect a cluster of properties immediately to the southeast.
- Realignment of Weald Park Way has the potential to adversely affect properties on Weald Park Way.
- Extending the footbridge from Weald Park Way to Spital Lane has the potential to adversely affect properties in the vicinity.

In the operational phase, Option 4 is likely to give rise to noise increases in Lower Vicarage Wood in the Opening Year and the Design Year. A minor decrease in noise on the east bound on slip to the A12 is predicted in the Opening Year. Negligible changes to noise are predicted on the A12 and M25 road links unaltered by Option 4. There is the potential for increases at Nag's Head Lane (west of M25) due to the new diverge in this location.

Option 4 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road.

People and Communities

The construction and operation of Option 4 is likely to have a similar significant effect on all types of receptors as the first two Options however the level of magnitude on amenity is likely to be less due to a smaller footprint than option 2. The construction and operation of the option would impact on the NMUs and Residential receptors identified which would result in temporary and permanent adverse effects ranging from negligible to major adverse. However, identified NMU are only likely to be negligibly effected on operation. It is likely small parts of private property linked to the residential receptors will be required. The impact on motorised travellers views from the road will depend on the design of the bridges and embankments but is likely to create new visual intrusions due to the amount of roads in view from, and crossed.

Road drainage and the water environment

Option 4 ranked 2 out of 7, with 7 being the most environmentally damaging for the water environment based on the four new watercourse crossings and would also traverse the flood risk zones. Providing adherence to best practice mitigation during the construction period, there should be no significant effects to the water environment. During operation there would be potential impacts to water quality from discharge of polluting runoff and potential direct morphological changes to four water course crossings.

17.4 Option 5A, 5B and 5C - Single lane cloverleaf variants

Air quality

The scheme area is located within the Havering AQMA, designated for exceeding the NO_2 annual mean and PM_{10} 24-hour mean AQS objectives and within Brentwood AQMA Nos. 1 and 2, both designated for exceeding the NO_2 annual mean AQS objective. The scheme is expected to lead to an increase in traffic on a number of roads in the vicinity of Junction 28, which could potentially lead to an increase in pollutant concentrations at receptors near the affected road network, including those within the Havering AQMA and within Brentwood AQMA Nos. 1 and 2. The scheme is also expected to lead to a decrease in traffic on the northbound off slip from the M25 south of Junction 28, and on the southbound off slip from the M25 north of Junction 28, which could potentially lead to a decrease in pollutant concentrations at receptors near

these roads. The scheme is likely to lead to an increase in emissions based on the expected increases in traffic.

Cultural heritage

The construction and operation of Option 5A, 5B and 5C will not give rise to any significant effects on the cultural heritage resource. Option 5A would impact on the setting of a small area of non-designated historic woodland, which would result in a permanent slight adverse effect. Option 5B would not impact on any heritage assets. There is the potential for impacts on unknown buried archaeology as a result of its truncation or removal.

Landscape

No significant landscape effects were identified for option 5A. As relatively small scale construction activities are expected for Option 5A, the landscape effects would not be significant. The elements of the Proposed Scheme would also not alter significantly local landscape character in the operational stage. Some visual receptors would be significantly affected during construction stage, however only few receptors are predicted to be affected significantly during operational stage as the proposed planting would mature to integrate the Proposed Scheme into the existing landscape.

No significant landscape effects were identified for Option 5B. As relatively small scale construction activities are expected for Option 5B, the landscape effects would not be significant. The introduced elements of the Proposed Scheme would not significantly alter the local landscape character in the operational stage. In considering visual receptors, only Grove Farm would be affected significantly both in construction and operational stage.

No significant landscape effects were identified for Option 5C. As relatively small scale construction activities are expected for Option 5C, the landscape effects would not be significant. The elements of the proposed options would also not alter significantly local landscape character in the operational stage. In considering visual receptors only Grove Farm would be affected significantly both in the construction and operational stage.

Nature conservation

Options 5A, 5B and 5C will involve direct impacts to Ingrebourne Valley SMI, including realignment of the stream between Grove Farm and the A12. Direct loss of habitat from Ingrebourne Valley SMI would have a significant effects on the conservation status of this designated site at the Metropolitan level. Effects on notable (non-designated) habitats or species are not considered to have an effect above the Local level.

Geology and Soils

The anticipated geology and soils present within the proposed routes for Options 5A, 5B and 5C comprise Landfill Material, Made Ground, superficial Alluvium and Head Deposits and solid geology of London Clay Formation, including Claygate Member in the southern portion of the site. There is potential for impacts to: the scheme associated with ground conditions that may be encountered; and human and/or controlled waters receptors associated with potential sources of contamination within or in proximity to the proposed routes, including localised deposits of Made Ground, Brook Street Landfill and other potentially contaminative land uses such as the sewage treatment works to the south-west of Junction 28 and an MOT centre (Option 5A only).

Materials and Waste

At this stage of the design process no information on the use of materials or generation of waste associated with the proposed options is currently available. However, it is assumed that proposed options which cover the greatest area (physical extent) will require the greatest amount of demolition works, have the greatest volume of earthworks (excavation works), and will require the greatest volume of construction materials, thus have the potential to produce more waste. A summary of the key effects associated with options 5A, 5B and 5C designs are summarised below:

- Potential excess material use / waste generation if wastes are not reused / recycled where practicable;
- Potential for the disposal of large quantities of excavated materials, if the materials are found to be hazardous and thus not suitable for reuse (for further details see the 'Geology and Soils' chapter in Section 5.9);
- Potential for enhanced quantities of demolition waste airings associated with the demolition of the existing Nags Head Lane Overbridge (Option 5A only);
- Increased waste arisings associated with the construction / widening of viaducts (Option 5A and 5B);
- Increased excavation waste arising due to the underpass beneath the railway line / M25 (Option 5A only); and
- Increased construction waste arisings associated with the construction / extension of bridge(s); and
- Increased construction waste arisings associated with the construction of watercourse realignments.

Noise and vibration

The main construction activities that are likely to take place are site preparation, demolition, earthworks, retaining wall construction and road works. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. Where it is required to close the motorway to undertake the works (e.g. new viaducts passing over live carriageways or railways) the potential for adverse noise impacts at night is very high. This would also be coupled with the wider impacts of re-routed traffic during the night-time. The particular construction activities associated with Options 5A, 5B and 5C that have the greatest potential to cause disturbance are as follows:

- Realignment of Nag's Head Lane has the potential to adversely affect receptors on Nag's Head Lane (Option 5A).
- New diverge lane to west of M25N has the potential to adversely affect properties on Nag's Head Lane, requiring demolition of the existing Nag's Head Lane bridge and construction of a significant retaining wall close to properties (Option 5A).
- Construction of new viaducts over the existing Junction 28 has the potential to adversely affect isolated properties close to the junction (Options 5A and 5B).
- Construction of a loop to the north-west of the existing junction has the potential to adversely affect Maylands Golf Course and Grove Farm (Options 5A, 5B, 5C).

In the operational phase, all sub-options are likely to give rise to increases at Grove Farm. Traffic data for Option 5B shows that a moderate increase in basic noise level

on the A12 eastbound through the junction is likely in the Opening Year and Design Year; however this is unlikely to have an effect at any receptors.

Option 5A would additionally involve the realignment of Nag's Head Lane taking it away from the housing along this route which may cause some reductions in noise levels where not already dominated by noise from the M25.

Option 5B and 5C have the potential to negatively impact on Noise Important Area 5750 at Junction 28 whilst Option 5A has the potential to additionally impact negatively upon noise Important Area 5749 adjacent to Nag's Head Lane.

People and Communities

The construction and operation of these sub options is likely to have a similar significant effect on all types of receptors as other options however the level of magnitude is likely to be less due to a smaller footprint of the loop. The construction and operation of the option would impact on less NMUs and Residential receptors than the previous three options which would result in temporary and permanent adverse effects ranging from negligible to major adverse with Option 5A ranging from negligible to moderate. However, identified NMU are only likely to be negligibly effected on operation. It is likely small parts of private property linked to Grove Farm will be required. The impact on motorised travellers views from the road will depend on the design of the bridges and embankments but is likely to create new visual intrusions, however this should be less than the first three options and decrease through the sub options.

Road drainage and the water environment

Option 5A is ranked 4 out of 7, option 5B is ranked 3 out of 7 and option 5C is ranked 5 out of 7 with 7 being the most environmentally damaging for the water environment. This is based on the following:

Option 5A would cross four new watercourse, including the River Ingrebourne and Weald Brook

Option 5B would cross two new watercourses including the River Ingrebourne and Weald Brook

Option 5C would cross five new watercourses, crossing Weald Brook in three locations.

All options would also traverse the flood risk zones. Providing adherence to best practice mitigation during the construction period, there should be no significant effects to the water environment. During operation there would be potential impacts to water quality from discharge of polluting runoff and potential direct morphological changes to the water course crossings.

17.5 Option 5D and 5E - Two lane cloverleaf

Air quality

The scheme area is located within the Havering AQMA, designated for exceeding the NO_2 annual mean and PM_{10} 24-hour mean AQS objectives and within Brentwood AQMA Nos. 1 and 2, both designated for exceeding the NO_2 annual mean AQS objective. The scheme is expected to lead to an increase in traffic on a number of roads in the vicinity of Junction 28, which could potentially lead to an increase in pollutant concentrations at receptors near the affected road network, including those within the Havering AQMA and within Brentwood AQMA Nos. 1 and 2. The scheme is also expected to lead to a decrease in traffic on the northbound off slip from the M25

south of Junction 28, and on the southbound off slip from the M25 north of Junction 28, which could potentially lead to a decrease in pollutant concentrations at receptors near these roads. The scheme is likely to lead to an increase in emissions based on the expected increases in traffic.

Cultural heritage

The construction and operation of Options 5D and 5E will not give rise to any significant effects on the cultural heritage resource. The construction and operation of the option would impact on the setting of the Weald Park Registered Park and Garden, Weald Park Conservation Area, South Weald Conservation Area and the listed buildings within the village of South Weald, which would result in temporary and permanent slight adverse effects. There is the potential for impacts on unknown buried archaeology as a result of its truncation or removal.

Landscape

Significant landscape effects were identified during both construction and operational stage for Option 5D. This is due to partial alteration to the local landscape character as landform, landscape pattern and land use would be altered in the construction stage. Whilst the scheme would partially blend into the existing landscape during operational stage, new features of the Proposed Scheme would become prominent in the operational stage resulting in significant landscape effects. Significant visual effects are expected during construction stage due to their scale for some receptors. Fewer visual receptors would be affected significantly in operational stage as parts of the scheme would be accommodated within the existing landscape through the maturing vegetation.

Significant landscape effects were identified during both construction and operational stage for Option 5E. This is due to partial alteration to the local landscape character as landform, landscape pattern and land use would be altered in the construction stage. Whilst the scheme would partially blend into the existing landscape during operational stage, new features of the Proposed Scheme would become prominent in operational stage resulting in significant landscape effects. Significant visual effects are expected during construction stage due their scale for some identified receptors. Fewer visual receptors would be affected significantly in operational stage as parts of the scheme would be accommodated within the existing landscape through the maturing vegetation.

Nature conservation

Options 5D and 5E will involve direct impacts to Ingrebourne Valley SMI (including realignment of the river where it is culverted under the new loop road), The Oaks LWS and Lower Vicarage Wood LWS. Direct loss of habitat from Ingrebourne Valley SMI would have a significant effects on the conservation status of this designated site at the Metropolitan level. Loss of habitat from The Oaks LWS and Lower Vicarage Wood LWS would have a significant effect on the conservation status of at the County level. Effects on notable (non-designated) habitats or species are not considered to have an effect above the Local level.

Geology and Soils

The anticipated geology and soils present within the proposed routes for Options 5D and 5E comprise Landfill Material, Made Ground, superficial Alluvium and Head Deposits and solid geology of London Clay Formation. There is potential for impacts to: the scheme associated with ground conditions that may be encountered; and human and/or controlled waters receptors associated with potential sources of

contamination within or in proximity to the proposed routes, including localised deposits of Made Ground and Brook Street Landfill.

Materials and Waste

At this stage of the design process no information on the use of materials or generation of waste associated with the proposed options is currently available. However, it is assumed that proposed options which cover the greatest area (physical extent) will require the greatest amount of demolition works, have the greatest volume of earthworks (excavation works), and will require the greatest volume of construction materials, thus have the potential to produce more waste. A summary of the key effects associated with options 5D and 5E are summarised below:

- Potential excess material use / waste generation if wastes are not reused / recycled where practicable;
- Potential for the disposal of large quantities of excavated materials, if the materials are found to be hazardous and thus not suitable for reuse (for further details see the 'Geology and Soils' chapter in Section 5.9);
- Increased waste arisings associated with the construction / widening of viaducts (Option 5D only);
- Increased excavation waste arising due to the underpass beneath the railway line / M25 (Option 5E only); and
- Increased construction waste arisings associated with the construction / extension of bridge(s).

Noise and vibration

The main construction activities that are likely to take place are site preparation, demolition, earthworks, retaining wall construction and road works. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. Where it is required to close the motorway to undertake the works (e.g. new viaducts passing over live carriageways or railways) the potential for adverse noise impacts at night is very high. This would also be coupled with the wider impacts of re-routed traffic during the night-time. The particular construction activities associated with Options 5D and 5E that have the greatest potential to cause disturbance are as follows:

- Construction of a new merge lane to the A12 eastbound (east of Junction 28), potentially causing an adverse effect at the residential area to the south of A12 in Brentwood.
- Extending Wigley Bush Lane overbridge has the potential to adversely affect a cluster of properties immediately to the southeast.
- Construction of a loop to the north-west of the existing junction has the potential to adversely affect Maylands Golf Course and Grove Farm.

In the operational phase, both sub-options are likely to give rise to noise increases at Alder Wood and Maylands Golf Course as well as at Lower Vicarage Wood. Increases are also possible at Grove Farm. The traffic predictions for Option 5D show that a minor increase in basic noise level is predicted for the A12 in both directions in the Opening Year, with negligible changes to the basic noise level predicted in the Design Year. Both sub-options have the potential to negatively impact on Noise Important Areas 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road.

People and Communities

The construction and operation of options 5D and 5E is likely to have a similar significant on receptors however the amount of receptors affected by these sub options is likely to be the least of all the options proposed for Junction 28. The construction and operation of the option would impact on least amount of NMUs and Residential receptors than the previous options which would result in temporary and permanent adverse effects ranging from negligible to moderate adverse. However, identified NMU are only likely to be negligibly effected on operation. It is likely small parts of private property linked to Grove Farm and French's Farm will be required. The impact on motorised travellers views from the road will depend on the design of the bridges or underpass and earthworks but is likely to create new visual intrusions, however this should be less than the first three options and decrease through the sub options.

Road drainage and the water environment

Both options 5D and 5E are the most environmentally damaging for the water environment based on five new watercourse crossings and would also traverse the flood risk zones. Providing adherence to best practice mitigation during the construction period, there should be no significant effects to the water environment. During operation there would be potential impacts to water quality from discharge of polluting runoff and potential direct morphological changes to five water course crossings.

17.6 Option 6 – Two lane southern link

Air quality

The scheme area is located within the Havering AQMA, designated for exceeding the NO_2 annual mean and PM_{10} 24-hour mean AQS objectives and within Brentwood AQMA Nos. 1 and 2, both designated for exceeding the NO_2 annual mean AQS objective. The scheme is expected to lead to an increase in traffic on a number of roads in the vicinity of Junction 28, which could potentially lead to an increase in pollutant concentrations at receptors near the affected road network, including those within the Havering AQMA and within Brentwood AQMA Nos. 1, 2, 3 and 4.The scheme is also likely to lead to an increase in emissions, based on the expected increases in traffic.

Cultural heritage

The construction and operation this option will not give rise to any significant effects on the cultural heritage resource. The construction and operation of the option would impact on the setting of the Grade II listed Nag's Head Inn, which would result in temporary and permanent minor adverse effects. The option would also result in the removal of a small area of non-designated historic woodland, which would result in a permanent neutral effect. There is the potential for impacts on unknown buried archaeology as a result of its truncation or removal.

Landscape

Significant effects have been identified for landscape receptors as a result of Option 6 during the construction stage and for some visual receptors both for both construction and operational stage. During construction stage a considerable loss of vegetation is expected along the A10 and A12 roads with some alterations to the existing landform as new cuttings and earthworks would be required. During operational stage implemented environmental measures are likely to integrate the scheme into the existing landscape and introduction of the viaduct is a better option in landscape

terms, as the existing landscape pattern, vegetation and land use under the viaduct would only be affected slightly.

Some visual receptors would be affected significantly due to the large scale of construction activities at the construction stage. The large scale of the viaduct would result in significant effects for some visual receptors in the operational stage as existing views would be altered considerably.

Nature conservation

There are no effects on designated sites or ancient woodland. Effects on notable (non-designated) habitats or species are not considered to have an effect above the Local level.

Geology and Soils

The anticipated geology and soils present within Option 6 comprise Made Ground, superficial Head Deposits and solid geology of London Clay Formation, including Claygate Member in the southern portion of the site. There is potential for impacts to: the scheme associated with ground conditions that may be encountered; and to human and/or controlled waters receptors associated with potential sources of contamination within or in proximity to the proposed route, such as localised deposits of Made Ground along the proposed road route and the railway line, and other potentially contaminative land uses, including a service and repair garage, associated tanks, petrol filling stations and electricity sub-stations.

Materials and Waste

At this stage of the design process no information on the use of materials or generation of waste associated with the proposed options is currently available. However, it is assumed that proposed options which cover the greatest area (physical extent) will require the greatest amount of demolition works, have the greatest volume of earthworks (excavation works), and will require the greatest volume of construction materials, thus have the potential to produce more waste. A summary of the key effects associated with Option 6 are summarised below:

- Potential excess material use / waste generation if wastes are not reused / recycled where practicable;
- Potential for the disposal of large quantities of excavated materials, if the materials are found to be hazardous and thus not suitable for reuse (for further details see the ‘Geology and Soils’ chapter in Section 5.9);
- Increased waste arisings associated with the construction / widening of viaducts;
- Increased construction waste arisings associated with the construction / extension of bridge(s).

Noise and Vibration

The main construction activities that are likely to take place are site preparation, demolition, earthworks, retaining wall construction and road works. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. Where it is required to close the motorway to undertake the works (e.g. new viaducts passing over live carriageways or railways) the potential for adverse noise impacts at night is very high. This would also be coupled with the wider impacts of re-routed traffic during the night-time. The particular construction activities associated with Option 6 that have the greatest potential to cause disturbance are as follows:

- Construction of a new viaduct spanning Nag's Head Lane, the M25 and the railway has the potential to have an adverse noise and vibration impact on properties on Nag's Head Lane.
- Construction of the new slip road on embankment to the southeast of The Poplars has the potential to have adverse noise and vibration impacts on The Poplars.
- Construction of a new viaduct over the A12 to the east of Junction 28 has the potential to adversely affect properties to the south of the A12 in Brentwood.
- Construction of a new merge lane to the A12 eastbound (east of Junction 28) has the potential to adversely affect the residential area to the south of A12 in Brentwood.
- Realignment of Weald Park Way has the potential to adversely affect properties on Weald Park Way.
- Extending the footbridge from Weald Park Way to Spital Lane has the potential to adversely affect properties in the vicinity.

In the operational phase, there is the potential for noise increases at properties close to the new slip road, including to the west of the M25 on Nag's Head Lane. At The Poplars there is the potential for an increase affecting the south east façade of the building. Potential increases in these areas were predicted in the Opening Year and the Design Year for this option.

A minor increase is predicted for the A12 in both directions in the Opening Year and a negligible change is predicted for the same road links in the Design Year.

Option 6 has the potential to negatively impact on Noise Important Areas 5749 adjacent to Nag's Head Lane, 5750 at Junction 28, 5752 around River Road and 5751 around Selwood Road.

People and Communities

The construction and operation of Option 6 is likely to have the most significant effect on all types of receptors out of all the options proposed. The construction and operation of the option would impact on the NMUs and Residential receptors identified which would result in temporary and permanent adverse effects ranging from negligible to major adverse. However, identified NMU are only likely to be negligibly effected on operation. It is likely small parts of private property linked to the residential receptors will be required. The option would also require a commercial property (Brentwood Garden Centre) for land take resulting in a loss of that business. The impact on motorised travellers views from the road will depend on the design of the viaduct structure but is likely to create new visual intrusions due to the amount of roads crossed.

Road drainage and the water environment

Option 6 is the least environmentally damaging for the water environment based on the limited number of watercourse crossings. The option however, would involve a new crossing over the River Ingrebourne and would traverse the flood risk zone from this river. Providing adherence to best practice mitigation during the construction period, there should be no significant effects to the water environment. During operation there would be potential impacts to water quality from discharge of polluting runoff and potential direct morphological changes to the River Ingrebourne.

Appendix A: Location Plan

Appendix B: Environmental Constraints Plan

Appendix C: Scheme Layout Plans

Appendix D: Landscape Appendices

Appendix E: Heritage Assessment Appendices

Appendix F: Ecological Legislation

Appendix G: Air Quality Assessment Appendices

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Appendix H: Water Environment Assessment Appendices

Appendix I: Enviro check report

Appendix J: Geology Figures

Appendix K: People and Communities Assessment Appendices

Appendix L: Noise and Vibration